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MOBILE HEALTH OPTIONS FOR DEPRESSION: EMPOWERING THE PATIENT AND THE PRACTITIONER

REPORT:

AN INTEGRATED ANALYSIS OF THE MEDICAL AND INFORMATION SYSTEMS FEASIBILITY OF AN
M-HEALTH APPLICATION FOR MILD TO MODERATE DEPRESSION MONITORING AND
TREATMENT IN THE SOUTH AFRICAN CONTEXT.

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ABBREVIATIONS AND ACRONYMS

Acfee	African Centre for eHealth Excellence
API	Application Programming Interface
CBT	Cognitive Behavioural Therapy
i-CBT	Internet-Cognitive Behavioural Therapy
c-CBT	Computerised Cognitive Behaviour Therapy
CHW	Community Health Worker
CMD	Common Mental Disorder
DHIS	District Health Information System
EMA	Ecological Momentary Assessment
eHNA	eHealth News Africa
EHR	Electronic Health Record
GP	General Practitioner
GPS	Global Positioning Systems
GUI	Graphical User Interface
HCP	Health Care Provider
HIS	Health Information Systems
HIV/AIDS	Human Immunodeficiency Virus and Acquired Immunodeficiency Syndrome

HNSF	National Health Normative Standards Framework for eHealth in South Africa
HTML	
ICT	Information and communication technologies
ID	Identity
IHE	Integrating the Health Enterprise
IM	Instant Messaging
IS	Information System(s)
IT	Information Technology
MHCU	Mental Health Care User
MRC	Medical Research Council
NGO	Non-Governmental Organisation
NPO	Non-Profit Organisation
NHI	National Health Insurance
NHIS/SA	National Health Information System of South Africa
NDoH	National Department of Health
OS	Operating System
PHC	Primary Health Care
PHQ-9	Patient Health Questionnaire-9
PMI	Patient Master Index
PPP	Public-Private Partnership
RCT	Randomly Controlled Trial
SA	South Africa
SMS	Short Message Service
SOA	Service-Oriented Architecture
SSI	Semi-Structured Interview
Sysadmin	System Administrator
TAM	Technology Acceptance Model
TB	Tuberculosis
TOE	Technology-Organisational-Environment framework
UCT	University of Cape Town
USSD	Unstructured Supplementary Service Data
UTAUT(2)	Unified Theory of Acceptance and Use of Technology(2)
UXD	User Experience Design

1 ABSTRACT

Mental health issues in Africa, such as depression, have taken a backseat to more visible diseases such as AIDS and malaria. However, the prevalence and impact of depression is significant and increasing. Access to quality public mental healthcare is limited and mHealth poses a possible and exciting channel to potentially manage or treat depression. This research first surveyed the literature to identify core requirements and then the mobile app market place to see what existing solutions offer. Crucially, it seems that no applications exist to link patients and healthcare providers within the healthcare system, integrating multiple stakeholders across the levels of care in the context of South Africa's eHealth system. The research aims to fill this gap by providing a proposed set of requirements for a depression mHealth solution based on the literature and market review, but expanded and contextualized through the input from interviews with a panel of experts. Hopefully, the resulting specifications will facilitate in designing an effective mHealth intervention which is appropriate to the South African context.

2 INTRODUCTION

2.1 RESEARCH INTEREST

From personal experience and observing fellow students, the author's attention was drawn to the pervasiveness of depression on the population. A personal desire to monitor and track moods and physiological variables, while journalising daily experience resulted in the conceptualisation of a mobile application ("app") to facilitate these functions, as well as ways to send relevant data collected to personal health care professionals. As a medical student, the author proceeded to consider ways to integrate such an intervention into the health system.

With mobile phones being almost ubiquitous in modern society, mobile health interventions ("mHealth") empower the mental health care user (MHCU) to monitor their own wellbeing.

In this paper, the broader term MHCU is used in favour of "patient" when referring to individuals who may potentially make use of the supportive aspects of the system outlined in this paper, as the term "patient" implies a level of severity that requires formal treatment at a health care facility, whereas an MHCU may desire the extra support (e.g. for additional "coping skills" offered by the programme, but may not consider themselves as mental health care patients.

Not only could an mHealth intervention increase access to rudimentary health services, which is vital in a health system characterised by inequitable distribution of health services, but by remotely connecting the patient to their health team or the health system, mHealth can aid in long-distance monitoring, potentially reducing the need to physically access services, reducing the burden on the health system as well as benefiting the patient by reducing health care costs and the inconvenience (often extreme and costly in rural areas) of visiting clinics.

mHealth has the potential to build up the health system's technological framework – or eHealth – by introducing computerised interventions and electronic information systems into daily practice. This has the potential to reduce reliance on paper-based systems which are often inefficient and wasteful, and result in lost information or redundant duplication of information as a patient moves through referral networks. Computerised data can facilitate epidemiological research and allow for patient tracking.

The potential benefits of mHealth described above were used as justifiable base for the development of this study.

2.2 PURPOSE OF THE STUDY

The aim of the study is to gain an understanding of how an mHealth application for depression can be developed for the South African context and to consolidate health care and technological aspects of designing an mHealth intervention for depression to provide a backbone for future development of such interventions.

2.3 DEFINING THE RESEARCH QUESTIONS

1. What are the needs of patients within the mental health system with respect to mHealth interventions for depression?

2. What programmes are available internationally and locally? What are the gaps in the depression mHealth market? Is another programme justified?
3. How efficacious are mHealth interventions for depression?
4. What costs are involved in developing an app and how can funding be attained?
5. What programmes/functions could/should an app aimed at sufferers of depression include and what should be involved in the selection process?
6. How can an intervention be integrated into the health system?
7. How is a health intervention rolled out to reach as many people as possible?
8. If the programme is to connect mental health care users with health care practitioners, who exactly will use the system and how will they communicate using it?
9. What are the risks involved in such an intervention?
10. What are the necessary components to consider when designing and programming an app and who should be involved?
11. What determines how acceptable the programme will be to users?

3 LIT REVIEW

3.1 INTRODUCTION

An estimated 16.5% of South Africans suffer from major depressive disorder (MDD) and other common mood disorders (CMDs) per year. 75% or more of these cases are untreated. (1) Hundreds of mobile applications (“apps”) on online marketplaces are offering depression-specific screening, monitoring and treatment solutions (2,3), that are cheap accessible and convenient in modern life. Online sources estimate smartphone penetration in South Africa in 2015 is between 36 and 47% (4,5) suggesting that use of apps for promoting wellbeing through mHealth interventions is becoming a real possibility. However, mHealth fits into a broader eHealth framework. So while this overview of the literature intends to look at the current state of mental health and mental health care in South Africa, focusing on mild to moderate depression, as well as research conducted on mobile and computerised interventions for depression, the state of the eHealth and mHealth fields in South Africa is also examined. Current mHealth and eHealth initiatives are outlined as well as organisations and frameworks that support development, providing a base to explore the feasibility of an m- and eHealth intervention for MDD.

3.2 MENTAL HEALTH IN SOUTH AFRICA: PROVIDING CARE FOR DEPRESSION

After the Apartheid era, South Africa’s health system continued to be fragmented and inequitable – especially on race-based measures; public mental health care was particularly under-resourced (considering the relative burden of disease (6)) and resources were concentrated in large specialist facilities in urban areas, serving a select few suffering from chronic severe mental disorders through institutionalised care. (7) In 2002, the Mental Health Care Act No 17 sought to address this by calling for decentralisation, requiring a 72-hour observation period in regional facilities before referral to tertiary institutions to provide mental health services more locally and prevent needless referrals. (2)

However, Peterson and Lund (1) note in their keystone 2011 review that although there has been a reduction of resources in centralised institutions, there is an insufficient concomitant growth of community-based and primary/secondary care. Because of a lack of resources and a reported paucity of training and support for primary health care staff, the 72-hour observation period has not been adequately implemented, and patients suffering from acute or severe mental disorders are often referred straight to tertiary institutions, frequently without adequate information.

A “revolving door” phenomenon is also described (1), where, due to a lack of resources, mental health care users (MHCUs) are being discharged from specialised care too soon and are not monitored or provided with sufficient community-based rehabilitative care, which resulted in relapse and readmission. They note that although psychotropic medication is widely available at in- and outpatient facilities, it is not always available at primary care clinics, where it has to be prescribed by a general practitioner (GP) and nurses are only able to maintain prescriptions. This, too, leads to an increased likelihood of relapse.

However, there is a significant lack of information regarding the screening, management and treatment of CMDs such as anxiety, depression, substance use disorders and impulse control. This likely reflects the inadequacy of services, as well as a lack of information gathering regarding the use of services at primary care. Typical treatment for anxiety and depression centres around a programme of psychotherapy as well as psychotropic medication for moderate to severe cases (8) and both require sufficient and accessible local resources.

Tomlinson et al's (9) report on the South African Stress and Health study attempts to fill this gap, investigating the epidemiology of depression. They reported a 9.8% lifetime prevalence, and a 4.9% 12-month prevalence of major depressive episodes. The mean age of onset for females is 26, and 25.6 years for males and prevalence is highest between ages 40 and 49. Shockingly, the mean days out of role (affecting productivity in the workplace) was 57 days—this is in comparison to less than 15 days for most chronic conditions. The fact that those who have left school after achieving a Grade 7 or below are 3.8 times more likely to experience a major depressive episode in a year than those with higher levels of education partially backs up Peterson and Lund's (1) suggestion that South Africa's high levels of unemployment, poor education, high exposures to traumatic events and childhood adversity (such as violence and HIV/AIDS bereavement), as well as a history of discrimination and exclusion all have a direct impact on the high prevalence of CMDs in South Africa. However, it is difficult to find comparative international statistics, and Tomlinson et al (9) note several limitations of applying international surveying techniques in South Africa. Another study adds that there are approximately 9.3 mental health workers per 100 000 people – although its definition of “mental health care worker” is unclear – and this figure differs vastly between provinces. (6)

Some of the main barriers to treatment that have been identified in the literature include stigma (self-stigma, perceived stigma and actual stigma) resulting in isolation, unemployment and a lack of health-care seeking behaviour (1,6); traditional explanatory beliefs (particularly in the case of psychoses and schizophrenia); language, cultural and class barriers in treatment (1); concurrent use of both traditional and western care (especially in the case of severe mental disorders) with little co-operation/communication between the forms of care (1); poor residential, community-based and/or psychosocial care characterised by a lack of resources (1); and poor forward and backward referral pathways with inadequate communication/monitoring, skills and incompatible or simply incorrectly used health information systems (currently the only measure for mental illness in national health care statistics and public health publications is the number of mental health visits). (9,1) Other shortcomings include inconsistent and irregular identification and treatment of CMDs because of a lack of time, training and support amongst primary health care (PHC) staff (1) and inequalities in resource allocation and subsequent quality of care. A “vicious cycle” is also described of increased childhood adversity leading to poor education and thus a greater risk of unemployment, poverty, ill-health and exposure to violence. These lead to poorer mental health, which in turn results in increased social exclusion and poorer conditions. (6) Finally, the lack of adequate health information systems, such as a lack of data on mental health budgeting and tracking of intervention effectiveness is said to stand in the way of new interventions and initiatives. (9)

The studies mentioned above were part of a significant rise in the number of studies and reviews in 2009-2010 on the state of mental health care in South Africa, which potentially helped to inform and spur the development of the National Mental Health Policy Framework and Strategic Plan for 2013-2020. (6) This plan seeks to address some of the major gaps in treatment by focusing on integrating mental health care into general PHC services; by increasing public awareness (and thereby decreasing stigma and increasing help-seeking behaviour); by empowering communities by encouraging MHCU, community, inter-sectoral and non-governmental organisational (NGO) participation and collaboration; and finally by establishing a monitoring and evaluation system that will help insure that all planning and initiatives are based in evidence. It is rooted on the principles of mainstreaming mental health care and integrating it into all levels and all aspects of care (promotion, prevention, treatment and rehabilitation) (see appendix for principles of PHC), to bring it into parity with other aspects of health care, as well as incorporating it into all aspects of governmental policy. It hopes to encourage accessible care in the community, focusing on recovery and rehabilitation that is delivered in the least restrictive form possible, with acceptable, culturally relevant care that is sensitive to gender-related issues and broadens the network of support to include families and carers. Admission should be seen as a last resort, and the focus of all care should be on encouraging citizenship and participation and reducing discrimination. (6)

In order to achieve this somewhat idealistic vision of health care, the policy suggests a pyramid of service distribution: the majority of care should be self-driven, supplemented by informal community care provided by community health workers, self-help and peer-led services through NGOs and family organisations. Formalised community services at the local clinics will be provided by nurses and GPs. These services will be closely monitored and supported by supervisory specialist health teams. Community health services should provide residential and day care and basic outpatient services, including public mental health education schemes. Referral to the district system will focus on more specific non-specialist work. Between the two, routine screening, detection and monitoring, medication monitoring and psychosocial rehabilitation care will be provided, with reference to stepped management and referral frameworks. (6)

Specific mental health training for general staff is also prioritised, as well as the introduction of clinical protocols for assessment and interventions, which has culminated in the development of the Primary Care 101 Guideline (8) which uses a symptom-based approach to diagnosing and managing ill-health on a primary care level (see *Appendix 2: Mental Health Care Frameworks*

Primary Care 101: Depression and Anxiety

for the framework for managing depression). The development of the programme was based on World Health Organisation publications, such as the mhGAP (10) and WHO Practical Approach to Lung Health (11).

However, because these frameworks and policies are so recent, there is little to no information regarding their implementation, which makes it difficult to assess the needs of a shifting health care system and how interventions can potentially align themselves to services that are not yet established.

But what is clear from this research is the dire need for patient-centred initiatives that focus on self- and community-care for the screening, treating and monitoring of CMDs. Interventions must be able to provide routine epidemiological data which are self-evaluating and as cost-effective as possible. The mean incidence age of 25.8 and prevalence between ages 40 and 49 indicate that the majority of the population suffering from depression would comparatively technologically competent. A proposed intervention must be equitable and large-scale, as well as acceptable and appropriate for the diverse South African population.

3.3 ASSESSING COMPUTERISED INTERVENTIONS FOR DEPRESSION

3.3.1 *An mHealth future*

As a technologically savvy population seeks to take control of their own health, the online mobile app marketplace has responded by bringing out a large number of “solutions”. mHealth can travel in the user’s pocket, offering customisable, contextualised care (12) that is accessible across geographical and socio-economic barriers. (13) Two key drivers are the relatively low cost, as world-wide health care costs soar with the increasing prevalence of chronic conditions, and the almost exponential increase in smartphones penetration. (14)

The technical potential of mHealth is vividly described in a paper by international consulting firm *Ernest and Young* (14). It details an ideal interoperable mobile health system that spans across an entire nation, even internationally. Health consumers and practitioners alike could have interactive profiles on the Cloud, and apps on the consumer’s phone and biometric wearable technology constantly record data, which builds up an electronic health record (EHR) – a patient profile. Ideally the patient/consumer can choose what information gets sent to practitioners by looking at practitioner profiles and efficacy rates. Hospital technology should feed collected data into these data systems and Cloud-based “big-data” systems will combine and compile the information streaming in, select what is relevant, picking out dangerous health trends and highlight patients who are heading towards hospitalisation, all the while collecting epidemiological data. Scheduling can become completely automated across the entire consumer and practitioner pool. Practitioners could consult effortlessly with specialists, consumers could consult with practitioners, and consumers could consult with fellow consumers, all instantaneously across any geological divide, with all the information literally at their fingertips. (14)

However, this dream of ultimate patient-empowerment and autonomy juxtaposed with complete interconnectedness and interoperability is exceedingly complex, and the majority of the literature focuses on a targeted intervention. eHealth (any electronic system of health care delivery) for depression seeks to overcome the recognised barriers to psychotherapy of cost, distance to health care facilities, practitioner work-overload, time (average psychotherapy sessions will comprise of 12-16 hours of sessions), and even attitudes and stigma – where discreet use of apps in public appeal more to patients than standing in a queue outside a health facility. (15,16)

Using the above as part of the argument for mHealth interventions, this section reviews some of the major treatment options in app form aimed at MHCUs, including momentary ecological assessment and distance cognitive behavioural therapy, and what determines app user acceptance. It then assesses some of the difficulties in compiling evidence and conducting research in the field of mHealth as well as concluding with some of the arguments against mobile interventions, or difficulties that prevent broad uptake. A table summarising the studies reviewed can be found in Section 9.3.

3.3.2 *A depression app: review of existing functionalities*

In their comprehensive review of the app marketplace, Shen et al (13) note that the majority of apps offer either therapeutic treatment or psychoeducation (34% and 32% of apps respectively). “Therapeutic treatment” typically consist of hypnosis, brainwave entrainment, music therapy, spiritual or faith-based apps and behaviour training.

“Psychoeducation” apps were typically eBook-style static text-only apps about depression, or with advice on overcoming depression. There was also a high prevalence of medical assessment (17%; Involving PHQ-9 style questionnaires) and symptom management (8%; checklists or journals) apps. 4% offered cognitive behaviour therapy-based (CBT) apps. (13)

Another functionality that is gaining popularity is the idea of ecological momentary assessment (EMA). EMA refers to the patient data gathering at the time and place that the data sets are produced. (17) This could refer to the simple manual self-recording of experiences as they occur, or through using “context-aware” programmes that utilise built-in smartphone technology to note the environment: background noise and social interaction (using the microphone), ambient lighting conditions (through the camera), location (through GPS), kinaesthetic activity (with the accelerometer), as well as allowing for the addition of hardware sensors such as wearable technology to monitor heart rate, breathing rate, temperature, etc. (18) Proudfoot, (18) a significant voice in mHealth, suggests in her 2012 article that EMA helps to capture symptoms that are highly variable and are subject to poor recall during clinical interviews, particularly if adherence is encouraged through SMS prompts. (18) Saeb et al (19) recently published a study using phone sensors to provide EMA for depressive symptom severity, and Ben-Zeev et al (20) conducted a trial into the use of smartphones for ambient ecological monitoring and claimed that EMA could help “transport assessment out of the clinic and into the environments in which individuals negotiate their daily lives”, and although their study is clearly only an introductory “toe-dipping” into a lake of potential, with little focus on clinical relevancy and the theories behind behavioural expressions of emotion, automated EMA shows definite promise. However, the study makes no mention of system requirements (such as the toll on battery life and data usage), and constant data streams require advances into the processing field of “big data” in order to separate “normal” from abnormal. (14) Once this is achieved, however, proponents believe that these interventions could help identify treatment needs in time for very early intervention, and use data analytics to predict patient treatment outcomes. Cost effectiveness assessments must weigh the value of data produced by these systems against the costs (and thus large-scale accessibility), particularly if extra hardware is required. (14)

Much more research, however, has been conducted into the use of distance cognitive behavioural therapy – as a telemedicine intervention, as a computerised or internet therapy and now a mobile therapy (c-CBT, i-CBT, m-CBT), the former of these featuring in literature as early as 2002. (21) CBT is considered to be suited to distance and computerised therapy because of its structured yet interactive programme involving “homework” questions. (22) In a widely-cited systematic review and meta-analysis, Richards and Richardson (23) assess computerised psychological treatments for depression. They attempt to determine the efficacy of distance therapy, looking at efficacy post treatment and on follow-up; the amount and type of support – the efficacy of interventions with no support or some support versus the standard face-to-face therapy; and whether communication should be synchronous or asynchronous. They discuss dropout and its sometimes differing role in various trials as well as the problems in determining an optimal length of treatment. However, ultimately they conclude that there is definitive support for the effectiveness of computer-based psychological interventions for depression, helping to understand negative mood triggers. (23)

Other functions for apps relating to depression identified by the literature include cues to action, feedback, social support (including networking with support groups or therapists and sharing information/progress with friends and family), mindfulness-based cognitive therapy, and a mass of self-help applications promoting sleep-hygiene, meditation techniques, exercise routines, etc. Applications designed by professionals often utilise theories of self-determination, social cognition and behavioural activation for understanding negative mood triggers. (16) Some utilise reward systems. (23) Payne et al (16) and Keeton (24) claim that mobile interventions have a significant potential to bring about behaviour change through the constant and ecological reminders that a mobile phone can provide: (25,16), indeed Proudfoot (18) suggests the potential of the development of new theories of change specific to mHealth. Other features that increase user acceptability include limited time per use, integration into daily routine and ease of use, convenience, the discrete use of the app in public, seeing progress over time and automatic functions. (16)

3.3.3 Incoherence in the marketplace and research setting: acceptability and evidence

However, Shen et al (13) highlight that the confused, poorly-categorised and “flooded” online marketplace does not supply MHCUs with sufficient information regarding the legitimacy of the source of the application: 65% of apps

examined did not report an affiliation, 12% of the apps studied were produced by commercial developers and only 5.3% were designed by universities or medical centres. The report recommends that the “credibility” of an app is made clear to MHCUs through a standardised reporting system for certifications and professional vetting. Although a number of studies have begun to emerge evaluating interventions, there is still not enough comprehensive data, conducted through controlled trials to validate most of the interventions, a point that has been reiterated in many other reviews and studies. (13,12,26,25,17) On the other hand, Olff (27) notes that a few websites do act as an access point for evidence-based interventions to aid consumers in selecting an app. (13)

Although lack of a quality evidence-base is one of the main problems facing widespread systems acceptability, systematic reviewers and other researchers have struggled to compare, contrast and analyse what has become a highly divergent field. (16,17) mHealth can refer to: education and prevention, screening, monitoring, treating, training and support or communication. It could target the patient level, the primary care-giver level, communication between colleagues within the health system (3), communication between health users and health givers (12), broader-scale health systems data gathering (3) or communication between health users. (14) The platform can be telehealth – with health care givers manually calling users, or SMS-based question/answer services or reminder-systems for adherence, or more advanced web-page- or application-based platforms that have been specifically created. Each platform has its own strengths and weaknesses, as evaluated by Norris et al (22) and Proudfoot (18). Beyond the studies done on c-CBT, (23,12,21) there is minimal evidence comparing functionalities and interventions for apps for depression (particularly long term effects (18)), often because trials for initiatives often use incompatible methodologies with small sample sizes that do not take all variables into account – especially those that have to do with the design of the intervention itself. (23,17)

3.4 EXISTING mHEALTH AND eHEALTH INITIATIVES IN SOUTH AFRICA

With mobile phone penetration estimated at 93-94% (2013) (16) and smartphone penetration estimated at between 36 and 47% by various online sources, (4,5) mHealth has a potentially unparalleled ability to give (mental) health care access to thousands of South Africans in remote, rural, and/or poverty stricken areas, or improve the quality of care in under-resourced, understaffed, over-burdened districts. (25) mHealth requires relatively low literacy levels (3) and mobile interventions are considered highly acceptable in today’s social context (3). South Africa has a strong information and communication technology industry and the government has a positive and supportive outlook on eHealth. (3)

The mHealth field is growing rapidly in South Africa. This section evaluates existing mHealth apps in South Africa, looking at individual interventions, as well as platforms and solutions designed by local corporations. A look is taken at broader at the state of eHealth in South Africa and the goals of potential interventions, with some of the major players identified, along with promising developments. Finally, major policies and frameworks which should guide all future initiatives are outlined.

3.4.1 South African mHealth apps

eHealthNews (28) provides comprehensive coverage of local and international eHealth and mHealth news. Section 9.4.1 lists mHealth applications relevant to the South African context identified by *eHealthNews* using the tag “mHealth”. The majority of patient-aimed interventions are SMS or USSD-code based and focus on providing health information.

A manual search of *eHealthNews* also revealed several local companies that specialise in creating platforms for mHealth initiatives

Mobenzi (29) focuses on creating platforms to work with the governmental health organisations by facilitating CHW activities and communication, by producing electronic health records (EHR) of patients to capture data, allowing for supervisory functions, and help with tracking patient referrals. *Mobenzi Researcher* is a standalone application programming interface (API) which can be personalised and extended, creating personalised surveys and forms-based applications. *Mobenzi Outreach* is a platform that adds functionality to *Mobenzi Researcher* which allows for effective collaboration with CHW teams and other community care initiatives. Functionalities allow for building of patient profiles on a central database, scheduling of patient visits, with personalised instructions, CHW visit data collection,

algorithms and protocols for decision support for CHWs, electronic referrals to specialists and remote consultations, contextualised SMSs which can be sent to patients, co-ordination, monitoring and data verification of CHW activities, automated generation of reports, and web interfaces for supervision and facility-level control. By combining aspects from *Mobenzi Researcher* and *Mobenzi Outreach*, a system which spans four interfaces – namely a mobile interface for CHWs, a mobile interface for Facility Managers, a custom web interface for the clinic or pharmacy and an integration centre for the District Health Information System (DHIS). Section 9.4.2 gives an outline of the projects *Mobenzi* has been involved in.

Cell-Life (30) is a non-profit company which provides technology-based solutions for health management. They are perhaps best known for their iDART (Intelligent Dispensing for Anti-Retroviral Treatment) system, designed to support ARV dispensing in the public health sector. The system aims to automate drug supply management, with controlled dispensing, stock control and re-order statistics. Identifiable, multi-lingual bar-coded labels are created for every drug and patient package. The system links in with existing patient record systems (such as PREHMIS, utilised by the City of Cape Town) to streamline processes and prevent duplication. SMSs are sent to patients with clinic appointment reminders and daily positive living SMSs. Besides iDART, *Cell-Life* has designed flexible platforms that can be applied to the specific needs of various organisations. Capture is a JAVA-based platform designed to facilitate survey and questionnaire data capture, reducing the need for paper-based forms. Likewise, *Communicate* is a web-based platform to facilitate bulk SMS services for health campaigns. Section 9.4.3 outlines various *Cell-Life* projects.

There are other South African companies involved in mHealth technology, who are perhaps less involved with government tenders and creating scalable interventions, and who typically design more specific applications. *Sensi* (<https://sensicardiac.com/>), has created a programme to assist in diagnosing heart defects. *HealthQ Technologies* (<http://www.healthq.co/>) seeks to produce solutions in eHealth and biomonitoring across various disciplines; *KardioFit* (<https://www.kardiofit.co.za/>) assists with blood pressure monitoring and is linked to local emergency services. (28)

LifeQube (<http://www.lifeqube.co.za/>) is a Johannesburg-based company that has produced the MobiQube-LifeQube platform which seeks to improve ICTS through a mobile-driven primary healthcare clinic management system. (28)

Because of the major flaws in communication pathways and information gathering/data handling, many mHealth initiatives in South Africa have been aimed at the practitioner. Leon et al (3) looked at three case studies on data collection/management, monitoring of community health workers and routine monitoring and evaluation data (and suggest data collection, clinician service delivery, health promotion activities and training as priorities for apps in community-based settings). Banderker & Van Belle conducted a qualitative survey monitoring practitioner acceptance of mHealth. Others, such as Norris et al, (22) took a broader perspective, evaluating the use of various platforms to address depression – whether targeted at the health practitioner perspective or the patient perspective.

However, in a comprehensive and informed essay entitled “Scaling up mHealth: Where is the evidence”, Tomlinson et al (25) note that few, if any, mHealth initiatives have gone beyond small-scale pilot studies, or if the interventions have continued, they have not been maintained to gather follow-up efficacy information. (3) This means that it is difficult to come up with efficacy or effectiveness data to support future initiatives or to promote broader implementation. In what is essentially a fore-runner to the essay, Van Heerden, Tomlinson and Swartz (31) use the phrase “frontier mind-set” to describe the rapidity with which trials are designed and rolled out – often forfeiting scientific validity (such as grounding in theories of behaviour change or study design flaws (25)) or encountering later problems due to a lack of prior acceptability and feasibility studies. (27) However, Olf (27) warns against expensive, lengthy randomised controlled trials that do not match the expectations surrounding technological innovation in today’s market. She suggests keeping a look-out for developing methods of testing mobile application efficacy and new research agendas, and continual post-marketing surveillance.

van Heerden, Tomlinson & Swartz (31), Olf (27) and Tomlinson et al (25) provide useful research agendas and checklists for developing mHealth, which can be found in Section 9.5.3, as well as an information systems model for assessing the likelihood of adoption of a mobile tool.

3.4.2 eHealth structures in South Africa

mHealth is only a facet of the broader field of eHealth. mHealth is an access point for data entry and data retrieval, whereas eHealth refers to the broader information system.

Due to a government system where each province/district is free to interpret and implement national policy individually, and after 1996, when the National Healthcare Management Information System was decentralised (32), a multitude of disparate health information systems has developed, causing health information, where it exists, to become isolated into silos.

The NHSF (32) lists thirty-nine different health information systems, whether patient-centric implemented provincially or nationally, surveillance/data aggregation systems, middleware or other systems. The framework provides much needed clarification of these health information systems and the standards, operating systems and programmes in use. The document notes that the current level of HIS maturity in South Africa is very low, with most clinics making use of paper-based systems, and most hospitals using IT HISs solely for admission and discharge, but patient files remain paper-based.

Paper-based systems are incapable of efficiently tracking patients as they access different health services over time. In order to electronically track patient use of health facilities, maintain patient files, monitor prescriptions, a patient profile, or electronic health record (EHR) linked to a unique patient identity needs to be created. While an EHR is a complete longitudinal health record of a patient, the NHSF distinguishes this record, which is under the custodianship of healthcare providers, from a personal health record which is a patient-held record. Finally, an electronic medical record (EMR) is a record of a particular instance of medical service provision. (33)¹

Much of the dialogue surrounding eHealth concerns the development of a master patient index and an interoperable database that allows for the efficient transfer of patient information across medical facilities which would streamline access to patient histories, track medication usage, allow for the collection of epidemiological data, improving referral pathways, etc.

The African Centre for eHealth Excellence (Acfee) (<http://www.acfee.org/index.php>), a non-profit organisation based in South Africa, has dedicated itself to building eHealth leadership and capacity in Africa. It collaborated with Stellenbosch University's Faculty of Medicine and Health Science as an academic partner. It is engaged with keeping abreast of eHealth developments through its online information source *eHealth News Africa* (eHNA) (<http://www.ehna.org/>), it is involved with creating eHealth curricula and eLearning platforms and developing eHealth leadership. It offers consulting services through the tinTree International eHealth.

Acfee has developed several resources, including an eBook on eHealth lessons learned (34) – a useful guide to consult before embarking on any eHealth or mHealth project – and a report on an African eHealth Forum that they hosted in July 2015 (35). The Forum, besides discussing Acfee's role in growth of eHealth in Africa, suggested that countries address challenges to eHealth (and it provides a comprehensive list of these challenges), rather than simply investing in new applications, while investing in smaller-scale initiatives as well as large projects that focus more in information at points of care to benefit patients and health workers directly, rather than focusing on management information, suggesting finding an equilibrium between smaller initiatives (mHealth apps) and larger ones (developing EHRs). (35)

In their article *Have EHR, Will Travel*, *eHealthNews* (28) outlines the major players in private healthcare EHR development. Two of the major South African health insurance companies, *Discovery Health* with their *HealthID* and accompanying patient app (<https://www.discovery.co.za/portal/individual/medical-aid-news-nov13-discovery-app>) and *Metropolitan Family Health Network*, (<http://www.metrofhn.com/Pages/ehrs.html>), have established EHRs which store the medical history and chronic illness cover and benefit information, as well as allowing for electronic prescriptions. Practitioner access to patient information is manually granted by the patient. Independent companies

¹ The distinction between EHR, personal health record and EMR is not upheld or maintained in this paper. Further references to an EHR may allude to patient-held records as well as health system controlled records, as the author believes that patients should maintain control over health systems records, although the electronic health record may be stored in health information systems databases, and that data may be entered from both patients and the health system. The distinction between EHR and personal health record does not apply to this scenario.

have, such as FOLUP (<https://www.folup.com/>) and CenHealth (<http://cenhealth.com/>) have created EHRs with patient access, allowing for communication between patient and practitioner to varying extents (allowing for distance monitoring, EMA, etc. to be built into the EHR), provided both parties have committed to the service provider. Best4umed (<http://www.best4umed.com/>) has implemented a fingerprint security for controlling practitioners and patient access. MEDITECH (<http://www.meditech.co.za/>), a private informatics provider, is at the forefront of developing interoperable EHR platforms for health systems, although they do not seem to allow patient access and input into the EHR.

3.4.3 eHealth and mHealth frameworks and standards in South Africa

The body of regulatory frameworks and guidelines for eHealth and mHealth in South Africa is rapidly progressing.

In 2012, The National Department of Health (NDoH), issued a report detailing the South African eHealth Strategy until 2017 (26) The report, drawing on the international ideals that had gained huge amounts of popularity at the time, calls for a system of complete national interoperability, and extensive compatibility that equitably enhances patient-centeredness by increasing the efficiency and effectiveness of care. It gives a problem statement, with a situational analysis. Challenges to eHealth are examined and it outlines the role of eHealth in the NDoH's strategic aims. eHealth objectives for interventions required are suggested and a roadmap and delivery strategy for a well-functioning national health information system is given, comprising of ten "strategic priorities".

The National Health Normative Standards Framework for Interoperability in eHealth (32) (HNSF), released in 2014, is the most progressive and detailed report in the South African eHealth arena. It discusses the context for eHealth development and the components of eHealth, interoperability and enterprise architecture. It contains eleven core recommendations for eHealth in South Africa (see Section 9.5). The scope of the framework is to discuss and evaluate interoperability standards for sharing patient-centric data. The document contains a comprehensive list of profile definitions for describing the flow of information, the access points and the packages of data transferred, termed *Integrating the Healthcare Enterprise*. It lists applicable standards necessary for interoperability – identifier standards, messaging standards, coding and terminology standards, content and structure standards, EHR standards, health-specific security standards and general IT standards. It also provides instruments for assessing and benchmarking eHealth applications. (32)

In sections on ICT and communications, the Western Cape Department of Health's vision for healthcare for 2030 (33) outlines the future of integrated patient data into a PMI with single, consistent and accurate patient identifiers, which, it is hoped, will ensure that patient data is kept complete and up-to-date while reducing duplicate records, will be condensable and available across institutions and health professionals. Ideally, this will improve continuity of care, enduring that patient data does not have to be re-entered at each referral. A Continuity of Care Record has been developed, which is essentially a truncated EHR, although whether this system is interoperable with other patient records systems is not stated.

In the same document, mHealth is referred to as part of a chapter on healthcare infrastructure and health technology in the limited scope of public health education/awareness through messaging, remote access to training resources, data capturing, enabling patient reporting on service provision and sharing of patient-related data between health professionals. There is no mention of patient-supplied data or integration of mHealth initiatives. (33)

The National mHealth Strategy for 2015-2019 (36) adopts key principles of adhering to the standards of the HNSF, of simplicity, sustainable partnerships, converging disparate eHealth initiatives and mHealth initiatives with other ICT initiatives, and converge mobile and fixed technologies. The document recognises the uses of mHealth defined by WHO, namely "the development of emergency response systems, disease surveillance and control, human resource coordination, management and supervision, synchronous and asynchronous mobile telemedicine diagnostic and decision support for clinicians at point-of-care, remote monitoring and clinical care, health extension services, health promotion and community mobilisations, health services monitoring and reporting, health related m-learning for general public and training and continuing professional development for health care workers." Like the eHealth strategy, it gives a situational analysis, an outline of the problems and challenges to mHealth, the contribution of mHealth to

national health objectives, the aim of the implementation plan, a description of proposed mHealth interventions and a roadmap to achieving them

Finally, the Private Healthcare Information Standards Committee (<http://www.phisc.org.za/>) attempts to maintain health information standards in the South African private healthcare system, covering clinical coding standards, healthcare information governance, messaging standards, pharmaceutical coding, diagnosis related groups, and the formation of a national EHR. The site lists several documents and standards that they have produced.

3.5 CHALLENGES FOR INTEGRATING eHEALTH INTO THE SOUTH AFRICAN CONTEXT

The above frameworks have compiled an extensive list of challenges facing eHealth development, and have suggested various ways forward. The complete lists can be found in Section 9.5.

By compiling the challenges and suggestions provided by the NDoH's the 2012 eHealth strategy, (26) the 2015 mHealth strategy, (36) the HNSF, (32) the Acfee report on the African eHealth Forum (35) and the eHNA's eBook on lessons learned, (34) as well as a paper by Leon et al, (3) several common themes emerged.

Most stressed the importance of addressing the leadership gap for eHealth to oversee and take responsibility for governance and regulation and ensure accountability. Some felt this role should be filled by a governmental institution, and others by an independent board. However, the need for developing leadership skills was also highlighted, as well as the multidisciplinary nature of overseeing teams with cross-functional teams, taking a participatory approach with stakeholder engagement.

The latter is vital for addressing the current state of poor connectivity, with siloed information structures with low degrees of interoperability and collaboration. There is currently no PMI or consensus on unique patient identifiers, and government stewardship and participation is required to establish common data standards, terminology, norms and standards. Data sharing needs need to be identified through collaboration with the private sector, NGOs, research organisations and even other governments. Data sharing needs need to be identified, and existing initiatives need to be examined for possibilities of interoperability. Many sources note, too, that although there are standardised protocols for interoperability, there are multiple standards in use. Although government stewardship is required, over-regulation without sufficient input from a national leading body would stunt progress.

However, many problems for eHealth initiatives stem from the current lack of ICT capacity, considering the prevalence of paper-based systems and lack of human capacity to embrace eHealth in the healthcare system. A lack of broadband connectivity and a digital divide between rural and urban areas, with limited capacity of entry-level phones, along with the costs of ICT systems, whether mobile or fixed have proven to be sometimes insurmountable obstacles.

Many of these sources suggest focusing on building foundations for eHealth through an incremental approach with multiple levels of advancement, while maintaining modularity. By forming a simple action plan and reporting on its progress, building on existing ICT structures, focusing on early wins and on maximum value, benefits can be more easily advocated and confidence in eHealth as a solution will grow. Building the capacity of the workforce to embrace eHealth is also vital, by integrating skills into learning and training curricula and providing ongoing training.

In order to fully realise the benefits of eHealth by focusing on acceptability to the end user (see the UTAUT model in Section 9.5.3) through simplicity, flexibility, durability and an interface that streamlines work processes for end-users. Interventions should strive towards benefiting health and supporting health care delivery, grounded in principles of efficacy, equity, patient-centeredness and efficiency. Interventions that directly impact patients must be fully assessed through a medical, ethically approved risk-based approach, bearing in mind that the risks of eHealth have not been sufficiently established. There is also limited legal protocol concerning information sharing and security in eHealth.

By developing risk mitigation plans for obstacles, with built-in mechanisms for problem-shooting and defining root causes for problems, initiatives can start realising benefits. The risk of obsolescence must also be kept in mind, and all initiatives must be constantly and routinely monitored and evaluated.

Vital to success, too, is defining sustainable business models and the mechanisms for upscaling from the start. This involves building realistic timeframes (being aware that timeframes are almost always underestimated) and allocating

resources by clear defining of priorities though engaging with suppliers and exploring open source alternatives. Financing models need to be clear from the start, ensuring that sponsorship will be consistent, keeping the timeframe in mind, as well as the role that the numerous stakeholders (e.g. private healthcare institutions, insurance companies, developers, NGOs) will have in business models.

3.6 CONCLUSION

This literature review has covered the state of mental health in South Africa and demonstrated the need for a systemic intervention. mHealth interventions for MDD were evaluated, including prominent areas of interest such as momentary ecological assessment and computerised CBT. Some of the difficulties facing researchers and consumers alike in assessing potential mHealth interventions were elucidated. The local literature on mHealth and eHealth was then examined to establish mHealth intervention precedents in South Africa, and the frameworks and regulating structures that have emerged in the field, along with the challenges that they have identified, providing a base to explore whether an intervention based in mHealth as well as eHealth for addressing MDD and electronic healthcare delivery in South Africa is feasible.

4 RESEARCH APPROACH AND METHOD

4.1 RESEARCH PARADIGMS

Based on the nature of the research questions listed in Section 2.1, a qualitative descriptive/exploratory approach was considered the most appropriate research design. This initial feasibility exploration is relying on the perspectives proposed in the literature, subjective innovation provided by the author as well as knowledge provided by a sample of experts in the field. The focus is social and interpretative rather than quantitative (37). As stated by Wisker (38), quantitative methods are typically used in the evaluation of existing hypotheses. This work is meant to provide background for the establishment of future hypotheses, which will allow for statistical quantification to determine variables pertaining to acceptability and efficacy.

Descriptive research “aims to find out more about a phenomenon and to capture it with detailed information” (37) – although it is noted that often the validity of a description may deteriorate with time. Descriptive research, in the context of this study, was considered necessary for describing mental health care in South African context, defining the existing mHealth field – both the international depression app marketplace and the general mHealth solutions for South African – and finally providing an outline of potential functionalities described by previous initiatives.

The exploratory aspect of the study was used for gathering new insight around the research questions. By conducting interviews with various experts, a deeper understanding of the context – particularly the South African mHealth context and the context of intervention design – was gained. No explanatory, predictive or action mechanisms were included in the study design, due to the lack of previous exploratory insights. (37)

A constructivist paradigm was used, as described by the *Postgraduate Research Handbook* (37), to take disparate aspects of international mHealth interventions and apply them to the South African context, attempting to “reconstruct” the concept of a South African mHealth intervention to an app that was scalable and capable of systems integration, using the author’s subjective assessment of market requirements (38). Methodology was typically dialectical and dialogic rather than focused on systematic objectivity—the presentation of ideas was to suggest a possible change in existing constructs, to present a new understanding and expression rather than to validate and prove a clearly defined hypothesis.

4.2 RESEARCH DESIGN

Initially, background research was conducted in the fields of interest in the form of a literature review. A compilation of the functionalities for computerised interventions for mild to moderate MDD was made from the literature. This was combined with functionalities derived from a survey of existing tools available on online app marketplaces – namely Google Play Store and iTunes, using the keyword “depression”. Relevant apps mentioned in the literature were also followed up where possible. Apps were selected for inclusion by identifying primarily as a tool for treating depression and by assessing the number of downloads and user ratings. The attributes of each app included were

recorded, the functionality was listed and any positive or negative comments were summarised (See section 9.7 for full results of the survey, and section 3.3.2 for an abridged table).

A “loose” research design (38) was favoured because of the lack of defined theoretical constructs for the type of study (due to the interdisciplinary nature) and the flexibility that the design allows in sampling methodology – employing purposeful (39), non-probability sampling. Expert sampling, a subset of purposeful sampling, was considered the most appropriate for relatively unrestricted exploration of the topics in question. A “flexible, iterative and continuous” (38) interview structure was used, where interview design is adapted throughout the interview process, both within the interview and between interviews – for example, following up leads in later interviews mentioned in previous interviews, and using previous interviews as a guide for changing sampling parameters.

Semi-structured interviews were used, with a questionnaire of topics and subtopics to be covered designed before the interview. Because no statistical analysis was required from the interviews, questions were almost exclusively open, however, as far as possible, the several topics/questions were asked at every interview to provide comparative data (38). Salient topics were drawn from the literature in accordance to their relevance to the research questions, focusing on utility, acceptability and perceived challenges to uptake. See Section 9.6 for the interview instruments, which also included a brief synopsis of the proposed intervention to orientate the interviewee.

4.3 DATA COLLECTION

4.3.1 Sample recruitment

Mental health care professionals, such as psychiatrists and psychologists, as well as primary care professionals such as general practitioners and nurses who would come across patients requiring mental health care in daily practice, were identified as having useful information to impart. Other persons of key interest were programmers or IT experts with experience in app development; experts in information systems, particularly health information systems (whether public or private); managers in health departments; researchers involved in public mental health interventions, as well as mHealth initiatives (the latter referring to general health care interventions; epidemiologists with experience in health intervention trial design; and finally legal experts with experience in bioethics. It was decided that persons suffering from MDD would not be interviewed, because the exploratory nature of the study did not justify the contact with a highly vulnerable population, although indirect MHCU perspectives are captured in user comments/reviews of existing mHealth tools (Summarised review of mHealth marketplaceSee review of the app marketplace in Section 5.1.). However, future MHCU input will be vital in later stages of development in determining user needs, intention to use, and acceptability.

After obtaining ethical approval, expert interviewees were recruited from various fields who the author considered would provide insight into the research questions.

Professional contacts of the researcher and academics affiliated to the University of Cape Town were used as points of departure, who were also asked if they could suggest other participants (“snowball sampling” (38)). Field experts were also identified from the literature and contacted. All participants were contacted via email, given a brief introduction to the nature of the study, advised that the interview would take between 30 and 60 minutes, assured of confidentiality and asked whether they would like to participate. No incentive to participate was given. If a prospective participant responded positively, interviews were scheduled at their convenience and the consent form, certificate of ethics approval and interview instrument were emailed to them.

4.3.2 Procedure and data collection methods

The interviews were audio recorded with permission, and the length of the interviews was determined by the participants. The interview instruments were used as a point of departure, however topics that emerged during the course of the interview were pursued. Interviewees were informed that they were free to decline to answer any question that they did not feel qualified to answer

As all interviews were transcribed by the researcher personally to ensure confidentiality, ensure quality (given jargon-rich/subject-specific content) as well as to minimise costs, time proved to be the primary limiting factor on the number

of interviews conducted. Other limitations stemmed from interviewee unavailability, an inability to identify a potential interviewee through the recruitment process, or a self-professed lack of expertise from the potential interviewee.

A total of eight interviews were conducted (in chronological order): a public mental health researcher from the *Alan J Flisher Centre for Public Mental Health (PHR)*; a social sciences researcher involved in an mHealth project also from the *Alan J Flisher Centre (SSR)*; a clinical psychologist from *UCT Student Wellness Centre (PSLGT)*; a psychiatrist practising in both public and private capacity (*PSRT*); a professional programmer (*ITE*); a researcher from the *South African Medical Research Council* also involved in an mHealth initiative (*MRR*); and a professor from UCT's information systems department (*ISP*).

All transcriptions, with potential identifiers removed, are included in Section 9.8. Any reference to information sourced from interviews are referenced in the report by the identifiers listed above in brackets in bold.

4.3.3 Data analysis

Any additional resources suggested by interviewees were followed up and incorporated into the literature review. A thematic analysis of the information extracted from the interviews was conducted and categorised into themes which loosely correlated to the research questions which emerged in the literature and design elements of the author's innovation, which can be found in section 4.3.4. As suggested by Flick (37), categories were derived from the material, rather than from existing theories. No coding or statistical analyses were performed, due to the diversity of the sample and minimal comparative data that emerged from the interviews. (37) Qualitative analysis software was not available to the researcher at the time of the study, however, as there was no need to evaluate complex relationships between concepts, or hidden themes that needed uncovering, relying more on refining pre-identified concepts, it was not considered necessary to make an effort to access the necessary tools.

Potential functionalities were evaluated according to their prominence in the literature, and support from the interviews, and were combined into an integrated system with defined data flows by the author. Other themes that emerged that would require addressing in future developments upon this design included business models and sustainability, privacy, information security and the legal aspects of health interventions and the development and testing of the tool in terms of technical functioning and the testing of acceptability to users (including systems acceptability and interoperability) and efficacy and safety as a health intervention. Finally, a list of factors that may affect user acceptability was also compiled.

The significance of these results was analysed in Section 6, supplying a point of departure for future initiatives.

4.3.4 Funding Information

There are no research grants, sponsorships or other external sources of funds for this project. Transcription was done by the author, and thus no transcription costs were incurred. All transport and consumable expenses were minimal and were paid out of personal funds.

5 RESULTS

5.1 REVIEW OF MHEALTH MARKETPLACE

5.1.1 Summarised review of mHealth marketplace

	App Name and version (Offered By) Year. Price.	Functionality	User Comments
A	MoodTools - Depression Aid 2.1 (MoodTools) 2015. Free (in-app purchases)	ThoughtDiary Activities (Behavioural Activation Therapy Safety Plan Information Test (PHQ-9) Video	Pros: export thought diaries (share with therapist). Simple design, easy to look at. Convenient, confidential/surreptitious. Developer response to comments. Most find the thought journal the most helpful. Also YouTube videos. Allows user to track physical states. Liked pre-set drop-downs. Good light therapy tool. Cons: put positive thoughts in diary, need more tests. Goal making tools (CBT). Would like reminder functions. Needs a lock function. For editing entries. Time stamp. Monthly

			chart. Limited space to write. Shouldn't diagnose. Log of conditions and meds
B	Depression CBT Self-help Guide v1.8 (Excel At Life) 2014. Free (in-app purchases)	Test (with Graph) Articles Suggestions, tracking Depression Assistance Audio Cognitive Thought Diary Emotion Training Audio Relaxation Audio Password Protection Customisation of graphics	Pros: Good, helpful articles. Free, private. Relaxing. Nice for monitoring. Lots of resources. Liked audios, depression sleep aid, daily quote. Motivating points system. Works on many different levels Cons: Poor user interface- confusing and unattractive. Requires time, effort. Not very interactive. List of contacts. Test needs to be daily (not over last two weeks). Privacy - make reasons clear
C	How Are You - Mood Tracker v1.6.2 (Quantum Lab Co.) 2015. R156.15	Mood assessment >30 mood boosting hints mood tracking average mood, mood graphics, compare with world results analysis feature Buddy feature (share with someone close to you gratitude diary	pros: attractive. Quick to use ("minimal burden". Non-intrusive. Can choose multiple ratings to represent entire day. User friendly. Good reminders. cons: crashes. Not able to customise options. Not able to back up online
D	MoodSpace - Depression Self-Help v1.2.2 (Boundless) 2015. Free	interactive mood workouts - habit building exercises that are completed on the phone.	Pros: helps focus on positives. Tidy design. Cons: Limited functionality.
E	Anti-Depression v1.5 (SoundMindz.Org) 2014. Free (in-app purchases)	diagnostic questionnaire recorded messages providing an action plan a workbook with information and exercises relating to therapy daily progress tracker On-demand reporting Access to latest research via website	Pros: up-to-date information. People like the audio recordings and video links. Always with you. "Simple, beautiful". Cons: messy. Have to create an account (allows for syncing) - many people seem to have struggled with this.
F	7 Cups of Tea: Care & Therapy v1.04 (7 Cups of Tea) 2014. Free	Free anonymous and confidential conversations with trained active listeners (including licensed therapists). Choose your ideal listener	Pros: platform for neutral opinion, to be free, to "open up and be pampered", overcome insecurities. Helps those who aren't good with "face-to-face" communication. Highly supportive community. No fear of judgement. Convenient, with instant alerts. User-friendly interface. Very accessible. Allows for giving back by training as a listener. Available online as well as an app (many find the app more convenient than having to use a PC). Appeals to people who are sceptical about therapy. "calming name". Safe (moderators). Cons: occasional inexperienced or poor listeners. Sometimes slow. "not the smoothest application". A couple of UI issues, several complained of bugs. Training session' should be included in app. Settings not customisable. Limited functionality. Requires effort to find someone who is compatible. No history for 1on1 conversations. Perhaps have a profile page as an introduction.
G	eMoods Bipolar Mood tracker (Yottaram LLC) 2014. Free (in-app purchases)	Tracks moods, symptoms, sleep, medications and allow for printable charts at the end of each month. Does not log multiple moods/symptoms per day. Reminder alarms	Pros: easy to use, private allows for pattern recognition, seeing the effects of meds, collaborating with therapist.. Export functionality. Notes function. Reminders. Can edit days you missed. Cons: no back-up reminders, some back-up bugs. Limited symptom list, not customisable. No password protection. Should be able to flag something. Doesn't track substances, exercise. Limited space for notes

H	Life Reboot - Fight Depression v1.3 (photonapps). 2015. Free	Anonymous forum, diary medicine reminders daily motivational quotes jokes games: painting and tic-tac-toe	Pros: "cute", helpful for relaxing Cons: none were mentioned (very few reviewers)
I	MoodKit - Mood Improvement Tools v3.0 (Thriveport, LLC). 2015. \$4.99	over 200 mood improvement activities (tailor recommended) email/text/Facebook sharing of activities iOS calendar integration Thought Checker Mood Tracker: exportable mood charts weekly/monthly views. Journal. Pre-formatted templates. Voice entry support. creates own entries and journal templates link custom reminders to favourite tools security features	Pros: convenient thought checker interface. Impressive variety of activities. Well designed. Cons: only one mood per day. Journal questions sometimes cheesy, annoying or unhelpful.
J	eCBT Mood v2.1 (mindApps llc). 2012. \$0.99	Overview of CBT Feelings and thoughts log Automatic thought identification tool Structured automatic thought challenge tool Identify and challenge core beliefs Daily mood assessment and report Weekly mood assessment and report.	Some features a little cheesy, but easy to use and useful. Well-phrased questions
K	Sad Scale v1.2 (Deep Pocket Series LLC). 2009. \$0.99	Edinburgh Postnatal Depression Scale Zung Depression scale (monitoring changes over time) Geriatric Depression scale Children depression scale	A screening rather than diagnostic tool. Very useful for primary care doctors. - especially ability to email graph/score. Increases awareness of the disease.
L	Operation Reach Out v1.0.2.70 (The Guidance Group Inc.). 2011. Free.	Help Centre - hotlines and emergency personal contacts help for suicidal people - 12 videos. Help for people trying to prevent suicide - 10 videos.	
M	DBT Diary Card and Skills Coach v2.9 (Durham DBT, Inc.). 2015. \$4.99	a reference manual behaviour checker skills coach password locking daily reminders advanced text editing media playback skills, emotions, behaviours, coaching, customisability, emergency skills, email.	a few changes to customisable features necessary, very useful coaching skills, clear description of skills.
N	Optimism v2.5.9 (Optimism Appsa). 2015. Free	develop and monitor health strategies, learn triggers of a decline in mental health, recognise early warning signs of a decline	tracks stability and what affects it - self-awareness. Well organised.

		detailed charts and reports, emailable.	
O	Happy Habits: Choose Happiness v2.2.1 (Excel At Life). 2014. Free	Happiness Assessment Audio guides Happiness Journal 50 CBT suggestions (Customisable) Points for what you do each day Graphs Articles Emotion Training audios Relaxation audios Password protection Customisable graphics	Pros: articles helpful. Flexible and customisable. Good advice. Reward system. Links to other apps and websites are helpful. Cons: Sometimes a bit American-based.
P	MoodTrek V1.4 (Cerner Corporation). 2015. Free	Mood tracking/rating when it changes or on reminder Journals Syncs to Fitbit® to track physical activity Automated capturing of sleep quality Easy sharing to doctors who are also using Cerner electronic medical record. Export and share. HIPAA compliant	
Q	Beating the Blues (18) ² £49.99	Computerised CBT: 8 50 min sessions Endorsed by NHS	
R	myCompass (Black Dog Institute) ³ . Free	Mood tracking with reports on patterns and behaviour over time. Interactive modules for mood management Diary Stories of other experiences Access to articles/reading material	

5.1.2 Gap analysis: an mHealth intervention for depression to develop mental health care and support eHealth in South Africa

From Section 3.2, it is clear that mental health care, particularly CMDs such as depression, should be a priority for health care interventions and initiatives. Section 3.3 shows that there is huge scope for mHealth to act as an intervention for MDD. However, although there are numerous applications online acting as interventions for MDD (Section 9.6.6), these apps may not be living up to the lofty ideals and providing the claimed benefits to the majority South Africans suffering from MDD.

Major gaps in mental health care delivery in South Africa have been identified as limited access to a dedicated personal psychotherapist and almost no access to specialists, a lack of skills at primary care levels and associated support structures, poor referral pathways and stigma of accessing health services (*PSLGT, SSR*). *Psrt* notes that help-seeking behaviour, recognising a mental health disorder and deciding that it is acceptable to seek treatment is a huge barrier to access, along with stigma of accessing services. Primary care practitioners often fail to recognise common mental disorders, or are unable to manage them appropriately (*Psrt*). Along with psychotherapy, psychotropic medication is the other mainstay of treatment. There is a low uptake of antidepressants due to unavailability at primary clinics and

² An online application (www.beatingtheblues.co.uk) that must be bought from the Wellness Shop (<https://www.thewellnessshop.co.uk/>)

³ An online application (<https://www.mycompass.org.au/>) only available to Australians.

PHC nurses being unable to prescribe them (**SSR**) (1). Adherence to medication is other severe problem (9). In the private sector, affordability of care is the major problem, and practitioners often fail to look beyond individual patients to engage with public health (**PSRT**)

A mental health app developed should increase access to psychotherapy (**PSLGT**) and address the lack of continuity of care (**SSR**). An app could potentially reduce the time needed for face-to-face therapy (17), provide discreet access to care (reducing stigma) as well as providing care even if a potential MHCU does not self-identify as “depressed” (depending on how the app is marketed). If rolled out correctly, the care could be accessible, equitable and culturally relevant. Besides providing self-help tools, medication adherence functionalities combined with distance monitoring services can also impact continuity of care by during rehabilitation after discharge from institutionalised care, preventing the “revolving door phenomenon” described by Peterson & Lund. (1)

The apps available on online marketplaces may not be contextually appropriate for South Africans (being Western-based, and, in all likelihood, only in English). Many of these do not have explicit quality standards (13) and thus their efficacy is questionable. Shen et al (13) note that a flooded market can bewilder a potential user, who will have to exercise personal discretion to choose a suitable app, assuming that the MHCU is actively independently help-seeking and sufficiently technologically literate to search these marketplaces themselves.

There is also place in the market for multifunctional apps that can adequately keep track of comorbidities, or monitor general health as well as depression, or programmes that are highly customisable to the patient’s specific needs or triggers. This could include tailored modules which could be selected, targeting common South African experiences-considering the high incidence of HIV-related depression, and exposure to traumatic events and untimely bereavement in this country. Although one or two apps are linked to health providers who also have profiles on the system (Apps **Q,R**) (18), the majority of apps require manual exporting and sending of data to health care practitioners.

An app independent of the health system would have limited efficacy because of the lack of communication between patients and health providers in the health system, which means that the care provided by the app cannot be fully integrated into the health care services provided by the health system. (14) Health systems endorsement of an application would also have a greater reach as practitioners can recommend that app if the MHCU is not independently health-seeking and thus, if correctly scaled up, the app can reach all outposts of the public health system. Patients may have greater trust in an app that is vetted by health professionals and the government compared to those freely available on online marketplaces.

For an app to be applicable to the public health system, it would need to fit into the prospect model of “pyramidal care” (see section 9.2.2) (6), where the majority of the burden of care is placed on the patient, with support from NGOs and CHWs who provide evidence-based counselling in supervised teams, along with primary care services, with hospitalisation and access to specialists being provided only when necessary (**PHR**). Self-care empowers patients to take control of their own health, and an intervention that utilises mobile technology is likely to be highly acceptable, considering that a mean age of onset of MDD is estimated at 25.8, with the highest prevalence between ages 40 and 49 (9).

Technology that aids screening, diagnosis and basic treatment, as well as providing basic training would also be helpful to support CHWs, as well as facilitating the communication between CHWs and supervisors/clinics. A system that links patients to CHWs, CHWs to specialists, health workers to clinics, and clinics to secondary and tertiary institutions, facilitating communication between health practitioners and allow for efficient transferral of patient data and instructions would be highly beneficial to integrating care across South Africa.

A mobile application as an epidemiological data collection tool that records patient information, but also tracks access to health care services and monitors CHW activities is ideal – collecting data from both the user and the supplier of health services. According to **PSRT** “patients are potentially an enormous resource.” Data collected through mobile technology is instantaneous and far more efficient than paper-based systems. Data sets are more complete and there is no loss of information (**PHR**). Indeed, several of the current mHealth projects also seek to collect epidemiological data, although this tends not to extend to patient data.

Creating an application that is linked to health information systems – beyond providing more holistic care for the patient – can also potentially feed into mHealth programmes established by the government, and can contribute towards mHealth goals (36), providing patient data and integrating health services, as well allowing for on-going in-depth epidemiological data collection. However, in order to achieve health systems endorsement, the intervention must be proven to be efficacious, cost-effective and sustainable, yet the health system should be involved from the start, resulting in a catch-twenty-two situation.

However, despite the supposed emphasis on self-care in the NHI, there are very few mHealth tools that have any functionality beyond basic health information provision. Any mHealth communication with patients is limited to SMSs, mobisites or USSD codes. The main focus of mHealth has been on CHW coordination/facilitation, epidemiological surveying tools or diagnostic tools. And although private sector eHealth tools are giving patients control over their EHR and allowing for independent entry of data, national eHealth development seems to completely neglect the concept of having a patient terminal for accessing information and as a data source, linking patient mHealth apps to practitioner interfaces to a greater eHealth framework.

All mHealth and eHealth initiatives tend to be stand-alone, independent projects with little interoperability either with other apps or with existing HISs, which often fail to make it beyond trial phase (25). Designing apps for individual disorders that can share data and connect to the same back-end database, could create a holistic picture of a patient, while treating their specific set of requirements. Thus mHealth needs to be integrated with eHealth, so each intervention feeds into single patient EHRs that can be accessed throughout the system.

However, a point neglected by mHealth and eHealth strategies (Section 3.4.3), is that mental health is a national health priority – considering the high morbidity, decreased life-satisfaction and days out of role that are associated with CMDs (1). m- and eHealth guidelines and interventions focus on HIV, TB, maternity care and lifestyle diseases such as diabetes. There were no apps reviewed in Section 9.3 that specifically addressed mental health.

The frameworks and policies take a top-down approach: establishing health information systems that can be rolled out nationally, with special functionalities added later. Rather than wait for all stakeholders to come to the table, another possibility could be to develop an eHealth intervention from an mHealth intervention, from the bottom up; an intervention that is fully functional as a stand-alone app (in this case an intervention for MDD), but is sufficiently flexible to add user profiles and connectivity and data flows as more parties become involved and the initiative scales up. The intervention can grow its own EHR database through unique identifiers, so that it is not dependent on a currently non-existent PMI and NHIS/SA, but has clearly defined application programming interfaces and is adherent to standards that are fast becoming policy so that data is freely exchangeable with any future endeavours, meeting them “half-way”, so to speak.

5.2 FUNCTIONALITY

Following on from the gaps identified in the previous section, the author describes in this section the potential functionalities that will help improve self-care for MMD sufferers and allow for the creation of EHRs, while creating a flexible system to connect MHCUs to health care services, link health professionals to each other. Users and user roles are described and the potential functionalities for these users are listed – critically integrating inputs from the literature, existing tools and interviewees. The information flows describe how information could be transferred between users, including validation pathways for creating user profiles and the permission pathways to allow the MHCU to maintain control over their EHR.

As outlined above, at the core of functionality lies the development of a flexible backend database for developing robust EHRs that contains medical information directly relevant to immediate care (such as medical history, doctor’s notes and vital statistics), as well as EMA data that allows for discreet background monitoring and analysis for long-term health impacts. The functionalities described by the proposed intervention can be seen as a starting point: an initiative designed to set up the system – but the intention of the author is that it provides a backbone for other mHealth initiatives to build on... other apps can be developed for monitoring other conditions such as diabetes, TB or HIV, all feeding into the same EHR. A full medication-tracking application can be designed that links into existing pharmacy HISs to monitor adherence and medication usage, while providing patients with interactive reminders and

information about their medication. In this way, a user can develop a profile tailored to their individual health needs, creating a complete EHR that is within the patient's control, but provides health care providers with all relevant information at the instant that it is required.

However, the author proposes in the following sections a bottom-up approach of using a small, tangible intervention, which can be built upon through the wealth of creativity and innovation that exists in the country.

5.2.1 Users and user roles

Defining users and determining how they interact with the database – what information gets sent from the user to the database and from the database to the user – is at the core of a system's functionality. In the health system, there is an incomprehensible number of roles and positions, often with overlapping functions.

Service-oriented architecture (SOA) is a programming structure where functionality is described as a "service" – including any form of data exchange, data processing or data entry. Users then have access to certain services, which define the user roles. The HNSF (32) lists IHE (Integrating the Healthcare Enterprise) integration profiles which are essentially a set of standardised services that have been defined by health professionals and industry internationally to describe particular clinical requirements. However, the list provided, although extensive, is not definitive: While it is exceptionally useful for generic functions such as cross-enterprise document exchange, patient plan of care, referral summary, etc.; it is split into domains, such as radiation oncology, pharmacy, eye-care, cardiology etc. and no mental health domain is mentioned.

Each user will have access to certain bundles of services or IHE profiles. *ISP* describes two methods of assigning user access. A coarse-grained method is where users have predefined bundles of services; when each user gets added onto the system, the authority adding the user selects the user type, and all rights are pre-set and automatically allocated. A fine-grained method allows the authority adding the user to select what exactly which services or sets of services are assigned to the user. A fine-grained method allows for the easy addition of privileges which allows for more flexibility within the predefined roles; however, it makes the process of adding users significantly more complex and thus adds a point of weakness if the "authority" (see section 5.2.3 below) is incapable or has poor judgement.

For the purposes of this study, the details of each interaction with the system do not need to be clearly defined in terms of IHE profiles, although basic user roles will be outlined in a generic sense. *Dashboards* are described in section 5.2.2, which are essentially a collection of services with more or less specificity according to user roles.

Using the the primary health care model (see section 9.2.2), synthesising models from the literature (6,7,37,9)(see section 9.2.2), and considering information provided from the experience of interviewees (*SSR, MRR, PHR, PSRT*), a list of salient users has been created. These users include the *mental health care user* (MHCU), the *community health worker* (CHW), a *specialist supervisory health care professional, primary care administrating staff*, an *epidemiology terminal* and a *system administrator*. In the sections below, these users are defined and the roles suggested by the study are outlined. The details of the functionality of the interface for each of these users is further explored in section 5.2.2.

Potential users that have not been clearly defined include general practitioners working at primary care facilities; secondary/tertiary facilities, other managerial users (such as the Department of Health or NGOs), private practitioners and facilities and health insurance companies, or support staff for the system (e.g. technical support staff or hotline staff). Many of these users can obtain sufficient access by using a collection of the predesigned dashboards described in section 5.2.2, without any additional services – for example a GP may have access to the same services as a supervisor, but without the CHW supervisory dashboard (see below). As long as services are clearly defined in the underlying architecture, creating new user profiles according to need, whether through a coarse- or a fine-grained approach, should not be a problematic exercise (*ISP*). *ISP* also noted that in initial phases of development it is usually best to minimise the number of roles to reduce unnecessary complexity.

5.2.1.1 Mental health care user

User definition:

An MHCU is a consumer of mental health care: any individual who self-identifies as wanting greater control over their mental health and seeks out mental health care services. This may range from someone who wants to learn coping mechanisms for dealing with stress to a patient who requires institutionalisation for a severe mental disorder. A mental health care patient is an MHCU who is actively under care of formalised health care services; MHCU can refer to individuals who are not part of the health care system.

User roles:

During the creation of a profile, the MHCU utilising the mHealth service will create a unique identifier (either a pseudonym or an email address), which will allow for the creation of an EHR on the database. For interoperability of an independent system with existing HISs, the unique identifier on the server must be cross-linked with the patient identifier (e.g. a folder number, healthcare number, ID number, etc.) in the health information system of the provincial/national health department. This linking can occur when the MHCU accesses a health facility and then can manually input their HIS patient identifier into their app, which the database can then use to cross-link their EHR with the EHR on the NHIS. (*ISP*)

The MHCU will have access to personal tools and activities, which will be stored in the form of an EHR along with personal details such as medical history.

The MHCU will be able to link their profiles with health care providers and facilities that are also users on the system, by searching lists which provide details from public profiles created by other users. The MHCU will be able to control the amount of information contained in the EHR that is visible/accessible to other users. There will also be various communication channels open between the MHCU and other users, including access to technical support.

5.2.1.2 Community health worker

User definition:

A CHW is a lay worker who has been trained to deliver basic primary health care to a community, particularly preventative and health promotion, monitoring, surveillance and referral services. A team of CHWs will be supervised by a specialist (see below).

Community-based care is still being piloted across the country in specific NHI trial sites (**PHR, MRR**) and has not been implemented nationwide, thus their exact role and position within the health care framework is not clearly defined. CHWs may be affiliated/supplied by a local NGO/NPO (**MRR**), which may complicate supervision and will have to be addressed when the situation is more lucid. CHW activities may be outreach based – going door-to-door or to specific MHCU residences, or based in a clinic or community facility.

It is also unclear whether CHWs will be assigned specific functions – e.g. one CHW will provide on mental health care services – or whether they will provide a “package” of basic generalised primary care services.

Thus this definition needs will need further clarification in the future.

User roles:

A CHW profile will need to be created by a higher authority (see section 5.2.3 below), either the clinic or NGO to which they belong, or their supervisor.

The CHW will be able to personalise their profile to provide personal information to the other users – this may be in the form of a “public” profile that is visible to patients and fellow CHWs, as well as a “restricted” profile containing information for supervisors and health care structures (such as private contact details).

The supervisor and/or clinic will designate patients (with MHCU consent) to the CHW, “adding” them to a patient dashboard. The patient dashboard will allow access to patient EHRs and activities, and allow the CHW to add patient notes and annotate activities within the EHR. There will also be a tool to refer patients to the clinic or other supervisors, as well as communication tools.

The CHW will have access a professional dashboard with eLearning tools, logbooks, communication and reporting tools with supervisors and health facilities, as well as a personal dashboard with debriefing and supportive activities. There will also be access to technical support.

5.2.1.3 Specialist supervisory healthcare professional

User definition:

As with the CHW, there is a lack of clarity surrounding the exact role of the supervising specialist in the new PHC framework. *PHR*, *MRR* and *PSRT* have identified the specialists as typically being either specialised doctors or senior nursing staff who oversee a team of CHWs: ensuring that the CHWs are sufficiently trained and competent, co-ordinating and monitoring their activities and ensuring that they receive support and debriefing services. Typically the supervisor is based at the clinic while CHWs may go out into the community as an extension of healthcare services.

User roles:

A specialist profile will need to be created by a higher authority (see section 5.2.3 below) – probably an administrator at a clinic or a secondary or tertiary facility. Once the profile exists on the database, they can be affiliated with several different facilities.

The specialist will be able to personalise their profile to provide personal information to the other users – this may be in the form of a “public” profile that is visible to patients and colleagues, as well as a “restricted” profile containing information for health care structures (such as private contact details).

Patients can be referred to a specialist by other users (a facility or colleague), or a specialist may be added by the patient directly, which will add the patient profile onto the patient dashboard. The patient dashboard will be similar to that of the CHW (see above), although the referral tool may have more rights associated with it, communication functionalities may differ, and the supervisor will be able to add or remove the patient to CHW profiles.

The CHW dashboard will allow the specialist to create CHW profiles or archive them, access CHW activities, manage CHW patient dashboards, and allow for communication and the sending of instructions.

A professional dashboard will contain aggregated data, communication platforms between colleagues and with associated facilities and eLearning tools. There will also be access to technical support.

5.2.1.4 Primary care administrating staff

User definition:

Administrating staff at a primary care facility do not have any direct contact with patients but oversee the healthcare needs of a community by coordinating CHW teams and ensuring that the correct services are provided.

User roles:

The administrative profile will need to be created by a higher authority (see section 5.2.3 below) – probably a system administrator, or, if the system becomes more sophisticated, a managerial profile with higher authority. The administrator will need to create a public profile containing details for community members.

Patient dashboards will contain service access records of patients as well as limited access to their EHR (contact details, etc). Other functionalities may include referral, scheduling and/or recall tools. The clinic will be able to archive patients by logging a death or transfer to another facility

A service co-ordinating dashboard will contain a master index of patients as well as all health care provider profiles in the area, as well as details of other services for referral purposes. The clinic will be responsible for authorising specialists and/or creating CHW profiles. There may be limited access to supervisors’ and CHWs’ dashboards regarding patient distribution, and there will be various communication pathways for CHWs and supervisors, as well as alerts for patient referrals.

There will be access to aggregated, anonymised data for the area serviced by the facility.

5.2.1.5 Epidemiology terminal

User definition:

This profile can be allows health departments and research institutes to access data collected by the database.

User roles:

The epidemiological profile will need to be created by a higher authority (see section 5.2.3 below) – probably a system administrator. The profile will consist of a user identification and a security key, but the user has no ability to input or change any data in the database.

The profile will have access to anonymised data on MHCU usage statistics, CHW usage data and data for intervention evaluation. There will also be access to a master index of health care practitioners and services.

5.2.1.6 System Administrator

User definition:

The system administrator (sysadmin) is a superuser who has access to the entire system and does not require any form of validation, and must thus be a trusted user of high fidelity who is at the centre of the system design team.

User roles:

The sysadmin is responsible for the maintenance and configuration of the system. The user can control access rights and manages permissions. The sysadmin is responsible for ensuring that data is correctly anonymised, that the security protocols are in place, that data algorithms are correctly handling the data and that the system is generally functioning as intended.

5.2.2 Potential functionalities

5.2.2.1 MHCU interface

- Security: pin
- Profile creation
 - governmental patient ID (optional)
 - medical history (form field)
 - Psychosocial history and information
 - Privacy settings (who gets to use data. Information about data collection)
 - Customisable settings (reminders, themes, potentially choosing from an extended list of features)
- Doctor dashboard
 - Finding doctors and nearby facilities by accessing their public profiles
 - automated alerts to seek help based on EMA trends and the last time health services were accessed
 - List of doctors that are linked to profile and how much information they receive
 - health care facility visits
 - record of facility visits (satisfaction ratings?)
 - receives requests from providers that the MHCU attend a clinic - notification goes away when a clinic visit is registered
 - Communication:
 - IM communication with CHWⁱ
 - asynchronous outgoing: requests for appointments/visits from CHW, requests from health practitioners to access information, refer patient notes, etc.
 - record of therapeutic sessions, notes (audio-recordings?) from sessions (satisfaction ratings?)
 - "Add a doctor" – the MHCU enters the doctors ID code, adding the doctor to the dashboard and authorising the sharing of information.
 - "remove a doctor" (sends notification to doctor)
- Personal tools:
 - Monthly standardised test, based on an existing screening tool β (A,B,C,E,J,K,O)
 - Manual-input EMA: mood and physical attribute variablesⁱⁱ α (17,27,18) β (C,D,E,G,I,J,N,O,P)
 - Automated EMA: wearable tech, phone environment, corresponding to manual-input data. α (14,18,20,19,17) β (P) δ ⁱⁱⁱ
 - Journal: time-stamped free text entry β (A,B,H,I,J,D,P) γ (PSLGT)
 - tagging of key words/themes – tracking of theme recurrence, search by theme.
 - prompt fields (e.g. positive events, contact with friends –PSLGT)
 - Voice entry δ
 - Activities and resources^{iv}
 - CBT-based activities. personalised modules α (12,21,17,15,23) β (A,B,D,E,J,M,N,O,Q)
 - educational articles, podcasts, videos, allowing for exporting and sharing (can have modules aimed for sharing with friends/family for reducing stigma)
 - suicide plan β (A,L,M)
 - reminders of positive things from journal
 - "to do" of self-identified help solutions.^v
 - emergency contacts (possibility to contact them through app)
 - suicide help-line δ ^{vi}
 - Graphical representation and trend monitoring
 - Export/share function for all/any activities
- My medication β (G,H) γ (PSLGT)^{vii}
 - medication history
 - List of current medication with start/stop dates of treatment
 - medication reminders, with photograph of medication, number of tablets, which one to take when
 - find a way to note when medication is/isn't taken to track adherence
 - medication information
 - Monitoring - link to tracking- see side effects, response to treatment δ
 - potential to link up with pharmacy information systems at a future date δ
- other communication tools^{viii}
 - support group/community feature β δ
 - anonymous support from trained lay workers β δ
 - Community IM tool with formal support group within health care structure (with CHWs/supervisors as moderators)

- tech support: IM, web-based, call-line, built in manual

5.2.2.2 CHW interface

- security features: user ID and password
- Profile creation
 - verification tool/authentication instructions to access profile created by supervisor
 - public profile: public details for patients
 - restricted profile: details for specialists, clinic
- Patient dashboard
 - "at a glance" - alerts for patient trends, any warnings
 - notifications from clinic/supervisor to communicate with patients
 - individual patient selection
 - data from patient device^{ix}
 - journal reading, commenting
 - graphical representation of EMA data
 - communication
 - IM communication with patients
 - asynchronous: request for access to patient data, recommendation of articles, activities
 - consultation tools
 - log book and electronic note-taking tool
 - diagnostic tools γ (PHR)^x
 - survey tool for additional epidemiological data collection on demand.
 - referral tool – to supervisor or clinic^{xi} γ (MRR)
 - Tool to send notifications about patient to supervisor or clinic
- Personal tools^{xii}
 - own journal
 - own EMA
 - debriefing tools
- Professional tools
 - compile log book from individual patients
 - to do list: receives instructions from supervisors and clinic
 - training activities eLearning α (35)
 - IM Communication: α (3) (22) γ (PSRT, SSR)
 - one-on-one communication with supervisor
 - community forum with other CHWs in team as well as supervisor
- tech support: IM, web-based, call-line, built in manual, call-a-supervisor/colleague

5.2.2.3 Supervisory specialist interface

- Security: user ID and password
- profile creation
 - verification tool/authentication to create profile
 - registering tool to add CHWs
 - public profile for MHCUs
 - restricted profile for clinic interface, CHWs,
- patient dashboard
 - "at a glance" - alerts for patient trends, any warnings
 - notifications from clinic/CHWs about patients, alerts if a patient has not received care for a set period of time.
 - individual patient selection
 - data from patient device
 - journal reading, commenting
 - graphical representation of EMA data
 - communication
 - IM communication with patients δ
 - asynchronous/one-way: request for access to patient data suggestions for activities, sending them in for an appointment.
 - consultation tools
 - patient notes
 - diagnostic tools
 - activity recommendations for patient
 - referral tool^{xiii} γ (MRR, PSRT)
 - suggest a referral of a patient to another specialist/doctor
 - remove a patient from a CHW patient dashboard
 - refer a patient to a CHW patient dashboard
 - refer a patient to a clinic
 - archiving of patients after referral^{xiii}
- CHW dashboard^{xiv}
 - tool to "add" CHWs
 - tool to "archive" CHWs (requires approval from clinic administrators)
 - manage CHW patient dashboards
 - remove a patient from a CHW patient dashboard
 - refer a patient to a CHW patient dashboard
 - access to log books - monitoring of CHW activities
 - potential graphic display of hours spent active, etc.
 - managing CHW training activities
 - access to CHW journal, EMA, etc. (on request?)
 - send instructions to CHWs ("to-do list")
 - IM Communication: α (3) (22) γ (PSRT, SSR)
 - one-on-one communication CHWs
 - community forum with all CHWs in the team
- Professional tools
 - statistics for supervising area
 - "find a colleague".
 - IM communication with colleagues
 - to do list (can link to contacts), receives instructions
 - eLearning platform (connection to health news?) α (35)
- tech support: IM, web-based, call-line, built in manual, call-a-supervisor/colleague

5.2.2.4 Primary care clinic admin interface

- Security: user ID and password
- clinic profile creation
 - verification tool/authentication to create profile
 - public profile: contact details, services offered, catchment area, opening hours, etc.
- patient dashboard
 - logs patient access to facilities (QR code?)
 - recording of time/date, doctor seen, patient notes, prescriptions δ^{xv}
 - limited access to MHCU's doctor dashboard (which doctors they are seeing)
 - scheduling δ^{xvi}
 - referral tool^{vi} γ (*MRR*)
 - "send" a patient to a specialist - requires permission of specialist and patient. sending of patient file requires extra permission.
 - "send" a patient profile to a CHW - requires permission of patient. sending of patient file requires extra permission.
 - Refer patient to a secondary or tertiary institution
 - noting death of patient, request archiving of MHCU profile.
 - communication
 - asynchronous/one-way: request for access to patient data suggestions for activities, sending them in for an appointment.
 - Medication δ^{xvii}
 - Monitoring adherence
 - Monitoring prescription practice
 - Sending notifications for prescription collection
- service co-ordination dashboard
 - master index of specialists, CHWs, other mental health providers in catchment area
 - details of other programmes. facilities, private sector practitioners NGOs
 - master index of patients in the catchment area
 - limited access to patient information
 - limited access to view (?edit?) supervisors' CHW dashboard (which supervisors are overseeing which CHWs)
 - access to log books of CHWs
 - limited access to view (?edit?) CHWs' and supervisors' patient dashboards (which care providers are overseeing which patients)
 - alerts when patients are referred.
 - verification tool to authorise supervisors and CHWs, adding them to service provider dashboard
 - send instructions to CHWs
 - send instructions to supervisors
 - "map" function to locate CHWs, patients
- statistics
 - access to aggregated, anonymised data for catchment area
- tech support: IM, web-based, call-line, built in manual, call-a-supervisor

5.2.2.5 Epidemiology terminal

- Security – strong password
- anonymised MHCU EMA statistics α (14) (24) γ (*PSRT, SSR, i*)
 - incidence, trends, risk, outcomes, co-morbidities, distribution.
 - Health service usage
 - medication use, outcomes of medication
- usage statistics
 - frequency of use of each interface (time, location, amount of data)
 - amount of communication
 - of CHW performance – assess fidelity of CHW programmes
 - distribution of services, penetration
- ongoing evaluation of intervention α (25)
 - completeness of data sets, completion of activities
 - continuity of care
 - outcome variables, efficacy
- master index of services: clinics, practitioners, CHWs

5.2.2.6 System administrator

- security: enter ID and codes
 - secure password
- management of permissions
- removing identifiers from profiles
- compilation of master indices
- monitoring for rogue users/bad data
- monitoring IM content for inappropriate content
- updating system, optimising interoperability
- following up/archiving inactive profiles

Key:

- α supported by literature
- β provided by applications available online (see section 5.1.1)
- γ supported by experts (specify)
- δ not recommended for incorporation into initial designs

ⁱ Distance communication could be of huge benefit for increasing accessibility to care (22) (14). However, instant messaging between the MHCU and a health care giver – whether a CHW or a professional – changes the nature of the patient-practitioner boundaries from traditional models. Boundaries would have to be placed regarding availability, intimacy and privacy, and the system must attempt to address the possibility of abuse (see privacy, security and legal aspects). The respective comfort of practitioner and patient with text-only communication (including their typing skills) may have an impact on the quality of communication, and fear of the power of the written word may constrict conversation (**PSRT**). Literature has begun to evaluate the efficacy and risks of distance therapy (24) and development and design would need to take a risk-based approach to determining the type and amount of contact between various users.

ⁱⁱ Manual-input EMA consists of a series of sliding-scale questions to evaluate variables of well-being, recorded as values that are language independent. A standardised set of variables can be customised by a very extensive list of optional mood/physical symptoms to allow for monitoring of co-morbidities, watching for side-effects or looking at personal factors. Graphical representation of trends would be appealing to MHCUs. Entries should not be limited to a time-frame, but reminders to fill in data can be customised. Pattern/trend recognition using data analytics can provide can be useful for treatment, and negative trends in certain variables (e.g. suicide risk) may send an alert to the patient to seek help or to a health care giver to seek out the patient. Determining how to create, analyse and compile useful data requires further investigation with mental health care practitioners and statisticians. (**PSLGT**)

ⁱⁱⁱ Although context-aware EMA shows promise as an unobtrusive, yet effective intervention with monitoring and prognostic value (18) (20) (19), more advanced/expensive technology would be required (higher-end smartphones or wearable technology), which would significantly limit accessibility. More complex EMA features could be considered later in development or as an optional extra (**ITE**)

^{iv} Activities and resources should be carefully designed and evaluated for efficacy, acceptability and priority. Activities that have been found on online marketplaces (see ETS) or mentioned (13), but which do not provide any significant evidence of efficacy, include hypnosis, brainwave entrainment, audio-therapy (A,O), sleep analysis (through automated EMA) and instructions on sleep hygiene (O), exercise plans, instructions for meditation techniques, audio recordings, daily motivational quotes (H), goal-setting (C,O), etc. The specific therapeutic functions should be assessed during the design process. See development and design

^v **PSRT** mentions that there are “escalation levels” in terms of suicide risk and the intensity of suicidal ideation, which may suggest a possibility of designing multi-level suicide plans.

^{vi} Already existing hot-lines, creating one would be unnecessarily human-resource-intensive.

^{vii} Medication adherence is a major health concern, particularly with psychotropic medication (PHR, **PSLGT**, **PSRT**). Medication reminders, with a photograph of the medication (stored locally), how many pills to take and how to take them could help an MHCU take control of their medication. Extra information on effects, side-effects and warnings, potentially linked to the EMA feature would allow monitoring of efficacy – useful to MHCU, practitioners and epidemiologists. Reminders to pick up medication could also be helpful, particularly if it can be linked into existing pharmacy/prescribing information systems. A tool where an MHCU reports on actual adherence (specialised dispensing systems have been described), could also be very helpful if it can be effectively designed. Determining

the level of complexity and sophistication would need to be decided on during the design process (See development and design)

^{viii} Although support groups are an important part of recovery (**PSRT**) (16), any form of anonymous communication would require strict monitoring to prevent destructive/traumatic interactions (**PSLGT**, **PSRT**). Moderation would be human-resource intensive, especially if professional support is supplied. Professional moderation also carries issues of maintaining professional accountability.

^{ix} **PSRT** warns against providing CHWs with too much information that they are not equipped to deal with – for example intricate details about responses to medication.

^x CHWs can be equipped with simple interactive diagnostic algorithm tools, with electronic versions of interventions such as the PC101, to assist with screening and basic treatment decision-making (**PHR**).

^{xi} **MRR** outlines his project, a simple CHW-clinic referral pathway. CHWs are issued with mobile phones and the clinic staff with a tablet. If the clinic staff want to send a recall to get a patient back at the clinic, a message is sent to the CHW, who will track down the patient. If the recall is successful, the recall will close. Similarly, if a CHW encounters someone that they feel needs to attend the clinic, they can enter the referral onto the system, and the clinic can close the referral when the patient attends the clinic. The NPO functionalities (tablet) included a dashboard displaying all CHW visit records, generated automated reports and individual/team communication with CHWs. The hospital tablet could send birth notifications to the clinic and send recall requests to clients. The clinic tablet could send recall requests to clients or CHWs, send medication collection reminders to clients, access records of CHW visits to clients, access CHW referrals and communicate outcomes back to CHW. The CHW mobile phone functionalities included CHW initiated interaction with clients including a record of services provided and referrals made, visit-notes that are sent to the supervisor and reminders to clients; interactions with the general population including recording health promotion visits and referrals and clinic initiated interaction with clients including receiving recall requests and reporting the outcome to the clinic. The referrals in this system contained very little information regarding patients and functioned only between CHW and clinic. By containing more information in referral requests, processes at the clinic could be streamlined. Other levels of referrals to be considered include referrals between the levels of care. Ideally the EHR of the patient, including referral notes from the practitioner should be easily accessible to any doctors doing follow-up investigations in different facilities. A referral system should be able to track the movements of patients through various facilities in order to maintain continuity of care.

^{xii} Due to the lack of formal training, CHWs may struggle to debrief after supporting MHCUs. Having their own journal and EMA monitoring tools, which can be shared with their supervisors if they wish, may prove helpful. Training activities may also include de-briefing tasks.

^{xiii} Although patients should be able to be archived from the practitioner dashboards when they are referred or no longer being serviced, care must be taken that continuity of care is maintained (**PSRT**), and that patients does not “drop off the radar”. For this reason, the clinic is notified when a patient is archived from a supervisor’s dashboard. The patient may also receive a notification when they are archived – which they can accept/reject.

^{xiv} Further supervisory features may be explored when the nature of the supervisor-CHW relationship becomes more established as the NHI framework is rolled out.

^{xv} This process places a large burden on the administrative staff and may duplicate information that is recorded into native governmental health information systems. Ideally the information could be

retrieved from the existing HIS (although this would require a high degree of interoperability), or would be put into the system by the doctor at the clinic into the system database, which becomes available to the government health information system separately

^{xvi} By receiving referrals from CHWs and specialists, or requests from MHCUs for appointments, the system could theoretically schedule days/times for MHCUs to visit the clinic. However, considering the lack of any kind of schedule system existing in clinics currently, it is unlikely that the idea could be carried out.

^{xvii} Medication adherence is a major health concern, particularly with psychotropic medication (PHR, **PSLGT**, **PSRT**). Medication reminders, with a photograph of the medication (stored locally), how many pills to take and how to take them could help an MHCU take control of their medication. Extra information on effects, side-effects and warnings, potentially linked to the EMA feature would allow monitoring of efficacy – useful to MHCU, practitioners and epidemiologists. Reminders to pick up medication could also be helpful, particularly if it can be linked into existing pharmacy/prescribing information systems. A tool where an MHCU reports on actual adherence (specialised dispensing systems have been described), could also be very helpful if it can be effectively designed. Determining the level of complexity and sophistication would need to be decided on during the design process See **development and design**

5.2.3 Data flows

In order to maintain the fidelity of the intervention, it must be ensured that the right users get the right data in the right format. This means ensuring that the MHCU maintains control over who has access to their EHR through controlling permission pathways while promoting more efficient referral systems, but also validating/authenticating the identity of the health care practitioners and ensuring that information is anonymised correctly, so that certain users only receive anonymous data. The last point is a technical issue rather than a conceptual one, and will not be addressed in this section.

5.2.3.1 User validation and authentication and integrity of data

Once an intervention grows in scale sufficiently that not all users are personally known to the sysadmin, a system must be put in place to ensure that users are who they claim to be, that they have a right to access the data they are being given permission to access and that the data they are putting into the system is valid data.

ISP outlines two processes that are used by information systems to grant access to users, besides having all users manually added by the sysadmin. The first is that the system uses the same authentication profiles as another trusted system with the same users: if the NHIS develops a system for all registered practitioners using a “provider identifier standard” (6), a second information system could their identification system to create a “single sign-in”. However, this requires a high level of trust between the two systems, and the NHIS is unlikely to be sufficiently mature in the near future to allow for utilisation of this method. The second process is known as a “web of trust”, where every new user needs be validated by a user with a higher level of access than the prospective user. To provide an example in the context of this project: the sysadmin authorises profiles for clinic administrators (as the project scales up, more administrative and managerial users with higher access can be created), who in turn authorise profiles of supervisors and CHWs, and the supervisor authorises the profile of CHWs. The web of trust becomes complicated when users do not fit into a hierarchy, which is particularly true in the healthcare system with superimposed private and public systems and multiple forms of specialisations and multiple chains disparate career paths and varying administrative pathways. MHCUs exist outside of this validation system, as they have no access to data beyond their

own EHRs and the public profiles of health workers and facilities. Thus an MHCU profile is created when the user first accesses the system.

The exact process of authorisation will need to be elaborated upon: whether the higher power creates the profile for the subordinate who then gets an access code (more appropriate for CHWs); or whether the user creates their own profile and requests validation (more appropriate for specialists); and whether validation requires face-to-face contact using a method similar to Bluetooth pairing or QR code (Quick Response Code) scanning, or whether it can be done remotely through systems like one-time-pins.

This cascading method of validation requires close monitoring for “rogue users” who add too many users, or users that start creating bad data or accessing files that shouldn’t be needed (*ISP*). Ensuring the integrity of data is a whole sub-discipline of information system sciences that looks at controls and data quality measures (*ISP*). Although rogue users that have been incorrectly validated as health care practitioners or CHWs is far more worrying for patient care, it is also a concern if non-existent MHCUs start skewing health information systems data. While there are human controls, where supervisors and administrators should be aware of the data that their subordinates are collecting, *ISP* notes that immediate data validation rules can be implemented (for example if a CHW inputs the same data for multiple records), and batch statistical analyses on the types of records can be performed. *ISP* also suggests attention be paid to previous initiatives as many of these issues will have been addressed by other large-scale data collecting projects (such as those created by *Cell-Life* and *Mobenzi*) – and states that these problems can be addressed in multiple stages as it only becomes a more prominent problem as the project scales up.

5.2.3.2 *Permission-seeking and data access*

In the modern health care context, control over health information should lie in the hands of the patient. With the proposed system, the patient can view and edit their own EHR at any time, as well as control which health care practitioners and facilities can access what data. In order to allow the patient control while maintaining flexibility within the health care system and ensuring that health care professionals can access the data they need to provide competent, continuous care, an efficient permission-seeking system must be created. There is precedent for these systems, especially in private health information systems created by medical aid corporations (see section 3.4.2).

The interviewees stressed the importance of such a system, with *PSRT* noting that the process is currently typically very clumsy if the patient is not present, and that being able to electronically refer patients could be very useful. *SSR* also brought up that it could help address issues of continuity of care if health care providers can efficiently access EHRs without having to go through inefficient paper-based systems run through complex administrative systems, but can simply request it directly from the patient.

What follows is a proposed permission-seeking mechanism.

On initial set-up, the MHCU can set default privacy settings regarding what is sent to health care professionals, clinics and whether or not their anonymised data can be collected for epidemiological research. At a consultation, the patient will add a health care practitioner using search tool. The practitioner will be asked to confirm/decline the request. Should the practitioner confirm, the practitioner will be added to the MHCU’s “doctor dashboard”, and the MHCU will be added to the practitioner’s “patient dashboard”. The MHCU will have to confirm the privacy settings for data sharing, and will be notified that they have been added to the clinic’s patient list (if they are not already on the clinic’s system) and will have to confirm those privacy settings.

The health care practitioner has a tool to request more data from an MHCU which will come up as an “accept once/always accept/reject” function which will change the access profile for that practitioner accordingly.

Should the health care practitioner want to add an MHCU to a CHW dashboard a request gets sent to the MHCU with an “accept/reject” function (and potentially a text field for an explanation of the intentions) and the MHCU will be asked to confirm the privacy settings for the CHW profile. Once the patient accepts, the patient gets automatically added to the CHW’s “patient dashboard” with a notification to alert the CHW to the addition.

Should a health care practitioner want to share MHCU information with a colleague, the practitioner will have to manually select the information (for example, diary entries between specific dates), and send a request to the MHCU in the form of an “accept/reject” request that comes with a text field and the public profile of the professional receiving the information.

Should a health care practitioner wish to refer a patient to a colleague, again, the MHCU will be notified through a request, a text-field and the profile. The receiving practitioner can also accept/decline. Once the receiving practitioner has accepted, the MHCU gets notified and is asked to confirm the privacy settings for the new practitioner. Once the referral has been confirmed by both the receiving practitioner and the MHCU, the referring practitioner can choose to archive the patient, removing the MHCU from the immediate “patient dashboard” – which the MHCU will be notified of. The clinic will also receive a notification of the referral. This process will hopefully ensure that continuity of care is maintained and that patients will not “drop off the radar.” That said it is recommended that all referrals are discussed face-to-face with the patient, but the system allows for remote referrals to increase accessibility.

Despite the system described above, a mechanism for accessing health information without consent in the case of a medical emergency should be built in. Access could be gained by stating the nature of the emergency (through a code, for efficiency). The system could potentially keep a record of all files accessed by the health care provider during the emergency and be related to the patient after the fact, and the health care provider can be held accountable for actions taken, with sufficient freedom that health care providers do not restrict their actions for fear of litigation.

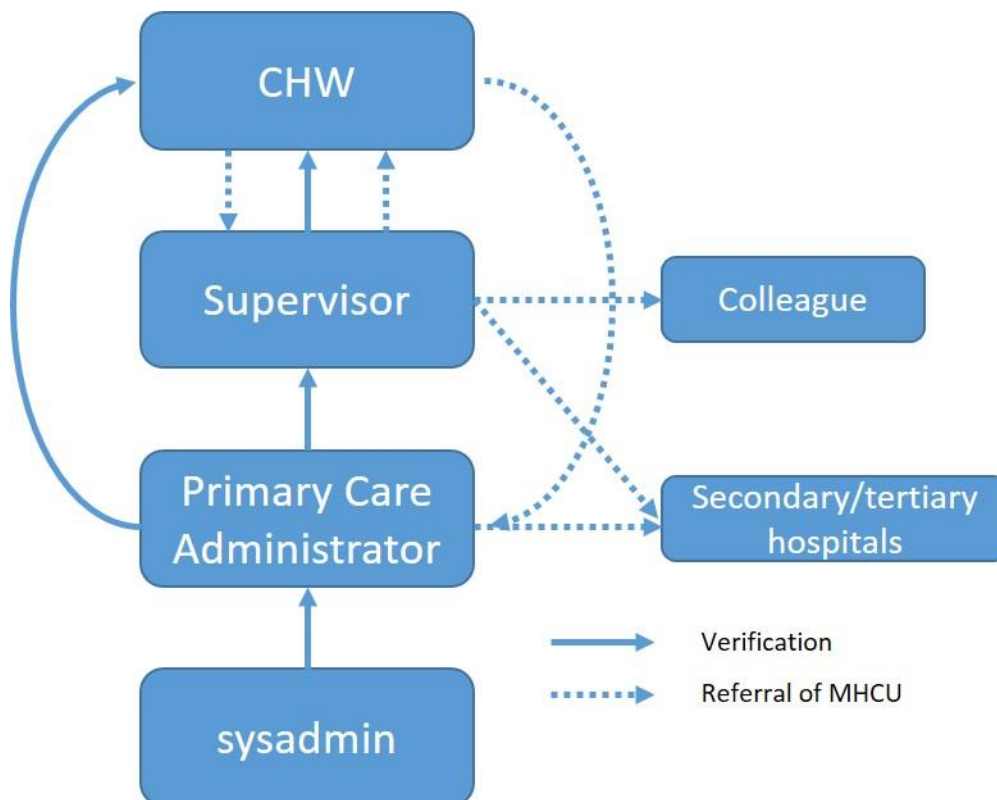
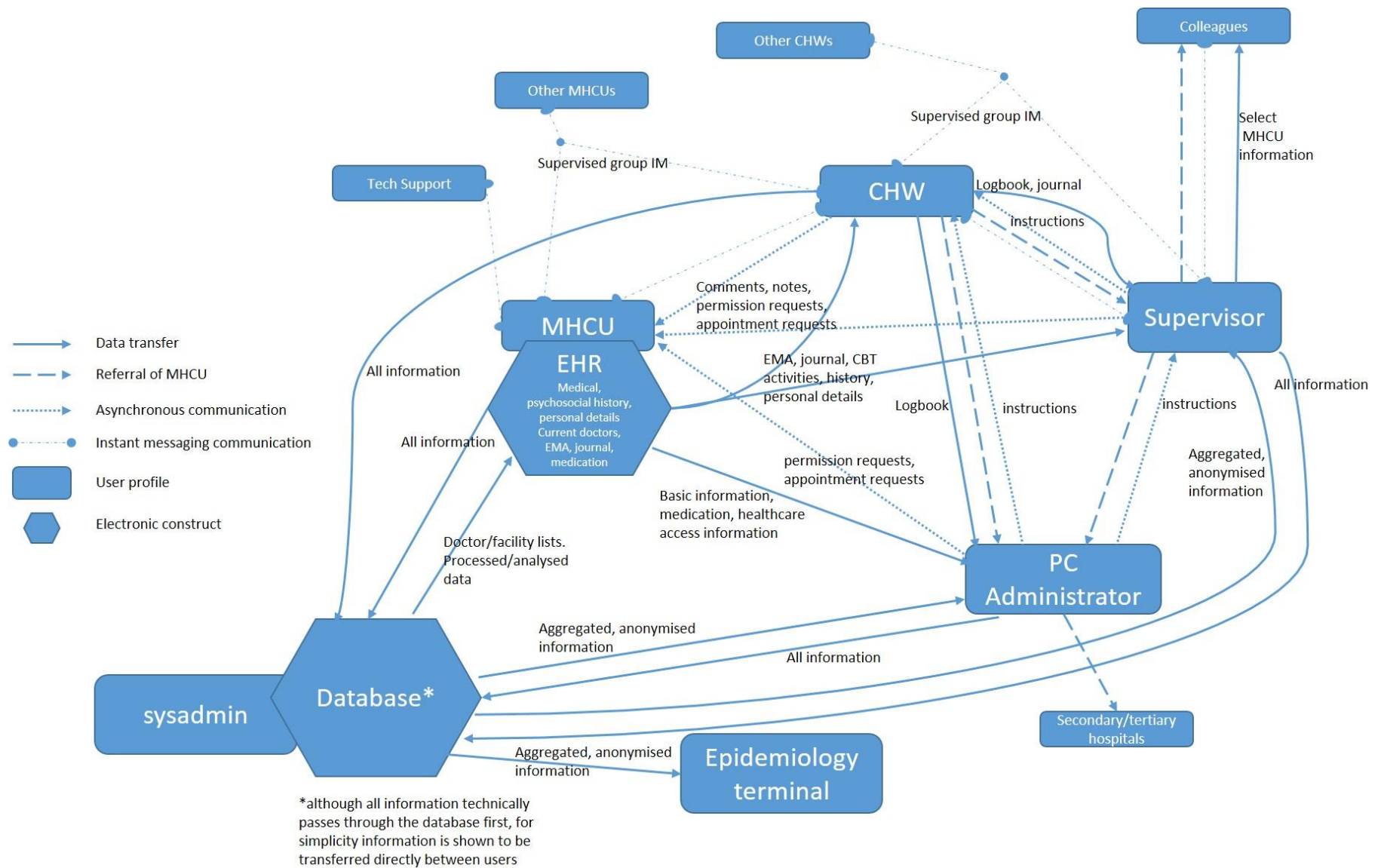


Figure 1 User validation/authentication web

5.2.3.3 Flow of information

Different functionalities require different levels of communication and interaction with the backend database. Information systems research provides various methodologies for describing the flow of information, including data flow diagrams and object models, these are highly technical exercises which the author is not qualified to design. In the same vein, the IHE profiles could also be used to clearly define the transfer of information, but functionalities would need to be more precisely defined by programmers and information systems specialists for these exercises. The below diagram is a lay-person's design of the flow of information in the proposed system.



5.3 BUSINESS MODELS

One of the key challenges in designing and implementing m- and eHealth initiatives in Africa is that policies and designs that are designed for developed countries are incompatible with the socioeconomics of lower middle income countries (38), and there are insufficient resources in public sector health for adequate technology for a functioning eHealth framework (26). Thus m- and eHealth frameworks (26,36,32), as well as research frameworks (35,22,31,25,3,34), all emphasise sustainability and cost-effectiveness as key components of any prospective intervention.

5.3.1 *Assessment of costs*

According to *ISP*, the costs involved can be categorised as development costs and running costs, which both feed into costs relating to sustainability and scalability.

5.3.1.1 *Development costs*

Development costs of designing and programming the system are typically the biggest. *ITE* notes that it is almost impossible to accurately estimate the development costs in advance (half of experienced developers will underestimate time required by a half), which can result in funding drying up and investors pulling out. The number of “programming hours” will also depend on the functionalities and the sophistication of the system (*ISP*).

There are various options regarding expenditure on programming and system development, which, unsurprisingly, has an impact on the quality and flexibility of the system. The first option is to source dedicated programmers with experience in building robust, industry standard applications and information systems (*ITE*, *ISP*). There may be a permanent position beyond initial development for system maintenance by someone familiar with the code and the frameworks. These resources are scarce in South Africa, and often development is outsourced to China or India (*ISP*). Another option is to outsource development or use existing interventions, which can significantly reduce programming hours (*ISP*) – many of the tools described by in Section 5.2.2 have been developed in the past (*ITE*), and *ISP* warns against “reinventing the wheel.” For example, creating an IM platform is described as “non-trivial” by *ITE*, and have been perfected in commercial products like WhatsApp, Facebook’s *Messenger*, Google’s *Hangouts*, etc. These would require entering into a business agreement with the developers, and imbedding large applications directly is “tricky” (*ISP*). Outsourcing development, whether using specific functionalities designed by another corporation, or allowing an outside company to develop the entire system, has been the precedent for mHealth in South Africa in the past, using companies such as *Mobenzi* and *Cell-Life* (see Section 9.4) is typically “a bit easier to do” (*ISP*) because they tend to use SOA models. These companies also have experience in the South African Health care context (*MRR*) and have established highly relevant functionalities and data models/structures. Another, cheaper option is to use students from academic institutions to develop code as part of a design science project, but due to lack of experience, the programs are typically of a very poor quality and are unable to stand up to rigorous use in the field (*ISP*). This applies to a certain extent to NPO programming projects (such as *South Africa Health Information Systems Programme* or *Coding for Africa* – *ITE*), where, although well-intentioned, they do not have the resources or the capitalist incentive to maintain the same standards as for-profit organisations (*ISP*). The last alternative is to use open-source code. This is particularly feasible with the more basic functionalities (*ITE* notes that many of those suggested aren’t particularly complex), and, barring complexities of reading foreign code, it can be incorporated and manipulated to suit the exact needs of the initiative. Again, however, the quality is often questionable, although active community development can result in very high quality applications (*ISP*). Bearing the above in mind, the majority of these suggestions

cannot be implemented in isolation and will still require dedicated programmers to form a coherent eHealth solution from the various “pieces” of functionalities that can be sourced externally.

Other initial costs, besides system development, include building up the eHealth framework to support the intervention: supplying CHWs with tablets, setting up broadband connections to primary clinics, providing basic training to hospital staff, etc. However, this is essentially the role of the NDoH (*ISP*), and the benefits of developing the ICT capacity of the health system would have benefits beyond the scope of the individual intervention, particularly in the context of the NDoH’s eHealth vision (26).

5.3.1.2 *Running costs*

Besides computing costs and data storage costs involved in maintain a functional server (*ISP*), in their eBook on “*Lessons Learned*” Acfee (34) outlines several running costs, including system administration and payments to ICT suppliers and contractors for services, running costs of developing new services, upgrading services to prevent obsolescence and the salaries of extra ICT staff and the resources for maintenance and support staff (34). *ISP* does note, however, that the better and more robust the initial system is, the lower the maintenance costs will be. More minor, but important, costs to consider include provision of data bundles to CHWs (*MRR*), which often rely on collaboration with telecommunications service providers. *Vodacom Business* has reportedly committed to supporting government mHealth initiatives (28). However, a goal of development should be to keep data traffic to a minimum, particularly for the MHCU, who cannot foreseeably be viably reimbursed for data used by the application.

5.3.1.3 *Sustainability and scalability*

Sustainability of a project usually depends on the correct assessment of the running costs and the development of sustainable investment plans, and Acfee (34) highlights the importance of carefully evaluating resource needs and prioritising them and carefully designing a business model accordingly. Proof of sustainability is vital for attaining systems support (32,36,26), and a reliance on aid handouts, sponsorship, donations and external funding, which lasts only as the funders maintain an interest, has resulted in the failure of many mHealth initiatives to grow beyond trial phases (25,3)(*MRR*).

Scaling up a project will result in a significant increase in both development and running costs as design teams enlarge and data integrity becomes a more significant problem, besides other human and non-human resources required. However, efficacy data and success stories could then be used to motivate funding appeals to the NDoH and other bodies (*ISP*, (31)). Should the author’s intention of having continuous additions to the functionality of the system as the project scales up, development costs will be almost continuous.

5.3.2 *Cost effectiveness*

But beyond simply identifying and quantifying the costs, it must be decided that the cost of the project is outweighed by the potential benefits of the intervention (14) i.e. the cost effectiveness must be evaluated through a health economic assessment (*MRR*). This extends to assessing whether similar efficacy and results could not be obtained with interventions that are less resource intensive (*PHR*, *SSR*). That said, the proposed intervention has far-reaching benefits and potential areas for further eHealth development beyond the scope of the initial intervention.

5.3.3 *Sourcing resources*

In terms of self-sufficiency, *ISP* notes that the project does not have much capacity to generate revenue. The interviewee suggests that in-app purchases or upgrade potentials for added functionality may generate income from users, and that many users would even be willing to pay an initial price to buy the app if it has the potential to reduce spending on health care, however, whether this is

applicable to impoverished communities with the least access to health care is doubtful. Wearable technology developers may see a vested interest in promoting monitoring interventions, if wearable EMA functionalities are incorporated. Another option, alluded to above, would be to source money from in-app advertising or data farming – although the latter has very questionable ethical integrity (see the following section).

The public health sector by definition is maintained by the NDoH. As an intervention geared towards the public health sector, the NDoH ideally should have a vested interest, and to a certain extent, a responsibility in providing funding for initiatives. Indeed, it pledges to allocate resources to m- and eHealth development in the respective strategies (36,26). However, realistically speaking, with South Africa's "quadruple burden of disease" (33) and resource-limited public health system, the NDoH may not see m- and eHealth development as a priority (note the author's previous comments on the lack of reference to mental health in the face of more "pressing" issues), and **MRR** notes that a lack of health department support is a major barrier to sustainability.

Public health bodies often rely on tangible efficacy and cost-effectiveness data to guide decision-making around supporting initiatives, but often there can be no proof of efficacy before the system is designed, resulting in a "catch-22" situation (**MRR**) (**ISP** describes it as a "chicken-and-egg" problem). Sourcing funds typically depends on human convincing and marketing, relying on theoretical or authority-based arguments (**ITE**). However, NPOs and international philanthropic organisations committed to nation development have in the past shown willingness to provide sponsorship (see the lists of mHealth initiatives in South Africa in Section 9.4, which include information on collaborators on projects).

Private health institutions, who generate profit from inpatient hospitalisation and face-to-face healthcare services, are unlikely to support an intervention that promotes distance monitoring, self-treatment, prevention and actively aims to deliver more cost-effective care. Medical insurance companies, on the other hand, generate profit from reducing hospital/healthcare costs and would thus for the same reasons potentially support such an intervention, as well as having an interest in aggregated health data – indeed this is probably the rationale for developing their own patient-centric EHR, distance monitoring, and mHealth interventions.

With particular reference to medical insurance firms or pharmaceutical industries which are notorious for controlling and manipulating information, any reference to private corporations within the app or in initiative advertising/marketing may cast doubt on the credibility of the intervention and could arouse suspicion in the user regarding privacy, for the reasons outlined above. In an informal conversation with a consultant for a major insurance company involved in eHealth, it was mentioned that a long history of a dual health system has resulted in distrust in the health care field, with more or less justification: the middle-class consumers distrust the quality of service provision in the public sector; the public sector distrusts any philanthropic gestures of the private healthcare sector that is not overtly profit generating; and the private sector believes that the public sector is stagnant due to inefficiency and wasteful spending.

That said, ideally the eHealth network can incorporate all healthcare services, public and private, to ensure that the MHCU has access to maximum service-provision. Individual private practitioners are unlikely to oppose the intervention and may be persuaded to become engaged in the project, because the author believes that the majority of practitioners do have the best interests of their patients at heart, however, it may be a negatively influencing factor that there is no readily apparent mechanism to reimburse practitioners for distance monitoring (Ernest & Young (14)) proposes that new business models be generated).

Throughout the development and assessment of business models, attention must be paid however to ownership rights of the technology, and who has access to information. Engaging in business agreements with private health care stakeholders must be done with caution, as there may be stakeholder tension if private companies see benefit in controlling the data and mHealth market, and maintaining siloed health information structures. *Psrt* warns against allowing these institutions to have access to too much information which can be used against the patient, and notes that there is very little mechanism for private/public collaboration at an information level (e.g. the transfer of patient files) to inform decision-making, although the government is well-versed in outsourcing certain services. Although Tomlinson *et al* (25) suggest a commercially viable ecosystem may be formed through cooperation between governments, funders and industry, considering the aforementioned distrust and tension, the author believes development and leadership that is coordinated and supported by a neutral third party, such as an academic institute, might be welcomed.

5.4 PRIVACY, SECURITY AND LEGAL ASPECTS

The above sections have made oblique reference to the stewardship of patient information, because with more data availability, connectivity and accessibility comes the risk of misuse of information. This is also intimately linked with concerns about the security of the information system that stores the information. Although generic laws such as the *Protection of Personal Information Act of 2013* (39) can be applied, the immaturity of the m- and eHealth fields, particularly in large scale interventions, there is limited specific legal protocol to advise mHealth and eHealth interventions and any mHealth initiative, like any health intervention, must also be evaluated through a risk-based approach (34,22) to understand the potential harm that may arise from mHealth programmes.

5.4.1 Privacy of patient information

A complex permission-seeking system is described in Section 5.2.3.2 to ensure that the MHCU is able to maintain full control over who has access to their EHR and how much access each user has. This includes customisable protocols for each and every healthcare practitioner and facility, and the option to allow exceptional access to information. The MHCU will also be able to control whether their personal data and usage information is used anonymously for epidemiological and statistical purposes. In this way, the patient can be said to own the data, rather than a health system. This is in-line with contemporary patient-centric care models (14,27) and policies regarding transparency of the flow of information.

However paternalistic care models have dominated for so long that there is significant inertia to overcome. This may be why patient control of the EHR is not a major focus of the NDoH eHealth Strategy (26) (or it could simply be due to the technological complexities it introduces). *Psrt* brought up interesting counterpoints that practitioners may feel disempowered if they cannot access patient records at will, and particularly in the mental health care context, information that the MHCU wishes to hide is the information that is often most relevant – and although this runs contrary to the grain of personal privacy and human rights conventions, it can be argued that, although it is paternalistic, it remains in “the best interest of the patient” that the practitioner has access to the information – especially if the information can prevent self-harm or harm to others.

A barrier to clearly defining access controls for an electronic system is the lack of clarity or formal protocol/regulations for protecting patient information and controlling access to patient files in the current health systems. The author has noted from personal experience that patient folders are often left lying around wards. *Psrt* notes that at a clinic level psychiatric notes are incorporated into the general folder, and thus sensitive information is omitted or written cryptically to prevent stigmatisation from general clinic staff, although at hospitals psychiatric files may be kept separately.

Another point that **PSRT** mentioned, reiterated in an informal conversation with a legal expert, was that the current system is based on “compassion” and trust – while it is not overly difficult to gain access to patient files, health care practitioners are expected to adhere to personal ethical standards regarding patient confidentiality, and use professional judgement when to share information with colleagues for a second opinion or corroboration. However, an electronic system relies on formalised protocols and thus requires such interactions to be defined.

5.4.2 *Security*

Linked to controlling access to patient information includes the security of the database – it is pointless creating complex protocols for access control if the database can be easily accessed by unauthorised users.

The problem of security can be approached from a purely technical perspective, however, both **ISP** and **ITE** agree that although it is possible to do security badly, developing security systems for large information systems of protected information has been done many times before (“the security technology is mature it’s used daily in lots of different ways” – **ITE**). This includes protocols for data encryption, storing primary keys separately from the data, anonymising data separately from personalisation data, backing up the data, etc. (**ISP**).

Linked to this is how secure each of terminals are to human imposters. Usually this is controlled through simple password/pin login systems, although biometric controls can also be used. Using online, Cloud solutions rather than apps mean that data is not stored on devices, adding an extra layer of security. Another consideration is that in South Africa, cell phones are often shared, thus access to the MHCU terminal must have certain restrictions – although phone security is usually deemed sufficient (**ITE**).

However, **ISP** points out that if a system is properly configured, the main point of weakness is the human controls (or “social engineering”) – this concerns issues of password stewardship for example (has the CHW changed the default pin from “1234” – **MRR**), and whether health professionals log out of the system before leaving a work station, etc. There is increasing risk with higher users as they have access to more patient records and more data; the sysadmin will have access to the anonymising protocols. Thus higher users must be appropriately trained to keep their login details secure.

A final concern that ties into the issue of security is who is given permission to access to the system. User credential validation and authorisation is fully explored in Section 5.2.3.1 – but again, as users are given more power – such as those gaining access to the epidemiology terminal – more care must be taken into ensuring that users are “who they say they are” and that they can be trusted to maintain security standards.

5.4.3 *A risk-based approach: potential to do harm and liability concerns*

Oloff (27) and Tomlinson et al (25) highlight the fact that the efficacy, acceptability and risks of mHealth have not been sufficiently determined following medically sound risk-based assessments, which is vital before it is ratified and taken up by health systems. The majority of apps available on the marketplace give no evidence to support their functionalities (13).

Although there is a growing body of knowledge surrounding the efficacy of distance CBT, other integral functionalities lying at the heart of the intervention may cause more harm than benefit, with the potential of facilitating looking inwards, when this may not be helpful (**PSRT**), and self-treatment using an app may allow MHCUs to justify avoiding formal healthcare – and the risks of such self-care again are unknown.

Although EMA analysis and trend extrapolation will hopefully be able to provide warning signs for potential decline in mental wellbeing, and initiate health-seeking action on the part of the MHCU or bring the trend to the attention of overseeing health practitioners, there may be a question of liability if the algorithms fail to recommend that an appointment be made, in a scenario of suicide or complete mental breakdown.

The IM platforms suggested by the study are also a significant area of concern. Psrt highlights how this will change the nature of the patient-practitioner relationship due to increased communication (**PSRT**). Boundaries would have to be placed by healthcare providers to prevent excessive familiarity with patients which may result in unhealthy dependency or intrusion into practitioners' privacy or personal lives. CHWs and even qualified professionals may not have sufficient training/knowledge/capacity to establish boundaries clearly.

There are also added complications surrounding the recording of patient-practitioner and even collegiate IM interactions.

Unregulated IM platforms such as patient forums, anonymous counselling services are considered by the author to have too many potential risks regarding quality of moderation and unhealthy patient-patient interaction that this study does not attempt to address them. A safer option may be a community forum between the patients overseen by a CHW, with CHW or specialist supervision as there is a greater degree of accountability and control in this system (see Section 5.2.2).

Psrt notes a personal unwillingness to communicate over email or instant messaging because of the "power of the written word" and that both the patient and the practitioner may feel less restricted in face-to-face communication. That said, the same concern could be seen as a benefit as it ensures that healthcare providers are monitored and can be held liable for damage that they may cause. Thus there are pros and cons to whether IM interactions can be used in liability cases or not which must be further explored.

Through distance monitoring services, automatically generated alerts or not, practitioners will also have an added responsibility to be aware of the patient beyond the confines of a consultation, and the degree to which a practitioner can realistically be held accountable for being aware of the state of a patient will be difficult to define

Time-consuming and expensive RCTs are considered the goal standard for thoroughly assessing potential risks as well as efficacy (see section **Error! Reference source not found.**). However, only once risks have been clearly identified can appropriate contingencies and support frameworks be put in place to minimise risk and the potential benefit fully realised.

5.5 DEVELOPMENT AND DESIGN

The technical aspects of system development and design are at the core of transforming a concept into a reality. That said, precise technical details are beyond the scope of this project, and this section serves to highlight some of the considerations and processes that require attention in future endeavour, mostly informed by **ISP** and **ITE**. Because of the central nature of this topic, several aspects of development have been covered in other sections, and will only be briefly outlined here.

5.5.1 Approach to development

Both **ITE** and **ISP** strongly recommend a phased approach, beginning with a "proof-of-concept" phase using a small development team to produce a limited number of profiles and functionalities targeted towards a small group of users. Subsequent phases build on these through a process of constant re-evaluation and troubleshooting, and as faith in the intervention grows with increasing evidence, more resources will be available to support further development of a more sophisticated system that can handle more users and more complex functionalities (**ISP**).

ISP notes that considering the incidence of MDD, designing an initiative for 500 000 users is a completely different exercise to designing one for 500 users, and suggests rolling out an intervention incrementally, working up from a pilot site to a province to the nation – although the initial intervention will bear very little resemblance to the full-scale one.

5.5.2 *The design team and collaborators*

Any design team requires a person with a vision to assemble the members together. This person has a conceptualisation of the project as a whole, with ideas surrounding the target market, the functionalities and the system capabilities. (**ITE**)

Naturally success of the intervention is dependent on the skill of the design team, and thus designing the team and identifying and sourcing competent team members (and finding the resources and enticement to recruit them) is a key challenge.

Programmers will be required to develop the system, and as outlined in Section 5.3.1.1 whether design is contracted to overseas developers, functionalities can be imported directly from commercial developers, development can be outsourced to mHealth solutions specialists, university students or NPO programming initiatives, or open-source code can be utilised, it is still vital to have programmers as part of the design team to understand the key requirements of system development and to modify/combine functionalities, or to design the functionalities themselves (**ISP**) – the number of programmers required will depend on the complexity of the system and functionalities, the amount of original code and the scale of the project (**ISP** and **ITE** suggest that one to three will be required for initial proof-of-concept development).

Whether they are incorporated into the design team, or are regularly engaged with in open conversation, other stakeholders will have vital input for designing a functioning system: potential users, mental health professionals (particularly for functionality design), health information systems specialists (both public and private), public health systems researchers or epidemiologists with knowledge about implementing health interventions, members of Acfee, members of the *Health Impact Assessment Unit* (**MRR**) and managers within the health system., both public and private. **MRR** notes that government sanction, support and collaboration is far more accessible when a member of a governmental framework is involved in the design process of an initiative.

Developers of other m- and eHealth solutions (see section 3.4.1) may be willing to share experiences or enter into mutually beneficial contracts, as well as other stakeholders with business interests in the field (Insurance companies, etc.). Of course, the availability of human resources and stakeholder negotiations are dependent on the affiliations of the design team. Whether stakeholders provide prior experience to guide design, or whether the design is guided to conform to the needs of stakeholders, communication channels should remain as open as possible.

That said, for obvious reasons, team cohesion is vital for transforming concept into fact, particularly between the team leader and the developers to prevent mental images of the system from clashing, and **IT** does warns that “putting one person in between adds years of development and pain.” Although as **PSRT** notes, the closer knit the team, the more difficult it will be to replace members.

ISP guestimates that an initial team can consist of about eight members excluding programmers for initial phases, but jumps to twenty to thirty members for large-scale projects which is described as “a scary move.”

5.5.3 Development life-cycle

ISP and **ITE** outlined a number of development methodologies, both for determining the needs of a system and then for deciding how to approach development.

Determining a framework for defining the requirements of a system at each level can be done in multiple ways. One favoured by **ISP** is an enterprise architecture framework, although again there are various applicable models, they usually follow a pyramidal structure that examines the business architecture (business needs and processes and the interventions required), which will need an information architecture (what information/data is required to meet those needs), which defines the requirements of the information systems architecture (what communication pathways can allow the data to be available to address the needs), which in turn identifies the data architecture (how will the data be structured so that it is accessible by the information system and by other applications), which is supported by delivery systems/technical architecture (the hardware required, the operating systems it runs on, the networking features). Other architectures include integration architecture which inform interoperability (see below) and security architecture (**ISP**). The HNSF's (32) "perspectives" include executive, business, architect, engineering, technical, and operational/implementation perspectives.

System development, too, has been structured into various models of approach.

The *waterfall* approach works in a linear phase moving from identifying the system requirements ("scoping" it through initial investigation), defining and listing these requirements, translating the requirements into functional specifications which become system specifications as well as technical specifications, before getting down to the actual development of the coding and databases, and finally testing and implementing the system (**ISP**)

An *agile* approach is used when the functional specification cannot be clearly defined and when there are high risks involved with the functionalities (**ISP**). After the initial investigation, an iterative cycle of defining requirements, designing the system and coding and testing goes on indefinitely until the final product is satisfactory and can be implemented. The original skeleton has very little functionality and data storing capacity, but each additional functionality adds complexity and completeness, but after each iteration the prototype is fully functional, which allows for the individual testing of functionalities as they are developed, rather than testing the final product as a whole.

Other approach variations include iterative and incremental development and prototyping. As **ISP** states, the development models should be seen as a continuum, and the amount of developing and functionality that is added between phases can be tailored to suit the design team.

The process must design must take into account obsolescence, considering the rate of technological development (34), as well as taking into account the changing health care system, which promotes a more agile, reiterative process that allows for discrete elements to be updated as the context changes.

Finally, with any kind of modular design it is important to ensure "internal operability" throughout the project– this means that the services created at the start of the project should be compatible with those created at the end, to prevent having to redesign functionalities from scratch each time. Like external operability (section 5.5.5), this requires creating a set of standards from the start - the main solution typically being SOA, outlined in Section 5.2.11, which informs external and internal operability (**ISP**).

5.5.4 Platforms

The term “platform” can refer to several different aspects: the operating system that will be running the programme; the form the application takes; where the information is stored, etc.

The operating system (OS) concerns are probably the most intuitive: smartphone devices and tablets utilised by MHCUs and CHWs could be running Android, iOS, or Windows. While desktop machines in South Africa can usually be assumed to be running Windows, older or limited versions may be in use, and private practitioners may be using iOS systems. Making an app that runs on any operating system would obviously increase accessibility, although further market investigation into operating system prevalence would help inform decisions.

One solution to address a multi-platform market is to create cross-platform apps, using a package to “translate” an app for multiple OSs. Both *ISP* and *ITE* agree that these packages tend to create clumsy, resource-intensive (in terms of processing power) and otherwise less attractive apps compared to “native” apps (apps programmed to function only on a specific OS). However, native design will mean that a separate app will have to be developed for each operating system, and *ISP* notes that it is often expensive and difficult to create apps for iOS. Also mentioned is that in the future, cross-platform packages will become more efficient and effective (*ISP*).

A final option, rather than a downloadable app, is to create a web-based HTML platform which will work on any device that has an internet browser. The arguments for and against a web-based interface were discussed at length with *ISP* and *ITE*.

Beyond being applicable to multiple OSs, a web-based interface is often more intuitive to public health users, as existing systems typically use this platform. In clinic/hospital settings, many computers do not allow users that are not system administrators to download external applications, and a web-based interface also allows users to log in from different devices (*ISP*). This is probably why it has been popular with other programmes for organisational structures – and because of the ubiquity of web-based systems the design will also be more intuitive to workers (*ISP*).

Web-based designs often offer a lot more flexibility in terms of changing the interface for users (through cascading architecture or style sheets) who can select their preferences (e.g. language or complexity of their interface) based on drop-down boxes. It also allows for updates to occur as a background process: each time the web-page is accessed it re-downloads the latest version, ensuring that all users have instant access to the latest version. In a downloaded app, each of these processes would require extra packages to be downloaded each time, and it more difficult to modify app stylesheets to fit content compared to HTML (*ISP*).

However, a major problem with web-based designs is that they require almost constant internet access during use. This is a problem in South Africa where mobile coverage is not universal, where many government facilities do not have (reliable) internet access (although the NDoH intends to see all clinics with broadband connectivity) (26) and where data costs are considerable. Although a limited amount of information can be cached on a device that will not need to be re-downloaded and will be accessible on-line (*ISP*) – the interactivity is limited and it is unlikely that a user will be able to input data while off line. With an app, all that is required is that the application syncs when the device is once again within coverage. Because data storage on the device is limited with a web-interface, the information must be re-downloaded each time the programme is accessed, so limiting the amount of content and keeping the interface very light will be a challenge (*ITE*). This means that apps have the potential for extra functionality – like storing pictures taken by the user (e.g. of medication for reminders) – which would be stored locally with an app.

ITE agreed with the author that another limitation of web-interfaces is their inability to run in the background once the browser is closed – this would limit functionalities such as notifications (although an email/IM/SMS service could potentially be utilised for a similar function), and background EMA (especially if wearable tech is available as an optional functionality)

However, creating a web-based platform does not eliminate the possibility of still creating an app for MHCUs – as long as they both communicate with the database in the same way. Thus a solution could be to create a downloadable Android application for MHCUs, while other MHCUs, and all other users, use a web-based interface. Even CHWs, who may have similar access concerns as MHCUs if they are working outside clinic bounds, may need an app-like platform. (**ISP**).

A final decision around platforms is whether the database is stored in the Cloud or on private servers. Again, both **ITE** and **ISP** agree that the first is the better option. According to **ITE**, it simply removes the burden of maintaining a database (having someone on the ground making sure the machines are running, updating software, ensuring that there is sufficient security, backing up the servers, etc.). Cloud solutions such as *Amazon* are well versed in dealing with sensitive information, and the major trend in information solutions is towards Cloud-based services. (**ITE**)

5.5.5 *User experience and interface design*

During system design, the end user must always be considered. A model of design science called user experience design (UXD) focuses on the user experience of the programme (**ISP**- informal conversation). This includes aspects like efficient use of processing power without slowing down the user device or draining the battery. It involves how smoothly the programme will run: minimising bugs and preventing crashes, with an intuitive, attractive design.

The question of simplicity versus comprehensiveness and customisability must also be addressed; the application must be utilisable by users with very low digital literacy, but users with more experience who expect more functionality customisability and flexibility, should also find the intervention appealing. When asked how to find the balance between these factors, **ISP** joked that “if I had an answer to that I would be rich” although several approaches were then mentioned. The first was to hide interfaces that become accessible through settings menus which can be found on exploration. Another was to have the user choose a complexity level (first-time user, moderate user, experienced user) from the start, which changes the whole interface accordingly. Another was to make upgrades accessible for a fee. As mentioned above, **ISP** said that it would be easier to manipulate interface complexity through a web-based interface.

Another consideration regarding user experience is the language of the interface, especially in the South African context with its eleven official languages. The technical translation is not an unreasonably challenging exercise (**ITE**): if free text (such as the journal) can remain in the language the MHCUs typed it in (as it only needs to be read by a CHW), and other data forms can be input as sliding scales (for the EMA) or defined by the service, then the only translation that is required is translating the interface the user accesses (although the interface design must then have the flexibility to allow for phrases to be longer or shorter depending on the language). Languages can be made available as a downloadable language pack, or apps in the various languages can be placed on the marketplace (this will make updating each app laborious). While **ITE** suggests that all that needs to be done is to give a translator a compiled list of all the text in the app, **ISP** notes that there are subtleties involved regarding the nature of the translation which require a considerable amount of effort to address, especially considering the scarcity of skilled translators who are able to work at the level of complexity and specific required. Words must be carefully translated with reference to their cultural connotations and context, particularly when dealing with mental health which could be considered to

be culturally sensitive. The translation of scientific instruments like the EMA mood tracking is another potentially problematic area – where due to subtle in word connotations, a certain point may have consistently higher/lower scores in one language compared to another.

However, *ISP* suggested that the issues surrounding language can be resolved at a later stage, although the fact that the basic application should be able to support future expansion, in terms of languages, users and functionalities, must be kept in mind during initial development. Security aspects (outlined in Sections 5.2.3 and 5.4.2) and how these protocols are presented and integrated into the interface, to be intuitive and unobtrusive while still being effective, must also be considered during interface design.

5.5.6 *Functionality design*

The design of the functionality should ideally involve open conversation with users – with psychiatrists guiding development of psychotherapy tools - as well as programmers and researchers who can comment on best practices and scientifically endorsed models, informed by user acceptability (see section 5.6 below), proven efficacy of interventions/scientific endorsement and the potential to increase system efficiency (31). Functionalities will need to be evaluated for whether the costs outweigh the potential benefits. Costs could include potential to cause harm, the addition of unnecessary complexity, the cost of development and the size of the functionality, device system processing required, data usage, etc. Functions that require downloading photos and audio files, for instance, should be avoided because of the high data demands of downloading media elements.

Listing potential functionalities according to relative importance/perceived value and implementing and testing them individually and then in combination using a phased approach should allow for effective assessment of the interventions. Surveys could be carried out to establish user views about functionalities. Functionalities could be assessed for behaviour-change elements that are incorporated.

To gain an understanding the navigational complexity of a given functionality, a tree of screens could be sketched (*ITE*). According to *ITE*, the majority of the functionalities outlined for MHCU interventions aren't particularly complicated, and have been designed in some way before. In fact previous designs of similar functions should be closely examined for user-friendliness to inform interface design. This holds true for therapeutic functionalities too, which should be based on programmes that have been successful in the past (*SSR*), even if a different delivery system was used. South African e- and mHealth solutions previously implemented can also be used as a basis (such as *MRR*'s referral system), depending on how willing developers are to collaborate.

Looking specifically at cCBT functionalities, there are a number of considerations that must be taken into account when designing the intervention.

The first is the idea of looking at competing therapies – practitioners employ a range of therapeutic techniques (sometimes using them as marketable points- *PSRT*), and although CBT has become dominant in the field of remote therapy, *PSRT* notes that it is somewhat artificially constructed, and because it is the easier to research it may lead to self-validation of the tool. An open mind should be kept to alternative therapeutic techniques (such as mindfulness-based cognitive therapy), and is generally supported by practitioners. *PSlgt*, however, feels that CBT incorporates several standard therapeutic techniques. While *SSR* feels that CBT is simplified and structured enough that individual practitioner interpretation will not significantly affect the efficacy of the programme (particularly if delivered by CHWs), *PSLGT* feels that the issue is non-trivial, and that care must be taken that the intervention is easily comprehensible.

The complexity – touched on in the above section in UXD – will need to be established. The amount of input from the health care practitioner on choosing activities can also be evaluated for complexity vs benefit, as well as the support/input from them as the MHCU completes activities

Special modules that are particularly relevant to the South African context (HIV/AIDS, diabetes, etc.) could be included. Care should be taken that the interventions, which are typically Western in design, are still applicable to South Africans, although *PSLGT* notes that concepts of tracking emotions and teaching coping and problem-solving skills are fairly universal interventions. However, scenarios and life applications referenced by the intervention should be contextually relevant.

5.5.7 Interoperability

As can be seen in the literature review (particularly section 3.5), interoperability is a key issue in eHealth policies – indeed it is the principle behind the creation of the HNSF (32).

Besides internal interoperability outlined above in section 5.5.3 there are numerous other forms of interoperability. Those outlined by the HNSF (32) include syntactical interoperability (the computers on either side must be able to recognise the information), semantic interoperability (the users on either end must understand the information in the same way), technical interoperability (the compatibility and connectivity of hardware) and organisation interoperability (agreeing on standards through open communication channels and collaboration resulting in the transfer of meaningful information). Acfee (34) notes that semantic interoperability presents the biggest challenge, although *ITE* comments that “the technical issues pale before the political horror” of getting stakeholders to talk to each other, in terms of organisational interoperability.

ITE and *ISP* suggest creating a “unidirectional” (34) system, where information created and modified by the system is accessible and readable by external systems with access (other HISs) but the programme can stand as an independent system, especially if external systems use clumsy or non-ideal specifications (*ITE*) or are particularly limited (*PHR*). The health care system can then access information from the database either by using the system alongside their own systems, or by changing their own systems to provide a space in their patient EHRs to connect to this from the system which can send bulk patient information (or potentially only processed, pre-analysed data, depending on what the health systems want - *ISP*), linked by the patient IDs (outlined as part of the user role of the MHCU in section 5.2.1.1). If the HISs used by health systems use compatible data structures, it will facilitate the incorporation of whole functionalities and increase interoperability. But as no information from external systems is transferred back across, the system is completely one way.

However, the data provided by the system must be easy to incorporate into other systems, or “friendly” (*ITE*). In order to make the information accessible, a Cloud-based SOA should be designed using defined services such as the IHEs outlined by the HNSF (32) with “proper data structures” (using international HISs as guides). *ISP* feels that although this is vital from the start, using clearly defined, acceptable data forms should be sufficient for early prototyping, and that the intricate details and higher levels of complexity involved in interoperability only need to be addressed in further stages of development, particularly considering that in the time taken to develop the initiative, health care systems may have evolved considerably.

However, the eHealth Strategy (26) points out that the fact that there are several “standardised” development protocols (such as ISO and CEN), which means that different systems can still use different standards. Localisation of these strategies to the South African context is also said to be required (although the HNSF is a step towards that). During development of the programme, attention must be maintained on potential refinement and elaboration of protocols in the HNSF and subsequent

publications. However, a little consideration should be given to international export/expansion of the system, particularly to neighbouring and other African countries that are striving towards similar health goals.

This leads on to questions about organisational interoperability. Only through open dialogue between stakeholders, motivated by strong leadership, can standards be agreed on throughout the field. The relationships will need to be maintained as systems develop and update (*ITE*), and in order to endorse and adopt the system, external systems must consider it to be useful, feel that it has sufficient security and believe that in the integrity of the information gathered. Finally it must be kept in mind that there is very little basis for private/public collaboration (see section 5.3 on business models).

5.5.8 *Testing and implementation*

Particularly because of the scanty evidence for mHealth interventions and as a medical intervention, a risk based approach is necessary (see Section 5.4.3) for all included functionalities, which will need to be conducted throughout development. Such studies are usually designed as well-structured, ongoing RCTs (*SSR*) – the longer the study the better the longitudinal results. But Olff (27) stresses the need to keep up with the pace of innovations, to reduce the amount of time and money spent in revising, updating and redoing previous work. And yet, as Van Heerden *et al* (31) point out, scientific integrity cannot be sacrificed, because proven efficacy will provide a backbone for systems uptake – besides insuring that the intervention is actually achieving what it set out to achieve.

5.5.8.1 *Acceptability and efficacy testing*

The testing of user acceptability (See discussion on UXD in section 5.5.5 above and 5.6 on user acceptance below) will need to start before development to guide function design, continue throughout the design process, and continue after roll-out, reviewing user comments and updating where necessary. This is particularly true with agile development, where each phase in development must be tested for feasibility and acceptability

A number of models have emerged to describe the numerous factors that affect user acceptance and likelihood to use an intervention. These include the TAM (Technology Acceptance Model) and UTAUT (unified theory of acceptance and use of technology) models, and the TOE (technology-organisational-environment framework) for organisational acceptability (see 9.5.3 on research agendas) (*ISP*).

Initial studies, conducted before the start of development, could include surveys amongst users of the perceived usefulness of proposed functionalities, as well as time-motion studies for health care practitioners and administrative staff to understand how best to integrate an intervention into daily routines and clinical practise (*PHR*). Market studies might also prove necessary to gain in-depth understanding of smartphone penetration and usage, as well as mental health care needs and informal care practises to guide functionality design.

Particular points that should be evaluated, besides baseline efficacy, is how to optimise functionalities – for example deciding on the optimum amount of contact and the form of contact between MHCU and health care workers (23), on how many variables to include in the EMA tools and how customisable they should be, etc. It is also important to test the platform itself – to decide whether mobile phone delivery is effective enough compared to conventional therapy forms and how effective tools are for various levels of disease severity. *SSR* warns against testing the technology rather than the intervention – that is to say, make sure that a poor design does not impact the assessment of the functionality itself. Previous systematic analyses (see the table in Section 9.3 of studies reviewed) should be examined to inform variables for trials, to optimise compatibility with international studies, allowing the body of knowledge to grow.

ISP notes that evidence-based motivation for efficacy and effectiveness requires huge data sets, which will not be initially available, so it cannot guide marketing of the initiative. Another problem is the inability to define control groups because of a lack of baseline data or defined “treatment as usual” (**SSR**). **MRR** mentioned that their trial they had no control group, but set an arbitrary target for effectiveness. Patient-reported outcome measures, or a proven statistical improvement over the usage duration can be gathered after implementation. Continuity of care can also be monitored over time.

5.5.8.2 Technology testing

Technology testing involved ensuring that the functionalities have been programmed to perform as they were intended to perform. **ITE** outlines two options: either the person who did the original designing tests it, because he/she will have the best idea of how it is intended to perform (although this will be very time-consuming), or otherwise pay potential users to test it. Testing will involve attempting to draw out bugs, performing quality control and perhaps testing and comparing different ways of programming the same function.

5.5.8.3 Implementation and uptake

Effective implementation is highly dependent on health systems endorsement, which will give the initiative access to facilities to include in pilot trials. **MRR** mentions that this includes getting ethical approval and going through the *Health Impact Assessment Unit*, starting with a pilot trial and adding more facilities to the trials as the project gains support. Because the structure of the initiative is based on the NHI primary health care structure, it would probably be best to include NHI pilot sites in the trial phases, although the design of the system should allow for it to function without CHWs – although implementing the project into a changing health system may pose unforeseeable obstacles.

Although most of the interviewees (all based in greater Cape Town) agreed that such a project would probably be initiated in the Western Cape (because of the author’s own location and because of the relative strength of the eHealth system in the province), and **PSRT** noted that in the Western Cape there are more resources to “absorb failures”. **SSR** suggested that the intervention can then be modified or scaled down to suit the health care systems in other province. However, one of the key elements of the programme is that it can still be available to MHCU uncoupled from the health systems – but still help work towards the NDoH’s goal of equity between the provinces (26).

Ideally, health care workers would be recruited through the health care system, but alternatively, individual recruiting of practitioners can be initiated. MHCUs will be approached through their practitioners, ensuring the MHCU-provider link is already established, but external marketing through commercial media can encourage MHCUs to download the app from online marketplaces. Dispersion methods and marketing strategies should be a priority during implementation phases.

Another consideration is the training and support requirements, both at the initial roll-out of the programme, as well as ongoing refresher training and technical support. **Psrt** noted that the majority of training for new interventions for primary care givers is slotted into standard “slots” – but that peer teaching is often highly effective for trouble shooting. **MRR**, too, noted that peer-to-peer interactions were often more helpful than reaching out to tech support because of the direct access to the programme. **MRR** and **SSR** noted that technological competency had not been a major barrier for health workers, although it may have affected their ability to make the most of the tools available.

Implementation science (**PSRT**) is a subset of medical research that focuses on implementing into clinical settings evidence-based medical initiatives, and the field could potentially be consulted for insights into successfully transforming an ideal into a reality. Dissemination research, as outlined by

Tomlinson *et al* (see Figure 5 in Section 9.5.3), includes providing evidence that standards for effectiveness and that the intervention can be delivered with fidelity to the model tested, making cost information available, and supporting the intervention with ongoing monitoring and evaluation tools.

5.5.8.4 Ongoing evaluation

Ongoing evaluation of the initiative is necessary to keep track of efficacy which will inform further decision making. Olff (27) suggests that key aspects of evaluation include evaluation of efficacy/effectiveness, of cost-effectiveness and of safety. Evaluation is necessary to allow for updates to the system to ensure ongoing usability and relevance, and efficaciousness and cost-effectiveness data is needed to evaluate scalability.

Keeping track of efficacy also builds up the knowledge base for m- and eHealth interventions. Tomlinson *et al* (25) note that a key problem in the South African mHealth field is that past programmes have failed to maintain efficacy data, and it is thus very difficult to evaluate the long-term effects of mHealth. Publishing efficacy data publically could help garner support.

ITE notes that usage statistics are easy to come by for mobile health interventions and mentions that *Play Store*, for instance, provides developers with detailed statistics (which would otherwise need to be built into the programme).

Not only can ongoing evaluation support the mHealth intervention, but it can also inform on the efficacy of the CHW programme and referral networks, as well as gathering high quality baseline data through post-marketing surveillance on mental illness (which may be a marketing feature in and of itself – *ISP*).

5.5.8.5 Upscaling

During the interview with *ISP*, an interesting paradox emerged regarding the balance between creating a sufficiently flexible base which will support future scalability by creating a programme that is not overly ambitious – designing a simple, affordable prototype for initial trial phases and building it up as it gains more support. In the first design phases, each of the ideas and issues presented will need to be critically evaluated for their potential impact on scalability before inclusion or rejection.

From a health systems perspective, Leon *et al* (3) provide a research agenda for scaling up mHealth, including government stewardship, an organisational capacity for implementation a culture of information, the technological capacity of the intervention, the cost-effectiveness of the strategy and secure plans for sustainable funding.

5.6 STAKEHOLDERS AND USER ACCEPTANCE

The key of the system outlined in this project is the ability to link multiple users and stakeholders. This requires broad-scale acceptability. Stakeholders will need to have faith in the efficacy of the program before they endorse it, and the program will have to live up to expectations in order to promote continued use by being effective and user friendly. This section explores identified factors that may play a role in user/stakeholder uptake and acceptability.

Initially, stakeholders will have to be identified. Stakeholders include all users, those involved in system design (outsourced resources or tenured programmers), as well as any parties endorsing the program such as the DoH and related structures, sponsors, private medical aids, and any institutions that may access the data.

Market research should involve interviewing, surveying and/or including each group of users in the design process to fully inform development and design, as well as to determine what resources will

be made available by funders (and what outcomes will be expected in return). Bodies that will be endorsing the system and/or funding initial design will need to be brought on board before efficacy can be proven – thus it will rely heavily on theoretical frameworks, authority-based concept marketing and exploitation of professional connections and relationships.

Rigorous acceptability and efficacy studies carried out in trial phases, as described above in Section 5.5.8.1, can be used to promote larger-scale roll-out and implementation.

Acceptance of the initiative can effectively be split into two components: users who interact with the interfaces and managerial frameworks and stakeholders

5.6.1 Users

Only if the user interface is acceptable to the end user will such an initiative be successful. Potential users must have sufficient faith in the intervention to acquire the programme, and then be sufficiently satisfied with the product to continue using it. The fidelity of the collected data is also dependant on user interaction with the programme.

As listed in Section 5.2.1, potential users could include the MHCUs, CHWs, supervisory health care professionals, administrating staff, epidemiologists and sysadmins.

An intuitive, appealing, easy-to-use graphical user interface (GUI) often plays a vital role in informing ongoing use of an app. Some of the design issues, such as operating system compatibility, interface language/cultural considerations and the balancing of flexibility with simplicity, have been explored in the discussion of programme design (Section 5.5.5). The ETS highlighted a number of factors that inform user reviews – poor and confusing GUIs and crashes were the main complaints, while users wanted non-intrusive, smooth and fast apps with technical support, customisability and back-up features. *ITE* noted that a simple design with less text and big buttons often goes a long way towards and acceptable GUI. Users were often concerned about security, privacy and data collection, suggesting that relevant information should be readily available and included in the interface and that users should be made to feel that they are completely in control of their data security. Similarly, users will have to trust that the user verification system is secure.

Many of the interviewees felt that technological literacy itself would not be a major stumbling block (BI). *PSLGT* noted that the “timing is right,” *SSR* felt that “there’s no doubt that the upcoming generations would probably feel very comfortable using apps” and had noticed in past experiences that the issues typically revolved around understanding the text and the instructions of the programme rather than using the technology itself. As noted in the literature review, however, data regarding rural technological penetration and literacy are scanty – a concern echoed by *SSR*, although *PSRT* made the observation that literacy (lingual as well as technological) can be improved by using well-designed picto-graphic/text integrated apps, which can support future innovations.

Smartphone penetration (rather than feature phones) is highly relevant for creating a universally accessible intervention, but *ISP* noted that the “digital divide” will be an ongoing problem for any intervention, although smartphone penetration will continue to increase (with entry-level smartphones costing approximately R600), and that a key decision will be whether there is a sufficiently large base to justify the intervention. Another problem that is not addressed in many surveys is shared mobile devices, which is a concern for MHCU privacy as well as the integrity of context-aware EMA data, although the former may be mitigated through login security.

The cost of data, which has a major impact on accessibility in disadvantaged communities has been mentioned in Section 5.3.1.2, with respect to both CHWs/health care providers and MHCUs. The cost of device system resources such as battery life have a more generic effect on acceptability.

Relating to costs and smartphone penetration, as well as digital literacy and even underlying intervention design, **MMR** noted that ambiguity surrounding the exact MHCU target market described in the study with respect to socio-economic status, education levels, and access to health services impacts attempts to define acceptability. Attempting to design a universally applicable intervention may be over-ambitious and unrealistic.

Initial marketing to mental health care users, encouraging them to download the application, can come from multiple channels. As mentioned in the literature review, the online marketplaces are flooded and can be difficult for an inexperienced user to navigate. Initiative is also required to prompt a search for applications. Marketing through the health system, via health care providers as well as paper-based material available in health facilities, will be vital, as MHCUs may be more likely to trust health-systems endorsed applications, or an intervention “prescribed” by their doctor.

Advertising using mass media may also recruit non-health-seeking sufferers. Using descriptors and tags that are not “pathology-specific” but refer to generalised mood disorders may attract users who do not associate their symptoms with a condition (if they do not believe they have “depression”), for example, “take control of your life,” “learn coping skills,” “gain confidence,” “understand your moods” etc.

The acceptability of an app interface (well described in the literature) for an MHCU includes highly accessible, discreet assistance that can reduce exposure to stigma (**ISP**), or with convenient integration into daily routine. (16) Limiting the time required for each use not only minimises the intrusiveness of the app, but **PSRT** also suggests that brevity is important due to the dangers of reinforcing self-absorption and social withdrawal.

Psrt raised an issue that applies to both MHCU and practitioners regarding the acceptability of electronic communication. As a practitioner, he felt that the “power” of the written word could restrict interaction (see Section 5.4.3 on legal concerns) and the creation of a safe space” will be an important feature for user acceptance. Personally, he noted that that his typing skills would limit his willingness to engage in electronic conversation.

Interviewees highlighted that the time required for monitoring and interacting with the program becomes a far bigger issue with respect to health care professionals: particularly clinic administrative staff and doctors/nurses (**PHR, SSR, PSLGT**). The burden of maintaining contact/interacting with MHCUs should be placed on CHWs (**SSR**). **PHR** notes that getting the practitioners on-board will be a vital aspect. Health workers will need to feel that time spent monitoring and interacting with the intervention is more valuable than other activities that would take up that time (**PSRT, MRR**). The programme should integrate into the day rather than increase the workload (**MRR**). The system should minimise redundancy, optimise the software to eliminate glitches and lag times and bear in mind limited access to advanced (up-to-date) technology or fast broadband internet.

Incorporating mHealth and distance monitoring into daily practice and even into consultations will require an ideological shift and practitioners may not feel comfortable changing the established boundaries of doctor-patient interactions, particularly older practitioners (**SSR**). **MRR** noted that in his experience, health care providers are far more likely to have a positive attitude towards and intervention if their superiors show enthusiasm for the initiative, highlighting the importance of effective, tiered marketing within the healthcare system.

In the age of evidence-based medicine, care providers, particularly specialists, will be far more discriminating in terms of the quality of data that is collected by the programme and the proven efficacy of any intervention (**SSR**). The validity of self-reported data and the relevance of the information for treatment will need to be proven. **Psrt** noted that often the most valuable information is what the patient does not wish to share. He also warned about sending too much information, particularly if the primary care practitioner or CHW is not equipped to interpret or act on it (**PSRT**). An individual is also more likely to engage with a system if they feel competent and secure with the technology.

5.6.2 Stakeholders and systems endorsement

As expounded on several times previously, integration with the public health system is a key component of the intervention: both to increase the effect pool of the app, but also to allow the eHealth frameworks contained within the system to interact with and strengthen national eHealth.

Implementation at a clinic level is dependent on receiving mandate from higher managerial levels, and **MRR** noted that individual clinic and subdistrict managers are more likely to endorse a system that increases their status within the health care system according to standard indicators of performance such as the number of patients attending the clinic or waiting time.

National and provincial management and policy makers “want to have a proper policy in place before they start to engage with service providers and vendors” (**MRR**). The development of policies, (such as the eHealth strategy (26)) are typically informed by international trends and field experts

As stated in the introduction to this section, initial marketing of a trial will be dependent on a theoretical basis and through authorities in the field (**ISP**). **ISP** noted that a key argument for the programme is the generation of statistics on mental health users and service providing that have not been collected thus far, that there is instantaneous collection of more complete data sets with less missing data than paper-based systems (**SSR**), although **PSRT** noted the need to evaluate the validity of the data obtained.

Local facilities, provincial health directors and ethics boards will need to be convinced of the relevance and safety of a trial. **MRR** suggested that having an authority from within the health system, for example a member of the *Health Impact Assessment Unit* or those involved in health information management, as part of the design team is hugely beneficial for leveraging policy makers, as well as for gaining access to information regarding system structures for interoperability.

A small trial is necessary to prove efficacy, yet efficacy statistics are necessary to get health care systems on board to provide information necessary for integration with health systems. However, the programme will have limited success without prior integration into the health system framework. The programme may have to be entirely redesigned if a trial phase programme which is not integrated into the health system, is to be transformed at a later stage into a programme that can be fully integrated into the health system. The financial implications of having to design a fully functional programme without initial systems endorsement is explored under Section 5.3.3, although independent mHealth research institutions may potentially have fewer caveats and may be more approachable.

If private health care providers are to be approached, the “marketability” of the intervention and its capacity to generate profit will need to be pitched. The willingness of the private and public health systems to cooperate may prove challenging due to a lack of protocol and an unfavourable history of interaction.

Finally, other stakeholders, such as independent vendors and service providers will need to have their interests assessed so that contracts and interactions can be mutually beneficial and to prevent clashing agendas.

6 DISCUSSION

6.1 SUMMARY OF KEY THEMES

6.1.1 *Justifying an intervention*

CMDs and other mental disorders are often side-lined by the fragmented, inequitably distributed and often simply inadequate South African health system, which focuses its limited resources on the quadruple burden of disease and has a shocking shortage of specialist mental health care professionals. The high prevalence of comorbid depression with both communicable and non-communicable (and typically chronic) diseases, combined with adversity-fraught environments, stigma- and education-related lack of presentation of sufferers, inconstant and irregular identification, inadequacy/unavailability of treatment and poor follow-up resulting in relapse and a poor prognosis, and the high morbidity and loss of productivity are all factors that suggest that an intervention for screening, treating and monitoring CMDs, such as depression, is warranted.

The intervention described in this paper focuses on creating an app for MHCUs that allows them to take control of their own mental health, while aiding in connecting them to their health care team and simultaneously creating an EHR on a backend database of patient information that can be extended for future applications and integrated into NDoH patient records. With cell phone penetration almost universal in the country, and smartphone population increasing almost exponentially, mHealth is a relatively low cost intervention with the potential for reaching a huge population. While mHealth in the literature can refer to anything from telehealth manual phone-calls, relatively little research has been conducted on fully-fledged interactive applications such as the one outlined in this report, probably due to the level of complexity involved in development and RCT assessment.

6.1.2 *Describing the intervention*

Key functions in the designed system on the MHCU interface include EMA (either manual or automated) monitoring of mood and physiological changes over time for early recognition of danger signs and for identification of triggers and patterns, along with journaling and CBT activities, while communicating with local CHWs. CHWs, in turn are monitored and communicated with by supervising specialists and affiliated clinics. Although context-aware and wearable technology shows promise as part of EMA functionalities, they are probably not feasible in terms of cost and additional complexity in early phases of an initiative.

Typically, mHealth in South Africa has focused on improving CHW services through data collection or clinic-CHW communication. The majority of patient-aimed interventions are simple SMS-, mobi- or USSD code-based and focus on providing health information or sending reminder, and while patient-centric apps can be found on online app marketplaces, it can be difficult to find a quality, professionally-vetted app in a flooded and unregulated market, and these apps stand completely separate from the healthcare system. There has thus far been little to no interaction between the patient and the South African public health system, although some private medical aid providers have begun giving their clients access to their personal EHRs via apps.

6.1.3 *Integrating of the intervention*

By focusing on self-care and self-monitoring, the intervention should minimise use of state resources, with the application identifying when external support is required, as well as providing tools that can

streamline consultation processes. This addresses the shortage of mental health care providers, and distance monitoring can improve access to health care and address health care inequity. EHRs can streamline and improve the integrity of referral pathways, ensuring that patient information is transferred intact. Utilisation of health care services can be monitored, ensuring continuity of care and allowing for collection of epidemiological data on mental health care services, which is currently limited.

With the majority of care being MHCU- and CHW-driven, the intervention follows the pyramidal burden-of-care structure promoted by PHC which is stratified according to skill-level. Stewardship of their own EHR and health care needs empowers the patient, while the discreet and appealing nature of accessing health care through mobile applications promotes acceptable and appropriate care which can be integrated into daily routine. This is particularly relevant for non-healthcare-seeking or stigmatised patients if the app is used independently of the health care system.

It is difficult, however, to assess how an intervention can be integrated into South Africa's changing health system. By facilitating interactions between CHWs, their supervisors and affiliated clinics, the project could support the NHI primary care model of community health teams if designed, tested and implemented within NHI pilot site frameworks, but the broader applicability of an initiative in the greater health system may then be questionable. It is also, as yet, difficult to predict the precise needs of a future NHI health system. It is projected that mental health care be integrated into general PHC, and thus the amount of training, time and resources dedicated to mental health as part of overall patient management, as well as the delivery of care itself may be significantly different to the current system.

In order to reach the target population and allow for full functionality of the programme (with respect to communication with the health providers), health systems endorsement is vital, while the health system typically requires a firm policy, guided by international conventions and precedent. Several policies on eHealth and mHealth, such as the HNSF (6) and National eHealth Policy of 2012 (26) and mHealth policy of 2015 (6) have been developed and it is also important to ensure that while following international protocols and guidelines is vital for international support and later exportation of successful programmes, it is also vital that the programme is tailored to South African health needs in interface design treatment modules and integration into the health system.

Overarching, national level "metaphysical" policies are typically helpful in guiding top-down, system-wide interventions (e.g. instituting a nationwide PMI or electronic health system), but these are often overambitious and are built on infrastructure that is unable to cope with a new system. The proposed system can work in isolation from the health system, building from the bottom up a standalone, isolated database of EHRs created as an intervention for a specific health problem, like many international interventions (e.g. myCompass and Beating the Blues), but which can then be slowly integrated into the existing health system databases, and can thus be combined with coinciding interventions. But to ensure compatibility and maximum efficacy, as outlined above, NDoH involvement from the beginning is crucial. Getting high level NDoH support without proven efficacy or precedent, for an initially small scale project, may prove challenging (see Section 6.3). Promoting implementation involves providing efficacy data through carefully designed RCTs, the assessment of risks and legal implications and gaining approval from ethical boards such as the Health Impact Assessment Unit, conducting feasibility assessments to determine the capacity of the health infrastructure to sustain the initiative, and conducting an economic health assessment to determine the relative value of budgeting resources towards the initiative. The infrastructure demands include, among others, ensuring internet access and providing tablets/mobile devices to CHWs and clinics, and a significant resource drain includes time required by health care providers to maintain the system.

However, the data-collecting and epidemiological aspect of the intervention may prove a significant draw-card for national health services. Beyond data on CMD prevalence and service provision, the proposed intervention can easily maintain long-term efficacy data which may pave the way for future initiatives in South Africa and other lower to middle income countries, while also encouraging further investment in the initiative. The data-collecting and epidemiological aspect of the intervention may prove a significant draw card for national health services. Until efficacy data can be provided, potential benefits of the initiative will have to be marketed through theoretical arguments provided by experts – a large portion of which may involve proving that eHealth development should be a priority for the healthcare system.

6.1.4 Implementation of the intervention

Ensuring, and then proving, that the system is acceptable to users is a vital step in implementation. Polls and interviews with users can be used for providing groundwork for project motivation, while in-trial assessments can be conducted to maximise acceptability, along with standard effectiveness vs efficacy vs risk RCTs. User interface, intuitive design and steep learning curve for use are vital for acceptance and continued user, as well as a belief in the efficacy of the programme – including the validity of the information collected. Users must trust the security of the system, and be sufficiently motivated to use the programme regularly.

Acceptability to health care providers includes a belief in the efficacy of the programme and that not only can they fit it into their daily routine, but that time spent using the system is more valuable than time spent on other activities. Motivation from employers and managerial structures is important, as is confidence in their own ability to use the system. More specific problems with mHealth and the intervention include difficulties in reimbursing practitioners for time spent on distance monitoring, and addressing discomfort regarding loss of control over patient information, the changing nature of the practitioner-patient relationship and potential legal sequelae (considering that interactions may be recorded).

Personal cost will be a driving factor for many MHCUs (e.g. data costs), as well as exposure to/accessibility of the programme. Privacy may be a huge concern (especially when devices are shared). Language and education may prove a problem, especially considering that the data they input must be appropriate/valid.

Beyond ensuring that users continue to support the programme, successful sustainability of implementation requires secure business models based on long-term investment. Many mHealth initiatives have failed to up-scale because funding agreements terminated or because follow-up data collection was not maintained. Many e- and mHealth policies have both sustainability and scalability as key principles, however, interviewees noted that as a project up-scales the system requirements become incredibly more complex, the development team can quadruple in size, and that cost requirements change completely – although the more robust and flexible the initial system, the more smoothly transitions can occur, by addressing internal interoperability. This flexibility, however, may be expensive in programming hours, when it may be beneficial to create a simple initial intervention for proof-of-concept.

When considering business models, a major concern is that the programme is not likely to be profit-generating or self-sustaining. As a health-promoting endeavour, the NDoH should be the major contributor to funding (and is likely to be a more sustainable option), although other sources of funds may come from NPOs or international aid organisations, and private medical insurance corporations may see value in supporting interventions for self-care (thereby reducing hospitalisation).

While entering into business relationships and partnerships with stakeholders (including acquisition of services), it is important to maintain the integrity of information ownership through data stewardship, as private ownership often leads to siloed information structures, and data farming should be avoided (especially as medical aids may abuse personal health information when charging clients). Decisions will need to be made according to what access to information and what degree of control over project development stakeholders can have, requiring strong leadership and vision from the a core person/developer to maintain organisational interoperability.

6.1.5 Design of the intervention

Leadership and leader-affiliations will have an impact on ownership of code. This will change depending on the source of the code: whether existing open-source code is customised; if programming is outsourced to local or international service providers (depending on availability of high-level programmers); if previous code is modified (to prevent “reinventing the wheel”) that is bought from other companies; or whether a dedicated team is employed. Ownership of code and patented ideas may impact future development of the programme or exportation. While maintaining an open-source structure is the ideal, the NDoH may want to maintain rights in order to maintain control over the programme if the department pays for a dedicated development team, while service providers may wish to own rights for future profit-driven initiatives. Because of mistrust amongst public and private healthcare provision services, and even health care users, it may be preferable for an unaffiliated organisation to maintain control over the project, such as an NPO (e.g. Acfee) or academic institution.

The source of the code will have a significant impact on the quality, utility ad flexibility of the end product, with cost and programming hours playing as the predominant restriction. The complexity of user interaction will have to be determined: how user roles are assigned, who inputs what data, who gets what information, who can communicate with whom, etc. As the project increases in scale, user validation will become a problem – as it no longer becomes feasible for each user to be manually added by a sysadmin, and may have to develop from a web of trust. Permission networks and will also have to be developed to allow the MHCU to maintain control over how their doctor shares privileged information, while allowing sufficient flexibility for emergency situations or efficient referral between health professionals and services, ensuring that continuity of care is not broken.

Looking at previous initiatives and developments may provide assistance for troubleshooting, with respect to enterprise architecture framework (the needs of the system), as well as security aspects: such as how databases are secured (whether stored on the Cloud or on dedicated private servers), ensuring terminal security and password stewardship training. Access to the database, beyond internal users, must also be considered, especially when information is shared with national health services. The current recommendation considering the state of national eHealth readiness is that bundles of read-only, pre-processed be delivered in a single packet for a patient, but that departmental systems cannot directly access the database. But this protocol should be re-addressed as systems become more sophisticated or future mHealth initiatives seek to provide compatible information which may aid in developing more complete EHRs.

While the issues outlined above refer to the eHealth system, simple functionalities of the programme as a health intervention must also be explored – comparing and contrasting various functionalities and combinations of functionalities for maximised effectiveness. Weighing up simplicity with customisability and efficacy will have to be explored. For example, modules for medication tracking co-morbidities may be included, or they may be left for future mHealth initiatives. Tailored design through agile or iterative development may prove helpful for constantly assessing each function in

individuality, rather than a pure waterfall approach of completing large chunks of the programme at a time according to pre-determined specifications. Constant testing may also ensure that the efficacy of the functionality as a health intervention is assessed rather than the technology, although the latter is important to test as part of acceptability. That said, extensive testing and lengthy development processes may mean that the initiative is unable to keep up with the pace of innovation, and a significant part of testing may have to be post-marketing, with the capacity for updating the system as the programme ages, while undergoing constant assessment and evaluation.

6.2 OWN CONTRIBUTION/INNOVATION

In effect, this paper serves to consolidate knowledge and research surrounding e- and mHealth globally and in South Africa, as well as the state of mental health service provision in the latter. Specific and entirely novel contributions include the conceptualisation of an mHealth innovation for depression, as well as interviews discussing the feasibility of such an intervention in the South African health system with mental health care professionals, information technology specialists as well as public health and information systems experts. The proposed initiative serves to provide a framework for evaluating how to apply previous knowledge as a way forward for future interventions in the South African market.

The intervention fills a gap for sophisticated patient-centric apps that function as a stand-alone intervention promoting self-care, while improving accessibility and quality of care through distance care and communication and monitoring communication with their health care professionals and distance care, while simultaneously having the capacity to build up eHealth and increase the international knowledge-base of such interventions, as well as collect epidemiological data. This is supported by literature describing the state of mental health care in South Africa, as well as existing mHealth and eHealth initiatives and service providers in South Africa (summarised in tables found in Section 9.4).

Much of the conceptualisation of the intervention attempts to apply information and communication technology principles to the requirements of the [mental] health care system. This involves analysing potential users and their respective roles and interaction with the system, with rough prospective design of communication pathway network describing the flow of information (see section 5.2.3 . A list of potential functionalities for each user profile was developed from previous interventions (see table analysing apps found on online marketplaces in Section 9.7) and annotated according to support from the literature, online marketplaces, interviewees and the author. Aspects and suggestions surrounding technical details of development and design such as who is required as part of the development team, approaches to development lifecycle, user interface design and the layers of complexity that are added due to platform and interoperability constraints, and testing of designs were explored, and how each of these factors are influenced by cost and time constraints, and in turn affect the quality and flexibility of the product.

Business models and an exploration of stakeholders in the health system, followed by an evaluation of patient confidentiality, information security and how to attempt a risk-based approach to implementation and testing through RCTs shift the focus to issues surrounding integration of an intervention into the health care system (supported by lists of recommendations and research agendas from the literature compiles in Section 9.5).

The paper attempts to provide a definitive summary of potential benefits as well as potential stumbling blocks in the development of such a comprehensive intervention.

6.3 KEY CHALLENGES AND OUTSTANDING ISSUES

As a consolidation of knowledge, one of the key purposes of this paper is to provide a list of elements that is as definitive as possible regarding the issues that will need to be addressed during development and implementation of an m-/eHealth intervention. Although attempts have been made to outline options or suggest a way forward for the various challenges, conclusive solutions for a formal development plan must be found, likely through in-depth dialogue with experts who are committed to the project and through open conversation with stakeholders.

Once leadership and the affiliations of the development team are established (likely determined by individual enthusiasm and willingness to participate), an initial step will be to develop the politics of the programme: assessing of the level of participation of the various stakeholders (see section 5.6) and the benefits each stakeholder will be seeking from involvement in the initiative, and committing to a patient-driven rather than profit-driven business model. This, along with thorough investigation of the costs in developing and maintaining the system (see section 5.3), will be vital for obtaining funding and planning the limits, scale and sustainability of the project.

Conducting an in-depth situational analysis will be needed to determine readiness, in terms of both technological development as well as health information system and infrastructure development.

Market studies can provide further, and necessary, insight into cell phone and smartphone penetration, usage behaviour and technological literacy, particularly in rural communities (which are most in need of accessible health interventions). Furthermore, decisions must be made regarding how specific or general the target MHCU market is to be, in order to inform the sophistication of the content of the programme. Input from lawyers and experts in patient rights will be required to inform on what frameworks must be put in place to protect both patients and their health care professionals, as well as input from the health system on how to define access rights to privileged patient information and folder information.

Acceptability to health care providers is another key research priority, in order to learn how best to integrate a programme into the daily routine of health care workers without adding to their burden, what amount of information and what functionalities should be included in their interface, as well as collecting information regarding the degree of comfort expressed regarding the changing nature of patient-practitioner relationship and the accompanying privacy and legal aspects. A major part of roll-out will deal with overcoming the “inertia” of traditional practice, and encouraging practitioners to embrace a new system. A system for reimbursing practitioners for time spent in distance monitoring as opposed to face-to-face consultation may also need to be established.

While designing methods for implementation and dissemination, it is also important to understand more about the health system that the initiative will be implemented into: whether it is to be operated in the current health system or whether it should be geared for the ideal NHI system, or fashioned to a more generic system. This is most likely to impact the nature of health professional user profiles and commands/services, although it will also impact the standard of the supporting infrastructure.

In the current system, where the vast majority of records are in paper-based systems, with no unifying patient identifiers, PMI or EHRs, it must be determined whether an attempt to introduce an eHealth system will be able to be incorporated into the national – even the provincial – HIS, and whether creating yet another system that stands apart from the health system is, essentially, worth the effort. Essentially, interoperability will be dependent on the level of commitment from the health department, and thus it is essential to gauge their willingness to engage in the project from the get-go, likely to be dependent on health economic assessments.

Only through NDoH participation will it be possible to get information about HIS protocols currently in use, which will determine the level of interoperability that can be incorporated into the coding in the initial stages of development – or whether interoperability will only be achievable in future, and what level of interoperability is ultimately desired.

This links into the vital question of scale: a decision must be made regarding the initial scope of the project (as mentioned above, this will depend on the availability of resources and support). This includes how code is developed and by whom (which will reflect in the quality), system flexibility (particularly of the database), platforms used, functionality sophistication and design and flexibility of the user interface. A well-designed initial project will fare better in trials and will be easier to up-scale, but it may be difficult to fund the development of an untested prototype.

Before any development begins, technical details (see section 5.5) regarding the programming protocol to be used and the database structure must be decided upon, whether this is based on standards already in use by the health system, or the services described by the IHE in the NHSF. It must be determined whether the IHE services are sufficient for describing the data-flows in the proposed initiative, as well as up-scaling, maintaining internal interoperability as the system updates to maintain viability, and/or to support future initiatives, or whether more advanced protocols are required. In order to determine, this, however, a formalised concept of the flow of information and services should be drawn up once a concrete design has been decided upon for the initiative. Like the interaction of services between users and the database, other systems that have been outlined in this paper must be assessed for viability and refined by experts. Security protocols must be established to verify user identity and to detect rogue users. Bad data must be detectable. A refined referral system must be developed, with efficient permission-seeking features ensuring patient control, while ensuring that continuity of care is maintained.

For the basic prototype development, key functionalities will have to be identified, and the approach to deciding which functionalities will be incorporated must be evaluated. Basic surveys could be conducted amongst MHCUs and mental health care professionals, while the latter could be consulted in combination with support from literature regarding popular/effective treatment and self-treatment techniques (eg CBT and cCBT). An important consideration should be the ability of users to correctly interpret the function and input data correctly. By designing a tree of screens for each of the proposed functionalities (*ITE*), the complexity and cost in programming hours can be weighed against the benefits of inclusion into the programme.

An efficient but high-fidelity method for testing each functionality and the design of the programme itself must be developed: how and when and to what depth each phase is to be tested, along with decisions about trial ethics, how to assess potential risks, trial population and roll-out sites, and how controls and variables will be selected. Mechanisms must be designed prior to roll-out for ongoing evaluation of usage of the programme (i.e. acceptability), and the success of the programme (i.e. treatment success).

Finally, it must be established at what point of development various issues will be addressed.

6.4 LIMITATIONS

The limited literature readily available for South African mHealth trials and case studies, as well as typical health care infrastructure and public health sector HISs, severely constrained the potential of this study to provide definitive recommendations. With respect to mHealth case studies, the majority of information was only available through a manual search of health news media and knowledge of

HISs were limited to guidelines and proposals. Unpublished data from ongoing trials (such as those mentioned by interviewees) could not be accessed for review.

Because the study aimed to provide a compilation of key aspects that must be considered when designing an initiative, actual additions to the knowledge base surrounding m- and e-health or mental health care initiatives is limited. Many problems are raised (see above section 6.3) but not fully addressed and although potential resolutions are proposed, the issues must still be examined by experts who will need to either refine the ideas, or may recommend a more efficient solution.

The sample size of seven interviewees was extremely limited, often with only one expert per field, which may create a distorted, non-generalisable view of issues or a limited spectrum of ideas around a topic (e.g. potential solutions to issues faced).

The nature of interviewee recruitment may have been biased due to the contact-based and “snowball sampling” method used – all interviewees were located in the greater Cape Town area, the health professionals worked in both private and public health sectors, but were based in urban areas within the Western Cape, and thus knowledge of other health systems may have been limited.

Because of the exploratory nature of the study (see methods under Section 4.1), the interview questions were relative unstructured and thus highly subjective. Because interview questions became more sophisticated and focused as the study progressed and the proposed initiative became more developed, earlier interviews were often very limited in scope. The limited time frame and access to experts meant that, not only was the sample size very small, but that the limited interviews could not be repeated or that subsequent specialists in the same field could be interviewed.

Other fields that should have been consulted that were not included include medico-legal experts, managers of health care institutions (both private and public), a larger scope of health care professionals, both general and specialised in mental health care, epidemiologists involved in trial design and implementation, and eHealth specialists in the health sector as well as in private initiatives and service providers.

Due to ethical constraints, potential MHCUs were not interviewed, as the descriptive/exploratory nature of the study did not warrant potential risks and ethical concerns of involving laymen or patients, particularly mental health patients who are particularly vulnerable.

7 CONCLUSION

7.1 EVALUATING THE RESEARCH AIM

The purpose of the study was to gain an understanding of how an mHealth application for depression could be developed for the South African context and to consolidate health care and technological aspects of designing an mHealth intervention for depression to provide a backbone for future development of such interventions.

A gap analysis revealed that the research aim needed to be expanded to include the investigation of an intervention that could be integrated into the greater eHealth framework, requiring an additional health information systems aspect to be included in the amalgamation of disparate fields of study. Not only would an additional focus on eHealth allow for integration of data collected by the programme to be incorporated into general patient information, but the initiative could be used as a stepping stone to a more effective eHealth framework for public health department HIS development.

7.2 THE WAY FORWARD

7.2.1 *Greater than the sum of its parts*

This paper outlines an initiative that combines three disparate aspects.

As a health intervention (in itself multifaceted), an app would serve to empower a marginalised population that is underserved by the health system, and, from the provider perspective, would assist in patient management for CHWs and primary care workers with minimal training, providing support and management frameworks. There are standardised approaches to health interventions, including evaluation of evidence of efficacy, risk assessments, and cost evaluations and RCTs.

As a technological innovation, development and programming becomes a main focus, with considerations about code development and formatting, operating systems and system requirements, the flow of information and user interface design and user acceptance.

And finally, a third tier adds a structure to be integrated into health information systems to allow for growth, increased efficiency and efficacy through modernisation and digitalisation of health information. ERH and PMI development has bearing on referral systems, patient tracking, data collection on service provision and integration health services.

Exploring and addressing each of these aspects fully, but not in isolation or neglect of the issues of the other aspects will prove to be the crux of the initiative.

While, essentially, the aspects could be addressed as separate elements, the loss in function would render the intervention described ineffectual and almost worthless.

Looking at a pure health intervention: it is unlikely that intervention described, as a self-management tool or a health professional tool, would be cost effective in the context of a depression initiative unless it is connected to greater health information systems: there are likely to be greater priorities for the health system that could be implemented at a lesser cost. Similarly, unless combined with effective technological development, the initiative would not be scalable or be acceptable to patients or users.

Looking at a pure technological innovation: an mHealth development without proper attention to health perspectives will not only inherently have limited efficacy, but it will simply add to a flooded market of untested and unreliable health apps. While private health corporations are beginning to realise the potential of incorporating mHealth into eHealth, integrating patient-centric mHealth applications into public health system services is a novel concept that fills an important gap in the market. However, health systems integration cannot be done without attention to the fidelity of the intervention itself.

With respect to a pure eHealth initiative, this “top-down” approach is typically what is outlined in most policy frameworks and development goals. However, attempting to develop a universal/blanket HIS intervention to integrate services has proven to be an unrealistic and unfeasible ideal. Thus starting from the bottom up, with a technologically sound and flexible basis, may prove a more feasible approach.

Using a multi-tiered approach, scaling can work on multiple levels: using the HIS system as a stable backend, more mHealth initiatives can be incorporated to address other aspects of health. Conversely, a stable and successful mHealth intervention that is able to create useful EHRs and PMIs can allow for deeper integration into other health systems.

7.2.2 *A composite analysis for motivating equipped and embedded pioneers*

Because of the importance of maintaining the perspective of the full scope of the multifaceted project, a team of experts for each of the aspects must be headed by a motivated, passionate and personally invested leader, who has an ear to the ground for developments in mHealth and eHealth, internationally and locally, and yet is intimately familiar with the South African health system.

Using a somewhat pyramidal approach, this leader can be informed by experts of various fields, who can in turn exploit resources and contacts available to them to fully inform the development (and later realisation) of a tangible initiative. However, to maintain continuity as well as the fidelity of project ideals (foremost of which is patient-centeredness), the number of individuals in the design and leadership team should be restricted to a dedicated few.

This analysis, which attempts to hold the whole in mind while compiling a catalogue of issues in design of all aspects that is as complete as possible, is intended to serve as inspiration for such a team, providing an outline and a starting point that can be fleshed out as desired. Although the author provides suggestions for the components of an intervention, and possible solutions to technical details and challenges, the fundamental intention is to motivate innovation focused towards meshing, networking and integrating interventions and organisational structures, as the world seeks information that is available on demand through a seamless, interconnected digital existence.

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9 APPENDICES

9.1 APPENDIX: DEFINITIONS

Health-related definitions as supplied by the National Mental Health Policy framework and Strategic Plan¹⁰

Table 1: Definitions

Community health worker	"Any lay worker whose primary function is to promote basic health or the delivery of basic health services within the home or primary care facility." (6). ^{p6}
Community-based care	"Care that is provided outside of institutional and hospital settings, as near as possible to the places where people live, work and study" (6). ^{p6}
Ecological momentary assessment	"monitoring and assessment in real-time and real-world conditions" (23). ^{p111}
eHealth	"the use of information and communication technologies for health to, for example, treat patients, pursue research, educate students, track diseases and monitor public health" (26). ^{p7} as defined by the World Health Organisation.
Health Care Professional	"These are individuals registered with the various health related Statutory Bodies who render health and any related care to improve and maintain the health status of all health care users within the Department of Health" (6). ^{p6}
Mental health care practitioner	"A psychiatrist to registered medical practitioner or nurse, occupational therapist, psychologist or social worker who has been trained to provide prescribed mental health care, treatment and rehabilitation services." (6). ^{p7}
Mental health care provider	A person providing mental health care services to mental health care users and includes mental health care practitioners." (6). ^{p7}
Mental health care user (MHCU)	<p>"a person receiving care, treatment and rehabilitation services or using a health services at a health establishment aimed at enhancing the mental health care status of this person. This includes a user, state patient and mentally ill offender and where the person concerned is below the age of 18 years or is incapable of taking decisions, in certain circumstances may include a prospective user, the person's next of kin, a person authorised by any other law or court order to act on that person's behalf, an administrator appointed in terms of the Mental Health Care Act, 2002, and an executor of that deceased person's estate" (6).^{p7}</p> <p>This broader definition is used for individuals making use of the system outlined in this paper, rather than "patient", as the latter implies a level of severity that requires formal treatment at a health care facility, whereas an MHCU may desire the extra support (e.g. for additional "coping skills" offered by the programme, but may not consider themselves as mental health care patients.</p>
Mobile Health (mHealth)	The delivery of eHealth using mobile devices such as mobile phones, tablets, etc.
Patient	A health care user who is making ongoing use of formal health care services
Primary health care:	"Essential health care made accessible at a cost a country and community can afford with methods that are practical, scientifically sound as socially acceptable. This approach is organised to reduce exclusion and social disparities in health, is people-centred, inter-sectorial, collaborative and promotes the participation of all stakeholders" (6). ^{p8}
Primary Level Services (Primary Care):	"The first level of contact for individuals seeking health care" (6). ^{p8}
Psychiatric Hospital	"A health establishment that provides care, treatment and rehabilitation services only for users with mental illness" (6). ^{p8}
Psychosocial rehabilitation	"mental health services that bring together approaches from the rehabilitation and mental health fields, combining pharmacological

	treatment, skills training, and psychological and social support to clients and families in order to improve their lives and functional capacities.” (6). ^{p8}
Recovery model	“an approach to mental health care and rehabilitation which holds that hope and restoration of a meaningful life are possible, despite serious mental illness. Instead of focusing primarily on symptom reliefs, as the medical model dictates, recovery casts a much wider spotlight on restoration of self-esteem and identity and on attaining meaningful roles in society.” (6). ^{p8}
Secondary Care	Specialist care that is typically rendered in a hospital setting following a referral from a primary or community health facility.” (6). ^{p8}
Task shifting	“The use of specialist mental health staff in training and supervisory roles to non-specialist health workers as a mechanism for more efficient and effective care.” (6). ^{p8}
Tertiary Care	“Specialist care that is rendered at central hospitals” (6). ^{p8}
User	
User Role	
Integrated Healthcare Enterprise (IHE) Profiles	

9.2 APPENDIX 2: MENTAL HEALTH CARE FRAMEWORKS

9.2.1 Primary Care 101: Depression and Anxiety

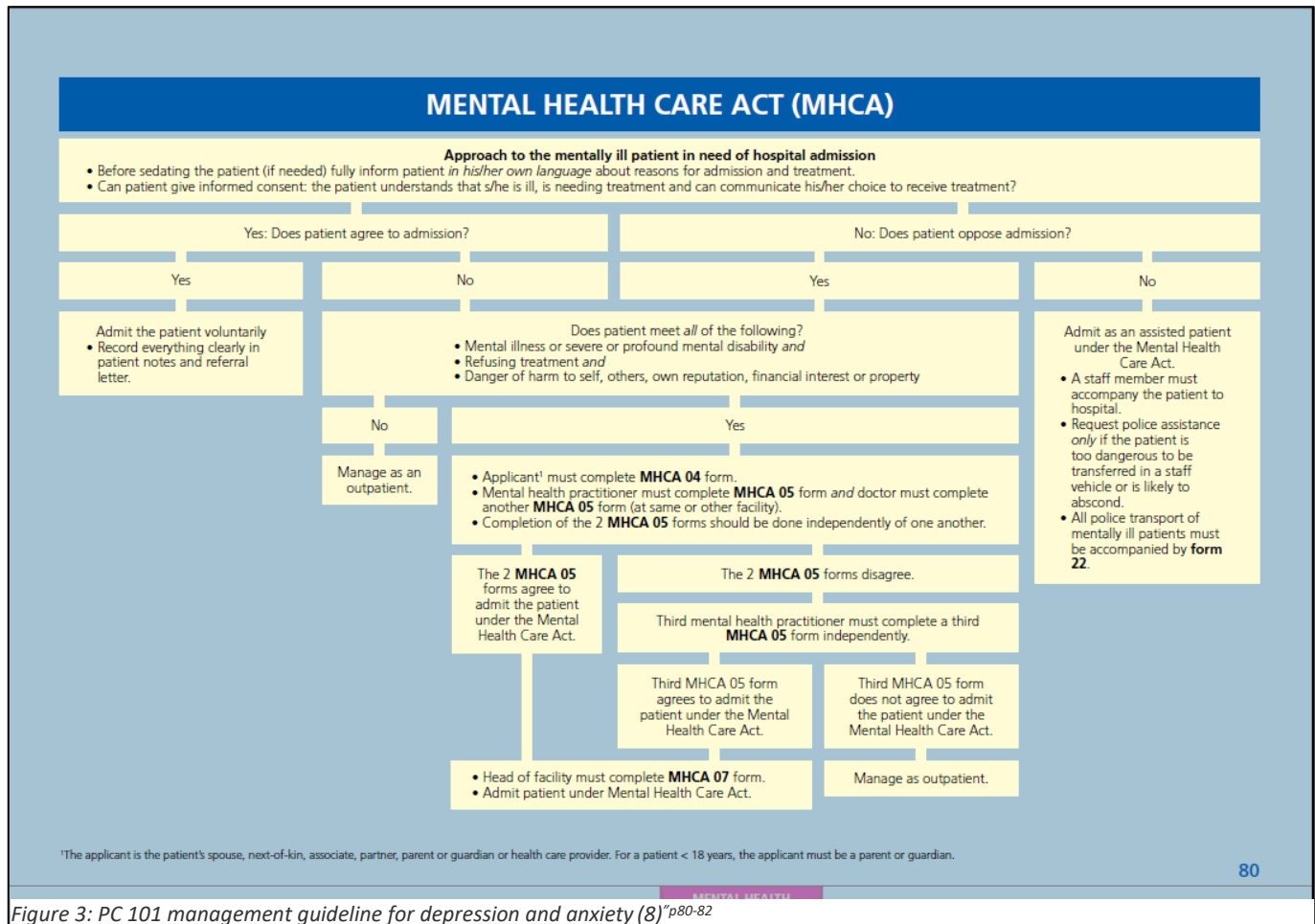


Figure 3: PC 101 management guideline for depression and anxiety (8)^{p80-82}

DEPRESSION AND ANXIETY: DIAGNOSIS

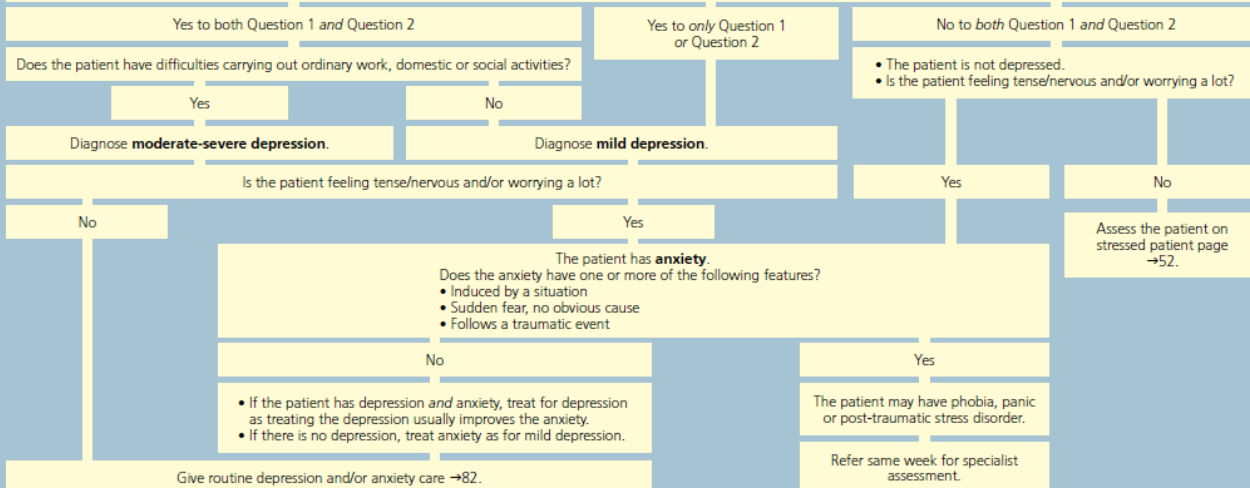
Ask the following 2 questions to assess for depression:

Question 1: For at least 2 weeks, has the patient had at least 2 of the core features of depression?

- Depressed mood most of the day, almost every day
- Loss of interest or pleasure in activities that are normally pleasurable
- Decreased energy or increased fatigue

Question 2: For at least 2 weeks, has the patient had any 3 other features of depression?

- Reduced concentration and attention
- Reduced self-esteem and self confidence
- Ideas of guilt and unworthiness
- Bleak and negative view of future
- Ideas or acts of self-harm or suicide
- Disturbed sleep
- Decreased appetite



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DEPRESSION AND/OR ANXIETY: ROUTINE CARE

Assess the patient with depression and/or anxiety

Assess	When to assess	Note
Symptoms	Every visit	<ul style="list-style-type: none"> • Assess for symptoms of depression and/or anxiety → 81. Refer if no improvement after 8 weeks of treatment or if patient deteriorates. • If patient has hallucinations, delusions and abnormal behaviour, consider psychosis →84. If memory problems, screen for dementia →86. • Assess and treat other symptoms on symptom pages. • Ask about side effects of antidepressant medication (see below).
Suicide	Every visit	If patient has suicidal thoughts or plans, refer same day → 49.
Mania	Every visit	Refer if mania (being abnormally happy, energetic, talkative, irritable or reckless) at diagnosis or develops on antidepressant medication.
Stressors	Every visit	Help identify the domestic, social and work factors contributing to depression and/or anxiety. If patient is being abused → 53.
Substance abuse	Every visit	> 21 drinks/week (man) or > 14 drinks/week (woman) and/or > 5 drinks per session or misuse of illicit or prescription drugs → 83.
Family planning	Every visit	Discuss patient's contraceptive needs → 91. If patient is pregnant refer for specialist care.
Chronic disease	Every visit	<ul style="list-style-type: none"> • Ensure other chronic diseases are adequately treated. • Discuss with specialist if patient is on medication that might cause depression like oral steroids, efavirenz and atenolol.
Thyroid function	At diagnosis	Check TSH if weight change, dry skin, constipation, intolerance to cold or heat, pulse > 80, tremor, or thyroid enlargement. Refer to doctor if result abnormal.

Advise the patient with depression and/or anxiety

- Devise with patient a strategy to cope when thoughts of self harm, suicide or substance misuse occur.
- Deal with negative thinking: encourage patient to question his/her way of thinking, examine the facts realistically and look for strategies to get help and cope.
- Encourage patient to do activities that used to give pleasure, to engage in regular social activity and to exercise for at least 30 minutes 5 days a week.
- Discuss sleep hygiene → 54 and relaxation techniques.
- Refer patient to available helpline and/or support group → back page.
- The best treatment for mild depression and/or anxiety is cognitive behavioural therapy. Antidepressants work best for those with moderate-severe depression.

Treat the patient with depression and/or anxiety

- Refer patient for counselling, ideally cognitive behavioural therapy, with counsellor, social worker or psychologist.
- Treat the patient with moderate-severe depression with an antidepressant. Refer the patient who is pregnant, breastfeeding or bipolar for specialist care.
- Emphasise the importance of adherence even if feeling well and to stop antidepressants only with the guidance of a clinician.
- Antidepressants can take 4–6 weeks to start working. Review 2 weekly until stable, then monthly. Refer if no response after 8 weeks.

Drug	Dose	Note
Fluoxetine	Start 20mg daily (or 10mg if > 65 years or if very anxious). If partial or no response after 4 weeks increase to 40mg daily.	Avoid in kidney or liver disease. Monitor glucose in diabetes and for fits in epilepsy. Side effects: headache, nausea, diarrhoea, sexual dysfunction.
Amitriptyline	Start 50mg at night (or 25mg if > 65 years). Increase by 25mg/day every 3–5 days (or 7–10 days if > 65 years). Maximum dose: 150mg/day (or 75mg if > 65 years).	Use if fluoxetine contraindicated. Avoid if suicidal thoughts (can be fatal in overdose), heart disease, urinary retention, glaucoma, epilepsy. Side effects: dry mouth, sedation.

Dr • Doctor to consider stopping antidepressant when patient has had no or minimal depressive symptoms and has been able to carry out routine activities for 9–12 months: reduce dose gradually over at least 4 weeks (more gradually if withdrawal symptoms develop: irritability, dizziness, sleep problems, headache, nausea, fatigue).

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9.2.2 Pyramidal model of care

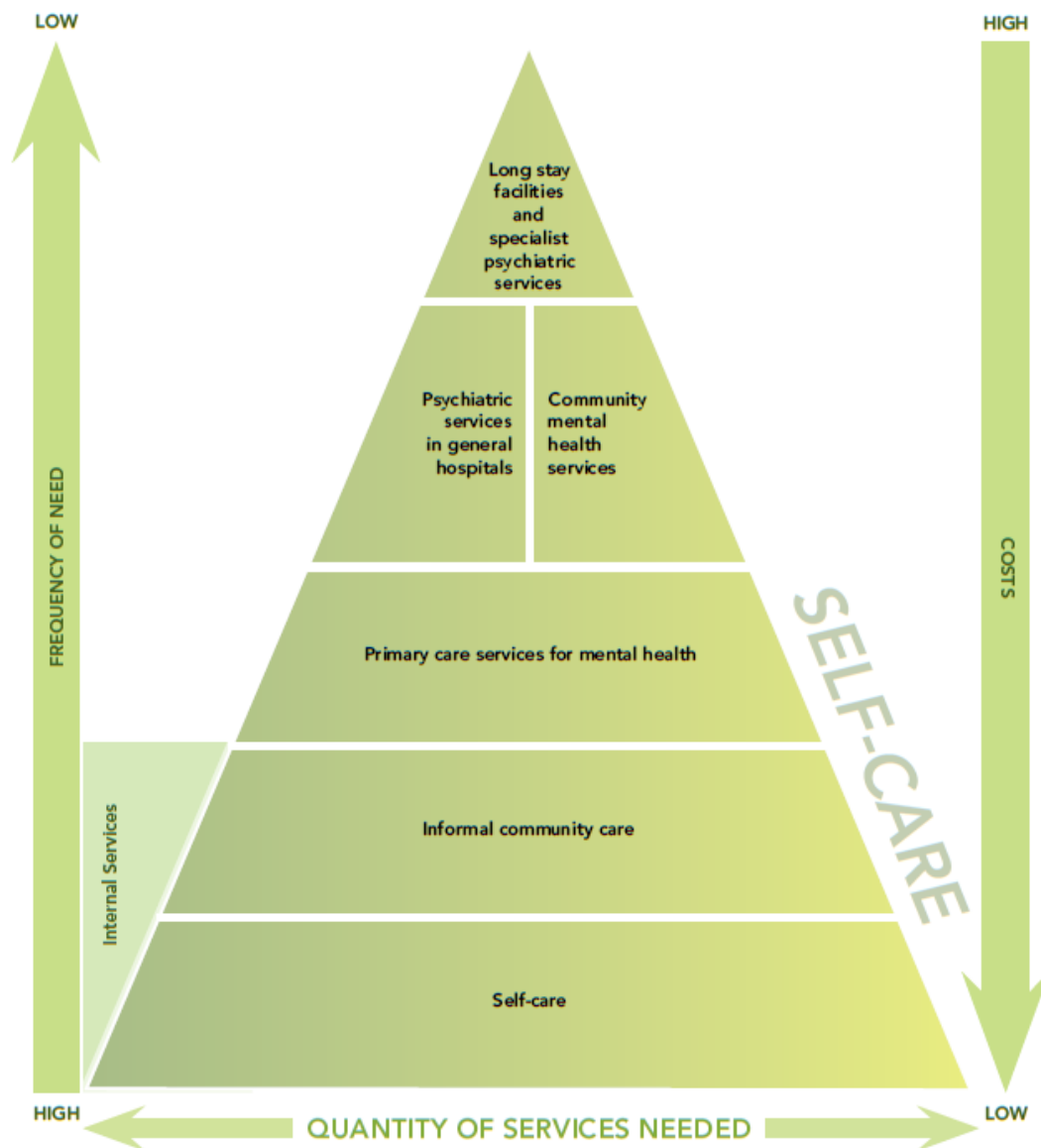


Figure 4: National Health Policy Framework and strategic plan 2013-2020 (6): Model for the organisation of services

9.3 APPENDIX 3: SUMMARY OF THE STUDIES REVIEWED ON mHEALTH INTERVENTIONS FOR DEPRESSION

*none of the work provided in this section is the author's original work. All language is taken directly from the stated source (typically the abstract), with only minor grammatical changes.

Author(s), TITeLe	Year	Type of study	Aim	Method	Sample	Findings and conclusions
Ben-Zeev et al (20): <i>Next-generation psychiatric assessment: using smartphone sensors to monitor behaviour and mental health</i>	2015	Cohort study	To examine whether the information captured with multimodal smartphone sensors can serve as behavioural markers for one's mental health	Individuals were enrolled as a single cohort and participated for a 10-week period. Participants were provided with smartphones embedded with a range of standard in-built sensors and designed software that enabled continuous tracking of their geospatial activity, kinaesthetic activity, sleep duration and time spent proximal to human speech. Participants completed daily ratings of stress, as well as pre and post measures of depression (PHQ-9) and loneliness (Revised UCLA Loneliness Scale)	47 young adults	Mixed-effects linear modelling showed that sensor-derived geospatial activity, sleep duration and variability in geospatial activity were associated with daily stress levels. Penalised functional regression showed associations between changes in depression and sensor-derived speech duration, geospatial activity and sleep duration. Changes in loneliness were associated with sensor-derived kinaesthetic activity. This suggests that smartphones can be harnessed as instruments for unobtrusive monitoring of several behavioural indicators of mental health.
Castro et al (15): <i>Efficacy of low-intensity psychological intervention applied by ICTs for the treatment of depression in primary care: a controlled trial</i>	2015	Study protocol: RCT	To assess the efficacy of 3 low-intensity psychological interventions applied by ICTs in primary care	Participants will be assigned to 4 parallel groups, one with a healthy lifestyle psychoeducation program with improved treatment as usual, one with a focused program on positive affect promotion and improved treatment as usual, one with a mindfulness programme and improved treatment as usual and a final group with improved treatment as usual. The PHQ-9 will be used as the main outcome, along with other tools as secondary measures. Assessment at baseline, post intervention and at 6 and 12 months post-treatment. An intention to treat and per protocol analysis will be performed	240 participants with mild to moderately depression	N/A
Payne et al (16): <i>Behavioural functionality of mobile apps in health interventions: a</i>	2015	Systematic review	To systematically search and describe the literature on mobile apps used	A review of the literature using key search terms in several relevant scientific journal databases. Only English articles pertaining to health interventions using mobile phone apps were included in the final sample.	24 studies (primarily feasibility and pilot studies)	Studies were primarily feasibility and pilot studies of mobile apps with small sample sizes. All studies were informed by behavioural theories or strategies, with self-monitoring as the most common construct. Acceptability of mobile phone apps was high among

<i>systematic review of the literature</i>			in health behaviour interventions, describe the behavioural features and focus of health apps and to evaluate the potential of apps to disseminate health behaviour interventions			mobile phone users. The results suggested early evidence that apps are well received by users and that mobile apps may be considered a feasible and acceptable means of administering health interventions. However, the lack of large sample studies signalled a need for additional studies, and a greater number of studies with more rigorous research and evaluations were needed to determine efficacy and establish evidence for best practices.
Saeb et al (19): <i>Mobile phone sensor correlates of depressive symptom severity in daily-life behaviour: an exploratory study</i>	2015	Exploratory study	To explore the detection of daily-life behavioural markers using mobile phone GPS and usage sensors and their use in identifying depressive symptom severity	Adults from the general community carried a mobile phone with a sensor data acquisition app for 2 weeks. A PHQ-9 survey was completed at baseline	28 participants from the general community	A number of features from GPS data were related to depressive symptom severity, including circadian movement, normalised entropy and location variance. Phone usage features, usage duration and usage frequency were also correlated. Using the normalised entropy feature and a classifier that distinguished participants with depressive symptoms from those without, an accuracy of 86.5% was achieved. This suggests that phone sensors offer numerous clinical opportunities, including continuous monitoring of at-risk populations with little patient burden and interventions that can provide just-in-time outreach.
Shen et al (13): <i>Finding a depression app: a review and content analysis of the depression app marketplace</i>	2015	Review and content analysis	To identify and characterise the different types of mobile phone depression apps available in the marketplaces	A search for depression apps was conducted on the app stores of the five major mobile phone platforms (android, iPhone, BlackBerry, Nokia and Windows). Apps were included if they focused on depression and were available to people who self-identity as having depression. Data were extracted from the app descriptions found in the app stores	243 of 1054 apps identified met the inclusion criteria	Two thirds of apps had providing therapeutic treatment or psychoeducation as their main purpose. Other main purpose categories were medical assessment, symptom management and supportive resources. A majority of the apps failed to sufficiently describe their organisational affiliation and content source. There was a significant relationship between the main purpose of the app and the reporting of the content source, with most medical assessment apps reporting their content source. A fifth of the apps featured an ebook, audio therapy or screening function. Most apps had a dynamic user interface and used text as the main type of media, and over a third incorporated more than one form of media. The results suggest that without guidance, finding an appropriate depression app may

						be challenging. Inadequate reporting of organisation and content source increased the difficulty of assessing the credibility and reliability of the app. The study demonstrated the need for standardised reporting in app stores to help consumers select appropriate tools, particularly among those classified as medical devices.
Donker et al (17): <i>Smartphones for smarter delivery of mental health programs: a systematic review</i>	2013	Systematic review	To systematically review the research evidence supporting the efficacy of mental health apps for mobile devices for all ages	A comprehensive literature search (2008-2013) in relevant databases was conducted. Trials were included that examined the effects of mental health apps delivered on mobile delivered on mobile devices with a pre- to post-test design or compared with a control group. The control group could consist of wait list, treatment-as-usual or another recognised treatment	8 papers of 5463 abstracts identified met inclusion criteria.	The 8 papers described 5 apps targeting depression, anxiety and substance abuse. Four apps provided support from a mental health professional. Results showed significant reductions in depression, stress and substance use. Two of the 5 evidence-based mental health apps were commercially available in app stores. The results suggested that mental health apps have the potential to be effective and may significantly improve treatment accessibility, although the majority of apps that were available lacked scientific evidence about their efficacy. Further rigorous research was required to develop and test evidence-based programs.
Watts et al (12) <i>CBT for depression: a pilot RCT comparing mobile phone vs. computer</i>	2013	Pilot RCT	To establish whether a previously validated cCBT program remained efficacious when delivered via a mobile application	Participants completed 6 lessons, weekly homework assignments and received weekly email contact from a clinical psychologist or psychiatrist until completion of lesson 2, after which contact was only provided in response to participant request or in deterioration. The Patient Health Questionnaire 9 (PHQ-9) was used as the primary outcome measure on completion and at 3 months follow up. Attrition was handled using mixed-model repeated-measures ANOVA.	35 participants with MDD	Both the mobile and computer groups were associated with statistically significant benefits and the reduction seen at 3 months follow up significant, suggesting that delivering a CBT program using a mobile application can result in clinically significant improvements in outcomes for patients with depression
Richards & Richardson (23): <i>Computer-based psychological treatments for depression: a systematic review and meta-analysis</i>	2012	Systematic review and meta-analysis	To systematically review the literature on computer-based psychological treatments for depression and conduct a meta-analysis of the RCT studies,	Database and hand searches were made using specific search terms and inclusion criteria.	40 studies and 19 RCTs were included in the meta analysis	The review describes the different computer-based treatments for depression, their design, communication types employed (synchronous, asynchronous and face-to-face), alongside various types and frequency of support delivered. The evidence supports their effectiveness and highlights participant satisfaction. Across 19 studies a moderate post-treatment pooled effect size was revealed. Supported interventions yielded better outcomes, along with greater retention. The results reported significant clinical improvement

			including examining variables which may affect outcomes.			and recovery post-treatment. The review and meta-analysis supported the efficacy and effectiveness of computer-based psychological treatment for depression in diverse settings with different populations. Further research was recommended to investigate the influence of therapist factors in supported treatments, the reasons for dropout and the maintenance of gains post-treatment.
Andrews et al (21): <i>Computer therapy for the anxiety and depressive disorders is effective, acceptable and practical health care: a meta-analysis</i>	2010	Meta-analysis	To review evidence that cCBT for the anxiety and depressive disorders is acceptable to patients and effective in the short and longer term	Systematic reviews and data bases were searched for randomised controlled trials of computerised cognitive behaviour therapy versus a treatment or control condition in people who met diagnostic criteria for major depression, panic disorder, social phobia or generalised anxiety disorder. Number randomised, superiority of treatment versus control on primary outcome measure, risk of bias, length of follow up, patient adherence and satisfaction were extracted	22 studies of comparisons with a control group were identified	Benefit was evident across all four disorders. Improvement from cCBT was maintained for a median of 26 weeks follow-up. Acceptability, as indicated by adherence and satisfaction, was good. Research probity was good and bias risk low. Effect sizes were non-significantly higher in comparison with waitlist than with active treatment control conditions. Five studies comparing cCBT with traditional face-to-face CBT were identified, and both modes of treatment appeared equally beneficial. The evidence suggested that cCBT for anxiety and depressive disorders, especially via the internet, has the capacity to provide effective acceptable and practical health care for those who might otherwise remain untreated.

9.4 APPENDIX 4: SOUTH AFRICAN mHEALTH SOLUTIONS

9.4.1 Table of independent mHealth applications identified by eHealthNews (28)

* Only applications that are specifically relevant to the South African context were included

Name	Collaborators	Availability	Description
<i>Aviro HIV Mentor App</i>	Private.	iTunes, Google Play Store	An HIV clinical support tool for nurses, providing training, mentorship, with prescribing assistance and easy contact to the HIV Hotline.
<i>B-Wise</i>	NDoH	https://b-wise.mobi	Targets SA's youth regarding health issues. Uses Mxit to provide health information on topics like sexual and reproductive health, mental health, TB, substance abuse, healthy lifestyles, etc. A live chat forum with health professionals will be provided. Users can also participate in polls
<i>Eden district mHealth project</i>	SAMRC, Norwegian Knowledge Centre for the Health Services, Karolinska Institutet, University of Edinburgh, Mobenzi. Community-based NPOs	Pilot project	CHWs and local facilities are equipped with apps aimed at streamlining data collection, supervision, communication tracking and coordination and activity recording of CHWs monitoring patients with chronic conditions.
<i>Health4Men</i>	Anova Health Institute, EJAF, PEPFAR, NDoH, SANAC	h4m.mobi	A mobisite provides men who have sex with men with information on sexually transmitted infections, substance abuse, a forum for anonymous questions and a function to identify and locate their nearest competent clinic
<i>hearScreen</i>	University of Pretoria		Geared towards generalist CHWs. App provides clinically valid tests, used with standard headphones. Cloud-based management of evaluations and recommendations and referral systems
<i>iLoveLife</i>	KfW (German Government Development Bank)	iloveLife.mobi or USSD *120*2121#	Aimed at SA's youth. A mobile platform with topics aimed to reduce risky sexual behaviour through looking at teen-life topics with assessments, quizzes, videos and articles, with a point-scoring/reward system for completing activities and going for testing.
<i>MomConnect</i>	NDoH, Praekelt Foundation, MAMA	registration	SMS-based application. Sends pregnant women weekly SMSs with information, encouragement to attend antenatal care and enables them to ask questions and send complaints or compliments. Mothers continue to get messages for up to a year after delivery. Stores all accumulated data (including patient details) in a central location.
<i>PHC Clinical Guide</i>	NDoH	Google Play Store, iTunes	Geared towards healthcare professionals, has clinical guidelines in mobile format, along with risk assessment tools, drug dosage calculators, and medicine stock-out tools
<i>Safe Delivery App</i>	Maternity Foundation, University of Copenhagen, University of Southern Denmark		A training tool for health workers with instructive videos on how to handle childbirth complications, with push messages and quiz questions and essential drug/equipment lists.
<i>StAR</i>	Oxford University, the Chronic Disease Initiative for Africa, the South African Medical Research Council	Trial stages	SMS messages to patients with high blood pressure, with prompts to collect/take medication, concerns that people have, suggestions for lifestyle, etc.

<i>TB App</i>	National Institute of Health, Aurum Institute, Fogarty	In development	App relays sputum tests from labs to health workers, with personalised text messages that inform patients of the results
<i>Vula Mobile</i>	Private. Grants from SAB Foundation, DG Murray Trust, The Innovation Hub and the Shuttleworth Foundation	Piloted in five hospitals across SA. iTunes, Google Play Store	Health workers. Allows for basic patient information capturing, photography, basic eye testing. Information can be sent to hospital-based specialists (also part of system)

9.4.2 Table of Applications of Mobenzi (29) systems

	Collaborators	Description
<i>HIPSS Cohort Study</i>	KZN DoH, PEPFAR, NICD, Epicentre AIDS Risk Management, SACEMA, HEARD, CDC, CAPRISA	The HIV Incidence Provincial Surveillance System, a 4 year cross sectional study with approx. 20 000 participants and an embedded longitudinal follow-up cohort, aims to measure HIV prevalence and changes in incidence over time. Additional research information such as comorbidities, treatment indicators and behaviour/psychosocial characteristic are also collected. The <i>Mobenzi</i> system has a mobile biometrics component (a fingerprint scanner) to ensure patient identity and maintain data integrity, and keeps track of baseline households, follow-up participants and replaced households linked to patient identities as fieldworkers collect data and can be seamlessly incorporated into a database.
<i>PHC Re-engineering in the North West Province</i>	North West Department of Health	The project, focusing on maternal and child health, treatment adherence and linking CHWs to professional support, is designed to support the revitalisation of primary health care in line with the implementation of the National Health Insurance scheme. A <i>Mobenzi</i> application of CHW phones collect data, track patients, record visits and connect CHWs with supervisors and local clinics, while the <i>Outreach</i> platform allows for logistics, operation control and supervision.
<i>Active Case-finding in Tuberculosis (ACT3)</i>	Woolcock Institute of Medical Research, National Tuberculosis Program (Vietnam)	A 4 year longitudinal randomised control trial in Vietnam which aims to monitor TB prevalence, where screening is conducted at homes through an interview and sputum sample. Interview data and QR codes assigned to sputum samples are done on mobile devices assigned to fieldworkers. Electronic identification of samples allows for real-time release of results and automated scheduling of follow-up and referral depending on the outcome of the test
<i>Evaluation of XTEND tool</i>	The Aurum Institute	A trial for evaluating a new tuberculosis diagnostic tool, XTEND, was for cost-effectiveness, impact on patient outcomes and transmission on a population level. <i>Mobenzi Outreach</i> generated follow-up forms, maintained longitudinal record-keeping of participants, coordinated schedule, linked clinic data, and monitored data integrity.
<i>Evaluation of South African National PMTCT Evaluation</i>	SAMRC	<i>Mobenzi</i> systems were used to support a national survey, the South African Prevention of Mother to child Transmission, where interviews were conducted at 6 weeks and at 6, 9, 12 and 18 months by fieldworkers. An application was designed for the survey on the fieldworker device, an SMS reminder system for caregivers was set up and sticker packs with generated participant identifiers were created.
<i>Philani Mentor Mothers Project</i>	Philani, Stellenbosch University, UCLA	To evaluate the effectiveness of a Mentor Mothers, a maternal and child health support programme, a system was designed to schedule and supervise CHW visits and enhance data collection. Longitudinal health outcome data is collected independently of CHW visits, with baseline assessments and interviews at 6 days and 6, 18 and 36 months post birth. CHWs ("Mentor Mothers") collected data on a mobile phone regarding amount of contact time and topics discussed.
<i>Good Start III</i>	SAMRC	The Good Start study was designed to show the benefit of mobile monitoring in interventions for improving neonatal survival. Antenatal and postnatal visits were conducted by CHWs at specific intervals, following participants for up to 12 months. Survey information from each visits relayed to supervisors facilitated planning and visit scheduling. Birth information-gathering allowed immediate

		dissemination and timeous visits. Supervisors, administrators and managers could access information (controlled to ensure blinding) regarding patients and CHW interactions
<i>Sisonke Home-based Counselling & Testing</i>	SAMRC	The <i>Good Start</i> study platform was used in a trial to prove the effectiveness and quality of data collection in the provision home-based counselling and testing services. Baseline community surveys were conducted and repeated two and a half years later. Follow-up visits were automatically scheduled for longitudinal data incorporation.
<i>Emergency relief and rehabilitation in Zimbabwe</i>	Africa Ahead	A survey was designed for community-based data collection on demographics, household health and hygiene behaviour and practice
<i>Mobile-assisted self-interviewing</i>	WhizzKids United	<i>Mobenzi Researcher</i> was utilised by WhizzKids United workers to conduct computer-assisted self-interviewing in schools, allowing for completely anonymous surveying

9.4.3 Table of Cell-Life (30) applications

	Collaborators	Description
<i>iDART (Intelligent Dispensing for Anti Retroviral Treatment)</i>	Desmond Tutu HIV Foundation, CPUT, UCT, Vodacom Foundation, CIDA, MatCH, CAPRISA, City of Cape Town	A system designed to support ARV dispensing in the public health sector. The system aims to automate drug supply management, with controlled dispensing, stock control and re-order statistics. Identifiable, multi-lingual bar-coded labels are created for every drug and patient package. The system links in with existing patient record systems (PREHMIS) to streamline processes and prevent duplication. Using <i>Communicate</i> (web-based SMS platform), SMSs are sent to patients with clinic appointment reminders and daily positive living SMSs.
<i>remedi</i>	EU, NDoH	A directory of mHealth services in South Africa, accessible through USSD code *120*9911*5001# or online m.remedi.org.za
<i>EatWell</i>	EU, NDoH, Health Promotion directorate	A series of 24 SMSs promoting healthy nutrition and diabetes/hypertension awareness geared at low-income cell phone users.
<i>iQuit</i>	EU, NDoH	Users register on a mobisite and receive 12 weeks of SMSs around their quit dates
<i>Mobile Data Collection project</i>	NDoH	A project to evaluate the use of cell phones for in-field data collection by ward-based outreach teams, empowering CHWs to collect data which can be managed Cell-Life capture systems. CHWs can easily liaise with each other and their team leader.
<i>Drug Stock Management (DSM) System</i>	UKaid, DFID, Jembi Health Systems	A system that has interface connectivity with each facility's dispensing system, allowing pharmacists to scan in drug orders, with on- and off-line monitoring of stock levels, with average daily consumption and delivery lead times provided
<i>Mobile M&E for the National HIV Counselling and Testing Campaign</i>	SANAC, HISP-SA, NoH	Field-workers access forms to collect data regarding the effectiveness of the HIV Counselling and Testing campaign and the rollout of ARVs. Data will be compatible with routine reporting currently done using the District Health Information System (DHIS)
<i>Rate My Clinic</i>	EU, Section 27, TAC, Soul City	A service enabling patient reporting of visits to public healthcare facilities.
<i>Mobile Alliance for Maternal Action (MAMA) Capture</i>	Praekelt Foundation, WRHI, USAID, Johnson & Johnson	A global movement that has collaborated with Cell-Life. Provides services across a number of mobile platforms (SMS, MOBI, USSD, MXIT, voice) to provide information and support
	Community Media Trust	Health education workers use a mobile or web interface to report on indicators of daily work (number of attendees, message, date, location) – allowing for monitoring of intervention efforts.
<i>Lungisa</i>	The Indigo Trust	A service using SMS, USSD or Mxit which allows for reporting on poor service delivery. A public website will display all reports, making service delivery transparent and holding service providers accountable

<i>Just Tested</i>	Vodacom, ICAP MOSAIC	An SMS-based service to supplement counselling giving during HIV Counselling and Testing. Information on the service will be distributed by counsellors, and patients can choose between Just Tested negative or Just Tested positive, and participants will receive 39 SMSs over 3 months
<i>HealthSmart</i>	ICAP MOSIAC	A series of SMSs designed to promote uptake of HIV Counselling and Testing and healthy sexual behaviours among men who have sex with men.
<i>TB Free SMS</i>	TB/HIV care, the School of Public Health from UWC, WHO, Vodacom	SMSs are sent to recipients (who sign up themselves, facilitated by healthcare workers) to support and inform people to adhere to their TB medication, promote healthy living and to tackle HIV & AIDS. The system uses Cell-Life's <i>Communicate</i> platform
<i>Ipas medical abortion rollout</i>	Ipas	A partnership with Ipas to provide services that inform and coach women on medical abortion and supporting medical abortion providers through SMS updates. A mobisite, IChooseWhen, has also been developed
<i>m-assist</i>	WHO	Provides a combination of information, self-assessment and support using mobiles. SMSs provide coaching and family planning information, and Mxit and a family planning mobisite (m.ichoosewhen.org.za) are also incorporated
<i>A tracking system between MOSAIC programmes</i>	MOSAIC	A system was developed to track referrals of clients assisted by 4 different MOSAIC programmes, as well as collect data.
<i>SAfAIDS Mobile Data Collection Project</i>	SAfAIDS	A monitoring and evaluation system was developed for CHWs to assist with data collection, using Cell-Life's <i>Capture</i> solution
<i>TB/HIV Care Association Mobile Data Collection</i>	TB/HIV Care Association	Using Cell-Life's <i>Capture</i> system, 8 mobile-based forms were developed and rolled out to streamline data collection, referral/recall of patients and reporting on data collection for the TB/HIV Care Association
<i>Mothers2Mothers data collection</i>	Mothers2Mothers	A consolidated solution for Mothers2Mothers was designed to capture data efficiently and generate automated monthly reports on the data collected
<i>IVR Study</i>	Unit for Research on Health & Society – Stellenbosch University	An interactive voice response platform was developed for a Stellenbosch University study on post-operative circumcised men, which allows for functionality on call flow and when to send voice messages to patients, along with the development of a web interface that allowed for control of the programme.
<i>Red</i>	NAHL	A Mxit platform that allows for HIV counselling through RedChatZone and a mobisite (redhiv.mobi)

9.5 APPENDIX 5: LISTS OF CHALLENGES AND RECOMMENDATIONS FOR E- AND mHEALTH INITIATIVES FROM THE LITERATURE

*none of the work provided in this section is the author's original work. All points are taken directly from the stated source, with only minor grammatical changes.

9.5.1 Challenges in eHealth

The NDoH's mHealth strategy (36) outlines the following challenges encountered by mHealth initiatives:

- Lack of alignment and integration of interventions into health plans, strategies and systems, (36)
- Absence of government leadership and coordination
- Poor documentation and learning from best practices
- Lack of use of open source options
- Absence of practical approaches to privacy and security
- Lack of interoperability

- Absence of a single framework within which to evaluate the role of mHealth and eHealth tools in strengthening the health system

Challenges to eHealth identified by the NDoH 2012 eHealth Strategy (26) include:

- No national eHealth strategy and corresponding enterprise architecture supporting the national health system
- Limited capacity or capabilities within the public sector to implement a national eHealth strategy
- Widely differing levels of eHealth maturity across and within provinces
- A large number of disparate systems between which there is little or no interoperability and communication
- Silos of information within levels of government, government departments and programmes within the national and provincial departments of health, resulting in duplication of effort and disparities in reporting
- Inequity of eHealth services provided and expenditure on eHealth across national and provincial departments of health (this may be related to differing strategic importance placed on eHealth)
- Broadband connectivity is expensive and still out of reach of many
- A low degree of cooperation, collaboration and sharing across all sectors
- Several past initiatives have not reached fruition because of poor planning or lack of consistent sponsorship, management and/or funding
- Need for strong information governance to ensure compliance with the necessary standards and procedures for, and appropriate use of, health information (both patient-based and aggregate)
- Different organisational structures for eHealth service provision exist in provinces, e.g. health ICT services may reside within a department of health but in an inappropriate section, or within another department
- The absence of a national master patient index and lack of consensus on unique identification of patients
- A lack of cooperation between various groups resulting from lack of a clear understanding that eHealth includes all ICTs for health such as mobile technologies, telemedicine and EHRs. This lack of cooperation prevents urgently needed progress in using eHealth as an enabler

The report on the African eHealth Forum (35) identifies the following challenges to eHealth:

- eHealth
- find the Pan-African big picture and common theme
- eHealth Leadership Gap
- inadequate human eHealth capacity
- delayed strategy implementation
- complex change
- history of eHealth failure
- inadequate surveillance
- missing links
- regulation gaps
- governance uncertainty
- non-standardised protocols

- poor risk management
- too many stuck pilots
- disparate systems
- financial risks
- weak business cases
- poor scale-up
- not cultivating local developers
- insufficient ICT capacity
- poor connectivity
- not embracing social media
- inadequate population health management
- not engaging citizens
- no continuous learning
- not engaging telecoms
- limited eHealth awareness
- Aid distorts priorities
- Capacity stretched over WHO building blocks
- Big reliance on paper records
- Inadequate ICT support
- Overseas ICT overreliance
- Continuous learning needs
- Data sharing needs
- Expanding data volumes
- Weak procurement
- Growing user-centric demands
- Inadequate networks
- Under-utilisation
- Clinical and management balance
- Poor fit to other healthcare resources
- Poor reach into rural communities
- Few solution development skills
- eHealth not integrated into research
- cybercrime
- affordability not dealt with
- not enough user acceptance testing
- inadequate architecture
- poor eHealth coordination
- weak financing models
- poor benefits realisation
- personalised care not realised
- static strategies
- ownership costs not identified
- not enough supplier engagement
- not integrated with medical education
- inadequate birth and death registration

Some of the eHealth challenges to interoperability outlined in the eHNA's eBook (34) include:

- Cost
- Producing consistent and timely reports
- Technical issues
- Identifying and implementing standards
- Unrealistic end user expectations
- Normalising data feeds
- Patient matching
- Trouble-shooting errors

Some of the eHealth “lessons learned” outlined in the eHNA's eBook (34) include:

- It is more complicate than planned, needs different resources for success than planned, takes longer than planned, is more than just ICT projects, needs changes to health systems to succeed
- Inadequate or late engagement with stakeholders
- Overambitious timescales
- Over-ambitious investment programmes
- Insufficient evidence about timescales from existing local eHealth projects
- Not referring to the experience from the timescales of proven eHealth projects
- Minimal affordability assessment
- Over-emphasis on ICT capacity, insufficient emphasis on human capacity
- Not investing enough in leadership across healthcare
- Underestimating the time needed to engage successfully with stakeholders, especially doctors, nurses and pharmacists
- Complexities in integrating and sequencing a strategy's required eHealth investment in a cohesive shorter-term plan
- Underestimating procurement complexity and timescales
- Not considering emerging technologies' opportunities and risks
- Lessons learned about EHRs
 - Potential impacts such as better outcomes for patients and better resource utilisation have not always come through
 - Risks of eHealth may result in fewer health and healthcare outcomes.
 - EHRs must support clinical work and research, by exploiting systems to collect as much data as possible.
 - EHRs may need extra staff and will not necessarily save time
- Not planning for obsolescence
- Inhibitors for projects include:
 - cultural perceptions
 - language choices
 - limited resources in rural settings
 - weak health systems
 - external financing schemes
 - lack of eHealth regulation

9.5.2 Suggestions and priorities for developing eHealth initiatives

The HNSF (32) provides the following priorities as a way forward for eHealth

- strategy and leadership
 - adopt an incremental approach to the development of shared, national electronic health record
 - accelerate the delivery of high priority eHealth solutions in a nationally aligned manner
- Stakeholder engagement
 - Workshop the HNSF with relevant stakeholder groups in order to gain acceptance of the proposed framework and refine it where necessary
 - Establish national eHealth stakeholder forums and working groups with cross-sectorial representation and clearly defined objectives and goals
 - Establish a national chapter for HL7, including all stakeholders
 - Establish a national IHE affiliate, including all stakeholders
 - Working closely with SABS, support the national ISO TC 215 mirror committee and maintain South Africa's status as an active participating member of ISO TC 215.
- Standards and interoperability
 - Establish a properly mandated entity (such as an eHealth Standards Board) to work closely with healthcare providers and other relevant stakeholders to develop, adopt and maintain eHealth standards-based profiles and base standards
 - Provide sufficient resources to such an entity so that it can perform these functions
 - Establish a national compliance function within this entity to test and certify that eHealth solutions comply with national eHealth standards, rules and protocols
 - Organise a national or regional connectathon to test interoperability capacity of systems that are currently implements or candidates for implementation
- Governance and regulation
 - Design and implement a consistent national legislative framework for information protection, privacy and consent
 - Establish an independent national eHealth regulation function to implement and enforce national eHealth regulatory frameworks
 - Develop a governance regime, which allows strong coordination, visibility and oversight of national eHealth work program activities
- Investment, affordability and sustainability/applications and tools to support healthcare delivery
 - Encourage investment in the development and deployment of high priority, standards compliant and scalable eHealth solutions
 - Establish mechanisms to encourage care providers to invest in the implementation and maintenance of an acceptable baseline of computing infrastructure
- Benefits realisation
 - Establish programs to encourage the adopting and use of high priority eHealth solutions
 - Implement national awareness campaigns that focus on communicating the scope and benefits of high priority solutions to consumers and care providers
 - Encourage healthcare participants to adopt and use high priority eHealth solutions and modify their work practices to support these solutions
- Capacity and workforce
 - Implement changes to vocational and tertiary training programs to increase the number of skilled, nationally available eHealth practitioners
- eHealth foundations

- coordinate the rollout of appropriate national broadband services to all care providers
- implement a set of national eHealth foundations that will provide a platform for health information exchange across geographic and health sector boundaries
- design and implement a national solution to enable the unique identification of South African patients/consumers and care providers.
- Monitoring and evaluation of the eHealth Strategy South Africa 2012-2016
 - Establish within the eHealth Standards Board a capacity for monitoring and evaluating the eHealth Strategy of South Africa 2012-2016 (26).

Strategic priorities for eHealth identified by the NDoH 2012 eHealth Strategy (26) include:

- Strategy and leadership
- Stakeholder engagement standards and interoperability
- Governance and regulation
- Investment, affordability and sustainability
- Benefits realisation: Ensure that a programme provides benefits to healthcare quality and improves access (safety, effectiveness, patient-centeredness, timeliness, efficiency, equitability)
- Capacity and workforce
- eHealth foundations
- Applications and tools to support healthcare delivery
- Monitoring and evaluation of the eHealth Strategy

The NDoH 2012 eHealth Strategy (26) recommends:

- Getting the basics right: infrastructure, connectivity, basic ICT literacy, human resources and affordability planning
- Take an incremental approach – build on what exists already both in the public and private sectors and fill the gaps where necessary
- Look for early wins in implementations and benefits to build the confidence of health professionals, patients and the public in eHealth
- Advocate the benefits of care enabled by eHealth and ensure that these benefits are realised
- Constantly evaluate eHealth initiatives and measure improvements in health outcomes in order to build an evidence base that demonstrates the net benefits over time of eHealth and guides planning and decision-making
- Establish national co-ordination on all initiatives in order to improve the effectiveness of eHealth at all levels
 - Enable integration between systems wherever possible
 - Enforce common standards, norms and systems across the country
 - Establish common data standards and terminology across information systems
- Encourage a collaborative approach by leveraging partnerships e.g. private sector, NGOs, other government departments, other country governments, research organisations.

The report on the African eHealth Forum (35) identifies the following steps for success for eHealth initiatives:

- Identify specific eHealth challenges in the eHealth strategy
- Develop risk mitigation plans to track their impact and significance
- Select the challenges relevant for each eHealth project in the strategy's implementation plan
- Select the sequence needed for maximised benefits from successful eHealth

- Design the measures needed to deal with challenges effectively
- Allocate resources to them
- Implement them alongside the eHealth project

The report on the African eHealth Forum (35) identifies the following eHealth solutions:

- integrate health information and management information systems
- share data between health workers and health and healthcare organisations
- plan for EHRs which can incorporate patient and medical records
- expand mHealth, which extends across a wide range of health conditions
- strengthen eSurveillance, given increased emphasis by the WHO
- support telemedicine, which can include telemonitoring
- boost supply chain management
- invest in business intelligence and predictive analytics
- develop the district health information system strategy
- encourage ICT collaboration
- promote eLearning for a wide range of health workers, including eHealth and continued professional development

Some of the suggestions for eHealth outlined in the eHNA's eBook (34) include:

- Not having ambiguous policies and inconsistent processes that confuse health workers
- Ensuring adequate oversight and accountability that identifies and resolves problems promptly
- Keeping technology up-to-date and efficient
- Constantly improving interoperability
- Ensuring adequate training for staff
- Having explicit and clear resource needs, priorities and allocations, including
 - Payments to ICT suppliers
 - Payments to contractors for services such as project management
 - Running costs of new services
 - Trainers
 - Extra specialist staff, such as ICT support, informatics and analytics, including their training and continuous development
 - Redeployment of existing resources already financed for activities such as engagement of health workers, changing clinical and working practices, training and procurement
 - Obsolescence
 - Risks
- Demonstrating strong commitment and top leadership support
- Providing the capacity needed to succeed
- Having an action plan and reporting on its progress
- Mitigating risks by defining root causes and identifying solutions
- Monitoring the effectiveness and sustainability of corrective measures
- Demonstrating progress
- A ten-year plan to achieve expanded interoperability includes
 - Building on existing health ICT infrastructure
 - One size doesn't fit all

- Empower individuals
- Leverage the market
- Maintain modularity
- Consider the current environment and support multiple levels of advancement
- Focus on value
- Protect privacy and security in all aspects of interoperability
- Enablers for mHealth include:
 - appropriate project design
 - effective stakeholder involvement
 - the right technology
 - the right resources
 - high integration with the health system

9.5.3 *Research agendas for scalable mHealth*

Leon et al (3) list the following dimensions required for scaling up mHealth

- Government stewardship
 - Strategic leadership that is present through policy guidelines that promote alignment with strategic health goals, funding sources, common ICT standards and partnerships for collaboration nationally and internationally
 - A learning environment where projects are evaluated systematically and where collaboration and sharing of knowledge can contribute to a central repository of evidence on mHealth, which can influence policy and practice
- Organisational:
 - A capacity for implementation, managerially and technologically, to successfully implement mHealth interventions. This includes assessment of eReadiness, a functional ICT environment and effective mechanisms for implementation, support and monitoring and evaluation
 - A culture of information use with an organisation culture and tradition of using health information for management o ensure that the increased access to electronic information is used for quality improvements in health services
- Technological:
 - The technology has ease of use, flexibility and durability and end users experience the new technology as benefiting their work
 - Interoperability of information systems ensures there is smooth commination across technological and information platforms as well as smooth integration with existing work practices. Common stands are developed through consensus amongst the multiple stakeholders including health ministries, digital providers, health management, clinical staff, patients and funders. The relative merits of open source versus proprietary software are addressed as this has implications not only for interoperability, but also for financial sustainability
 - Privacy and security of data is ensured. Additional regulations for protecting electronic data may be required to secure privacy of data
- Financial:
 - Securing sustainable funding for large-scale implementation is a major requirement and requires clear business and funding plans. Plans should be realistic, especially as ICT projects may cost more and take longer than initially planned

- The cost-effectiveness of mHealth strategies is evaluated mHealth interventions are weighed up against other priority and evidence-based interventions (in terms of costs, resources and capacity requirements) and opportunity costs are routinely considered. Unintended consequences of introducing new technology within a weak health system are monitored to minimise negative effects

The research agenda outlined by van Heerden, Tomlinson & Swartz (31) describes the following priorities for mHealth

- mHealth needs to develop an evidence base
- mHealth systems should be interoperable with existing Health initiatives
- mHealth should adopt and implement the same standards already present in eHealth
- mHealth should take a participatory approach
- mHealth should promote equity
- mHealth needs to focus on health, not on the technology

The research agenda for mobile mental health by Olff (27) suggests the following checklist for mHealth tools development and research

- Development phase
 - Having a multidisciplinary team (mental health professionals and I)
 - Based on evidence-based on informed principles or guidelines
 - Based on valid and reliable screening and assessment instruments
 - Instruments open access or copyright free
 - Short and smart
 - Providing a source of content
 - Providing scientific references
 - Tools tested on different devices
 - Design matching specific target group and problem
- Feasibility and acceptability testing on
 - Reaching the right target group
 - User satisfaction, interest, willingness to use
 - Perception of treatment credibility
 - Expectancies and attitudes
 - Adherence to treatment
 - Concerns about user privacy, confidentiality and online security
- Evaluation of intervention tools
 - Evaluated on efficacy or effectiveness
 - Evaluated on cost-effectiveness
 - Safety evaluated
 - Post-marketing surveillance

Tomlinson et al (25) provide the following recommendations for up-scaling mHealth

- Existing standards for research should be reconsidered in order to provide guidance as to when up-scaling is appropriate
- mHealth interventions should be guided by a plausible theory of behaviour change and should use more than one technique depending on the targeted behaviour

- an open mHealth architecture must be established based on a robust platform with standards for app development which would facilitate scalable and sustainable health information systems
- implementation strategies such as factorial designs that are able to test the multiple features of interventions must be explored, in order to provide the necessary evidence base
- scale-up of mHealth in low and middle income countries should be preceded by efficacy and effectiveness trials so that they are founded on an appropriate evidence base
- governments, funders and industry must cooperate in order to set standards to create a self-governing commercially viable ecosystem for innovation

The following model of research stages and standards is provided by Tomlinson et al (25).

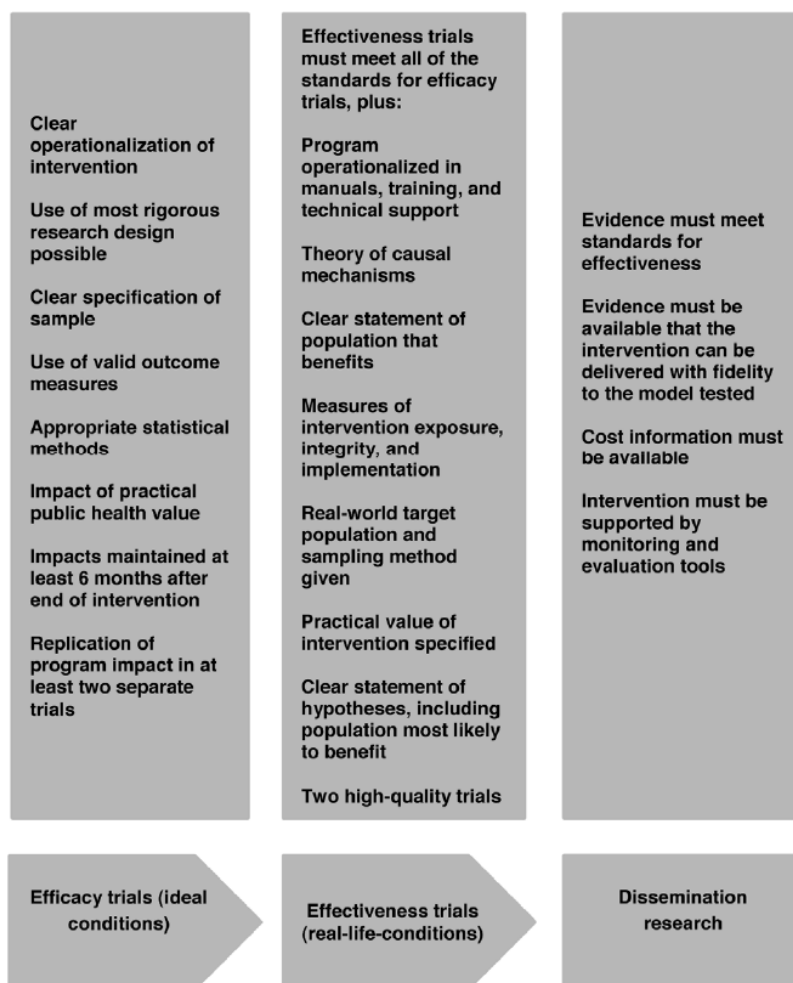


Figure 5: Tomlinson et al's adaption of a model for acceptable research standards and stages (25).^(Figure 1)

Slade et al (40) have modified the information systems model known as the *Unified theory of acceptance and use feasibility* (UTAUT), mentioned by *ISP* for a health-specific context, to assess the factors affect likelihood to use an intervention

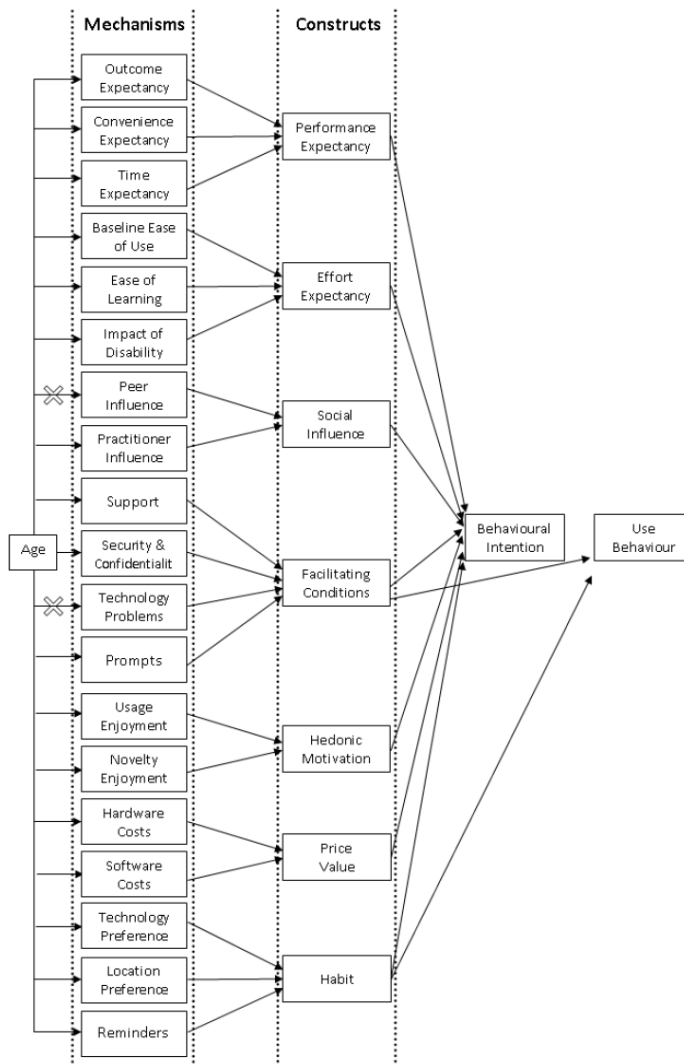


Figure 6: Slade et al's (40) Fig.2 UTAUT2 model extension for the health care context

9.6 APPENDIX 6: QUESTIONNAIRES

9.6.1 Public Mental Health Researcher

Administered to **PHR**

- In describing the current health care for those with mild to moderate major depressive disorder, what outpatient depression/mood services are there? What exactly is community-based treatment? Who is their “therapist”? how regular are the sessions. The app is designed on a single practitioner system. Is this feasible?
- How is mental health care typically provided in South Africa? By whom? How is scheduling arranged? Do they see a single health care professional, with whom they establish rapport, or do they just visit a clinic and see whoever is available?
- What is internet coverage like in facilities across South Africa?
- Since the studies conducted in 2011 and 2012, have there been any shifts towards improving the decentralisation process – has community-based care improved?
- Could you list some of the main barriers to care for mild-to moderate MDD?
- What barriers act to maintain the gap between policy and outcomes in SA?

- Do you think such an app for monitoring and support would be useful for a non-specialist doctor and/or nurse, considering our shortage of human resources.
- What do you think is most needed in SA: a app to screen, monitor or treat? Other options are supportive systems or psychoeducation.
- Do you think an app for monitoring and supporting patients could reduce the well described “revolving door phenomenon?”
- Any fruitful attempts at the Master Patient Index? Can you foresee a complex digital intervention being accepted into health systems such that it becomes standard practice? In the near/distant future?
- Could you make a comparison between the Western Cape and the rest of South Africa and Health Information systems? Do you think the WC is capable of piloting an interoperable mHealth system? Or would this simply increase the inequity between provinces in terms of eHealth readiness?
- If the App were to have a database of health practitioners, what is the best method to verify them? To cross-check them off a database from the HPCSA? Are such databases accessible? How can the programme verify a doctor should he wish to sign up? What about non-doctors? Nurses? Certified traditional healers? Who can act as a practitioner? How does one maintain a quality level?
- How do health care providers currently overcome language, literacy and cultural communication barriers? How do you think this would limit uptake of an app?
- Most interventions have relied on SMS or telehealth platforms. Do you think that healthcare workers would be likely to embrace this mHealth initiative, considering its increased complexity requiring smartphone literacy? Do you have any comments about mobile literacy about South Africa’s health workers? Do you think that we should first try and make the other interventions work before trying out more complex systems?
- Do you think that the platform for the health care provider should be based in mobile or computer platforms? DO you think healthcare workers might be more willing/able to adapt to mobile applications than computer programmes?
- How much support do you think would be necessary to ensure that community health workers will continue to utilise the intervention?
- Should this App only be available on recommendation of a health professional – i.e. the health professional adds a patient – which would allow proper monitoring and control of patient treatment to prevent self-treatment. Or should it be available for free download-recommending that patients seek professional help should they be suffering? Any thoughts?
- Can you see interoperable mHealth initiatives connecting across the public/private divide?
- Sustainability: long-term funding is usually provided by the government. What does it take to get governmental funding?
- Can you see any alternatives to upscaling, besides employing a governmental framework, yet maintain sustainability and ensure coverage in rural areas?
- What ethical considerations must be kept in mind when considering (online) storage and transferring of patient data? What are current South African guidelines?

9.6.2 *Social Sciences Mental Health Researcher*

Administered to SSR

- Current outpatient psychiatric care for those with mild to moderate MDD
 - Who, where, how often, what form. Community based treatment vs centralised treatment. Diagnosis. Psychotherapy. Monitoring

- Barriers to care – how are they currently overcome? How can they be overcome in an app?
 - Training, facilities, time, health care workers
 - language/cultural
 - Traditional healers
 - Stigma
 - Co-morbidities.
- Functionality of the App
 - what does SA need? Screening, monitoring, self-treating, distance-treating (through two way communicating), training for health care workers.
 - Complexity vs SMS, telehealth. Health worker digital literacy
 - Comparison with telemedicine: Time, efficacy, willingness of health workers
- Efficacy of the App
 - health practitioner's adoption – geared at a single practitioner. What level of practitioner should it be geared at. How much time will practitioners have.
 - Patient's adoption
 - What level of health professionals should it be geared at
 - How much time would you be willing to spend a day?
 - How much would you be willing to change the way you practice
 - If training was necessary – how much would it impact uptake
 - What evidence would you need to prove that it is effective
 - Do you think that it is necessary to get health systems backing for the device to promote widespread adoption
 - How would you rate your colleagues in terms of IT literacy (able to use an app) – should it be an App or computer based
- Patients uptake of app:
 - Would it increase adherence?
 - IT literacy – age barriers, language
 - Time
 - Smartphone penetration.
 - Cost
- Level of patient-practitioner interaction
 - How much patient- doctor contact should there be – limited to predesigned messages (e.g. requests for appointments, requests for patient data, etc.)
 - Qs and As over IM platforms
 - Distance therapy over IM platforms
- Design of functionalities.
 - How do they become widely approved.
 - Typically only western-based
 - Who should design them
- Current level of ICT frameworks
 - Extent – master patient index, facilities listed. Monitoring capabilities
 - Barriers - Health care practitioner training, flexibility, willingness
- Willingness of HIS to adopt/include mHealth.
 - Fitting in to current frameworks vs starting from scratch
 - Data Integration. Scheduling.
 - Top down national systems, VS highly variant bottom up approaches
 - How much support will be necessary for continual implementation

- Sustainability – is gov support the only way for long-term sustainability of such projects
- Western Cape vs South Africa
 - Pilots utilising WC's framework – how can we scale it from there
 - Increasing inequity between provinces.
- Verification of health practitioner qualifications
 - alternative therapists? Quality control?
- Ethical dangers, liable to abuse – can they think of anything?
- Extensions – hotline, on call therapists – is it viable to hire
- Integration into health (information) systems
 - Cross compatibility. Compatible with other apps that monitor co-morbidities
 - Interoperability: Fitting into health system “building a patient profile”
- Reimbursing health care providers of distance monitoring
- Access to app:
 - Should app be available to patients independently, or only supplied through the health system
- Health information security – how is it currently dealt with?

9.6.3 *mHealth Researcher*

- Current projects?
 - Aims?
 - Design? Complexity?
 - Levels of communication – who is communicating with whom
 - Platforms
 - Problems incurred? Acceptability to HCWs? Technological literacy? Who does it fit into regular practise?
 - Scale? Future development?
 - How does it fit in with other projects? With the health system?
 - Design: databases, who did the design, funding
 - Interoperability with existing structures?
- Knowledge of other projects in mHealth in SA?
 - How are they faring?
 - What are their aims? Who are their target populations?
 - Are they scalable? Broad systems endorsement?
- Knowledge of eHealth and health information systems?
 - Storing data, communication between levels of care, between institutions. Patient identification systems, etc.

Thoughts on my project:

- Intervention Design
 - what does SA need? Screening, monitoring, self-treating, distance-treating (through two way communicating), training for health care workers.
 - Complexity vs SMS, telehealth. Health worker digital literacy
 - Communication pathways (see Fig 1.) how much communication is too much?
- Adoption by mental health care users
 - Adherence. Time required, complexity, flexibility

- IT literacy – age barriers, language, urban/rural.
- Time
- Smartphone penetration. Internet usage.
- Cost
- How to reach them – through clinics, available independent of health care system (patient IDs.)
- Adoption by health care workers
 - Different levels of health care users – what functions would each level need (CHW, GPs, specialists, clinic interfaces, researchers)
 - Verification systems – adding profiles to the system (see Fig. 2)
 - IT lit
 - Training
 - Ensuring compliance. Willingness to change practise habits
 - Reimbursement – can't pay for time spent with patient (esp private) when distance therapy.
- Systems adoption
 - Fitting in to current frameworks vs starting from scratch
 - In order to scale – needs to become part of standardised care.
 - Who needs to be approached?
 - What needs to be proven?
 - How to get sustainable funding.
 - Interoperability. Building an interactive patient file
 - Getting private health care involved
 - Top down vs bottom up – national level vs provincial/community level.
- Development, research methodologies
 - Initial funding?
 - Design team? Who should be included? Where should they come from? Outsourcing?
 - Control group vs intervention? Any suggestions? Outcome measures
 - Minimising effect of actual design of application? Complexity vs efficacy/flexibility/customisability?
 - Maintenance of system once running
- Efficacy of the App
 - willingness to change the way you practice
 - If training was necessary – how much would it impact uptake
 - What evidence would you need to prove that it is effective
 - Do you think that it is necessary to get health systems backing for the device to promote widespread adoption
 - How would you rate your colleagues in terms of IT literacy (able to use an app) – should it be an App or computer based
- Ethical/legal implications
 - Risk-based approach to trials – what does that mean, exactly
 - Where can you foresee potential violations of patient/practitioner rights?
 - Security of information.- how is security of health information currently dealt with,

9.6.4 *Health Care Professionals – Psychiatrists, nurses and psychiatrists*

- Current outpatient psychiatric care for those with mild to moderate MDD
 - Who, where, how often, what form. Community based treatment vs centralised treatment. Diagnosis. Psychotherapy. Monitoring. Scheduling.

- Barriers to care – how are they currently overcome? How can they be overcome in an app?
 - Training, facilities, time, health care workers
 - language/cultural
 - Traditional healers
 - Stigma
 - Co-morbidities.
- Functionality of the App – what does SA need? What is useful? Screening, Monitoring, Treating.
- Level of patient-practitioner interaction
 - How much patient- doctor contact should there be – limited to predesigned messages (e.g. requests for appointments, requests for patient data, etc.)
 - Qs and As over IM platforms
 - Distance therapy over IM platforms
- Design of functionalities.
 - How do they become widely approved.
 - Typically only western-based
 - Who should design them
- Reimbursing health care providers of distance monitoring
- Efficacy of the App – will health practitioners and patients adopt it, will it help
 - What level of health professionals should it be geared at
 - How much time would you be willing to spend a day?
 - How much would you be willing to change the way you practice
 - If training was necessary – how much would it impact uptake
 - What evidence would you need to prove that it is effective
 - Do you think that it is necessary to get health systems backing for the device to promote widespread adoption
 - How would you rate your colleagues in terms of IT literacy (able to use an app) – should it be an App or computer based
- Patients uptake of app:
 - Would it increase adherence?
 - IT literacy – age barriers, language
 - Time
 - Smartphone penetration.
 - Cost
- Verification of health practitioner qualifications
 - Use existing databases. Personally verify them?
 - What about non HPCSA registered workers – traditional healers, community health workers, etc.
 - Maintaining quality control
- Access to app: patient or health system
 - Patient receives app through health system (allows for regulation)
 - Patient can download app independently and use functionalities without supervision
- Ethical dangers, liable to abuse – can they think of anything?
- Extensions – hotline, on call therapists – is it viable to hire
- Integration into health (information) systems
 - Cross compatibility. Compatible with other apps that monitor co-morbidities
 - Interoperability: Fitting into health system “building a patient profile”

- Western Cape vs rest of South Africa
 - Try to implement it here as a pilot.

9.6.5 *IT/programming experts*

Administered to IT

- Process of app development? Who is involved? Testing? Quality control?
- What often determines how successful an app will be in terms of uptake?
- Where are costs usually incurred during development? Development days per functionality?
- Mobile phone distribution, usage, demographics. Smart phones. Technological literacy (Age, language). Data usage
- What solutions are currently options for having a multiple profile system with different interactions between the profiles, potentially different interfaces for each level. How is profile creation controlled (e.g. verifying qualifications, linking patients with patient numbers) – how would you architect the system?
- What are the restrictions on entry-level smart phones? Size, processing capacity, data usage – what is the lowest platform we should design to?
- Balancing functionalities and ease of use – how do we find out what is too much? What are common barriers to making an app intuitive
- Data security, privacy, ethics. What are the options? What are the problems? Allowing practitioner to read it?
 - Privacy on phone – i.e. passwords etc.
 - Protection of data that is sent to a server
 - Extra protection that is required because it is health information - mimicking access policies for existing patient files
- A few servers in the Cloud – Hosted in the cloud or in a specific location? How many users can one server support?
 - How to process – where is it done, how resource intensive is it? Running costs?
 - What levels of processing power would be needed for different functionalities
 - What are some other issues – security?
 - Limiting upload/downloads
- Comparisons with telemedicine, SMS systems in terms of cost, efficacy. What adds to costs? Battery costs, usage apps?
- Compatibility across different devices – accessing the same database – do individual programmes need to be developed across different operating systems. Which operating systems should be included? Android, iOS?
- Integrating into HIS, compatibility, interoperability
 - Is it possible to fit into a pre-existing system? What is required? To supply data on usage statistics, efficacy, penetration. To provide clinical data on the patient – what medications they are taking their long-term mood. Potentially tracking which professionals interact with them
 - To make other apps compatible? After starting with one app? Developing complementary programs
 - To redesign the entire system
 - Western Cape currently uses Clinicom, Delta 9, PHCIS, JAC Pharmacy
- Complexity limitations, cost
 - How much can be put into one app?
 - How much flexibility?

- When do things start needing to be processed outside the smartphone
- Complying with national/international standards
 - What are the current standards
- Interface – common difficulties
 - Making things user friendly. How much flexibility?
- Updates, support – on-going costs – what is required
- Distribution systems besides health care system for widespread uptake.
- Sustainability. Corporate involvement (consider talking to medical corporations for working with the government). Other options.
- Limiting data usage

9.6.6 *IS expert*

Administered to IS

- Frameworks
 - Frameworks for new projects – assessing acceptability
 - Approaching design and development
 - Functionality
 - Database
 - Security. validation
 - outsourcing
- health information systems
 - any history of working with them?
 - any knowledge on how they order information?
 - How projects get started, implemented, etc (channels to go through)
- mHealth
 - direction of mHealth internationally, in SA
 - feasibility of interoperable, multiprofile system
- design, information
 - designing a system – process, models
 - design team, outsourcing
 - frameworks for creating a project
 - level of complexity able to handle
 - storage of information, creating a flexible back-end database
 - Interoperability with External systems
 - Interoperability with different user levels
- Users
 - Authentication
 - Access to information
 - Entering patients into the system.
 - Non-categorised(NGOs, private sector)
- User Acceptance

- Interface design, complexity, translation
- Improving health care worker, admin staff efficiency
- Smartphone penetration, literacy, capacity
- Adoption by health systems
- Security
 - Security of information at various levels, access of information. Privacy of patient information (precedent?)
- Sustainability
 - External vs internal funding
 - International projects
 - Long-term. Upscaling.
 - Business models.
 - links with private system
- Upscaling
 - Technical details

9.7 APPENDIX 7: REVIEW OF DEPRESSION APP MARKETPLACE

Table 2 Survey of Existing mHealth tools for depression

	App Name (Offered By)	Year	Price	Size	Compatibility	Functionality	Installs	Ratings (no of rating)	User Comments
A	MoodTools - Depression Aid 2.1 (MoodTools)	2015	Free (in- app purchases)	4.9M	Android 4.0.3 and up	ThoughtDiary Activities (Behavioural Activation Therapy Safety Plan Information Test (PHQ-9) Video	10 000- 50 000	4.3/5(792)	Pros: export thought diaries (share with therapist). Simple design, easy to look at. Convenient, confidential/surreptitious. Developer response to comments. Most find the thought journal the most helpful. Also YouTube videos. Allows user to track physical states. Liked pre-set drop-downs. Good light therapy tool. Cons: put positive thoughts in diary, need more tests. Goal making tools (CBT). Would like reminder functions. Needs a lock function. For editing

									entries. Time stamp. Monthly chart. Limited space to write. Shouldn't diagnose. Log of conditions and meds
B	Depression CBT Self-help Guide v1.8 (Excel At Life)	2014	Free (in-app purchases)	7.3M	Android 2.2 and up	Test (with Graph) Articles Suggestions, tracking Depression Assistance Audio Cognitive Thought Diary Emotion Training Audio Relaxation Audio Password Protection Customisation of graphics	100000-500000	4.2 (1013)	Pros: Good, helpful articles. Free, private. Relaxing. Nice for monitoring. Lots of resources. Liked audios, depression sleep aid, daily quote. Motivating points system. Works on many different levels Cons: Poor user interface- confusing and unattractive. Requires time, effort. Not very interactive. List of contacts. Test needs to be daily (not over last two weeks). Privacy - make reasons clear
C	How Are You - Mood Tracker v1.6.2 (Quantum Lab Co.)	2015	R 156.15	17M	Android 2.3.3 and up	Mood assessment >30 mood boosting hints mood tracking average mood, mood graphics, compare with world results analysis feature Buddy feature (share with someone close to you gratitude diary	500-1000	4.2 (51)	pros: attractive. Quick to use ("minimal burden". Non-intrusive. Can choose multiple ratings to represent entire day. User friendly. Good reminders. cons: crashes. Not able to customise options. Not able to back up online

D	MoodSpace - Depression Self-Help v1.2.2 (Boundless)	2015	Free	8.7M	Android 4.1 and up	interactive mood workouts - habit building exercises that are completed on the phone.	1 000-5 000	3.8 (19)	Pros: helps focus on positives. Tidy design. Cons: Limited functionality.
E	Anti-Depression v1.5 (SoundMindz.Org)	2014	Free (in-app purchases)	16M	Android 2.2 and up	diagnostic questionnaire recorded messages providing an action plan a workbook with information and exercises relating to therapy daily progress tracker On-demand reporting Access to latest research via website	10 000-50 000	3.7 (235)	Pros: up-to-date information. People like the audio recordings and video links. Always with you. "Simple, beautiful". Cons: messy. Have to create an account (allows for syncing) - many people seem to have struggled with this.
F	7 Cups of Tea: Care & Therapy v1.04 (7 Cups of Tea)	2014	Free	2.4M	Android 2.3 and up	Free anonymous and confidential conversations with trained active listeners (including licensed therapists). Choose your ideal listener	50 000-100 000	4.5 (2 946)	Pros: platform for neutral opinion, to be free, to "open up and be pampered", overcome insecurities. Helps those who aren't good with "face-to-face" communication. Highly supportive community. No fear of judgement. Convenient, with instant alerts. User-friendly interface. Very accessible. Allows for giving back by training as a listener. Available online as well as an app (many find the app more convenient than having to use a PC). Appeals to people who are sceptical about therapy. "calming name". Safe (moderators). Cons: occasional inexperienced or poor listeners. Sometimes slow. "not the smoothest application". A couple of UI issues, several complained of bugs.

									Training session' should be included in app. Settings not customisable. Limited functionality. Requires effort to find someone who is compatible. No history for 1on1 conversations. Perhaps have a profile page as an introduction.
G	eMoods Bipolar Mood tracker (Yottaram LLC)	2014	Free (in-app purchases)	Varies	Varies	Tracks moods, symptoms, sleep, medications and allow for printable charts at the end of each month. Does not log multiple moods/symptoms per day. Reminder alarms	100 000-500 000	4.0 (1 150)	Pros: easy to use, private allows for pattern recognition, seeing the effects of meds, collaborating with therapist.. Export functionality. Notes function. Reminders. Can edit days you missed. Cons: no back-up reminders, some back-up bugs. Limited symptom list, not customisable. No password protection. Should be able to flag something. Doesn't track substances, exercise. Limited space for notes
H	Life Reboot - Fight Depression v1.3 (photonapps)	2015	Free	6.8M	Android 4.0 and up	Anonymous forum, diary medicine reminders daily motivational quotes jokes games: painting and tic-tac-toe	5 000-10 000	4.0 (97)	Pros: "cute", helpful for relaxing Cons:.

I	MoodKit - Mood Improvement Tools v3.0 (Thriveport, LLC)	2015	\$4.99	5.7M	iOS 7.1	<p>over 200 mood improvement activities (tailor recommended)</p> <p>email/text/Facebook sharing of activities</p> <p>iOS calendar integration</p> <p>Thought Checker</p> <p>Mood Tracker: exportable mood charts weekly/monthly views.</p> <p>Journal. Pre-formatted templates. Voice entry support.</p> <p>creates own entries and journal templates</p> <p>link custom reminders to favourite tools</p> <p>security features</p>		4.5 (338)	<p>Pros: thought checker convenient. Impressive variety of activities. Well designed.</p> <p>Cons: only one mood per day. Journal questions sometimes cheesy, annoying or unhelpful.</p>
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J	eCBT Mood v2.1 (mindApps llc)	2012	\$0.99	5.4M	iOS 4.3 or later	Overview of CBT Feelings and thoughts log Automatic thought identification tool Structured automatic thought challenge tool Identify and challenge core beliefs Daily mood assessment and report Weekly mood assessment and report.		3.0 (100)	Some features a little cheesy, but easy to use and useful. Well-phrased questions
K	Sad Scale v1.2 (Deep Pocket Series LLC)	2009	\$0.99	0.7M	iOS 2.2 or later	Edinburgh Postnatal Depression Scale Zung Depression scale (monitoring changes over time) Geriatric Depression scale Children depression scale		3.0 (127)	A screening rather than diagnostic tool. Very useful for primary care doctors. - especially ability to email graph/score. Increases awareness of the disease.
L	Operation Reach Out v1.0.2.70 (The Guidance Group Inc.)	2011	Free	182M	iOS 4.2 or later	Help Centre - hotlines and emergency personal contacts help for suicidal people - 12 videos. Help for people trying to prevent suicide - 10 videos.			

M	DBT Diary Card and Skills Coach v2.9 (Durham DBT, Inc.)	2015	\$4.99	23.0M	iOS 6.0 or later	a reference manual behaviour checker skills coach password locking daily reminders advanced text editing media playback skills, emotions, behaviours, coaching, customisability, emergency skills, email.		4.5 (119)	a few changes to customisable features necessary, very useful coaching skills, clear description of skills.
N	Optimism v2.5.9 (Optimism Appsa)	2015	Free	2.1M	iOS 8.0 or later	develop and monitor health strategies, learn triggers of a decline in mental health, recognise early warning signs of a decline detailed charts and reports, emailable.		4.0 (574)	tracks stability and what affects it - self-awareness. Well organised.

O	Happy Habits: Choose Happiness v2.2.1 (Excel At Life)	2014	Free	5.9M	Android 2.0 and up	Happiness Assessment Audio guides Happiness Journal 50 CBT suggestions (Customisable) Points for what you do each day Graphs Articles Emotion Training audios Relaxation audios Password protection Customisable graphics	50 000-100 000	4.1 (555)	Pros: articles helpful. Flexible and customisable. Good advice. Reward system. Links to other apps and websites are helpful. Cons: Sometimes a bit American-based.
P	MoodTrek V1.4 (Cerner Corporation)	2015	Free	9.1M	Android 4.0 and up	Mood tracking/rating when it changes or on reminder Journals Syncs to Fitbit ® to track physical activity Automated capturing of sleep quality Easy sharing to doctors who are also using Cerner electronic medical record. Export and share. HIPAA compliant	1000-5000	4.4(19)	

Q	Beating the Blues (18) ⁴		£49.99		Online	Computerised CBT: 8 50 min sessions Endorsed by NHS			
R	myCompass (Black Dog Institute) ⁵		Free		Online	Mood tracking with reports on patterns and behaviour over time. Interactive modules for mood management Diary Stories of other experiences Access to articles/reading material			

⁴ Only available through the Wellness Shop (<https://www.thewellnessshop.co.uk/>)

⁵ Only available to Australians through their website (<https://www.mycompass.org.au/>)

9.8 APPENDIX 8: INTERVIEW TRANSCRIPTIONS

9.8.1 Public Mental Health Researcher (PHR)

Interview conducted on 12 August 2015 at Alan J Flisher Centre for Public Mental Health, by Sylvia Van Belle

SVB: Okay so the main think I'm looking at is ... in 2012/2013 there was a lot of writing done on mHealth and I've seen a lot of publications on stats analysing the state of mental health in South Africa. So what I'm looking at addressing is that huge treatment gap of CMDs, particularly depression. So first of all, I was wondering what (I mean they said that community health workers and nurses and that there isn't much) but what is the main treatment plan for CMDs in SA in general?

PHR: In primary health care? So we have a new national mental health policy, which is adopted by the national public health council (which I don't know if you've seen, I can send you the document) and that basically sets out the policy and plan of how public health care services should be structured for mental health and it's basically a pyramid structure, so the bottom of the pyramid is self-care, and then primary health care and then at then more-or-less at same level kind of specialist community outreach teams and mental health services integrated into district and regional general hospitals and then right at the apex of the triangle is specialist hospitals. So the bulk of services should be provided by primary health care and should be through the training of primary care providers like nurses and doctors to manage common medical health problems where necessary. And there have been many clinical guidelines to go with this, like the PC101 – so that's a sort of guideline – so in reality, of course it's quite different – but different provinces are in different stages of implementing that policy, so here in the Western Cape we have a working group which is developing (...) how many medical health teams should be working. I think the plan is to roll out training programmes for primary care nurses to be able to manage common mental health problems. So that's the plan

SVB: So in that plan, if someone is ... for example in private healthcare, if someone feels depressed they go to a psychologist, who might refer you to a psychiatrist, who prescribes meds, but in the primary health care model, that sort of basic psychotherapy, who is that provided by?

PHR: So that's what's all very much up in the air at the moment. So some of the models that are being piloted are around training community health workers to do some of that basic counselling, so at the moment we have a randomised controlled trial that we're doing in Khayelitsha with antenatally depressed mothers, in the Site B (...) clinic, and we're enrolling them and randomising them to receive either our counselling intervention, which is a structured succession intervention, using community health workers from Khayelitsha or enhanced usual care. So our model that we're testing, and we don't know if it's effective, but anecdotally and from our supervision, I think it works well, is community health workers delivering structured, but quite carefully supervised basic evidence-based counselling

SVB: because the app that I'm looking at – it's because most of the previous mobile health interventions have either been telecommunications or SMS (and SMS is obviously quite limited), but smartphone penetration is now considered up to 50%. So there's been a lot of ideas floating around, and if you look at the American publications, they're all looking at one integrated web of mobile health, where everyone's connected and you have patient profiles, and biometric

sensors which can keep track of real time heart rate, etc. Obviously that's not feasible, considering that we don't even have... Do we have a master patient index yet?

PHR: No, no we don't.

I mean, I think that there are many potentially applications. So to break it down as far as I understand it, you can think about direct patient interventions, such as mobile health psychotherapy – that could take people through structured programmes looking at their typical emotions, thoughts, and then behaviours, and then learning to distinguish between those three; learning how to manage stress, how to recognise negative self-(...) --- all sort of based around cognitive behavioural therapy. So that's the one option. The other option is using mobile devices to supervise community health workers who then themselves deliver the counselling – there has been a bit of research into that, if you speak to someone like Mark Tomlinson – because he's done that kind of thing. And I suppose the third is just general supervision and training, for primary care providers, a decision support device to help them manage common mental health problems. And that could be useful diagnostically as well as managing.

SVB: Often, the three things that a lot of the apps – they're either diagnostic – where they use the PHQ, and you just test yourself, or they're self-monitoring apps (*gives examples*). Ideally these would be highly customisable, but that often requires greater technological competency. I feel that a lot of the structures fail because people are sticking to their paper-based systems- they're not entering data correctly... so in terms of practitioners and health information systems, why aren't things filtering through to community levels

PHR: Well it's not an area I've done a whole lot of research in, I'm not sure if I'll be able to answer that question, but I think in order to make this work you'd have to do that kind of research – test of the market, if you like – but especially of primary care providers' behaviour; what do they do during the course of their day, would they have time to consult a mobile device, for example, so the PC101 – which is basically a kind of decision tree, for recognising common symptoms such as depression... if these lead on to those, consider this treatment option, consider this referral for counselling for a problem, consider antidepressants... so you could have that on a mobile device, that would be really nice, and quite cool for practitioners... but you'd have to look quite carefully at how they behave.

SVB: A problem for constant monitoring. Because one of the ideas is that it has alerts and popup notifications, if there's a negative trend.

PHR: And flag it for suicide risk... and I think you'd have to build all of those in. But what you need to do before you start designing the app, is actually do some time motion studies, where you observe what primary care nurses do, how do they spend their time –and then look at where would be the time to do interviews; “when, during the course of your day, do you have time” when they've got a queue standing outside the door... An app that maybe could save them time.

SVB: on that note, one of the American based models suggesting automatic scheduling – see when someone needs help (when there's suicide risks, negative trends) – then there's an alert and you can ask for a schedule when you feel like you need one,, but I feel like our scheduling system when you arrive at five o'clock in the morning to stand in the queue – it would be possible, perhaps, if all systems were integrated – if everything was being monitored all the time, but ...

PHR: I think that the idea is great in theory but my worry is that in the primary care system, I think nurses (who constitute the 70% of the staff of primary care clinics) – I'm not sure that they have

time to track individual patients – certainly in some of the clinics that we’ve been working in... it’s pretty basic – so you’d need to think carefully about that kind of model. My idea is that it could be something much more simple – like an app that patients could use, or that could help nurses to make clinical decisions – for now. And then further down the line ... - because I can see the fantastic advantages to both, at this stage.

SVB: The problem is that there are a lot on the market – but they don’t have the systems endorsement that is needed so that they can spread. At the moment it’s up to the individual practitioner or patient to say, “look, this works” to the prescriber. And a lot of the things on the market are not properly tested.

PHR: So it sounds like a lot of what you’re doing is a scoping exercise at the moment, which is really, really valuable – so what you’d need to be able to then say, “well, what are the gaps in the current knowledge base”(refers to the *WHO MH GAP intervention guide*) – so the World Health Organisation’s response to this whole treatment gap (which in South Africa is the same as any other developing country – you know, 75% of people who don’t get evidence-based care), so they’ve developed this MH GAP, a clinical decision guide – it does what PC 101 does in South Africa – so they went through a whole process of what’s called the “grey analysis” of cost-effective interventions – looking at systematic reviews, meta-analyses and randomised controlled trials – for what are the best interventions for common health disorders, and it’s all distilled in this guide – they’ve just done a revised version in 2015.

SVB: Because I’ve been looking at a lot of the models for assessing the effectiveness of interventions and how we scale up mobile health in South Africa, because its balancing how we make something effective but still simple enough to be acceptable. Another question I had... the PC 101 – are mental health care users still going to be using the same facilities as other health users?

PHR: No – in fact things are moving more towards it, with PC 101. (*explanation of PC 101*). There’s a whole section on depression – so you’ve got the stressed or miserable client – it says screen for mental health problems, screen for low mood and then it takes you to the depression – there’s consider psychosis, consider depression/anxiety – so then you go page 81 for depression/anxiety, and then it gives you the symptoms for depression. And you can diagnose moderate to severe depression or mild depression. If it’s mild, then you consider referral for counselling; if it’s moderate to severe, then you consider medication, and then it takes you to the care part – and this is the basic care, so advise them, treat them. And then these are the doses of fluoxetine and amitriptyline and so on. SO you can take this, and make it into an app – that’s one option. I think, you know, if you were to do you, you’d have to build on all the stuff, because there’s a huge amount that’s been done already – but I think that’s the beauty of the app – that you could actually build on this.

SVB: and things that are interactive are often more acceptable to people than just paging through a book. So in terms of the Western Cape/South Africa gap – and the Western Cap does have the patient index and the integrated pharmacy. So I was wondering if it would be more feasible to try a more complex app in the Western Cape, and then try and scale it up – but you wouldn’t be able to scale it up from there.

PHR: Yes, that’s the difficulty – the Western Cape is quite different to the rest of the country. You could potentially think about an app that integrates these different things you spoke about – the patient level, the practitioner, the health systems information.

SVB: but in a way that's just increasing the gap between the Western Cape and the rest of the country.

PHR: It feels like the first thing to get right, is getting the practitioner on board.

SVB: of course it's difficult to test, because the health system is so fragmented.

PHR: but I think the whole idea behind the NHI is to try and integrate these kinds of gaps.

SVB: But if you look at the mobile health policy - it has great things in it – it has the whole interoperability thing where each mobile health intervention or each electronic intervention needs to be compatible and the data needs to be able to be harvested and integrated into the system – which is what I'm trying to do, but there isn't the framework for it because, in order to do that you need to have a top-down approach, which they don't like because it's not flexible and they're not doing the groundwork that allows for the top-down approach.

PHR: PC101 is being taken up nationally, by the way. And there is also a Western Cape adaptation of it called PAC – Programme for Appropriate Care kit, although this (PC101) was developed by Lara Ferrel(?) and colleagues at the Lung Institute here at UCT, the Western Cape has got its own brand. So if you could "appify" this. But I think it's very exciting – I think it's a great idea.

SVB: That's what I was saying – there was a lot of interest in 2012/13, and I think then people realised just how far the problems extend, and there were some attempts to unify the literature and create models for upscaling, and then it just went very quiet. So I'm trying to see what happened there

PHR: Well, I think you run into these kinds of obstacles of, basically, the health system itself has a limited capacity to implement these kinds of things and that's why it's great that you're speaking to practitioners – because you need to ask – especially nurses at primary care clinics.

SVB: Yes, well, obviously my time is limited – I've only got 4 weeks, but that's the idea

PHR: well, this is a big, big project. What I think you could do, in terms of your special interest project, is really – it's almost like a scoping exercise, and you can identify where the potential solutions are and where the gaps are, and then you can make recommendations – especially where the research gaps are – so like a time motion study to look at how nurses spend their day, and how they could potentially integrate an app into that clinical practice – that would be great.

SVB: And a lot of the problems with the research, was that it was either done by health professionals or by information systems experts, from the commerce, technological point of view, and everyone comes with their own perspectives. And I think, as someone who hasn't specialised yet, I think I could really add something.

9.8.2 Social Sciences mHealth Researcher (SSR)

Interview conducted on 12 August 2015, at Alan J Flisher Centre for Public Mental Health, by Sylvia Van Belle

SVB: (explains project)

SSR: I'm the project manager for the AFFIRM project. The AFFIRM project is a hub of six countries – Ghana, Ethiopia, Uganda, (?), Zimbabwe and South Africa – it's about improving research in mental health and also improving services to try and narrow the treatment gap. So it's all about

building capacity to do research, it's about testing interventions. In South Africa we're doing a (...) project amongst pregnant women and we're running it at two sites. (explains intervention). Our use of technology is not so much in a therapeutic sense – we've used it just directly for data collection. All our data collection is done using mobile technology, so it's just a simple cell phone it's not a particularly expensive one – it's not a smart phone – and all the field workers have got all the screening tools and all the follow up assessment questionnaires on the cell phones and they get... Mobenzi – they do stuff around monitoring as well – they're a company that does all this mobile technology data stuff – and you can look at their website, in fact. (...) So the advantage is that there's very little missing data (...) and there's instantaneous delivery to the database – if there's cell phone signal. (...) So it's a whole process of data management which we have found particularly advantageous. And if, as has happened a few times, a cell phone disappears or is stolen, you don't lose anything – you lose the cell phone – but you don't lose the data. (...) So that's really how we've used it. We haven't really used it to monitor... the participant doesn't have any access to the cell phone technology – so it's a data collection device rather than a monitoring device

SVB: Okay, that's interesting, because it brings me onto the questions about the technological competency of both the community health worker level as well as the patient levels ?

SSR: I think initially there might have been a little bit of difficulty with some of the community counsellors just in terms of getting familiar with the questionnaire and that, but the technology – as you say – anybody can SMS. The challenges wouldn't be using the technology – it would be reading the text on it. Reading the text and following some of the instructions. We're working with a younger population – it's pregnant women – they've all got access to cell phones – but it depends where you target – in a rural area it would be a different issue – because you might not have quite as much cell phone penetration, but you also, might not have access to data (...)

SVB: The idea is that (...) with an app, if there's no data at the moment, you can just wait until there is data and then it will send the information; it won't stop working, and we're looking to make it as light on data as possible. (...)

SSR: So I'm not sure if that's a huge issue, but it would depend on which areas. And certainly our field workers... our counsellors – our control people - are probably the ones with probably the lowest literacy and they've coped absolutely fine

SVB: (asks about language difference and entering language in the database)

SSR: That (*colleague X*) would know a bit better than me – because they do make notes and I've got the feeling that they make them in English. But I know some of the counsellors... half of them speak English quite well, and half don't. so it could well be that they enter it in Xhosa and it gets just captured as that and then at some point we need to translate it – and (*colleague Y*) does that translation.

SVB: (describes access to the app) (describes functionalities) So data collection... What health systems information would you like about mental health users?

SSR: Some kind of diagnostic information, but also where they access health care – I'm not a health systems person – frequency of use, possibly what they use it for (gives examples) especially with depression where there are a lot of psychosomatic symptoms which come in to it so that would be interesting, the kind of costs that they have in getting to the clinic

- SVB: In terms of supervising community health workers (describes a basic possible mood-tracking intervention) – what supervision would you like to have over the community health worker?
- SSR: It has to be regular supervision. So, for example, (*Colleague Y*)’s a clinical social worker with strong counselling background – she’s got a Master’s in clinical social work – has a very strong set of skills around that. And it’s no doubt that that’s been an absolutely crucial thing – she meets with them – she did meet with them once a week, every two weeks they had an individual session, they also had group sessions – so group sessions, individual sessions. We also provided access to counselling for them if they required it, because it’s quite heavy work sometimes and I think a few of them took that up. We provided a couple of wellness things, some lectures on how you (inaudible); a few, kind of wellbeing things that they requested. So it’s support, its supervision, and the supervision also entails ongoing training and things like that. And because it’s a research thing, we’re doing quite careful monitoring of the fidelity of the intervention – so recording of the sessions... (*Colleague Y*)’s just checking that they are keeping up to the manual, what do they do in the sessions that might be right/wrong –that kind of stuff so she’s been monitoring that since the beginning. And they will pick up things with the counselling: you need to listen, stop giving so much advice – that kind of stuff. So support is absolutely crucial... exactly how much and in what form, is something that could be looked at. It needs to be easily available, and it needs to include some face to face, although it could be telephonic as well.
- SVB: That’s what I’m thinking – how could the app facilitate that, potentially... you could maybe just have a chat forum somewhere between...
- SSR: I suppose a chat forum for posing questions, and you’d want a confidential something or other between the supervisor and the community health worker but you might want a more open chat room between more of them. But I’m not a native to apps and things... so my creativity and thinking around that is not what your generation’s is
- SVB: (Description of the functionalities)... what processes would be required to make the intervention feasible for scaling and to be included in the health system?
- SSR: By showing that it works would be a good way. A lot of it would be motivating staff to understand how it could work. The problem that you face all the time is nurses in the clinics – they just don’t have time to do it, so to bring something – especially some of the older staff might just have a complete barrier against using this kind of stuff. But I think the first thing would be testing the effectiveness of it in some form or another, and it would be quite tricky, because there aren’t that many mental health services currently, so with “treatment as usual” there’s not much at the moment, so it would be hard to compare it to something else. At some point you’d have to do some kind of RCT to test the effectiveness, but I’m just getting stuck in thinking what you’d compare it to – maybe just treatment as usual - where there’s really not much at all. See we compared our counselling to what we called enhanced usual care so once we’d screened the women, it was difficult to not do anything with them if they screened as quite high – so we’re giving them phone calls, which is a lot more than what they would have gotten. So we’ve got a feeling that maybe we won’t pick up much difference between the phone calls and counselling sessions, but then it’s still a hell of a lot more than without. The Department of Health is planning to roll out mental health services at Primary Care level – so there might just be a little bit more there to compare it to. But yes, I would design some kind of RCT to really test the effectiveness of it. What you could do before, in fact, is a lot of feasibility and acceptability stuff – doing qualitative work with staff, with patients – showing things, trying out... before even doing a randomised controlled trial, because you don’t want the randomised

control trial to flop because people just aren't used to the app, working with the technology – so you'd want to establish that people feel comfortable enough so you're really testing the app rather than the technology.

SVB: (explains the idea of a time motion study for assessing patient follow up)

SSR: The problem with our primary health care public sector system is that I don't know that there's very much continuity – so that might be an issue – because I come one day, and then next time I come I see someone completely different.

SVB: Would the community health workers address that? Would they have a specific area in the community that they would work with?

SSR: I think so – they might be more able to create some kind of continuity.

SVB: Because otherwise it might have to be on a clinic level...

SSR: But if it's accessible... if there's an electronic system that the community health worker would be able to access it in some form at the clinic. And I suppose if the practitioner picks up somebody's case notes electronically, and they'd be able to pick up if there's something there – but I don't know enough about it...

SVB: (Explains the idea of chat forums and profile communication – questions how much contact there should be)

SSR: I'm not sure I can really comment on that... there's been – I think in HIV – there've been things around reminding people to take meds... there's been some stuff in Latin America around sending messages, tasks, but I don't know if it's been published or not – but I think there has been some work with trying to send messages, but I'm just not sure

SVB: There have been a couple of SMS things, but they have been limited to... they're either telemedicine or SMS prompts that have been done in South Africa. (ties up functionalities list) ... we'd have to pick and choose, obviously – we can't do all of them

SSR: I think limiting, what medical staff have to do, and focusing more on the community health worker and the patient interaction – I think it would probably be more feasible and more realistic.

SVB: (talks about scheduling)

SSR: I think we've got a long way to go before we can deal with that – that would be a later functionality.

SVB: (audio unclear – talks about supervision and training for use of app)

SSR: That's where doing feasibility stuff before would be quite important – to get the sense of what people would feel comfortable using. I mean, it's no doubt that the upcoming generations and that would probably feel very comfortable using apps.

SVB: So the idea was to do it in the Western Cape, but then it's not necessarily going to be scalable. I was wondering... is it still feasible to do the pilot in the Western Cape? And if it works in the Western Cape just leave it in the Western Cape?

SSR: I suppose it would be... are there bigger issues that need to be tested that would work in other places – that can be scaled up in other places that would have priority or to test it here with the

idea that it would get rolled out eventually – I don't know – I think that's a hard question... it's also whether the app could stand on its own without having to be linked to the health system – but is it then worth having – it's quite a tricky one – to what extent... what if they don't link up with the health service and are there any potential dangers of using these things without having access to some kind of health practitioner

SVB: Because there's very little done on it, it's very difficult to tell. I think the only way you can do that is through a trial – after implementation – what strange things people do. Another one of the main issues is the idea of sustainability – because this would be an ongoing, updating, you'd need to have IT professionals and health care practitioners. (talks about scalability)

SSR: (in response to mentioning a medication reminder) the uptake of antidepressants is quite low, in primary health care. We had very few of our participants on medication

SVB: Because they're not willing or because they're not being prescribed?

SSR: Well, we had a special population in that they were pregnant, so there might have been some resistance... but I think they just don't have access to it, because primary health care nurses can't prescribe it, and it's often hard to get... but there's not a huge uptake of medication. I think it's different for severe mental illness

SVB: There might be cultural issues ... The CBT kind of therapies are a very Western therapy and then if you want to include traditional healers on that same level as community health workers – who are not necessarily registered with the HPCSA, but who can give care – whether we should make allowances in the app for different beliefs

SSR: I think your app is getting too complicated. Success is also going to be determined by simplicity and ease of use. If you have someone linking to your person – and then that person being able to negotiate – I think keeping it as simple as possible is probably the best bet of getting it. And if you think about CBT a lot of it is problem solving stuff – it would be finding solutions to problems – yes, it's Western-based,, but there's an element of it that's very... that cuts across any culture. Traditional healers would also probably.. “what is the problem – let's identify the problem, let's try and find a solution for it.” I'm not sure... maybe there are forms in which might be very Western and American but I think there'd be lots of things that would be entirely appropriate. So I wouldn't throw it out... “have you been to visit a friend today” – enable activation and trying to get them to do something and it's not really any kind of cultural basis to, it's pretty universal aspect. A lot of our women are not necessarily clinically depressed in the sense of coming... it wouldn't necessarily be appropriate to take medication for depression – but are struggling to cope because they've got so many other stresses – so the counselling intervention is about helping them think through their problems, it's about getting them to develop resilience and coping skills in adversity. Or is that a treatment for depression, or is it just a way of enabling people to be able to cope better. (...) And it's that very grey area that we're looking at quite seriously in our participants – from if they just screen positive – so if they get a score of 13 on the Edinburgh postnatal depression scale – if they get 13 is that a different type of person to someone who gets 30 – or 25 who clearly has a lot more severe symptoms. So then what is the intervention doing is it in fact benefiting those with primarily slightly lower scores – so less symptoms – and those with completely severe – it might be more appropriate to have medication or something in addition to that. But yes, it is a grey area.

SVB: In terms of designing interventions – if you would have to have a CBT functionality, how would you design something like that – because I feel like if someone's writing articles or writing

questions it comes from a very – well, that is *that* practitioner’s perspective on how CBT should be delivered – how would you design something like that/=?

SSR: That’s a whole other process of looking at interventions that have been designed... for example the one that we designed for our trial has got very clear steps in each session – so there are some sessions which are very structured – so it’s very manual-based – so starting with something like that – you know – what are key elements that you would need to put in. So what kind of questions would you ask and then following on from that – what would be the follow-up question or statement. But you look at stuff that has been developed (...) you’d get people together to think through and there have been enough what they call task-sharing and task-shifting types of interventions which are really simplified types of interventions – either peer counsellors or community health workers to administer – that are already quite basic and quite structured. So you’d have a very structured intervention here. Though at some point one’s interpretation versus another- when you get to that level of structure – probably quite a lot of that would fall away (...)so it might be worth testing it out, not as an app, but as a face-to-face intervention – and then if that looks to work quite well... I mean there’s been enough examples – ours (I mean, we think it’s effective) – there’s been quite a lot of stuff in Pakistan, India – so showing that a very basic structured counselling works, so I mean it’s the same principle that uses something very structured and very simple – so I don’t think that would be too complicated

SVB:

SSR: And then kind of at every stage the feasibility of using the mobile technology, the feasibility of the actual intervention the feasibility of the link with the other databases Would people accept this kind of work, would they feel comfortable typing a message instead of speaking to a person. There are all sorts of aspects that you can take into account.

9.8.3 Health Care Professional: Clinical Psychologist (PSLGT)

Interview conducted on 12 August 2015, at UCT Student Wellness Centre, by Sylvia Van Belle

SVB: (explanation of the consent form, gives an overview of the project, begins describing functionalities)

There are a lot of apps online that promise to be able to track negative trends and thought patterns – and I was wondering... I’m sure there are psychological tools, but that requires input from a professional – so I was wondering what sort of things to look at for that.

PSlgt: I don’t really use any kind of... I mean I use a kind of suicidality – the (?) Suicidality Scale – but I don’t really use a particular... I usually ask around symptoms, rather than using any kind of instrument.

SVB: What sort of things would you look at to show negative trends or Negative thought patterns?

PSlgt: I use a thought diary so I suppose that would overlap with your journal – to cue people into some examples of the negative thought patterns – you’re talking about more negative cognitions? So I would in the course of therapy give examples of what those might be and in the course of CBT the person keeps a thought diary which would overlap with your journal idea of noticing negative cognitions and suicide symptoms and then part of therapy would be to try and change those, to try and think about how real and how true they are; how realistic they are – what’s catastrophic(?) thinking, what’s actually reality. So it would be a process

SVB: I think it would take a lot of work to try and optimise the journal tool – you possibly have a way to label... as you're writing you realise that that's a negative thought – and it will allow you to go back to that quite easily. But I think those sort of things will come with time. Maybe we should just get a basic sort of thing up

Pslgt: And the journal tool is quite a complex one, and I guess it's also quite important to think about how people feel about their journal being in the Cloud – it would be very useful if they're willing.

SVB: That is something that they would be able to choose.

Pslgt: It would be optional? Oh, that's nice. Yes, people sometimes feel quite self-conscious. Even if it is about symptoms and cognition... Sometimes people feel quite self-conscious even about putting it on their computer.

SVB: So something that's quite big in the IT field is the idea of gamification, which is just giving a value for having goals that you can achieve – it isn't necessarily an active game that you play – it's the idea of goal setting that I think is part of CBT too.

Pslgt: That could be useful. A bit of extra encouragement

SVB: With some programmes, for instance exercise programmes – they often have your nearest peer who also uses the programme and they compare – but I'm not sure how safe that is in terms of psychotherapy – it's not really a competitive thing.

Pslgt: No, and I think that, actually, people tend to compare themselves too much anyway – if they're depressed, they tend to sometimes think that either other people are worse off, so why are they making such a big thing of it and why aren't they just (?) better or that they're alone. So I think a comparative... I think the gamification could be useful for setting goals and being able to reach those goals – particularly in terms of just using the materials – but the comparative thing I'd be a bit concerned about.

SVB: The challenge is to weigh up complexity – trying to get as much info onto one device and make it as comprehensive as possible – and the idea of simplicity is sometimes better (...) But another option is that once you've got a database going you can create more apps that give input into the same database and then somebody who has, say, HIV/AIDS, who is pregnant and has depressive symptoms they could download three apps for their AIDS, then you could also get one for their medication (which I'm coming to) – but I think that would have to be left out or maybe if there's a CBT programme and there's a list of different activities that they can do and they can choose, with their therapist, maybe, there could be modules that they could select from.

Pslgt: That could be good.

SVB: (describes medication feature – with photograph)

Pslgt: That sounds like a really good idea. It almost replaces the psychiatric admission where some of the nurses hand it out. That would work

SVB: (describes positive thought pop-up) That could be customisable if they don't like the inspirational posters that go up on Facebook – they could just do their own... what they've thought about... personal ...

Pslgt: That could go under journal – be part of the journal, I guess

SVB: And the safety plan for suicide situations would also have, I imagine, would also have... type in your happier thoughts, reasons to live. So I mentioned CBT... is CBT almost universally applicable? As a short-term thing that people can self-administer...

Pslgt: It's a very useful technique – it's very practical. So whether one does CBT, one needs to assess whether it's appropriate, if it's short-term, but I think it's generally applicable and helpful for most people and it is the kind of thing that once it's explained properly. Another thing I always ask people to do that would add, although you've thought of so much, is into the journal to keep a list of all the positive things people say to someone because people who are depressed can't take it in, can't absorb it or disregard it – so that's another tool I find quite useful.

SVB: Another one of the issues when trying to see what will be most applicable is whether it would only be accessible through the health system (...) or whether they can get it without reaching out to the health system – they just download it for themselves – because a lot of these functions are stand-alone, but obviously it's good to have somebody else monitoring it, and I was wondering whether you could think of any dangers of self-monitoring.

Pslgt: You know, I'm just wondering, because I think that it would be limited if you only go through the health system because there are lots of people who don't access the health system who are... like most of the people who come here [UCT Student Wellness]... who would benefit, and who are in therapy, perhaps – or who are somehow linked to SADAG – South African Depression and Anxiety Group – and they might be useful people to speak to, as well... my concern... obviously you're trying to do something huge here, and something very comprehensive, but I would think it would be very applicable and useful for people privately to use on their own... but I'm wondering about the dangers... I'm not sure... I don't think that doing any of this would make people more at risk – I may be wrong – you may get different opinions – but I don't think it would... especially the journal, CBT, - and maybe somewhere in it you encourage people to go into therapy. (...) But just to say if you have any questions... and maybe a link to something like SADAG or chat support groups – you know, options... Because unfortunately the public health system is very, very limited as far as therapy

SVB: (Brings up community health workers) ... the community health worker who is the person keeping track and monitoring

Pslgt: and assessing when somebody needs to be referred, although who they'd refer them to, of course would be the challenge.

SVB: (talks about general eHealth ideas and integrating it into health systems. Wearable tech.)

Pslgt: Well, I know there's sleep apps as well – that monitor your sleep and when you're asleep, and your pulse rate but I don't quite see how they could work

SVB: There's something that's just come out now that monitors how much you use and where your phone is so if you spend a lot of time at home you're more likely to be depressed and they've done studies which have proved their theories – but I think we just need to get something simple off the ground

Pslgt: maybe that's something you could add on... The only thing I can think of is things like heart rate and rate of breathing – that kind of thing because of anxiety, more than depression – but that would be quite difficult to – it's probably quite complex.

SVB: Once you start doing full time monitoring, you start collecting huge amounts of data and you need to be able to pick out... it's a whole field called 'Big Data' – but then they have to be able to recognise what's normal/what's abnormal and link it to the rest of your data. It does become significantly more complex.

Pslgt: Absolutely. And you've got lots of good ideas here so I think it's about what you select and what you include because managing to do it all right now would be a huge challenge

SVB: (brings up patient-patient chat forums, and anonymous patient and employed therapists, as well as one-on-one chats with their personal counsellors)

Pslgt: It's a nice idea but I think you've thought it through – one would need a moderator – one would need a therapist involved and there have been instances – for example support groups for sexual abuse survivors where actually it's been traumatic – I've come across a couple of cases where it could be helpful but they're alone at home and they're hearing accounts of trauma which (*re?*) traumatises – so one would have to be quite careful, I think, about that... (*Suggests following up with SADAC*)

SVB: I was wondering if you think having a direct one-to-one conversation with their health care provider – would you think that's excessive communication?

Pslgt: It's quite complex – it would be a big issue around availability – around how it would feel if somebody wanted to have a chat with their provider when the provider isn't available, for example. And also how it would feel, if they're used to seeing their provider face-to-face, how it would feel to shift and to that forum. Personally, if people move – I never do this if I'm seeing people for the first time, but if I have an established relationship with a client, for example, and they go overseas and they want a Skype session with me I do that, but actually – but it is potentially... one needs to look at it in the context of therapy and the right process for everyone. So I think that may be problematic because it's quite nuanced and it would depend on the context and therapy and the particular relationship

SVB: I think especially if you're not having professionals – because if you're just using trained community health workers they might not notice or be aware of those difficulties – and they won't necessarily be aware of the boundaries that need to be maintained – so I think it might be quite dangerous.

Pslgt: Yes, I would leave that one out, actually. Both the chat form... both of them have got quite a lot of potential pitfalls

SVB: So one of the last points is about data collection for depression... what do you think is important data that should be collected on depression for the health system to know?

Pslgt: well, obviously prevalence, so it would be like how many people are using the app (although that would suggest motivated people who are actually help-seeking) – but obviously that would be helpful – and then, have some kind of incidence of the symptoms, the severity of symptoms, the level of suicidality – that kind of thing

SVB: ... and actually co-morbidities, as well... Okay, so on that list, which would you say would be the most useful

Pslgt: It seems almost like there are two kind of groups – there's what would be useful to a therapist who's actually seeing a client – which for me would be the journal, the physical tracking tool (if you manage to get that right somehow), the mood tracking – if I'm thinking of myself, that

would be very helpful – the daily quote, the positive thought... so for a therapist, I think all of that would be very helpful, in terms of being able to stay in touch. And I think one wouldn't necessarily need the online contact with the therapist because if someone has the sense that the therapist is able to access the material, that might in itself be containing. ...The daily exercises, the homework tasks, you know, all of that would be a helpful augmentation to therapy; it would be helpful if people could take away in between their therapy sessions... And as a kind of stand-alone – if they weren't necessarily going for therapy or in between therapy periods or have terminated therapy but want to help retain the gains... all of these would be helpful... I'm not sure about the between therapy communication...

SVB: So the other option with that, is that you have one-way contact – so instead of it being open communication there might be pre-designed... a request for an appointment, that could be sent through, or a request that they be contacted, or a request that they share their journal – which I think might be a little more

Pslgt: Yes, absolutely. And maybe an alert that a journal entry has been submitted – something like that. ...So there's that, which would be useful to someone like me as a therapist, and clients that I'm seeing, or for people outside the health setting, not necessarily seeing anyone who could find the App and download the App... and then there are the ones that are more helpful for research – graphical representations and statistical analyses, and the pattern recognition and the ...although that's helpful for the therapist, too. Sorry... I didn't add into the usefulness for therapists and clients is the goal-setting system and the safety plan for suicide situations – those are all helpful.

SVB: What should be included in the safety plan, exactly?

Pslgt: I think part of it would be emergency numbers – how to access help in the case of an emergency- but also I think part of it is quite individual because what some people want isn't quite the same, but something like a support contact and how to easily access them – maybe even links to their phone numbers – you know, something like that. A speak about a support system – not necessarily therapists, because one wouldn't necessarily always be able to get hold of the therapist, but so that that's easily accessible and then maybe for the person themselves to somehow be able to identify what helps them, when they're feeling down, what could be helpful – sometimes people say if they're feeling lonely in the middle of the night they like to go onto social media (...?) or go for a walk or make a cup of tea or phone somebody, breathing. I think it is quite personal – although the emergency numbers and who to contact would be an important part of it.

SVB: So although we've covered quite a few of my questions going though that, I do have some questions... SO, it's a bit difficult to say, because you obviously deal with private treatment, but from what you've heard in the public sector, who often would deliver psychotherapy?

Pslgt: Facilities like Valkenburg – and those psychiatric facilities... inpatient, but there are outpatient facilities – through psychiatric outpatient –like Groote Schuur and those facilities– but they're limited, unfortunately, and the interns who then have a limit to how many people they can see... psychiatric nurses... I think sometimes within any health facilities, there are some people who more psychologise and others who are open to the experience of patients but I think time's a huge problem, so community health workers – absolutely... doctors, but I think that in the public sector time is the great challenge

SVB: Besides time could you think of any other barriers to care – and this includes barriers to health seeking behaviour – that might exist in South Africa

Pslgt: I think accessibility is a big issue (location) and also often medical specialists – I've been practising at Constantiaburg and often medical specialists are not necessarily that open to the need for psychotherapy – they often focus on their specialisation – I worked next door to a cardiologist – he's never referred to me, for example – I think sometimes it's about that too, that people aren't referred appropriately when actually that may well...

SVB: ... especially in chronic diseases... And would you say stigma is a...

Pslgt: I think it still operates, exactly. I think it's still a factor, absolutely.

SVB: Do you know what some of the traditional explanatory beliefs are, around depression – if there are other views of depression that would cause people to not seek help?

Pslgt: I think traditional cultural beliefs may be that it's some kind of a calling... to become a sangoma... although that's often more psychosis – but it can be that somebody goes through a severe depression of some kind and it's seen that way.

SVB: In terms of training, community health workers are then trained to be able to give basic psychotherapy... what kind of supervision do you think they'd need?

Pslgt: I've actually done quite a lot of community health worker training - I worked in a community health project that started up in Malmesbury and Atlantis long ago – in the 90s – and I think in fact medical students went and did placements – but I think ideally supervision with a psychologist or a social worker, which involves also debriefing for themselves, but that would be very helpful

SVB: Because I was also potentially thinking about including some kind of a supervisory function but I'm not sure... maybe there could be room for a chat forum there – between them and their supervisor

Pslgt: that would be very helpful – because often supervisors are not necessarily available and especially in rural areas – yes, that could be helpful.

SVB: What do you think is the biggest need in South Africa? Do you think it's screening, or it's monitoring or it's treatment?

Pslgt: Treatment, actually. I think the rest is important... but they go together... especially the monitoring and the treatment.

SVB: So when we're designing a lot of these things, we obviously want to make them evidence-based, and they'll go through rigorous testing – but for instance in designing the CBT programmes – do you think there's a way to approach that that would minimise that would minimise the individual bias that would come if one practitioner designs it?

Pslgt: Difficult question, actually, because the whole issue about therapeutic interventions – is quite a complex one... that is a big question... *[Pauses – cannot come up with anything]*

SVB: So do you think the main level that the programme should focus on is interaction between patients and community health workers, or patients and nurses. I think, with the interface, and with the practitioner profiles – it would be best to create different levels – so you can create the interface for the community health worker, an interface for GPs and nurses at the clinic and

then also an interface for institutions or researchers – who can maybe just access the database straight from where they are. But then on a primary health care/clinic level – what kind of privacy level do you need, because often people don't see the same person – so should there be any kind of monitoring of the community... but I don't know how much information can be shared...

Pslgt: You talking about the practitioners having access to the patients' records and you're talking about also researchers also having access to the data

SVB: So the data for the researchers would be unnamed

Pslgt: And the data would be collated in some kind of way – it wouldn't be pointing to individuals? But maybe in the application there would be some way that only – it's difficult when there are multiple profiles, though. My thought would be that it's important that the clients/patients actually have control somehow... that they can see that X wants to see their records or whatever it is or that they give permission – that there's something where X's name pops up – and they say that this one or that one has permission to view... something like that.

SVB: How open do you think practitioners as well as patients would be to an app, in terms of technological competency?

Pslgt: You know, it depends on the practitioner – I would be very open to it. Most of the patients I see would be very open to it (*her treatment facility is geared at university students*). But I would think it's probably shifted quite a lot and I think a lot of people access apps – they find them themselves – you would have a better idea than me of the health system but, but certainly I think a lot of private practitioners would be open to it, I think a lot of patients would be open to it – I think the timing's right for something like this

SVB: One of the main things is obviously language barriers which is one thing that can be addressed by community health workers - although it's a fairly simple thing to translate the app itself, I think (it's mostly an IT barrier) the data would then be put into the database in the language that they're typing in – and obviously you don't want a database that's in 16 different languages.

Pslgt: And then you'd need translators translating it all... That's a real challenge... and unfortunately most apps are in English

SVB: We don't want the app to be in English, we want it to be in their language and even then we need to look at the plain literacy of our country

Pslgt: Unless there's some way... if some of it is... for example that (*points to mood/physical tracking on functionalities list*) could be in any language, but the response would be coded according to which line it's in.

SVB: And then only the journal function would be a huge problem, I think...

Pslgt: But the journal function most people wouldn't need to see – only the therapist – and the therapist would presumably speak that language, if that makes sense... but all the statistical stuff could be coded in such a way that if there are closed questions – then if it's a scale then the scale can be translated but the actual answer could be coded.

SVB: (discusses cost of the app)

Pslgt: The thing is that there are so many free apps – so then why not use some other app – I mean this is really unique to the South African context, and important in that way, but then I think cost is a big factor in the public health system. Hopefully you get sponsors.

SVB: The problem is that you actually need the health system to see it as valuable enough and buy in, because you can get sponsors, you can get funding from international companies, and then it dries up and you're back where you started. So you need to prove to the health system that it's efficacious. One of the questions that I was stuck on is – so you've got these practitioner profiles – but you obviously want to verify them. Yes, people have practice numbers from the HPCSA – but they're fairly easy to get hold of – so what systems are in place for verification currently?

Pslgt: I think, for example, if you got hold of the HPCSA, they'd have names, the registered address the HPCSA knows about

SVB: You mean go up and check on them individually? The other option that came up when I was talking to an IT programmer was that you have supervisors approve the people that they're overseeing – so you deliver it to the districts, and the districts approve the heads of clinics and then the heads of clinics approve... so a hierarchy scheme... I'm not sure exactly how we would work that approval, but I'm sure that could get worked out later (perhaps a QR code)... Um... ethical dangers... I think we've covered ... I think one of the main dangers of self-treatment is that people feel that they don't need to go and see someone...

Pslgt: If one looked at the ethics... there is so much self-help stuff out there – if you were to look at the ethics of allowing people to access this, I don't know how one would do that... the main ethical things I think would be confidentiality and consent and who gets to see the data and the patients have full control and full information about the research application... all of that... and then make that they sign some kind of online consent around the statistical... and we were talking about that they give consent to whoever looks at their profile in terms of the practitioner – that can be built in

SVB: That's important – because I think otherwise people won't use it, at all. (*talks about security on the IT side*) But it's convincing the users that that's true [*that it is secure*]. So then the last point on my question sheet is... I'm based in the Western Cape, I'm used to the Western Cape's health system, it's a lot easier for me to talk to practitioners in the Western Cape, it would be easier for people to implement a trial in the Western Cape, but the Western Cape isn't a very good sample of the rest of South Africa, so it may well work in the Western Cape and then not be scalable to the rest of South Africa. Do you think it's still worth trying in the Western Cape?

Pslgt: I think so, because, the thing is, even if it's not applicable to the rest of South Africa, it's still going to help the Western Cape.

SVB: The idea is that we're meant to reduce the inequity between the provinces

Pslgt: So it would be great if could be rolled out somewhere else, but you also have to think about logistical constraints.

SVB: And the other thing is if it works in the Western Cape, they can focus on the specific problems afterwards – once you know that it is functional. And one of the pros of it being an app is that other interventions, they've used SMS or telemedicine – where they call up people – they've done their small pilot study, seen that it works, and then they'll implement it and then they'll lose track of it. So they don't have that ongoing monitoring, but with this you can carry on seeing

if their mood improves with using the app, you can keep track of the data's [?] stored – so you can prove that it's helpful...

9.8.4 *Health Care Professional: Psychiatrist (PSRT)*

Interview conducted on 14 August 2015 at Observatory, Cape Town, by Sylvia Van Belle

SVB: [talks about HISs] the idea is that we develop something separately and then we can have an open terminal for them [the *Health Department*] to access and give them the information... we'd try to make it as friendly as possible

Psrt: So there's confidentiality – so there's enormous ones there. And hacking into it.

SVB: so security is on three levels: on the phone of the patient and then it's the fact that the data is being sent and then it's who gets to access the information...

Psrt: Now I imagine discovery health for example has got the patient information system which you can enter into – and join up with.

SVB: There's also the whole thing of how much do we... how much integration should there be between public and private... because I don't think there should be a separation... I think it should be accessible to all patients... but that requires collaboration with corporates... which is beyond my scope of knowledge

Psrt: It's also about the bureaucracy – what slows you down in the public system is the paperwork that's needed in the private system. So if you see a private medical aid patient at a public facility - let's say it's Victoria Hospital for example – and if the patient wants the medical aid to fund the admission there's quite a lot of paperwork involved in that and the other practical problem is - if you're working in private and public and - it's a limited, very small private component to your work – they mix up your work... they mix up your name and your practice number so it becomes a whole reparative process that you need to go through on a fairly regular basis, so it becomes quite time consuming. So separation works quite well for individual people – like doctors and patients if they are... obviously it's not what you want as an ideal system. It's hard to get massive interlinking communication systems and have them efficient... and not sort of have... problems occur along the way...

SVB: because I know with the NHI they were saying that they want to go for more public/private collaboration...

Psrt: The problem is there's very little mechanism there at the moment – certainly at lower levels – I don't know what contracts they're trying to make at higher levels – who are you actually having the agreements with – that is the other thing – private hospitals, the insurance companies – so people operate as a public/private partnership at a collegiate level between referral patients backwards and forwards and there's a huge packet of problems with that as well. You end up with a strange mixture – it becomes quite unclear as to who – and I suppose the medico-legal issues about who's got responsibilities for the patient.

SVB: So what I thought we could start with... so the idea is that we have all of these functions and then we test each of them as we're developing it... we assess them for their actual efficacy and effectiveness and that's another problem with a lot of interventions is

And literacy? 'Cause smartphones and whatever are going to help improve literacy so should they accommodate that

What's the cost of an entry-level smartphone now? And the person would obviously have to pay for data?

I think your main problem at a conceptual and research level I suppose is about the validity of what you're getting – obviously in the broad brush-strokes it's going to be pretty obvious – I suppose we're looking more at the broad brushstrokes more than the nuanced?

[how accurate is self-reporting]? It's difficult because... you take for example sleep disturbance... a sleep disturbance could be a reflection of a number of things – when it's plonked into the patient index – it adds into the [?] round the patient but it might not be depression. I think the difficulty is when you've got a symptom which as a symptom is reflected on a number of disorders – there's quite a variety of... it's quite hard I imagine to tease it out ..

[talks about tracking individual co-morbidities] – but obviously on an individual level that can track into different personalised domains, but... your other huge issue on a conceptual level is kind of in an evidence-based perspective – I'm just throwing it in – but if you can't do something about it, be very careful of finding it. Do not diagnose something if you don't have an intervention for it... and I suppose that sort of chicken-egg situation we often find ourselves in – you've got to be careful of the load you put on the health system with – I'm not saying it's unnecessary data but it's data which is difficult to manage. Or when you get co-morbid patients who might somatise quite a bit. So you head down pathways which you don't really have good entry-level treatments at primary level but you're starting to flag those as necessary for intervention. I know that everyone thinks that information's wonderful and more knowledge is better, but I kind of wonder sometimes about that. I'm just thinking at the rock-face community level, mental health nurse practitioner – you're basically entering a few questions about mental health.

[so maybe we could restrict the amount of data going the CHWs, but the data is being recorded][medication]

(gamification) or avoidance of discomfort – which is quite a different thing.

(Medication) They've done a study at Valkenburg looking at this, really with medication adherence with people with schizophrenia, in terms of giving them a cell phone and giving them an SMS reminding them to go to the clinic to get their medication and stuff. My understanding of that is that it's – you should have a conversation with (?) – on a very basic level... they were given cell phones with SMS reminders, whatever – it seems like it doesn't make much difference to the adherence... what does make a difference is the face-to-face contact with the nurse – and I think that's been seen quite a bit is that the human connection is the pull... is the impacting variable – just having a relationship... but maybe the world is changing – so some of this has been done and it might be useful just to see what the local experience of that is. But I mean, sure, it is conceptually almost one of the... a lot of people would think that is the most important – I don't think it is the most important – it's very useful in terms of the interactive communication tool.

(Suicide plan) It would be quite important – what that is – so you'd want to link that into standard care –pathways of care. I don't know whether you should make it as an escalation levels in terms of risk... that doesn't follow, but what I'm saying is... suicide ideation, suicide intent, suicidal

thoughts, methodologies, thoughts, organising things around your demise etc like wills... I don't think you should have it is a gradient thing... but you also don't want an all or nothing... because a suicidal thought is quite common – I would find it uncommon if someone had never had one – people think that it's strange but I think people [*rationality?*] contemplating suicide in an abstract way as an existential issue – and existential thoughts are fine. If you not thinking about it you're not engaging with life – or non-life. So you don't also want an all or nothing thing where “if you've got this, go to your nearest casualty” – you know what I'm saying – we say this to patients that if you are out of control but can you imagine if they took you literally – if everyone went “hey, I'm having suicidal thoughts” – well not quite that, but you're looking at [*?*] people saying they're having suicidal thoughts and some doctors don't appreciate that in general care – not that they're uncaring – but- being realistic ... the kneejerk is “buck-up and get on with it and function – don't waste my time” – it's not right, but you've... so it's hard to know that, but I think a safety plan of some description or some kind of notion about – maybe somewhere in this is resource guides or needs-based research levels, which I'm interested in talking to you at some future date because you seem so clued up on this...

(Talks about intervention programme) So you're basically just thinking of linking to existing resources, because one of the actual things with this is actually kind of like resource material – or are you going to create it yourself – or are you just going to link it to a web-page which requires negotiation

SVB: so that's the problem – when I said link it to external materials – I just meant that they aren't stored on the device because that would make it big, so either you can link it to existing YouTube videos which, are, you know, positive, but because we want to make evidence-based, it would be ideal for somebody in a university to develop the programme and then they can put it up on a web-page that's affiliated to the device [app]. But I was wondering... because there's a lot of therapeutic things it's very personalised, but what I gather from CBT is that it isn't – it's very structured – so it wouldn't really be a problem to design something like that that's widely acceptable, and not just one practitioner's opinion?

Psrt: You also have competing therapies and you have competing practitioners and ... whether you like it or not... it's a market-based [*?*] in which we function.

SVB: Because I know CBT is the one that's had the most research done on it...

Psrt: Well it's the easiest researchable – which is another issue, so of course people tend to research stuff which will fit existing paradigms [*?*] a way of validating knowledge so that is validated by the infrastructure [*?*] etcetera, so of course it will have... you know what I mean... and also it's a mechanistic sort of therapy ... in the sense of its structure, so you can understand where it got its validation – it's sort of evidence base etcetera, etcetera. So you can... it will be used, I suppose... it's not quite the gold standard... but a lot of people will argue that it's artificially constructed... it's such an evidence-based paradigm and existing ways of assessing knowledge and truth – but sure – you're wanting to work in that paradigm.

[we're wanting to get something out, we can't design a new paradigm for primary care] [*pause while they re-establish the thread of the interview*]

Psrt: So sure it's the kind of one which you're going to go for – and the mindfulness one now is now – it's assuming dominance there as well,

SVB: but as I said... if we have those different modules... it doesn't need to be called "CBT" ... and obviously a team would be designing it rather than a single practitioner and there'd be researchers as well and public health so they'd know what's necessary, ideally, for the situation. It doesn't need to be called "CBT" – it can just have very CBT elements to it.

Psrt: But there are online resources, but ... it's interesting to think where it's going... it's great.

SVB: So with the "Find a Doctor" function if the practitioners who use it have profiles, it just means... "in your area, this is a list of people who are available" – very simple – they'd have to create a public profile – maybe they [MHCUs] could read up on the doctor – maybe a little bio... that the doctor himself creates... or community health worker... something I was getting into, and a couple people told me not to go that direction, was looking at traditional healers and how they fit into this system...

Psrt: Don't... go near... But just an example of what I was talking about – that there are other competing therapies and systems... so sure, you want to be as inclusive as possible, but you want to be... you want some kind of boundedness. The problem with traditional healers is, for example – they are now a part of the HPCSA, but in a very unclear kind of sense about what the organising is – how it's structured, what their governance is, what their disciplinary structures are, what their standard of entry is, what their exit exam... for a political reason they were given entry into it, but without any of those basic kind of things put there... so now it sits there, kind of an anathema – because now what do you do? You've got all of this work to do within the group but technically, if they want to charge, and then access medical aids, the door is open to do that so already you're getting certain med [?] who've been seeing people... now it's all soft, fluffy, everyone's nice kind of world – no-one's got any agendas or ... personally enrichment-motivated... it's cool but the world isn't quite like that. Anyway but... things that are now established, but haven't been thought through, which haven't actually had clear pathways along which they developed alongside allopathic medicine, it's quite awkward. You've also got the alternative medicine group, which is also part of the HPCSA, chiropractors, [?], whatever else... which is also... of course now they're trying to push these groups --- they recognised the terrain was changing – to get in there and formalise – some of them are [?] the periphery but whether... that's your decision, around that, but I think that you need a certain boundedness, because...

SVB: ... what I do want to incorporate is an export function, so if they do want to say – save their graph and send it via email – they can send it to their traditional healer, and they can see the progress as well. They can send their journal, too.

Psrt: You might have, say an educational exit grade of say, standard 6 – just think – some of them are... they might not even be literate. I don't know quite how it's working out. But sure, you say, these things can develop.

SVB: So as you were saying with the HPCSA... one of the problems we're sitting with... is if a doctor wants to create a profile we'd need to validate him, because although... okay I'll explain the system of how patients link up to the health practitioners... but if they're accessing the data from the system, you'd want them to be qualified... and the practise number, from what I gather, is pretty much on people's prescription pads – it's not a very secret... or safe... so how do most organisations validate

Psrt: that you're part of the system? Ironically, I don't know in this country... but I certainly know in the UK and Ireland – online you can just punch the number in, or you put in the doctor's name and it will come up as to whether they're currently registered and have a license to practice. So

it's easy there, if you could just basically actuate it through the GMC – the General Medical Council – HPCSA – I don't think they have a function – you could just check on the HPCSA website if they've got a tab there saying "validation of registration" or something... or "find a doctor" or check a doctor's qualifications, or something...

SVB: If a doctor wants to download the app and wants to create a profile, and he just types in his number – he could be anyone – so instead of having someone go to him and register him, face-to-face, how would he prove that he is him... the one solution we came up with is that we have a hierarchical structure so that

Psrt: another thing's come up for me, with the anxiety and depression support group – which is a very big support group – have you seen it... SADAG... what happened to me is I didn't want to be on that support group mailing list and access list, because you find that... it's ungovernable, in a way, from my side and what happens is exactly what I was concerned about is both my email and my cell phone number just were given to patients from the person who's on the telephone looking at their list of "who's in your area – oh Dr x" ... so what do you do if they don't want to be on your list? –because that's a problem if you just accessing existing...

SVB: so the idea is that they can create a public profile as well as a private...

Psrt: but you're saying that there's a problem in terms of the person creating the profile on your...website...?

SVB: So, yeah, it's the original profile – so to register them as a doctor...onto the database. So one thing we said was that they get validated by someone above them – so that works fine, I think, in a public sector – where you have the provincial managers going to meetings, having a QR code which somebody [district manager] scans with their phone – to the districts, from the districts to the clinics – to the specialist consultants...

Psrt: conceptually it would be great

SVB: But the problem is what do you do about the people who are not in that hierarchy...

Psrt: you're wondering about how to be as inclusive as possible to people who aren't in pre-existing formalised structures. I dunno... but I suppose you don't have to make the perfect wheel at the moment – you just have to make one that's starting to turn... ... and these things will come along

SVB: ...and point out where the problems are... leave it to someone who's not a second year student....

Psrt: I suppose at some level I'm a bit worried about you... poor you... but we can talk about that when this thing's turn off...

SVB: So then you get to the American [*papers?*] overseas and the entire system can be automated and they can link into the hospital where everything can be mobile... so you can have access to your patient records, you're tracking your biometric systems through your wearable technology – through your watch which is measuring your heart rate, your breathing rate, your phone is detecting the noise in the area, the light in the area, the location tells you how much time you're spending at home and how much time you're spending in public places, your sleep cycle, how much you're using social media which apparently is directly proportional to depression,

Psrt: Did you see Mark Zuckerberg – the Facebook guy – came out with a statement – just it's sort of linked to this – that he's looking towards being able to share your thoughts as they emerge

with your Facebook – so you don't even have to bother – somehow – I mean, obviously it's a bit grandiose etcetera, etcetera, but the interesting thing is, people who know the technology – and obviously you in a sense know it, and you can see the usefulness of data, and how you can integrate and sift through data and try and make sense of it – that's a whole process now is just data accumulation and how to use that data and organise it – so it doesn't sound so crazy when you look at it in that way and just looking at this and one level can look grandiose but at another level it's just about data accumulation.

SVB: So with what I had been doing previously with the journal entries and putting in the variables – that's very specific time-based things, but once you start doing this continual monitoring

Psrt: And I'm not sure I'd want to screen through 50 of my patients' heart rates

SVB: So what they have is a field called "big data" – it's essentially pattern recognition and being able to identify what's normal and abnormal – and only the abnormal things would flag and it would link to the other data – it's a huge field – and it's where things are going – but I think with what we're doing and the fact that those technologies require high-end phones, they require a lot more battery power they require constant access to the internet

Psrt: So is that the limiting factor – the battery part – finally something I can understand... if your only limit is the power source

SVB: well, processing power, and the fact that wearable technology is expensive... But what [omitted for confidentiality] was saying... because he's into business ideals... which is very different coming from a medical perspective sometimes we ...

Psrt: well, it's interesting, that, as well, you're talking about business ideals in terms of profit generation? ... but then with a social responsibility, I'd imagine...

SVB: So wearable technology would be looking to fund these because they don't have enough things that utilise their technology... so they might be willing to invest in it – so you could create an extra arm later, once you've got the basic thing going, so add that, if their keen to fund it – and under the big data and the extra processing – but that's not yet because that's definitely can't be rolled out to the majority of South Africans...

Psrt: Why are you limited it to depression? Because obviously... well, I know it's a point of entry – and it obviously isn't, because if you look at this structure – okay, you've got a disorder and you're calling it depression and there are certain reasons why – both personal and broadly - you're wanting to look at that – and then it opens – it enters into a structure which accommodates any mental health problem – in fact any other health problems – an medical problems – it's basically – it's a really sophisticated resource guide – at every level

SVB: So once you've got the data base you can do anything. But the problem is – there've been a lot of papers on the feasibility, on research frameworks for implementing mHealth, but there haven't been a guideline saying "this is how we can upscale a specific intervention" – so I want to try to start with a specific intervention

Psrt: well, that's a public health thing, it's a particular kind of thing – the up scaling and that's a whole new science in itself – implementation science...

SVB: it's stayed theoretical and there hasn't been as much implementation as there could be – so I want to have something that's implementable on a small scale and then can scale up... then you can utilise the framework that you've laid down – the foundations that you've laid down...

there's been a lot to say "these are the obstacles" but there hasn't been anything to say "this is something we can see and set our minds to working on"

[some discussion about the nature of the nature of the SSM project and supervision]

SVB: so the last arm that I need to look at is the talking between the profiles – so essentially, the patient can download the app – they can use it with or without a healthcare practitioner... there will be – at various intervals a screen saying "maybe you should go see someone." Then if they go to someone they can add someone [the practitioner] to their profile and then under settings they can choose how much information gets sent whether they want to send the variables, whether they want to send the journal, whether they want to send CBT... then they can also choose how much data the local clinic gets, and how much info... I drew a diagram

Psrt: well, can I see it – you mustn't be self-effacing about this, because you're dealing with a complete neophyte

SVB: so the dotted lines are what the mental health care user can control – so they can choose how much information goes into their patient records in the primary care clinic, they can choose how much of their journal, their mood tracking and their CBT activities go to the community health worker or, if they have a specialist that they're seeing personally... then the community health worker, and this is something else I need to discuss...

Psrt: that brings up a whole issue in itself – I'm just thinking of the pragmatics of dealing with... of communicating with people... communicating with patients... and about what that trust level is... because what is withheld is interesting. It's always interesting what people will withhold, and it's always interesting what people will be prepared to tell you and here you've got control completely there [at the MHCU] – which I understand... you know you can see that as the human rights obvious issue... and autonomy is – it's a central... it's an ethical thing – but it does... when you're a clinician, you're often kind of wanting the information that people will not want to put across in terms of – so I suppose the information needs to be seen in a certain way when you're looking at it from there - it's incomplete or it's particularly patient-controlled... like... is the guy a paedophile... has he got a [?] history.. is he a sexual molester... all of these things come into being in various aspects of psychiatry – I'm not saying... they're probably also the ones who don't want to... you might not say that's not information you necessarily need to know in terms of managing data but it's an interesting.. I'm talking about some of the profiles of patients that we see in terms of psychiatry, I suppose... it's not all... depression's a different area, I suppose...

SVB: So one of the main issues I suppose is that contact here – the communication – so the one option is that you have an instant messaging which allows for distance CBT and distance therapy but it also means that there's too much contact. So what some suggests are is that you have structured times where you say "I'm available between office hours – you can contact me between office hours" – but there's also how much time... they'd [HCPs] would be logging time effectively treating somebody, but they're not sitting with someone in front of them so it'd be difficult to reimburse people for that... so I think that's a bit too much – that contact, I think we can save that for a future intervention. But the other option is that you have one-on-one ... so the patient can request an appointment, the practitioner can request more information... request a journal entry... request that they share their CBT activities/homework with them...so there are preformed commands that they can send... which is what I was thinking might be more practical. There's another option, which is a more expensive... another level of communication is that you have between patients they can have chat forums, support groups,

also in an IM/WhatsApp situation – I’m not sure how safe that is, though, you’d need to have moderators to watch over that to make sure that things stay on topic. And then the third option is an external... either a helpline or... what one app that’s available does is they have a number of health care providers who provide anonymous therapy... in a way, but that would require employing people and I don’t think we can support that with our human resources.

Psrt: you come to the [?], you also need a... once you’re providing it through a system you also responsible for what they essentially say, and the consequences

SVB: and we’re already dealing with enough unknown ethical issues because we don’t have the protocol for it. So obviously technical support – but that goes on in the background... so then another interaction that we’re looking at is between the community health worker and their supervisors, and what support a community health worker would need, in the field... I don’t know if you’ve done any work with community health workers..

Psrt: Well, it’s an area that is starting to become really important on a basic community-based level – CBWs ... because, in terms of our systems... look on the most basic level – vulnerable people who have been in hospital and have just got out and then don’t have the right clinic visits and the right – and it’s a very simplistic staffing thing is to go and get the CHWs in – the community health workers to go and do a health visit and then obviously that has to be arranged through a referral pathway – through the [CBS?] system.... This is obviously a potential evolution a lot further down the line... and also with a lot more literacy in the population... but it goes hand in glove – it goes together – because you establish literacy by starting the thing and ... the people can’t go through schooling but they can certainly become literate by starting to use a cell phone.

SVB: So one thing we thought is that there’s just a basic communication of a log book of the hours that they’re doing – their daily check-in... and they can also have potentially a journal and a mood tracking to keep an eye on their mental health. So then where I thought there is space for a chat forum is between the community health workers together as a team with their supervisors and then potentially, one-on-one chats

Psrt: no, this is really interesting – that’s very interesting – [*mentions that he has experience supervising mental health nurses – edited for confidentiality*]

SVB: A lot of the research has focused on... and most of the mobile interventions that have happened have happened on this level, but I think we need to start making it patient-centred. [...] so there’s also the idea of... maybe they can have some training resources on there as well... and they can have training activities – like there’s CBT activities... just basically making sure that they’re reading articles (depending on their literacy), completing homework, to give ongoing training to the community health workers using the same... but like I said, maybe that can come later.

Psrt: I’m wondering what they’ll do if I [?] them homework...[wryly]

SVB: so let’s see, what other interactions are there... so then what happens is all of the data that is accumulated will go to the central database and then a system administrator high rights will compile the data, will remove any user labels and be able to give statistical feedback to the primary health care centre about the health care needs in their area, to the information systems level about the usage, the effectiveness of the ... if there’re any trends... is the intervention helping, so there’s this ongoing monitoring of the intervention as well as the epidemiological data... because that’s one of the things is after the initial trial, the pilot, they’re released and

afterwards they lose track of their systems, they lose track of the efficacy of the long-term effectiveness... so that is the model

Psrt: Wow... I mean obviously here... this is a system... so it involves people... it involves employed people... it involves people either making this money in terms of the system being established within an existing financial resource – let's call it resource or organisation such as the health system... Western Cape government health department – or it's contracted out to the private system where it's got whole other issues in terms of how it's being funded by an external source, or you're generating capital as a business...[?] [omitted for relevance] like the Innovation Hub, I'd imagine up at Groote Schuur is also about generating some sense of profit for the [?] system... and obviously there's huge areas of profitability somewhere in this around... whether it's advertising, whether it's... where that information goes, who's contracted to have it... all of those things – so that's a whole other ethics to kind of put in within your framework... but yours is narrowed down to ethics around a certain study but the bigger conflict of interest is now what is also starting to emerge – once you start...

SVB: And that is what has been touched on in the literature but mostly it's just unknown

Psrt: no, of course it's unknown – because it's piecemeal and you don't look at it in a very... it's not grandiose... it's more of a holistic overview.

SVB: what I've looked at is... there are various initiatives in Cape Town, for instance there's a company called *Cognition* that provides... I think they create a chatbot, almost, for cooperate training, in a way... therapies saying "how can you work more effectively – so it's like a chat interface but they're talking to automated replies – so I thought we could utilise that for CBT or something (if it's very clear the person isn't real) – but we could link with them... we could hire them... but for this project in my head with my "noble" ideas... 1:03:32

Psrt: no sure... this is about a growing... It's happening in a sense it's modifiable as you go but you'll be aware of what they system... what the squares [*in the diagram*] in the sense of how things work at the moment

SVB: the thing is these people are employed by the state – the health care clinics, the

Psrt: so where would the outside funding come in

SVB: so the outside funding would be for the tech support, for the development of the programme and

Psrt: it could also be in-house if it evolved that way... because I think our tech support within the – you'd probably find there are quite... fairly equipped people in sitting in various areas in the health department but they are probably bound in terms of what they can do in terms of their productivity

SVB: and we need to talk to them so that we can make our systems compatible

Psrt: sure... but then you're also looking at the –there are a whole lot of issues around how to manage these outside ones – what's the financial issues – obviously you don't want to be on the front page of the Sunday Times for being corrupt... you stand a risk of that in terms of developing these things because there's obviously... ..how the funding streams work

SVB: the idea is obviously that the design team itself that designs the system and administrates it would be a very small team

Psrt: what happens if they get sick? ...no, it's important to bear... it's like having a system where the one cogwheel is out the whole thing collapses and no-one knows how to fix the cog... [] but look these things operate like this anywhere at the moment – the whole system [?] on the tech person who's the only one who understands it burns out – or whatever he does... []

SVB: ...so the main costs involved would be in the maintenance of the system itself – so they would be mainly tech people and a couple of med...

Psrt: ..so your costs are here [*points at diagram*]

SVB: and the system administration and then obviously this [external anonymous support services] if we develop it but I don't think that's happening... with hiring people... hiring therapists

Psrt: this one here? ... no, I wouldn't do it, actually. I really wouldn't – I just wouldn't do it. It's too un... I'm not a control freak but

SVB: in terms of variables, in terms of things that could go wrong

Psrt: ya and it's too.... You've got authentication/validation issues there in terms of qualifications, you've got different styles of approach – it's the kind of difficult that becomes... the counselling services even within the health department is a nightmare at the moment – they can't ... it's completely [stuck?]

SVB: I put that in the diagram because I mentioned it in the functionality list, and for completeness's sake.. I'm also very unsure about that [*MHCU-MHCU interaction*] because I heard from a psychologist that it can be traumatic, in fact, sometimes – if you're sitting at home hearing other people's traumatic situations....

Psrt: this can be, I suppose it's probably around support... about support groups – not just that – I meant that's an example of other mental health care users... but it's probably really about how one moderates it... and that's got a problem in itself... autonomy issues and self-development etcetera, etcetera. But it's very much in what's called the recovery model – so recovery principles in terms of approach to mental illness... it's not just recovery movement, that's just one of the... kind of faces of change...

SVB: But the running costs I don't think would be that huge... I think it could be maintained by the health system depending on

Psrt: and these techy guys or whatever – would this be their sole thing that you're doing or would they also be managing, sort of... advertising agencies, models, film extras... [*playfully*] – I mean, we won't want to call the patients in in terms of job opportunities?

SVB: No I think they'd be full time... but I think if we start hiring in corporates then it would... or outsourcing things... it might start getting expensive and complicated... and that's not my headache to deal with

Psrt: it's obviously needing to grow in a sense from probably small beginnings.

SVB: So that I think can be financed by the health system... how we get them to finance it in the first place when we haven't proven efficacy is a problem... so I think then we just get financing from ... a research foundation...

Psrt: But this [*CHW-supervisor relationship*] is a very interesting one to start with, I would imagine... [*points at interaction between CHWs and supervisors*]... because this is where you have relationships established and in order for things to gel, ironically, [?]

SVB: that's where everything is at the moment, so I want to move away from that and focus on the patient and empower the patient...

Psrt: and you for altruistic reasons are wanting to look at that... but linked to your selfish knowledge, or selfish – personal - experience.

SVB: ...so... I think we have covered his [*the diagram*]... so what other support do you think community health workers could want, could need?

Psrt: Community health workers... besides... well I think... who are these people and what's their role and how are they seen in the current scene because you have to work in the terms of healthcare 2020 or whatever their calling it now.... So the ones are... you've got the mental health nurses, you've got your primary care workers in terms of the GPs and nurses and then you've got the community health workers which are the sort of home-based care kind of systems... which in terms of the health structure... and then obviously you've got all the NGOs and all those kind of linkages which are outside the formal... within the primary care system and the district system we are often trying to engage with other people outside of the salaried health department to basically – well, basically because there's not sufficient direct human resources – so you are trying to do that community based organisation – NGOs, self-help kind of system – And along with it you're trying to develop as much of a formalised/semi-formalised/informal kind of network of support and it's got all its own governance and moderating in terms of things... so we've operated in the kind of face-to-face kind of supervision with health nurses – so that's what I'm aware of... and that's we can have an ideological discussion on this... but I think is the most important – but probably because I'm not immersed in terms of this as you are... or other people immersed in it... they are probably also savvy about using these things for support and I'm not saying you drift away from the face to face – but I'm just interested in why... because you're talking from a directly experiential viewpoint and you're very tech savvy and you know this technology – in terms of its evolving, developing [*face?*] so you can see the potential and you can see where it can help you ... because you've got much more sense of it... I'm not saying that I'm not a potential client or user or whatever or have been [*in the past?*] but your point of entry has been that, hasn't it... so you're asking me as [...] a supervisor? That's an important distinction...

SVB: but the idea is that the supervisors are usually pressed for time

Psrt: where the ideological imperative is what one thinks is the most important... the down from the supervisory thing is important, as well... I think the communication aspect is important. What I find practically difficult is being a supervisor in a very clinically orientated role at the same time... and not linked in an office very often and on the road and basically seeing a lot of people in terms of direct supervision... let's call it a ward round [*...location omitted for confidentiality...*] and how do you provide... it works quite well in terms of accessing me with a cell phone or occasionally an SMS... but then I usually reply verbally because I really don't like sitting there with... I just find I don't have the space to do it... when you're working with people, you can't just ... hold on a second [*mimes typing on his cell phone*]... or in a meeting, 'cause that's rude... so I try and do it in terms of just picking the phone up and phoning back... it can get expensive phone-wise but it actual has [*appeal?*]... or they come along on a [*...day omitted for*

confidentiality...] to a designated time and space and we talk face-to face about it which has worked well and I suppose a part... including myself... I'm very resistance [] sitting with a screen in front of me – I don't like it – I can't... I don't hate it, but I use it in terms of Facebook and trawling... but I find in my experience it's a lot more efficient in terms of, ironically, because I know this is also about efficiency and data... n another level the data accumulation is another thing... but it's more efficient for me to talk... it also... when you're in a medical system... what you put down in the written word develops a certain power which can be uncontextualised and spliced into something later... and I suppose I'm a little bit wary of that... so we use these sort of safe... it's about safety... and a more sort of safe space in a kind of way... so what a person says [...] it stays safe

SVB: 'cause what I read in the literature was that people thought that that was a plus because it can help people defend their positions... but I guess...

Psrt: no... it's a nightmare... it becomes time consuming because then you're either needing to be very careful in terms of language but that maybe a bit of paranoia... but it also can set up other conversations which need to keep going... so often it's about how you end the conversation – but you're probably more adept at this in terms of who you are... in terms of the usage – it's developed its own culture but ...we're in a culture... not quite in transition – well, it's transitioning all the time and how we negotiate the norm those [?] spaces about behaviour is not clear... and certainly it's not clear yet about the legal aspects about information [...] and doctor how can you say you didn't know x, y and z... in complex interpretive situations for example if he kills himself with a very angry family... so it's partly an evolution... also about a social sense of how collectively on how humans work or communicate. I suppose is about asking what do you find useful...

SVB: See for me I have social anxiety about calling people – I hate calling people – picking up the phone – so I would far prefer to email

Psrt: so my [inherent/irritant?] anxiety is about having to write to them... so you're quite good at 're quite good at [*typing*] – you can do that... probably because you're quite fast with your fingers as well... and you've grown up like that, as well... mine is it's far easier to find out about the actual situation in conversation so it's an interesting... I mean that also is going to impact

SVB: Well, like you were saying you're far more aware of the impact of text... I read somewhere about a study how younger generations are more than happy to share personal information online because we've grown up with it... whereas the middle-aged generation is very careful about it and the elderly aren't aware of the implications

Psrt: we try and think of the right word or the right phrase which tries to put in ambivalence or nuance in a situation – which is obviously much easier to manage in terms of broad-frame conversation...

SVB: I think they're not always as aware of what information is relevant where and because I'm so used to a data-based environment... I know how little [or how much] meaning personal details have... in a way... how no-one out there really cares... I dunno... [...] we've pretty much covered most of these [*questions*]... what are the main barriers to accessing healthcare for mild to moderate depression in South Africa

Psrt: well, where to start... I mean obviously... I'd say stigma's a huge one... knowledge is a huge one – about actually recognition about what... is the experience... accessing is a bi-directional

process – accessing requires the knowledge in the individual who is going – first of all to be able to – there's a stigma around – so sure I think stigma does affect access – both in the self-stigmatisation or the lack of knowledge or the lack of resources or the sense that it's a legitimate entry point into... to take to the thing... and then we've obviously got the resistance in terms of health care system itself – an untransformed system – it's only been integrated fairly recently – mental health structures into general structures

SVB: I think it was 2003-2004

Psrt: Well that was at the district hospital level – it came in with the Mental Health Care act – it sort of rode on the back of that – I suppose post '95 was the start of that – that was a very interesting journey, let me tell you – about trying to get mental health into district structures – sure – so it's still very new ... and then the referral route is still to come into the general pool – see the general doctor – which needs to be... or see the clinical nurse practitioner- get managed at a basic level – so part of the management is about actually the education of the health care workers to recognise, manage, etc. and also to know when to refer on – and then those referral routes on ... I suppose that's also just the up-skilling of the support structures around... so it's partly that whole thing that the resistance is – is just a developed culture – mental health [?] culture at entry levels... and I suppose there are lots of other things, but I suppose that's probably a major one. The private system it's about funding and PMB kinds of stuff – it really is somewhere around that, and then orientation with practitioners to also take on a wider role besides just treating the individual patients... which is a whole other... what I'm saying is people work in isolation so at the moment in the private system you will – I suppose GPs can access – if you're looking at the private system... this year, and it can be seen as a positive but these knee-jerk things often rebound – so what's happened with lots of medical aids – not Discovery at the moment – is they've suddenly from April put the issue that if you want to access a specialist you have to have a letter from your GP referring you, but they haven't thought about what that practically means now so you've got chronic depression for example – so you go along and you might form a relationship with your psychiatrist and suddenly, out of the blue, you go along as usual and your medical aid says “no ways I'm not paying this” because they've changed the system – now you need a letter from your GP – it's not clarified how often – or for every appointment, or how's it going to work – so I'm just saying that's a practical thing... but that's probably well intentioned.. it puts an economic base -the specialist is the most expensive so you've obviously got to broaden management to others – sorry that's a bit all over the place.. but it really is... educating I'd say doctors and other health care workers about managing a mental health condition.

SVB: So we touched briefly on the level of patient-practitioner interaction and I think that's something that's going to have to happen gradually on how to moderate – because you can either send those predesigned messages, you can have a question and answer platform, you can have open therapy – but I think that's something that's going to have to develop with time as we get information happen

Psrt: You wanting a comment? I think patients are potentially an enormous resource – users, consumers, survivors, clients – whatever you want to call them... and it would be quite useful to be able to refer people you see to go and have a conversation with a person outside, with permission – but there are quite difficult technical confidentiality systematic and I suppose and relational issues in terms of that relationship between the doctor and the patient, in terms of doing that and in terms of [“norming”?] that – and that's also what I'm talking about in terms of an evolving society and social norming about what happens in that relationship...

SVB: And I think if we're dealing with CHWs most of the time they don't have the training to be able to be able to recognise the need to

Psrt: It's about the seeking of permission which can be quite hard – how does one do that- and how does one do it in a not so time-consuming fashion. What I'm saying is it's actually easier to deal with your own life -to manage your own life – I'm not saying it's fulfilling – but it's easier – to only allow entry through the door – to control the door – to open it up and say “hello, would you like to come in now?” and that's some part of relationship happens there – and that's the historical notion of a patient-practitioner relationship – it's a safe space –you go for an hour and you see whatever, whatever – that's a psychiatry/psychology kind of thing – it's the core boundaries – but actually is that a good way, or is that actually how it should be working – but we do that because it suits us because we can then carry on with our life outside – because it's quite hard... for example [writing an email to a teacher of a kid who's got depression and has a maths test outside the consultation time -*edited*]... now you have to... once you open that it becomes hard... it becomes complex and then you can't watch your TV programme – I'm just saying it's that complexity – it's about control

SVB: So you've spoken a bit about health practitioner adoption... [...] so obviously time is an issue... when in the day do health practitioners have the time to look at something which is why I wanted to do something with pop-up alerts – like you were saying – you had to go outside of office hours to write the email – miss your TV programme

Psrt: ja, no, it's about that... and I think time management in this world has becoming more of a difficult... it's about the fact that it's not isolating – if you're looking at your computer and you... I suppose these are skills and norms that people are learning or that they're completely changing the nature of the human brain – how one works – because does one answer... you know you've got your Facebook page coming on there, and you comment, “like”, and then you carry on there – you're obviously able to focus down but you probably have been doing a lot of other multitasking at the same time. So I don't know... it's becoming quite hard to kind of know what to advise people in terms of their health. Like is it good to have 2 hours just to have exercise... go and walk up a mountain and leave your cell phone at home [...] but practically it's a thing about creating spaces to do certain tasks in a fairly focused way and I don't know how much multitasking you can do within a certain time – and does it not end up getting a little sad – for me

SVB: One of the main issues is how much training it takes to use the app, so making it as intuitive as possible – but how much space is there in the current system [phone rings] so with community health workers... how much time is available for training them – would it have to be a specialised programme – do you see that being a major pitfall in implementation, or...

Psrt: I think it's completely individualised... I think some people are going to grasp it immediately – probably a lot faster than I would – and it would probably be to an extent age related, I'd imagine – as we were mentioning earlier – but it's also just orientation for it as well... I don't think you're going to find the one jumpsuit that going to fit everyone on this one – but you're wondering in terms of training – how much time to set aside... the reality in terms of systems is that you put aside a thing for training and then you do it and tick it off as something you've done and then that's how it works. For example what we would do... with the nurses we use existing structures – so your whole thing would use existing systems so how much training within that existing system- it's completely variable what you would probably do is train and then – and then you have the time and the system's already accommodating that training time

so you need it to be there and then it just carries in an ongoing fashion and then at a sort of ad hoc basis... and peers would... it would happen in the corridor for example if somebody didn't know, they'd ask XYZ – so it would move towards an informal sort of

SVB: ... and then as long as there is a tech support system I think, as well

Psrt: yes, in terms of... for accessing... but what you'll find happens is as happens anyways is this persons going to go ask another person "oh, I can't do this" – and if no-one can help them then they'd probably access the tech support – you do it anyway... you probably don't need much support...

SVB: And patients' uptake... do you think they'd be likely to be keen on the idea of self monitoring? Do you think it's a very western idea of health care system... all these health care apps – have you notices... in your practice – I don't know whether they tell you if they're using an app or not

Psrt: I don't know in terms of the app... in terms of an experiential position – the notion of self-monitoring – I think the tricky thing with clients or people is – is often, is in a sense – say with a condition such as anxiety or depression where you are wanting at a conceptual level to be looking, possibly outward, rather than inward, a lot of the time, because inward looking can be... scary and it can possibly exacerbate... especially if one's got other ruminatory kind of symptoms – whatever – and social withdrawal, etcetera... it can reinforce that.. so in a way you're wanting a person to engage outwardly because that is going to provide reinforcement and also provide... contextualise themselves in possibly not such a hopeless world which the internal milieu might be. So you want them to look out. So I have a conceptual concern about self-monitoring I know at some level it can give - with mood disorders you can get a sense of where it's going, but I think people start knowing that anyway.. although it can creep up on you... and I think mania and stuff like that is an example where you know... self-monitoring... and depression possibly as well, but I think they start picking up that they're depressed... and it can help but the tricky thing is about doing it but also not focusing on it and not letting it become an obsessive preoccupation so that's what I worry about in terms of these monitoring things

SVB: I've noticed that in terms of experience... but because nobody else had picked up on it...

Psrt: But you teach people all the time with schizophrenia or whatever to kind of have an awareness of symptoms... or maybe sort of one... but I think one should aim for brevity or a smallish list or a self-knowledge notion, rather than a long checklist... because it just immerses you in your illness. Anyway, so that's my conceptual more than technical issue on that...

SVB: on that note... any other ethical issues... on ways that it could be harmful to use in isolation – not being connected to the healthcare system at all – or if they're just self-monitoring – can you see any potential harm – essentially we'd be liable

Psrt: if somebody hasn't engaged, or disengaged from the clinic or a doctor – or just doesn't want to think of themselves as ill... stigma or self-stigmatisation etcetera ... and don't want to think of themselves feeling towards health care... so is there a danger about what?

SVB: to give them access to a way to side-step the health system.

Psrt: This is an uncontrollable factor... isn't the world now defined in terms of open access to the information – isn't that the value and isn't that norm? So isn't that knowledge [?].... It's like saying to someone... you get this in a very concrete way... when a patient is suicidal and they're on amitryptaline, which is lethal in overdose and you say to them "you're on a medication called

amitryptaline, which is lethal in overdose” – now should you not tell them that or should you tell them that? Because now you’re giving them the means to kill themselves – but if they want to they’ll find some other access source... so I think the norm is open access to information, isn’t it?

SVB: So using that worst-case scenario – someone has access to the app doesn’t access healthcare systems, commits suicide

Psrt: and you wonder if you’re liable – if you’re going to go land in court? [?How could you have done this?-unclear] – I don’t know if you should have a link to *Exit* or *Dignitas* or these sort of self... legitimising euthanasia and providing you with means to do it kind of websites – but someone might link that up for you anyway – can’t they?

SVB: Not on the...

Psrt: Well that’s a relief... well they might just put a comment... “are you suicidal, well actually, have you considered, of actually going through with it ...”

SVB: well, that’s the problem with the open forums is that that could happen, easily

Psrt: So obviously here it’s about balance – you don’t want someone to get completely absorbed in the – you’re also saying in a sense that you can form connections because is it going to be a connect ability site? ...well you see some kind of interesting comment and it resonates and you engage with it and then you meet up for coffee... I dunno, is that going to happen? It could be a support sort of thing... it could obviously lead both to destruction... I dunno... I’ve got no idea in terms of whether that’s good or bad...

SVB: And that’s the thing, we don’t know where this leads, so the only way to do is to see what strange things people do

Psrt: I suppose in a way you’ve got a... it’s a wonderful overview of the thing, but obviously it sits in a libertarian framework... is that the right word... libertarian? Well, it sits in a sort of open-access, right to choose, freedom to [meander?], make choices etcetera. And you saying in a sense – people are vulnerable and they might not have the capacity to make the choices... Ja, difficult, I don’t know.

SVB: So, one of the last questions... in terms of information sharing between health care professionals... about patients without patients’ knowledge... so for instance in a clinic, how much information gets shared, how does the patient file get controlled – who gets access to the patient file?

Psrt: look access to information is a whole other kind of thing... at a kind of informal – let’s call it collegiate – level, people share information all the time... formally, historically, that’s been quite frowned upon... in terms of using case precedence: when there was a case of sharing of an HIV diagnosis between practitioners on a golf course – which was actually going to court and I think they found against the guy who was sharing – and possibly, because where it was happening didn’t seem to be – well, that’s the difficulty now, because is this the golf course... it is kind of... a really big one... but um.. sharing of information – I think it’s now... uncontrollable, in a way... which is why I’m saying the written word is so powerful as opposed to the spoken... and probably the defensive route is to talk... but also sometime the defensive is to write it very clearly when you are being defined, but when you are trying to work towards an understanding of a complex problem such as a mental health issue in a person or in a group... I think one is

going to share collegiately – that’s a whole other area about what defines collegiate... what are the bounds of collegiate – which is what you were doing now... but we’re certainly not talking about individual people so we have a passive sense of what’s appropriate

SVB: The worry was, on this patient level here... if the patient notes get sent to the clinic - who has access to these notes – so when they’re sending to individual practitioners, obviously that’s a secure

Psrt: it’s a very difficult one... obviously what practically happens is for example at the moment, and now looking at information technology is a whole other ballgame... but we’ve always at clinic level just put psychiatric notes within the general folder because obviously to manage a separate filing system just means that the bottom drawer gets crowded and then it ends up in the dustbin... and is that a safer system... so we’ve put them there but obviously you must be careful in terms of language use and use certain norms and understandings – but that’s not formalised, it’s an informal understanding. At [...*name of secondary hospital omitted for confidentiality*...] we keep confidentials within the office because we don’t want a whole lot of personal information about sexual forays and habits, associations etcetera, etcetera sitting there in the broad folder when they go for their orthopaedic [appointment?] or they come in for whatever reason. So these are unclarified sort of situations... we’re relying on... I suppose one’s relying more on ethical, compassionate sense about people... a good sense of compassion. I don’t think I’m answering your question in any way, but I can just talk to you from my experience it’s not..

SVB: Because that was my understanding... that it was unclear... and I didn’t know if there was a clearer

Psrt: I don’t think there is... but it’s going to be a confounding issue for you...

SVB: Last question: Western Cape versus the rest of South Africa... so it would be a lot easier to implement something like this in the Western Cape

Psrt: what... as opposed to the Eastern Cape... for example?

SVB: for example... so a lot of the things in the policies are like, “we want to decrease the inequity between provinces.” So the idea is if we do it as a pilot in the Western Cape, because it’s nice and we’re here and UCT is here and it’s comfortable here

Psrt: of so you mean “part of a broader South Africa”

SVB: yes so if we’re doing the pilot here and it works here, and then we say, “well, we want it to work somewhere else” and those are the places... out of a sense of nationalism or patriotism [*also to get health systems support*] and then it doesn’t work there... we’re just increasing the inequity between provinces... do you have any thoughts on this point.

Psrt: I think you do the best you can in the area that you’re working in, in terms of what you have...and I think you do have responsibilities outside of where you are but I suppose... for example I do have responsibilities outside of my immediate family and I’m going to concentrate on around my immediate family’s [wellbeing optimisation?-*unclear*] with a kind of sense about it... so in terms of the app it does need a kind of a balance, but the problem is that it might not get going unless you do it where you’re familiar... so I’d also first want to take the risks in my own family... because this is also about risk – not just about sort of heuristic development – automatically getting better and achieving – there are lots of risks associated with it – and I’d

rather work within the group where I have relationships and can apologise to more easily than transport something and test it out somewhere outside – so I think that would be an argument – it's untested, unclear... certainly unknown as to what happens – it's easier to achieve it where you have relationships going, and to absorb failures.

SVB: and it's also because our system is better it can absorb the shocks better – there're backups.

Psrt: That's a good point – so within it you've also got the ability to absorb, financially, a little bit easier than others do... and also not to be exporting untested things to systems which maybe are not yet able to cope with the failures and the failed relationships – if relationships fail, rather have it in the family – because you might be able to repair it. But that's how I would think about it.

SVB: So those are all of my questions – if you have any other comments you would like to share...?

Psrt: um.. no look I think it's great, I think it's a wonderful conceptual endeavour for me to look at... I think I've been thinking in terms of resource guides – [where with need-sourced ?-unclear] resource sort of ways, which sort of comes in – I mean you obviously are very... I'm just intrigued at the level of the questions – as to how you allowed it to grow so large for this particularly... because it isn't just for your particular thing that you're doing now – that's a little side off-shoot that you've already in a sense covered with the literature review

9.8.5 Information technology expert: professional programmer (ITE)

Interview conducted on 15 August 2015 at Glencairn, by Sylvia Van Belle

(Summary of project) So I've made a list of the functionalities – it's probably best to start with going through each of them, and potentially discuss how difficult, how resource intensive, how many development days it would take and how resource intensive they would be.

ITE: Okay, I should say, just first of all, some of those are big questions, so if I, or a big company were to implement a project like this – just getting the spec together would typically be months of work, so to be very sure of what one wants to do, and making estimates of how long it will take – it's a huge problem in software. Even 50% of highly experienced developers underestimate time by one hundred – two or three or four hundred – percent.

SVB: (explanation on the scope of project). So these functionalities go from the more basic to the more complex. So specifically tracking mood and physical stats using a sliding scale for each of the variables. My idea is that it's highly customisable, so that you can add your own variables. And then everybody wants things to be displayed graphically. So I was wondering how much space graphs would take up – because either you have to download it and recreate it online, or you save them as an image, or you have the processing done on the app itself.

ITE: Yes, I would do the processing in the app, so you get the data, and you draw the graph, I wouldn't store graphs – when you start moving images around – there's no reason for that.

SVB: And in terms of making things like that customisable – how much does that add to the complexity?

ITE: Flexibility is always expensive. Everything you want to make changeable does add a bit, but it's all doable – but it's impossible for me to say “so many weeks extra”. The way I would approach something like this, would be to start by drawing out some screens – and it needn't be detailed, it can be very rough – but exactly how you envision – if the app opens up – what the person sees, what buttons they can push, if there's a menu, what menu options there are, and then for each button push, exactly what the screen would look like then, how exactly this will be displayed and these will be the inputs. And then if you have the tree of those screens, of how one moves around, that's an excellent place to start thinking about how difficult it is to develop.

So in very general terms – the stuff that you want to do isn't complicated – it's all been done many, many, many times before, it's just moving data around and displaying it in some form. So you essentially have some way to input stuff and you have a server somewhere that stores information, and the app talks with it. So that's box standard stuff – so that's good. Adding flexibility, so allowing everybody to add their own variables – that adds complexity in at least two ways – the one is that, internally, the database where the stuff is stored has to be able to handle that flexibility – there's complexity – but that's manageable. I think probably the biggest deal is that it depends on what technology you use to build the app, but it will mean that the display changes – so there's a longer list of stuff – so depending on how you do it – there's a web-based approach to making apps where the app is essentially a small webpage, and if you do that sort of thing then it's fine – then you can just have a longer page that you can scroll up and down. Another approach is when they try to design initially the screens that you see – it is designed so that you see exactly that – so it's very fixed, and there's usually no scrolling. So the moment you have a design like that, which is in some ways more desirable (the web way tends to be a bit clunky), then it's a bit more tricky, to have stuff that's adaptable.

SVB: Because in my head it was a drop-down box, or a series of scales that would be flipped through. And you can set the questions under settings, or something

ITE: Ja, that should be fine. It's definitely doable – it's not impossible, and there is additional complexity, but it's not that bad, it's manageable.

SVB: When we say complexity... I believe that it may be relatively easy to get initial funding for this because of the inherent appeal of mHealth, it would just be long-term funding allowing for up-scaling. And in order to get systems endorsement it is vital to have sustainability, as well as the adaptability and flexibility. In terms of complexity, on the programming side, I'm not sure that it's not as much of a problem as the size of the app, or the data requirements for everyday running.

ITE: I don't think data traffic is a concern – it's minimal compared to your other data usage. You'd probably be able to do weeks of data as much as you do in a webpage. The moment there's an image. So data's not a concern.

SVB: With a lot of apps there's constant synching but if we set it to synch once or twice a day

ITE: Because the only time you'll need to synch is really when the user adds anything, or when they open the app – there's no reason for background synching at all, so it's not an issue.

SVB: And the other problems are the size of the app and the processing power of entry level devices.

ITE: So performance... so a very big deal with mobile stuff is whether you develop natively or cross-platform. And the native ones are faster, better performance, always, and they usually tend to look better as well. There are a number of cross-platform tools that all differ a bit, and it's a

huge advantage to be able to develop only once and be able to deploy on Android and iOS, and whatever other niche ones – so that keeps drawing people to that but if you do go for that then you have to find someone that really, really knows what they're doing. You really need a good track record to see what you've done. So bottom line is if performance is an issue – and it needn't be – this isn't really performance intensive – but going for entry-level device – it does argue for native development.

SVB: So can you then develop interfaces separately that are compatible with the database – if, for instance, the health practitioner is using an iPad?

ITE: Yes, the back-end will be the same. It's not particularly difficult to make it compatible. – It's sort of a given, almost.

So there is another approach as well, and that's to make the whole thing web-based. So instead of an app, you just have a mobile website, and people use that. There's a lot of advantage to that – it very much simplifies development. The only issue is performance, well-written apps function better than web-pages, because you don't have to load the whole webpage, you just load the tiny bits that change. But maybe, as a first cut – I think that's something to consider strongly – you make the whole thing web-based.

SVB: I was just thinking that it would be more data-intensive

ITE: It is more data intensive – but depending on your design - you don't do animations – so if you have a simple webpage, it's not that much more.

SVB: And also the fact that data access is sporadic across the country – so an app can synch when it finds data connections. Health facilities, as well as communities are without very good connections.

ITE: That's a very good point. That's a critical point, actually

SVB: And are pop-up notifications possible with a web-based design? Medication reminders, reminders to complete activities... etc.

ITE: No, no there're not.

SVB: Okay. For the next functionality. We mentioned graphical representation and statistical analyses... and then export functionality is probably fairly simple.

ITE: Just on the previous point still, so something like graphs – there are slight pros and cons if you want to do graphical stuff with a web-based model or an app – but you can get away with it either way, so it's not a huge problem.

SVB: So with statistical analysis, one of the things that has come up when I've been doing gap analyses etc., is that often apps will offer to track when there are negative trends – but I'm not sure what exactly we're looking for, so we'd need health practitioner input.

ITE: You would just need to copy what they do by hand usually, I imagine there must be some standard guidelines of what's considered "bad" or "good" so in that case... if there isn't, then it's not that big a deal. But from a mathematical point of view it's trivial – you do something like fitting a straight line. But this should really come from the medical practitioner.

SVB: There seems to be a great deal of interest in gamification... I'm not sure how appropriate it would be, in this setting, because we're trying to make it a very functional app, and I think it

requires a lot of processing power and a lot of animations and graphics, that I think could be better spent

ITE: yeah, well, gamification – there are two aspects to it – the one is making it visually attractive, but the other is that you are creating a target – you’re making a game in the sense that there’s something to influence – a target to achieve, as well as competing with other people.

SVB: Perhaps within certain therapy activities, where there is goal-setting, there may be place for a point system, but again, it’s something that I have to chat about to health care professionals.

ITE: So gamification in this context I would concentrate on goal setting, and the community aspect. It does seem to invite participation

SVB: And I think the community aspect might be quite a strong point to note, particularly in a depression app.

ITE: (uses Outsurance’s driving monitor app as an example of successful gamification) – and that seems to work really well in getting people involved... so it might be... but it depends on the health professionals.

But about that there are medical insurances that have medical personal information systems, where you can log stuff, so they might also be people to talk to.

SVB: So that’s a big thing, which we will come to later, -is interoperability. And I don’t know how you’re aware you are of the health system in South Africa, but there’s a public versus private gulf – they’re planning of reforming the public health system. The point is that 80% of the resources are in private health care and they go to about 15-20% of the population, and it’s just getting more and more expensive and less and less feasible – there are huge areas in South Africa that don’t have any access to health care at all. So we’re aiming to make this public and the Department of Health has issued an eHealth strategy which is based in the mobile health dreams that came out of the dreams of interoperable systems where everybody has their own profile and you monitor everything, and everything is linked. But this obviously isn’t feasible because we don’t have a single system with patient files. We don’t have a master patient index that keeps records across the country of health facility use (we do have it in the Western Cape). But then what they say is that they want any development in eHealth to fit in with the system. So that’s a big point that we’ll come to later, because in order to get support from the government, we’ll need to give them the information.

Okay. So medication tracking... I feel like it’s almost a separate app, but what I’m trying to do is create one big, all-encompassing programme – and I don’t know how feasible that it

ITE: It seems, from a usability perspective, that people prefer apps that do one thing – they tend to get lost, huge things that do many things.

SVB: And in terms of downloading several things that interact with each other, that access the same database, and then, in terms of interoperability, if it does work, we can start getting things for monitoring AIDS, TB, and they all use that same database.

ITE: Yes, I think that’s a good approach – a phased approach is good – just getting something simple going and then later add stuff, and then, I think, doing different apps rather than making one app more complex

SVB: so we should probably start with the basic tracking.

- ITE: Yes. The way people tend to use the phone is they want to do something, and they want to click the icon, and press one or two buttons and be done. Every tap, every click makes a difference.
- SVB: That's really good to know. So the medication tracking – things like just having a photograph that they take with their phone. Because patients frequently identify their medication by appearance – they don't know the names, they don't know what it does. So while they're sitting in the clinic, they take a picture of the medication, they type in how many times a day they take how many pills, and then it sets up a reminder system. And then it can potentially have links to an online service that lists the side effects. Again, that could potentially be linked to the physical tracking – watching for dizziness, nausea, fatigue, sleep. But I think that could be something that could potentially get added later
- ITE: So in that case, the photo would just be stored locally – because the moment you have images ... But that's a very good idea. That's actually worth an app all on its own.
- SVB: (talks some more about customising it for co-morbidities – keeping track of all the meds)
- ITE: That's a very good idea. For something like that you don't even need the server component – you can just have a stand-alone app.
- SVB: Although it would be nice to know on the system what they're taking
- ITE: Yes, well, if you're building the system anyway, then it can be part of it. I'm just thinking if nobody else does anything about this that's an app that can be out there.
- SVB: Coming to the more therapeutic things which would need very significant health practitioner input... so on start-up of the app, if you get a customisable quote or positive thought or happy memory that they can input themselves, which can be disabled as well. There's also the idea of an inspiring photograph, which some apps had, but then once again you've got a photograph, which I suppose could be stored locally, but if you're downloading them, then again it's extra weight.
- And cognitive behaviour theory is a theory of psychotherapy where you complete activities and you monitor your thought patterns and is aimed at getting people functional again. It often comprises of 6-12 sessions – and that's what the issue is – we don't have the time to do that. So there have been attempts to computerise that, and there have been internet based [interventions], which have shown moderate success, but I think that might have to be web-based, or have links to things, so you can get the text-based, but videos and audio files and functionally I think it may be better to have links to that, but I'm not sure whether we could just get articles, and basic activities – and that was where I was thinking the reward system might fit in, but that's where complexity starts to come in. The health care practitioner can customise them individually for a patient's needs – if there's a list of activities and you and select which ones... and track completion...
- ITE: Yes, there is complexity there. There's a company *Cognition* – local start-up – and they have a product that they sell to large corporates mostly and it's a bit like coaching, so there's some sort of script that's set up and the format is that you're chatting to somebody, so there's a computerised tutor, with a chat-type interface and it asks questions and you can do responses. So for something like *Cognition* I think that existing interface is worth looking into – that probably does everything. So one can link to existing systems, and work with them. And I think that is quite a big deal – they've been in start-up mode for about three or four years – and are still trying to ...

SVB: So they might want to get systems endorsement, as well, in fact. Something I need to look into is that you want it to be government and you don't want there to be too much unregulated data mining – you need to be very aware of security aspects of health information and privacy. But private health corporations might be interested in it – simply because it is useful, and corporates aren't all bad and it is worth seeing how they would react to the idea. And out-sourcing is what the government does.

ITE: Yes, yes – there is good stuff out there

SVB: so the therapy aspect is one of the main things I want to look at, and I think that would need an IT professional and a health care professional – a qualified psychotherapist – working together to try and see what that needs – I can't do that now, I think. But I think I also need to see how useful that would be – but I think that would be the main gap, because people aren't getting the regular psychotherapy, they're just getting the meds and then going home.

So then I mentioned that we had various profiles for the practitioners: one of the things I'm not certain about is the access to the app itself – whether we want to put it on a public marketplace like Google Play or iTunes or whether we want it to be available only through the health system – where it's a lot easier to keep track of things like patient numbers – but then people won't be able to get access if they don't go to a clinic

ITE: No, I'd definitely put it on Play Store. You get extraordinarily detailed statistics from Play Store on your app – at any time you can check on exactly how many devices, what types of devices, geographically where it was installed – so you'd probably keep much better track than you'd be able to do yourself.

SVB: And then have an ID system for integrating it with the health system then? Because there needs to be a way to link the patient ID with the app ID

ITE: Typically, when the patient downloads the app and starts it up, it will ask for some sort of ID – and that ID they can get from the health professional

SVB: They can even put in their ID number. But that limits access to SA citizens – but that's a little beyond the current scope.

ITE: Alternatively, when they go to a health care practitioner, and download the app and start it up (or before, whenever) – but the first time they run it, the system can assign them an ID, and then they give that ID to the health care practitioner

SVB: And then every time the health care practitioner wants to look at the data they use that ID. That brings up a similar issue – if you've got these different profiles, and different levels of profiles, you want doctors to be certified to be able to use a doctor profile. So there are obviously lists of qualified health care practitioners – the Health Practitioner's Council of South Africa – that's where you get your practice number from – but is there any other way to verify the doctor associated with the practice number without physically being in their presence?

ITE: I would say – so if the doctor registers in the system, I would have them supply their practice number

SVB: But the practice number is very easy to get hold of – it's on their prescription sheet... it's not a secret number – but maybe then combined with their ID number – I'm sure there's a way around

ITE: Yes – that’s a tricky one... even for the practice number, to make it useful, there’d have to be some online service where you can check ...

SVB: I’m fairly sure there is an existing database – I’m not sure how easy it would be to gain access – you’d need to contact the HPCSA, but other services, like PathCare, make use of practice numbers as a source of identity. But for the initial sign-up I think you need more than just a

ITE: It’s non-trivial – it might be very, very difficult to solve... You can have a permission/access rights hierarchy, so the administrator of a hospital ...

SVB: He adds all his practitioners and then they add all their psychologists that they work with. Or the district manager...

ITE: That’s probably the best shot.

SVB: So a *Find a Doctor* function

ITE: Yeah, that’s doable.

SVB: So then the grand ideas: the complex biometric mobile-based monitoring through wearable tech that measures your heart-rate, etc which keeps track of everything, and once you start doing that you get big data implications, but I don’t think we’re going to touch that.

ITE: The big data stuff is probably less of an issue than all that hardware – it’s a lot of money

SVB: We just don’t have the hardware in South Africa. [Omitted for confidentiality] suggested that we approached wearable tech companies for endorse the project because they want programmes that are cross compatible with them, but it’s just not feasible in South Africa yet, I don’t think. We will need to wait to see more developed countries, where there is the money for wearable tech to implement that first, and then later

ITE: Yes, well I all the other stuff is running, you can just add it on top.

SVB: But I think one of the main things we need to get up is that database that’s just collecting routine data.
So then there are three linked points which are the communications between the different profiles. So the first one is patients-to-patients. SO I was thinking, instead of creating our own chat forum, whether we could piggyback off WhatsApp or...

ITE: I would use existing stuff – not even piggyback – I would have it just have the contact details supplied – there must just be some mechanism for them to have access to those contact details – phone number, email address.

SVB: Because I suspect the problem with communicating with a doctor, is that they may want to limit the amount of contact that they have, because of time restrictions.

ITE: That’s up to the doctor then. I would say then the doctor can create a special email address or a dedicated WhatsApp account, and manage that separately. I mean, to create a good chat client is a non-trivial exercise. So there are communication technologies that work very well – I wouldn’t try to recreate that.

SVB: And in terms of group chat forums, with other patients?

ITE: Even for that, I would use Google Groups or ...

SVB: in order to do that would you need to get permission from the existing technology

ITE: no – it's all free stuff.

SVB: And then one way pre-designed prompts – so that a patient can request an appointment, or the practitioner can request more information... but I guess if you've got the other communication channels open...

ITE: The notification mechanism, on Android specifically – I don't know on iOS, I imagine it's pretty much the same – that's not very difficult to use. So you can use that. Maybe for stuff like appointment reminders.

SVB: Again in the literature from overseas, they had the idea of automated scheduling. The scheduling system at the moment is you get an appointment on a date at eight o'clock and everyone pitches up at 5 o'clock

ITE: That's something that a friend of mine wanted to do – a scheduling system like that – automated scheduling. The doctor says they want to see this patient, or the patient says they want to see the doctor, and then it schedules and updates in real time – so it can let you know the day before and two hours before – this is when you need to be there. He's never done anything with it – it's also a lot of work, but I also think there's enormous benefits. He was even thinking just an SMS system, sending updates – “you should be there in two hours” or whatever. So I think there's enormous value in that.

SVB: But I think that it's beyond the scope of this

ITE: Probably. So it is a bit of extra work

SVB: Data collection for the health system – so what they'd probably want to know is how much the app is being used, as well as looking at the reported trends – to see if people are getting better using the app, possibly where the app is being used – depending on how we use the app to supervise – they may want to know that as well – you'd have to build in the functions specially, but they wouldn't be very resource intensive.

ITE: No, that's fine – that's trivial actually, so essentially, if they do any kind of update on the app which touches the database – you already have the information – it's just the last time the person used it, how many times they use it and when they use it – you get for free

SVB: And even how they sue it, as well.

ITE: Exactly; the only thing you can add perhaps is location and that's just a bit of extra information

SVB: One of the things they've noticed in the literature, especially with the SMS and the telehealth – once it's gone beyond the pilot stage – where they're closely monitoring it, they no longer monitor how it's being implemented and used – so they lose track of them and they don't have any data on the efficacy – so that needs to be built into the system. But I think that's one of the benefits of an app – is this constant monitoring and connectivity. Moving on from the functionalities... if you could outline for me the basic process that happens during app development – who's involved, where testing gets done, quality control... it's probably quite a broad question

ITE: It is quite a broad question; I'll tell you this – for every person between the person that's writing the app and the person that's using it, you get an enormous amount of horror added, so ideally, you want to have one person that knows exactly what this app should do – it must be you or

whoever is driving the project, and it must also be somebody who is going to be using the app themselves – ideally a doctor or some health professional – and there must be one person who takes responsibility for being that person – the person with the vision who knows what this thing’s going to look like – and they must speak directly to the team who’s writing the software. That’s absolutely crucial. You put one person in between and you add years of development and pain.

SVB: So then would you have a team, or would you have a specific programmer?

ITE: So for this, I would have a small team – two to three people. You can have one person... so again if you’re doing a staged thing – it’s feasible for one person to maybe work a year on this – get a first polished first stage up to work well – so that’s the one person team – but I would get someone who’s done a lot of apps before who’s really comfortable with the process

SVB: The idea of a smooth interface is really important – getting rid of those headaches because it’s such a broad-scale project – there are already language barriers – but the different levels of technological competency – but just having a smooth interface – you’d need somebody who what they’re doing. So testing in this case, I think would be more medical testing...

ITE: So again that person with the vision would have to sit and run through that thing – make sure it does what they want it to. You’d expect the person who writes the software to also do testing to get the basic stuff right – but that’s something you need to sit and figure out with the person who’s writing it – it’s a trade-off – if the person who’s writing the software spends hours doing quality control, you are essentially wasting time. Whereas the person who’s going to use it, if they test it – both you need to pay the person who’s developing it because it’s developer’s time and the person who’s getting a better idea of how it feels to use this thing, to make sure it runs smoothly.

SVB: And then from a medical perspective you’d want to test the efficacy of each feature. So there might have to be a staged development where each function gets released separately, or just disable something...

ITE: There’s something called agile development – so there’s a whole world of different development processes and philosophies – so what’s big at the moment is something called agile development. Previously you used to get this enormously long document of specifications, and you talk about it with the guy who wants it done and then the developer goes away for a year and sits in the basement and creates the spec and then goes to the developer and the developer says “No, no! This is not what I want.” Agile development says the person who wants it done and the developer work very closely together. And they say we’re going to do this feature, and the guy goes away for two weeks and implements it and says is this what you want, how does it work. And I think that is the better way to do it. – So very close interaction all the time, incremental development, all the time seeing if it works.

SVB: Okay. In terms of language if you want to translate the app, is it literally just word-for-word? Would you then need to create a new app for Xhosa or Afrikaans?

ITE: No you can make one app where you can switch language – there are different ways to do that, and I’m not sure... but that stuff is usually fairly sorted out by now – it’s a very standard feature to have – I don’t think that’s an issue. Typically you’ll write in it English first – and the way the development environment works is somewhere you’ll get a table out with every bit of text in the app, and you give that to the translator

- SVB: SO the initial app we can pilot in the Western Cape – so we just get it in English, Afrikaans and Xhosa so then as it progresses, as it scales up (if it scales up), we can get more languages.
- ITE: The developer must just know, that it will have to support various languages – it helps if you know that before. It's also something to keep in mind with the user interface design – to make it flexible, because some languages take a lot more space than others
- SVB: So we've already covered balancing functionality with ease of use – you were saying with every button-push – people just don't like it, so it's better to have separate. Any other comments on common barriers to intuitive usage, and intuitive interface.
- ITE: As little information as possible on one screen – large font, large buttons
- SVB: Especially because of the low literacy levels in our country – I don't think we want to make it too text-heavy. Oh, so one of the huge issues – even when I was looking on line – some of the comments, was that they didn't like the app knowing their personal information. Obviously, we will need to know the personal information – but people are very aware of it. There are two levels of protection – the privacy on the phone – having a password protection, I don't know how much finger-print scanning is in use...
- ITE: You can rely on the phone's security... security for the App I would have a simple pin, maybe – I wouldn't bother with more than that
- SVB: And protection of data that is sent to the server? There may be one or more hoops that people need to jump through because it's health information
- ITE: There might be specific standards but that's usually standard stuff, but again, the people who develop this must have experience and done it before. It's possible to do the security badly. It's all been done before. And the security stuff is not mobile specific – the security technology is mature it's used daily in lots of different ways – all the banks, etc. So I don't think that's an issue, as long as the people who develop it know what they're doing – if they use the technology right it's not a problem.
- SVB: And then using the Cloud versus having a location specific private bank of data on a university campus or hospital
- ITE: this is again something you'd have to sort out with the specific developers who do it; I would go for a Cloud solution – it's a very strong movement that way, it's one less thing you have to worry about – if you have your own computers standing there somewhere in the university, then somebody must keep track, make sure that the machine is running, must do software updates, security is extra hassle, you must do backups – you don't want to lose this data after six years – and your whole database is just gone. So Amazon – I would go for that – give it to them, it's their problem you don't have to worry about it
- SVB: So then it doesn't really become an issue of how many users per servers...
- ITE: That's another very nice thing – you just scale as you need to... go on for ever.
- SVB: And it just increases the costs a little. And I think the costs aren't too bad...? Especially if it's a government project, we can make them fund it. That's the main issue – we want to get sustainable funding, which you can't get through NGOs – and only if supervisors say "you need to tell your patients to use this app" – and only through systems endorsement can we scale this to reach the populations that need it, which is why we're looking so closely at systems

endorsement.

In terms of fitting into pre-existing systems – so what I saw the Western Cape uses, is Clinicom, Delta 9, PHCIS and JC Pharmacy – they're using these systems for keeping track of when patients use health systems, and I'm not sure how much detail gets recorded. But I was wondering how difficult it would be to integrate our database with their database.

ITE: That depends entirely on their system. There are many variables there. There's just the plain technical stuff – exactly what sort of system they're using. Ultimately you should be able to build some solution. But the biggest thing is how happy are they with allowing other people to integrate with their system. And you'll need cooperation from their side if you're going to do anything that interacts – and they'll have to sustain that cooperation – if they're going to make changes to their system, you'll have to make changes to your system, so you'll have to maintain that relationship, and they have to be responsive.

SVB: The idea is that the government wants everything to be open-source, and freely sharable, but because they're outsourcing it, I don't think it's necessarily in their hands. But I think that's something that can be sorted out later.

ITE: I have to tell you, typically, this doesn't work well.

SVB: What I think needs to happen is that somebody needs to do something that allows other people to design things that will use the database, as long as it doesn't screw it up...

ITE: This is not easy stuff. The technical issues pale before the political horror – just getting people to talk to each other and working together. I would say – to get this thing off the ground, I would have it entirely on its own. And do work to make it accessible to other systems. Make it friendly from this side. If you can make it very friendly, then get them to do the development to you – then it runs as smoothly as it possibly can. But if you have to depend on them to do stuff to connect to them, it's even more difficult. So it's a big advantage if you can determine... because there must be some specification of interaction... and if you can determine that specification – say "here it is – you go change your system, do whatever you have to do to make this work" – one half of the problem is solved. Otherwise you have to sit with their horrible specification that might not work very well

SVB: And having apps that might not be designed by our specific team. And you were saying our system is friendly, but how much interaction should we allow with other people designing similar interventions.

ITE: It's a tricky question – it depends on exactly what you want to do and how much you trust other people. Typically I wouldn't just give them access... so you can partition the thing to be in some way linked, but they have their own little world that they can do what they want. Each patient would have some master ID and they just do stuff, but as long as you can link with the ID – but this is fairly technical, you'd have to know exactly what you want to do and then work out the details.

SVB: Because my dream is that you've got someone who has the idea, gets themselves hired by the government, and then just doing apps – and they can get someone else to fix bugs and do ongoing maintenance, and that's their job, is just creating this network of apps that collect all the data you need and is customisable.

ITE: There's an NGO... Coding for Africa... Coders for Africa... something like that... and their idea is to get idea is to get programmers to donate a year or two... essentially volunteer programming

for government – there's something similar in America – where they've done some really good stuff. So it's almost like doctors give... so programmers go in to some government office, and they just sit around for a while and they watch what people do, and they see, well, here they can write a small thing that can save hours and hours.

SVB: Um... international standards – I think somebody else can go and look up at a later stage... quality control... which is why you're getting systems endorsement – so that people will trust it. And then there's security regulations, but I think that's beyond the scope of this project. So how much processing power do entry level smartphones have.

ITE: Oh nothing that this app is going to do is going to make the phone slow... if it's well written... it's not very difficult to bring it to its knees with a badly written app.

SVB: Last question. I mentioned distributing via the health system or via the Play Store, can you think of any other system of distributing?

ITE: There's two aspects – the one is just getting the app installed and the other is just marketing, essentially. So the app itself I would just have in the Play Store and then whatever marketing channels you have – just link to the Play Store.

9.8.6 mHealth researcher (MRR)

Interview conducted on 14 December 2015, at the Medical Research Counsel, by Sylvia Van Belle

SVB: we're doing this interview for my project on the depression health app that's a feasibility report for... looking at developing an app that is useful for depression but has a backbone that will be flexible enough to support other apps. The main purpose of it is to link up the patients with the doctors and with the health system. So although the app can be used by itself by patients for their own monitoring purposes or there may be CBT activities involved ... all the things on the app will be determined through... creating an evidence-based trial – seeing which ones are the most effective... so that would involve those kinds of trials, but then it will also have a way to send information to the health system, to their overseeing – either community health workers or their GPs – whoever's in charge – obviously in that level there're a lot of legal aspects about privacy and consent as to how much data gets sent and whether it can be used for epidemiological research...

MRR: there I'm missing the link... so to whom are you going to issue the app?

SVB: so it would be issued... there would be four separate apps that all link into the same system... so there's the main app that goes to the patient that has those functionalities that I was talking about...

MRR: where do you recruit the patients?

SVB: so that's the point I haven't decided on the trial structure... it's one of the problems and it's been looked at in the research... because a lot of people say it's the standard RCT will take too long... but it would be interesting to see that the recruitment.... Because the idea of the app is that it can be used not only for treating but also for screening and monitoring... so if someone reports to the GP and the GP suspects that a patient is depressed they might suggest it... or if he patient initiates it, they can get the app supposedly from online market places, like Google Play... as to for a trial I don't know what...

MRR: okay so that's the patient app... but then you're talking about health workers

SVB: that... one of the problems is that we need to try and get health workers involved, so obviously

MRR: health workers - define those?

SVB: well, hopefully everyone: so we get community health workers, and then we get, obviously GPs... and looking at the new system that they want to implement, you have the specialist overseeing the community health workers... so each of the levels will have their own access to the system... and then there's also a system for clinics

MRR: they are to service people who struggle with depression?

SVB: yes... so delivering basic psychotherapy, and medication depending on how that system works out... of course they're trying to reform the system at the same time... because obviously we're not quite at that level yet so we don't have the community health worker doctor teams everywhere... so that's one of the problems that

MRR: so everything is geared towards people that struggle... that you want to help, through an app on their phones...? Or do you say three apps.

SVB: ja, so, if we look at this diagram..., which is somewhat complex... so the mental health care user, the patient, can send their journals or their activities that they're doing to the community health worker and the community health worker can have an interface where all of their patients are on there and they can select a patient has said and if there's a trend that can be seen, if the patient is going downhill

MRR: ja, I saw you said somewhere there's alerts that can go up...

SVB: ja, so they can send that information... it highlights that patient if there's any information... sends a little warning, so the community health worker can go and check up on the patient... And then the community health worker can also have special functions so, because they might be at risk for depression too, or you want to just check their state of mind, they can also have journal functions, as well as log books and you can maybe have training activities included and all of that information gets sent to the supervisor... so the supervisor... what I'm wondering about is whether the information about the patient should be sent to a clinic in the form of a patient file... because at the clinic you have to know who's accessing the system, and who's getting access to the patient file notes .

MRR: just repeat that.

SVB: so if there's information that's being transferred is about the patient... you want to possibly include it in a patient file for the system to recognise, but then there are access problems... so the local clinic at which the community health worker is based or the supervisor is based, and they want to send information to the primary care clinic... but then you need to decide who at the clinic has access to that. And then data can also be collected by the system administrator...

MRR: so the doctor is [...] but I don't see a doctor here?

SVB: that's where I'm not sure – the doctor can stand in place of the community health worker... or the supervisor... because I'm not sure what the GP's role is, exactly in the new system, because it's not really mentioned in the literature where the GP stands in...

MRR: what do you want to get now from your time here with me?

SVB: so I want to understand the projects that have existed and the problems that you've encountered... so the technological problems... perhaps also around study design... how you've been deciding the studies, who you're using as your control, who you're using as the intervention group. I want to know how you're addressing the idea of scalability... so how you're going to implement it in other areas if it's successful... so fi you could just, perhaps, describe the current projects that you're working with?

MRR: so the first one was started in 2011/12 – that was in North West... so 10 or 20 care workers were issued with phones and the stationary was uploaded and it was one of the new NHI pilot sites, so they were tailored according to the new stationary, the new protocols. There was no study design, it was merely... the key research activity was to see what the difference between paper and phone records and how compatible... and also correspondence between those two... We partnered with the Health Systems Trust as well. When we left – I think it was four months we spent there... Health Systems Trust continued a bit with this and then the software service provider - the vendor – he sponsored a bit of the implementation because the problems in the North West was coming to the table but they were slow on the table... but eventually they got to the table – so that project is now being expanded and it looks like it's being utilised – that was after we withdrew – after the projecting funding came to an end so that got sustained on its own. Then those photos I showed you was in 2012/13 – it's basically the same. One big lesson learnt there was... we bought second-hand phones from another unit – and they gave endless problems – there were a number of care workers were keen but the phones were giving problems. So the funding came to an end after month six. Then we got bigger funding from the Swedes. We are now partnering with the Karolinska Institute – a Swedish university. We took the same principle of getting all the stationery that's being used one the phones and *Eden??* is the Western Cape's Health Insurance pilot site- so the scope of their practise is currently geared at this new model of community-based services. We added some features to it, which seems to be working very nicely...[indicates diagram]... so this recall... in the clinic there's a staff member – one of the existing staff members issued with a tablet – it's an admin clerk – and if the professional wants someone back at the clinic- she then enters it and it's routed to the care-worker and the care worker then goes and sees whether she can track the patient. And then this correspondence between the two is instant messaging ro WhatsApp. So then if she's [the care worker] successful – they will then close the recall and we know after four recalls, two people came back – what the reasons were, why they couldn't be found, or maybe they don't want to come – so that's a new feature. And the other one is if this community care worker does encounter anybody that she feels needs to attend the clinic for any reason, then she enters that on her phone and then it gets displayed on the tablet. So when the referred person attends the clinic, she will then close on the referral – and to say we did A, B and C, and we want you, the care worker to do A, B and C and follow up. So this communication has some resemblance to what you're talking about... and then this one could be your specialist. So she does have a dashboard where all the information is displayed... the recalls she received, the referrals she made, she can track the number of visits made by the patient or missed visits and the like, so these two are actually the same... the hospital only does have both notifications that they send out. And we now have this phase two feature that the care worker ca also send an SMS – a visit reminder - to the patient... we'll see how that goes. So the project has been running in two subdistricts... there are about 96 care workers in about 20 clinics, and we will end in March, and then I will take my bags and leave... Sustainability... we started in April/May 2014... so my first encounters with the Department was to say, "let's keep sustainability in the back of our minds... where are we going" – but they don't

have the money to sustain it. The district manager says she's happy with the continuity of care that's being offered through the emails, but they don't have money to sustain it, so most probably we will just collect the devices and donate it to the province if they do have another project running up... they do have... I know that there's a *Catch and Match* programme that's going to be implemented in the metro. So you asked about sustainability – that's a challenge. You need to first show that it works and then it takes time to get it working.. and then get funding, how long do you have funding... so it's not that easy. The problem with the province is that they do have kind of an email vision, but my understanding from engaging with them is they want to have a proper policy in place before they start to engage with service providers and vendors and it's been going on for a while. Now the *Catch and Match* programme, I think is going to be a different kettle of fish because they mandate it – somebody in the Health Impact Assessment Unit – a registrar that's now going to run with it – so they will have far more leverage with the information management directorate to enable interoperability. We were saying all of these would improve if you can link it within the existing electronic system running at the clinic. But because the MRC is an outsider to the province it's not that easy. Some people said "let's use this as a sandpit to play a bit" but the people with the key didn't think and they're not going to entertain that idea. Now apparently with the *Catch and Match*, it's something that they will be able to... well, it's going to be easier to get permission- because they are themselves the bosses of this project... it's not somebody external...

SVB: because that is one of the things the key things that we want to do is... the whole idea with the depression app is that that's an example and we can run with it and show that it works but then with that same backbone, but then with that same system of patient IDs and practitioner IDs we can add other apps so if there're co-morbidities or something, so a diabetes app... and then the patient can just download all the apps that apply to them... and then they all feed into this one patient file that would *hopefully* be linked into the system – so under one patient identification...

MRR: ya, and they do have a patient master index number... there is a unique identifier...

SVB: is that... I was under the impression that it's running but it's not nationally implemented

MRR: ya, I believe so...

SVB: because I'm not actually sure what the Western Cape is doing... I tried to find it in the literature... but how extensive the communication is within... either the Western Cape or nationally.

MRR: what communication?

SVB: just between different set-ups... so between different clinics, how they communicate with... what the referral pathways are... because this is a really good example of referring between

MRR: this system is running external to the in-house system... I think there's two systems – a primary health care information system – if you enter the clinic with your folder number they can scan and they can pick me up in any clinic that's linked to this server. There's another one called ClinicCom, but I'm not too sure what the difference is between the two. In any case they are geared towards having an electronic system that can link a patient in any facility

SVB: when we do clinic visits and they're discussing how they do referrals... there're still all these forms that everyone has to fill out... with this system, you can potentially send a lot more

information about the patient when they go for a referral, because all of the information is already plugged into the system, as keeping track of the patient.

MRR: What Professor [removed] said... we do have a referral system in place, when I was talking about this one – so it should be adaptable, so that this person in the clinic is not maintaining two systems – so my piece of advice would be to... before you sit down with the service provider and you get the fancy scheme on how to do it... get permission to go and speak to the clinic people and see what's happening there

SVB: in information systems, one of the key things that they look at is interoperability of systems, and you need to find out what the system's doing and I think the department is quite close-mouthed about that so you need to get someone from the inside, as you were saying... so when we were looking at what a design team should look like, I think it's very important that we include someone from there... we also include... in the team that's designing it... I don't know if it would come from a university or something... everyone's engaged in the project that's their goal, so even if we outsource some of the programming...

MRR: With Prof [removed], the product that I know he's involved in is *Catch and Match* and the guy there is [removed]

SVB: but the idea is that we have this design team made up of people... from... some governmental people or one governmental person who can inform us or if he's not part of the original design team... that at least there's very close contact... and then also people to advise on the legal aspect, and then another to inform on the study design and show that the study design gives enough information for it to be acceptable to the government, so that they see that it's implementable... but that's also very difficult to understand what the government wants from us... so what they'd be willing to take on... so you mentioned the interoperability as one of the things...

MRR: I suppose you need to... I'm engaging with people that's with the community based services programme... I don't know which people you'd engage with, in terms of mental health, because your programme is geared towards mental health

SVB: but it's also, sort of, which level do you talk to for getting wide-spread approval for a project... but I guess you'd have to work in a small community first, a trial.

MRR: but do you know the hoops that you need to go through... [removed] will tell you, but there's the Health Impact Assessment directorate, and you submit your application, to conduct a study to them, and they give you their permission... you need that piece of paper from the ethics... then you will say to them A, B and C in terms of what clinics you want to go to and what you want to do, and then they decide if they're going to give you permission. Study design for this study... there's no study design... there's no baseline data available, on people being recalled back from their homes... you know, it's practice... it's not something that came about when we issued the phone, it's something that was happening but there's no record of how many people eventually come. And similarly there's a referral...care workers will refer people upstream but there was no record so by asking the district... what kind of target do you set... and now we're measuring it against that target that they set, but the target is a thumbsuck, so if we get six out of the ten back we will be happy but the one thing that I didn't do sufficiently, because it's too complicated for me is health economic assessment- that would be something to think about when you set out collecting evidence... is the rand and cents of the system

SVB: I was speaking to someone who is in programming... and depending on how complex we make the system, we don't know how many programming hours, it's almost impossible to decide how much just developing the system would cost and then obviously there are running costs, I don't know what that involves, but then there's also the sustainability... and other aspect that we were looking at is if we can get the private health care system involved... it's another huge big mess that could be looked at maybe in the future, but the private system might like to have some more information – more information is good... because there's a lot of cross referrals and people going from the public health care system to the private health care system... whether you can send information across... but the whole idea of the system is to reduce the number of hours spent at the clinic or to make it more efficient – so that obviously doesn't appeal to the private health care system – because it's preventative and self-management in a way.. and the private system wouldn't like that or if they the information system where they get the patient information... they'd like to keep it for themselves rather than share or use it...

MRR: who's the patient? Is it the people from low income contexts or...

SVB: well, we'd preferably appeal to either people who are unreachable, or low served so that they have so that they have more empowerment because with the system there's long communications so if you can monitor a patient across geographical divides... so that they only need to come in when they need to

MRR: What I'm asking is are they going to be people in townships or people in Constantia

SVB: it would hopefully be both, but we'd probably market it at townships first

MRR: it's quite different [on account??] the Constantia people are not going to see these people... this would be the doctors...

SVB: the private health care doctor... I think, at this point I shouldn't look at that... I should keep my scope a bit narrower and not look at the private/public health care system, but the possibility of getting some finance or collaboration from the private health care system might be something if they're willing to work with us, but I don't want to look there yet.

[Omitted due to irrelevance to topic]

SVB: have you ever had problems in the system with the competency of either people in the hospital staff, or the clinic... I don't know how complex your system is ... but people who struggled to grasp... or how you did the training of the various functionalities, the various interfaces

MRR: there are two care workers that didn't manage to master the technology so in the one instance the colleague is helping her to enter her information on the system and the other one is... the supervisor is helping her... so out of the 96 people the competency or the use of the system is fairly okay... most of them just picked up on their own.... How to manage smartphones... there are one or two... but it's a little early... that's not used to touch screens. The supervisors, the team leaders... they are older people – they are retired nurses – so they struggled initially with the tablet and now they're managing okay... in the clinics – the biggest challenge is not competency but having to find time if they have to do over and above... this is not their main job... so anything that's an extra... and adds onto their current work is problematic. There are one or two of them that's not that computer literate – so they don't make the most of the system – they manage here and there, but not as well as they could. So I don't think you will have problems with people managing the system. It should be intuitive, and not too many

different screens that's difficult to navigate between the screens. The display of the phone is nice because the icons are self-explanatory.

SVB: so basic training of the staff?

MRR: well, the service provider did the training and on the phone there's a help icon with notes on the system which is useful. And you need someone within easy reach to do some trouble shooting... so in this Eden work, there's one team leader that's very competent, so she can serve the people in and around her area. And then the other two areas – those coordinators are not shy to contact the service provider themselves – so if their care worker is struggling – the care worker will tell [omitted] and [omitted] will phone the service provider... I imagine you would be around but it would be good to see if you can identify a super-user among the care worker themselves – just to have a pair of ears and hands and eyes apart from yourself within that team.

SVB: it was in the design structure that you have a tech support person, but what I think your idea of having people within the system

MRR: the tech support person is still a problem, because he or she will phone here, but this guy is struggling to understand what's happening on the screen here, but if there's a colleague, that can help her to navigate, it's preferable... you need this [tech support]... but...

SVB: ...you need people on the ground

MRR: ja. So [omitted] will call me up and then I'll say I can't understand what's happening on your screen.

SVB: you mentioned the service provider... where did you source them... who are they, how do they fit in...

MRR: our unit has a long-standing standing relationship with Mobenzi – seven, eight years, and they are very competent – so they are sitting in Cape Town... I had quotes from Cell-Life and one or two others but I'm happy with those people and their services are good... but if you can to sort that you will do yourself a favour – it is expensive if you outsource it

SVB: but the other problem is having people who know about the design of the health system.

MRR: no, that's true... they do have nice experience in that field

SVB: so that you can cross-link the systems nicely.... So do you know of any other mHealth projects that are going and what I saw in the literature was that a lot of the studies focus on this relationship between community health workers.

MRR: so this one is going to be geared towards catching, I think, under 5s and match them with services... and there's another one... the colleague down the passage, she's doing some work... Star – I think there's been a publication or two – that was an SMS service to now get the people... Leon. Natalie Leon – you will find reference to her publication. Now they are expanding a bit.

SVB: oh, ja, I think I have come across...

MRR: there's another publication, that's kind of a framework for mHealth, that they should be looking is the *Star*.

SVB: no I definitely have heard of her, but I don't think I've come across *Star* so I think it was just some other papers that she's written... because I haven't found anything that links... although that one does have a link between patient and supervisor... the *Star*... that's obviously the patients who are diabetic

MRR: no, I'm not too sure, but in my understanding is that the patient will receive some kind of notification through an SMS system and will pitch at the clinic – I'm not too sure whether the patient... what's the link there...

SVB: because one thing that this does is it empowers the patient a lot more to take, either, a lot more control over their own health or it facilitates some kind of communication between... so if they're struggling they can...

MRR: *MomConnect* is also something... have you heard of that? That's a huge... it's a national programme... pregnant... postnatal mothers that are linked to the clinic I don't know whether they can be called or receive messages and information... but that's a big one

SVB: but that's also interesting because it's nationally rolled out... with all the provinces because if you look at the national health policies – they say that everything needs to be equitable and they all need to be linked into the system but each province has their own health information system, so you can't really roll things out on a national level, that will work with them all... so either they need to take control on a national level for the development of it or they need to accept that things will only be rolled out in one province

MRR: but you get the saying that you get the country and then you get the province.... The Republic of the Western Cape, so they are on their own mission there

SVB: well, I think there's also extra resources here, and the problem is once they've started sorting things out, there's a lot more communication in any case and then things just work better... if you've got the backbone to work on here...

MRR: they're performing well so the system works – that gives them leverage to say to the national department "what we're doing is working better than what they are"...

SVB: but I think there's also... I've heard rumours of it, but not much more that there's a pharmacy system that's quite capable... and that's also very interlinked so they can track medication use across... check the prescriptions... and it's also linked into private pharmacies – so they can check that people aren't collecting multiple times... so if you can link in with that system as well, it would be useful especially with antidepressants which can be used for suicide...

MRR: ja if we had the money, because on their electronic system they do have a collection week, and if we thought to put some kind of reminder to the patient in that collection week, you can encourage them to remind them to get their chronic medication

SVB: ja, that's another... the whole pharmacy system and if you have a completely separate app that can, say, send out reminders and allows you to monitor for side effects and each day. or have a description of each pill, so which pill needs to be taken, how many times a week – I think that, in itself as a project would be hugely beneficial, with a picture that they take themselves of the tablet and it says "once in the morning, once in the evening" and then you have another tablet, because, these people who are taking 10-15 tablets a day, and I know adherence to taking medication in the right way is a huge problem... so you guys, did you design all these apps – what did you design them with – was it Android.

MRR: it's running on Android devices

SVB: and the mobile phones were also android?

MRR: ja, ,it's an entry level Samsung, an the tablet is some kind of MobiCell. This thing is R600 and this one is one thousand and something...

SVB: because that's another aspect that there isn't much information on is, you'd hopefully want to use existing... if you're going to roll it out large-scale, you can't really supply everyone, so you need to find out, especially with the patients

MRR: that becomes tricky because if you expect me to use my private phone for work purposes, then it's going to cost me, so you will have to find a way to convince me to make my phone available

SVB: ja, I mean, obviously we're going to try to keep data costs to the minimum – there are ways of ensuring that it's very low on internet usage, but also, looking at smartphone penetration, there are estimated figures between 40 and 50% of the population has a smartphone

MRR: but what I'm saying is it's fine but I do have a smartphone, and I do have a smartphone and I do have a smartphone... but...

SVB: but they need to be convinced that they can use it

MRR: this one most probably because it's serving her or him... but this one might take some convincing... if it's costing her... and you say low cost but if she is earning a thousand rand per month it would have to be very low for her

SVB: so providing packets of data, or something, but then it might get used for other things and run out of

MRR: well, that's the thing... that's the lowest cost in this Eden project – they get 100MB – it's not expensive. The expensive bit is the licensing and hosting of the data.

SVB: I suppose that if they're using their own devices, though, by supplying, data it can easily get used on other things... on private things, and then they run out of data and can't use them

MRR: and you can't say, "well, we'll phone on another next month". So they can... this has been logged down... but they are careful enough to circumvent.

SVB: but if we're looking for an equitable system that gets people in rural areas to be able to communicate with clinics that are, say 100km away... then we don't know the specifics... so they've got these estimated things saying 40-50% of the population has a smartphone ut you don't know... the majority of those are probably living in urban areas, and we don't know what the penetration is like in these rural, outlying areas, so that's another issue to look at. So you were saying, looking at the clinic level... the time that's an issue with these nurses...

MRR: it's not the nurses, it's the admin clerk...

SVB: so the idea would be to somehow make it part of the system... part of their day's job... make it in some ways easier, especially if you have the system logged on the same patient number, it could sort of automatically file, but I guess you were saying... it's the GPs that don't quite fit into the system... so you've got the community health workers, who, maybe, their specific job is mental health... or the supervisors whose specific job is to monitor the... but if they've got several functions... how to make mental health screening and upkeep of mental health – how

to make that part of the routine that they have, especially if their schedules are full... and that would obviously make it tricky to... so if the GP does things, we need to convince them that this can be made part of their daily practice of just... either recommending their app or just quickly checking to see if their warnings on the system and convince them that it's worth the time... I think that's another place where it's difficult. So with the people that you were working with here... what sort of patients were you looking at? Was it all patients?

MRR: anybody who has been cared for by community care – some of them are bed-ridden, some of them are on chronic medication for any condition... maybe it's blood pressure or diabetes or under 5s that are being taken care of...

SVB: so it was any... more kind of simple... looking... just at that sort of communication aspects... so you could just say... when they send information about the patient... would they just send a patient number

MRR: well they didn't send the patient number because the system is not interoperable... they will say "I referred Sylvia to the clinic today because she has a really bad cough"

SVB: okay, so you did put some sort of basic information about...

MRR: if Sylvia can give her file number or folder number then that would be entered as well...

SVB: but obviously a lot of these people...

MRR: ja, don't remember, or they might remember incorrectly.

SVB: but that sort of basic "this is what they are here for" to make sure that there is that level of communication, so that they don't pitch up and the doctor is clueless about why they are being sent to the clinic, if that makes sense?

MRR: it's not really what... the purpose was actually to get some record of how many people that they did refer, can we track as has been successfully referred, and likewise for those people who we want to get back to the clinic, how many do they get back, so it's not necessarily to streamline the process at the clinic but it's rather just to do some recoding.

SVB: to get that communication. So we'd need to, I think prove actually, what I was saying, about trying to get people to adopt it into their system. Were the people... because obviously you recruited specific clinics into the trial... how willing were people to adopt it into their routine... were they sort of... did they feel like it was an extra burden.. or....

MRR: the spectrum of... the subdistrict is managed by a manager and there's two subdistricts and the one subdistrict... the manager bought in the system from the start so in her clinics there was less resistance and a better uptake. In the other subdistrict the uptake was a bit less enthusiastic – so it's very dependent on who engages with them – if that person is buying into the system and sees the value of it

SVB: if the supervisors... and then it filters down... because obviously there'd be some level of... how we market the device to clinics in their... I mean, how d'you say this will make a difference to the way you practise... make a difference to the way your system is run

MRR: well, I said we started in April 2014 with the negotiations with province and then they referred us to the district, and from the district to the subdistricts so that whole caboodle... you must budget enough time for yourself. They will say... "this is fine" and then you go do some

development and then talk to the service provider and then you go back... so it's not as if you will do that within two months.

SVB: so you need to market it and pitch it to each level, as it were

MRR: ja, I think so...

SVB: especially with a design like this where it tries to act on multiple levels.

MRR: the problem is... my understanding is... you can't go and knock on the clinic door on itself... you need some kind of introduction to go and do your briefing and [?].

SVB: as a second year... I'm planning on presenting this and laying it on the table saying "this is a new way that we can look at mobile health..." but I'm busy finishing off a medical degree, so I can't go off and work on it. If there's anyone that's interested I'd obviously be willing to talk to them... but I'm not sure if I can be the main driver of this...

MRR: what's the selling point in the subdistrict where it works and it's a principle that I think just how laymen work – they start to see an increase in the people that are cared for by the clinic, because of this recall function... so you need to keep that in the back of your mind... if you see the value of the system then you will use it. So you might be interested in mental health... there must be something that's selling your scheme of things to the people that provide mental health...

SVB: so for them it's mostly about statistics, I guess... to increase the statistics to make them look like they're a well-run facility.

MRR: but that's the case... they are running against... measured against indicators, and they must achieve their targets

SVB: so we must look at what those targets are

MRR: and then you're set for that

SVB: that's a good point. So I think with your project there were very few risks involved... what sort of risk-based approach I should be taking for this project, but I mean, looking at yours

MRR: there's a lock-down pin, and when we issued the phone it was set at 1234, and I had to force them to change the pins... so that's a security measure that you should have in place... and I'm not sure how comparable it is... Oudtshoorn is to Khayelitsha... I don't assume very much... so the theft and mugging less, I think, of an issue, walking around with a smartphone in Oudtshoorn... Ladysmith, is the other site... than it would be in Nyanga... so I know when I started to talk about working in the metro it was a concern that... will they not be mugged if people know that they are working with smartphones... although if they're using their own phones that will not be a concern.

SVB: but what's more of a concern is the access... especially if you're sending data about mental health care patients that's very sensitive...

MRR: ja, but I don't think, but I don't think that's too much of a concern because you can build in any kind of security measures to have access and the various [groups?] of access. The technology allows you to be...

SVB: very flexible around that...

MRR: ja, and they're fairly secure...

SVB: I mean another problem is, if you're doing a small trial it's okay because you know all of the people in the system but if you want to sort of roll it out nationally... you need to know that the community health workers *are* actually community health workers that are accessing the system that the supervisors *are* supervisors and it would be quite difficult to verify them, I mean you can use maybe, HPCSA numbers, but they're on people's prescription pads, so it's not like they're particularly secret... so that, in terms of security is quite difficult... what I suggested is that we work on a verification basis so the district manager knows all of the GPs and then if they've got a password that they can log in the other person and say that this person is genuine, this is his code... this is who he is... and then that supervisor can do all of the community health workers below him. I mean it's not a perfect system... but I think it's the best one that I came up with, at least. But I think at this sort of scale of things... and you're working with this specific clinic, you can work on a face to face basis a lot easier

MRR: ja, but the care workers are managed by NGOs, so

SVB: ja that's also a problem, is how you talk to NGOs that are outside the formal system, I guess... how they link into the... but that does cover all of my questions... I don't know if you have any comments...?

MRR: no. good luck.

SVB: thank you! I mean it is very complex but I think having something this complex allows for other things to be built onto it, because there are a lot of small projects that are around that show promise... but as you say the funding dries up, or there's no follow up after things get implemented so it's difficult to see long-term effects. And with something like this it collects its own data... so you can.... um... anyway thank you very much for your time. I really appreciate it.

9.8.7 Information systems expert: professor from UCT's IS Department (ISP)

Interview conducted on 26 December 2015, at Fish Hoek, by Sylvia Van Belle

SVB: This is Sylvia Van Belle interviewing [omitted] in Fish Hoek on 26 December 2015. You've signed the consent form, you understand that this interview is being recorded and that you will remain anonymous in the final report and any further publications thereof?

ISP: Yes.

SVB: First of all, would you like to clarify exactly what your position is at UCT?

ISP: I'm a professor there in Information Systems, I'm the director of the Centre for IT in National Development. So my interest there is our use of IT in developing world contexts, direct to mobile technologies [?].

SVB: Okay. So in Information Systems, especially the academic side of it, there are a lot of frameworks that people use to format their work. Because my project has taken quite a strong Information Systems turn, it has to do with health information systems, I was wondering if you could clarify some of those frameworks that people use to structure their ideas around – especially if they are beginning to design a new project – how would they assess the acceptability of that project?

ISP: What do you mean with a project, an information systems building project?

SVB: Yes.

- ISP: Okay. Because there's frameworks at a whole lot of different levels. So when you are developing a new system, you have a whole lot of tools and methodologies around that. Normally we call it system of development methodologies. So you can go from the technical level, like when you're building a system... you choose between if it's a large system and a very organised structured web, we call it system development life cycles... and that's where you develop a system fairly straightforward in a linear fashion, from getting the requirements from the user, or (scoping) it first, then getting the requirements from the user, or scoping it first... then listing all the requirements, translating these requirements in functional specifications... detailing them down to system specifications which then incorporate technical specifications as well. And all the way down then to development, meaning coding, designing the databases, to then testing it, implementing it. And that you do have feedback loops as well. And there can be multiple iterations of that as well, but that [?], we call that the waterfall method [*hand gestures*]... which you can't record that but it's showing you each step that falls directly to the next one. The... probably more appropriate development method for yours would be an agile development methodology. An agile methodology is where you are not 100 percent sure of the requirements... you have a fairly self-contained system, and you want to – you're unsure about what functionality to include and what not to include. 'kay it's also used normally in high risk projects as well, which is where you develop something that works and has got minimal functionality and where the users keep adding functionality and then enlarging it. It initially starts off from a skeleton, sort of with very little functionality or actual data-saving in it, but as you develop you add a functionality, add more data to it and make it more real. So you actually basically work almost from a functional prototype and interactively – that's why it's called agile development. So that's at a development level.
- SVB: That would be helpful because in health systems you need to determine the effectiveness of each specific intervention, each specific functionality as it stands.
- ISP: So these are two opposite ends, and normally people sell that, you know... in your typical course... you do this one or that one. In reality you can do a combination, of course, so most companies... so what probably works better for you is because you have a really good handle on your requirements, is actually you could combine – you know, could do the waterfall method for your article, for your research and pretend it's sort of straightforward but then actually when you come to the development is actually work on multiple – don't quite do the agile method where each week they have a fully working prototype, but basically have four or five iterations of the waterfall method in terms of functionality sets. So you can combine... it's really a continuum in between that, that you can do... it depends a bit on how your development team
gels together.
- So then for thinking about systems or how they fit in an organisation, you've got what's called enterprise architectures. There's hundreds of frameworks around that one. And that's I think a little bit too far out of scope for yours but it helps structuring your themes... because in an enterprise architecture framework when you look at all the computer systems or information systems in the organisation... they have specific angles... and a framework that I like very much, I just suggested it earlier to you is where you look at a technical level - you normally start from the top down... so you look at the business needs and you normally look at how the business works... so you look at the business processes, like how the healthcare industry works, how people would deal with patients with your depression disorder or whatever you call it... issues... work, and what they typically want to do to improve themselves. And then you from that, you say, okay, that is the type of interventions we want to do with our app. So you look at the functionality of the app and you look at the data that's needed to provide that functionality.

And then you lower down from that and it says... okay, what [IT?] systems does it need to work with, we call that framework the systems architect – sorry –systems architecture ... so the systems architecture is really the data and information the functionality architecture. So called information systems architecture, where we'd call it the system... the data architecture would be how the data is structured and how it can be exchanged with other applications... the integration architecture is how it fits with other applications, in your case the interoperability... And then the technical architecture will the look at what hardware platforms it runs on, the operating systems it runs on... what networking features it would need to have. And then you could have security architecture along with that as well. And then in terms of when apps get out there, the new information systems or new technologies get out there... whether they're being accepted or not – which is also a very important one, then you have a whole lot of theoretical frameworks around that as well. If you're talking about individual users, then you can pick out things like the TAM and the UTAUT model, which I mentioned to you in our previous conversation. So the TAM – the Technology and Acceptance Model – we have a fusion of innovation models which talk more about society, how it gets into society. And then in an organisational context we have other models... we can use diffusion of innovation models, or you can use something called TOE: *technology, organisational, environmental* factors. It's really a framework of classifying the factors. And then if you have the hybrid of organisation and individual adoption, you can talk about technology, organisation, environment, the task fit, and sometimes individual factors, as well (that's the TOET? model). And then in project management you also have a lot of things that are a bit out of your scale.

SVB: In terms of health information systems, have you got any experience with working in that field before? Or any contact with people that you know in any kind of way, how data is structured in them?

ISP: I've had two points of contact with that. One is I have a lot of my students work on looking at mobile health applications in the world that have already been fairly successfully run or have been prototyped elsewhere in the world, and then doing a gap analysis between the major public health issues in South Africa – which health applications exist that, as far as we know, weren't implemented here in South Africa... and I had to then speakers and health professionals and saying like, which of those health applications we found out there could be used in South Africa and what are the issues. Okay – so that was sort of a more of a conceptual analysis. And there were some quite interesting findings there that's it's... even if you have what you think are fairly straightforward issues, that in South Africa things work very different often and you can't just transpose a mobile health application from one country to another country. And it can sometimes be very simple, like language, but sometimes it can be quite difficult. And I think you will have that for your problem as well. Like one of the most easy ones that we thought were weight-related ones, so where obesity apps, specifically for healthy management of your weight. We discovered that even though there's lots of apps overseas that help with that, with motivation and all those aspects, they would never work in South Africa because the majority of the population doesn't see weight as being as issue, a health issue.

SVB: And also things like diet and things are so completely different, and views towards exercise.

ISP: Yes. But it was specifically the conceptualisation of weight, which in Western society and a lot of other societies, people don't want to be overweight. Whereas a lot of the black South African populations view it as a status symbol to be overweight. And they see like anybody...especially the European, American model of what an ideal weight is... it's such a negative. So you may

have the same issue, and one of the other issues is language. Is that the majority of the – I mean, what our conceptualisation of the concept of depression amongst the majority of the population of South Africa – do they have words for that, what do those words mean? How do they see it being? Sometimes it can be positive, because in terms of a mobile health application, they don't need to divulge to their... you know...they can't talk to their peers about it because they don't see it even as a real issue... but it is a real issue for them. There the mobile health app could be positive because at least they've got a resource... a bit like a sexual diseases issue – they don't want to talk about it but if there's somewhere, another means of getting information or [*help about it*], it's a positive thing.

SVB: It also has to do with how you market the app. If you use, for instance, emotive words rather than calling it something like depression. In a lot of the marketplaces, the way you search for it is for depression but if... I mean there were two places where we were thinking of marketing – having it on online marketplaces and then also have healthcare practitioners proposing it to their patients. But if it comes on the radio or something as part of a promotion exercise, you would market it differently to different population groups. But just returning to your point on language, what are the... when you translate an app, especially on things when you've got people inputting data – if you looked at the functionalities, lots of different functionalities, lots of different data forms, how would you approach translation?

ISP: There's been quite a bit of research done in multilingual apps. So it depends very much on two things. First of all, the user interface... it's fairly straightforward to have an app in multiple languages. It's a bit like a website as well. And you're going to have to decide on that as well – whether you want to develop the app, if you want to go multi-platform, if you're actually going to develop a code or whether you're going to go for HTML 5 or VHTML or one of the mobile versions where actually most of the stuff is going to be a dynamic website which is not platform specific. So whether it runs in a browser or whether it runs as a downloaded app. If it runs in a browser then you can use cascading style sheets to change the layout and the look and formatting, whatever it is. So everything is done dynamically but it requires a browser. So it depends a bit on how much coding you actually need to... how much processing you have to do, whether you can – ideally as a website, because then they don't have to update and all those things. But then you need an internet connection and you have to be... the coding load needs to be quite light... it's quite a technical decision... because then the interface can be any language that you choose from. If it's a downloadable app then you often – or you can choose again... you can create a new app for each language, but just translate the interface, and/ or you can sort of download language packs with the interface and on installation the users choose which language they want to choose.

SVB: Sorry, just elaborate on the last one.

ISP: So basically what happens is all the prompts on all the screens are in different languages.

SVB: But if you download a language pack, is that the same app that you designed?

ISP: Yes. So basically you have one app and then on the installation you decide which of the languages you're going to display. It's a little bit trickier for a mobile app I think than for a – I haven't had any practical experience in designing multi... or what the technical implications are for a multilingual mobile app. Because I know how the fields... sort of each screen stands on its own. So it may be a little bit trickier than it seems at first so it may be easier just to, you know, when you develop it, just to translate the whole app and have a different app in Xhosa or English

or Afrikaans and they can download the app that they choose. But it makes it a little bit trickier for you to update the apps because then each time you generate a new app you got to update the whole bloody set of apps and that's not so straightforward on the Play Store... So that is fairly straightforward. What's not so straightforward is when you actually input the data. So let's say you do diaries...

SVB: (Those would have to be in there)

ISP: So the diary, any textual input by the patient will then also be in their language. The health practitioner that wants to access that data will then have to speak that language as well. Although I would think that most of the things, like even if you have to rate your mood level and you have to choose between five levels, the coding for those levels would be the same irrespective of the language used. You might have to do some research later on to see whether the gradations that you've used in one language and another language, whether they are really the same. Like very important or I feel very happy... you know... and if you translate that into Xhosa might be slightly different, so people may rate themselves consistently slightly higher because the language used actually... the meaning is slightly different. But I don't think it's a major issue. So in principle it's fairly straightforward, in practice it's a little tricky. So I would not go for the eleven national languages. But you would have to do some market research on who the major users are and then actually asking them... because that's the other thing, a lot of people, even though you make the app available in, let's say mathematics, a lot of people actually... or financial stuff... people prefer to use the app in English even if it's their second language, not their native language because a lot of the concepts don't translate very well. But it's also not straightforward, especially when you are using instruments. Each time you translate an instrument, like your depression-measuring instruments, a lot of words are very sensitive, in translation... and translating instruments is not straightforward. Because of the language used, because of the lack of translators that understand the terminology. I've had some experience of trying to translate questionnaires for instance, and it is tricky. There's a lot of testing that goes around that one. So not as straightforward. I would highlight as an issue to be resolved and a potential thing... but I think in a first phase you wouldn't go for them... because you need quite a few resources. It's not technically or conceptually very difficult, I would say, but there's a lot of work involved, both in the translations, in the technical issue of the app, and in terms of the validation later on, at a later stage.

SVB: Still staying in the theme of user acceptance, things like interface design and complexity. So there will have to be a trade-off between having a very flexible interface which, depending on your situation, you might want. For instance, me as a competent user with a high technical literacy, I'd want a very flexible app. But people who struggle to grasp the concepts might want a more simple, more straightforward app. How do you find the right balance between flexibility and simplicity?

ISP: If I had an answer to that I would be rich. Because that's the challenge with any information system that you design. So there's a lot of approaches to that. The one is to hide interfaces, to have the same interface for everybody but to hide the more complex functionality one or two levels down. You drop down, or typically you have one button for settings in most systems, okay and then when you click on these settings and then you have all these arrays and then you have advanced settings, sort of one button which then explodes into a whole lot of other arrays. So that's the normal approach that we use. So basically the same interface for everybody but hiding complex functionality deeper down, which, as users get more experienced and typically friends inform them or as they get the time to explore... or as they use the function more often,

they go and drill down and explore these... but when the user, at the first time it looks very simple and simplistic and straightforward. So simplicity of the initial interfaces is very important but then you have a lot of functionality hidden one or two levels down. That's the one approach. The other approach is to actually change the whole interface, so allow the user to... [design?] sort of a first time user, and then, when it presents a simple interface. And then as you get more experienced you can change the interface to more experienced. So you can choose intermediate level or advanced, expert user level, and then you actually have a much more complex interface right at the beginning. So instead of hiding the complexity, that complexity is actually brought forward... the functionality, advanced functionality is available almost from the beginning. So that is the second way. The third way is to have different sets of apps and that could link into a business model when you have a simple app, with simple but most critical (functionality) and the most appealing functionality straight away. And then have a more advanced app, so like Windows Home and Windows Professional. You pay more for the Professional version but you get a whole lot more functionality with it. Basically you could either let them download that or offer that as a download or you can charge for that, encourage the user with the simple app and then have a more advanced functionality app, have an advanced paid-for option, for instance. Again, if you do a set of stand-alone apps, if you have a web interface, it's a little bit easier to implement that because with the web interface you can quickly have the drop-down boxes, you have multiple entry pages... simple ones for more initial users, and more advanced ones for more experienced users.

SVB: I think the main problem with the web design is the lack of coverage or the lack of access to data. For instance, if people don't have coverage all the time then as soon as they can get back into coverage it can upload everything and sync so that they can use it away from coverage as well.

ISP: I'm not sure whether that allows for... once all those webpages are cached... if you could store those pages and store – you can definitely store the pages and the interface but whether you can store the data is another story... that is something to be... I think there may be options around that but it won't be straightforward... it could be a good option, though for the health care user [*intended to say practitioner*]... for the professional, rather than the individual patient...

SVB: You've read up quite thoroughly on my project. But in terms of a healthcare worker, one of the main things that we need to look at is improving overall efficiency of run time. So we don't want – it goes on to integration of systems and interoperability. We don't want to take up too much time and have people have to learn to use multiple systems. How is it we can use these to increase – or to fit it into people's day easily... do you have any insights on that?

ISP: The one option is obviously... one interface that everybody's used to, is again the browser. And that links into what I said earlier on. Instead of having the health professional download a separate application, you've just got all sorts of organisational problems as well because particularly in a hospital they work on locked-down [?] images... of system images..., so they're not really allowed to install additional software. And even if you allow them to install the software, they often back it up... somebody's got to maintain it, they move computers and so on. But then for the healthcare professional, both taking into consideration that they don't have the freedom to download software onto their systems and there's issues with the data availability and transfer and back up security issues... so I would strongly suggest that you actually move to a Cloud computing model whereby the whole interface is basically very light... is web-based and so then you have full control of the data, even though you can allow them to

download certain things like certain data for their patients and stuff which they can work on. That would then resolve at least the software updating, you know, they'll always use the latest version. It solves a lot of security issues in terms of access. It gives everybody the same interface as well... you don't have to worry about the platform to access it. It allows for mobility because they can access it on any device that supports a browser. So that's the first thing, the app... the interface or the software that the health professionals would use, I would suggest would be web-based...

So in terms of interface and then streaming that data to other systems, it's going to be a big challenge. So but at least you can address that then at a system level by the central repository, the data system administrator that runs or looks after where the data's sitting. That data I would suggest gets exchanged directly with the health information system. I think it's going to be a long dream before your system will ever form part, an integral part of the national health information system. I think, rather than- I mean that national health information system's going to take forever and ever to be built. So I think your system should initially... until there's clarity on what even that system will look like. At the moment I think you should just ensure that you have compatibility with the data structures and the data is easily accessible. The National Health Information System can then either call for the data only and exchange some data and compatibility and you can use that to reconcile it and there's various methods of doing that, either in real time, meaning every transaction that happens, is automatically validated against the National Health Information System or each time there's a new transaction in your system, it gets posted in the National Health Information System... or it can be in batch, whereby once a day or once a night normally or once a week, batch data gets exchanged between them. Hopefully the national health information system is going to build very modular in little blocks and then if they're going to do that one of the best options again, I think it would make sense to do the national health information system also on the Cloud. So then it's likely that they use a service-oriented architecture. So within the modules they identify small pieces of functionality, each running as a service. And then if you develop the application similarly, you can either have a layer on the top that exposes some functionality and services instead of exchanging data, you can hook into some of your functionalities and vice versa. You might be able to link to services of the national health information system. So there's two or three different levels there which you can [talk?]...

SVB: On that note, a lot of people have been talking, especially in the literature... about international programming protocols. I'm not entirely sure what that means and how we access them and how difficult it is to assess them and whether people are aware of them and whether it's going to be a huge mission – how much extra work it will be to adhere to them.

ISP: I think it would be very important that you look at those.

SVB: Where do you get the information about them?

ISP: The British have proposed public standards on data structures for national health information systems. So they have a very strong working group on that one and all that information is public. So I don't think you have to design your app and functionality of your app with inputs of those standards. But the person who will be looking after the data structure, I think there will be at least one person just to look after that one. That person... he/she should take cognisance and look at least at the standards that have been used in Britain. It seems like South Africa uses a lot of these British standards. And/or, I don't know about Australians... whether they've adopted something or created something, and obviously America there's also one... so you just need to look at the data models they've used and take the subset that's applicable to you. I

think you'll find already a lot of overlap. That's not a huge exercise because obviously if you look at the entire data model it will be extremely complex. But if you just look at the subset that's important to your research project, they are both publically available and they're not that big to do. So that will be an exercise that's really worthwhile exploring. The national health information system in South Africa hasn't got anywhere there but I would think that their programmers will be [?]. ... and not reinventing the wheel. The British and American and maybe Australians as well are investing huge amounts of money in that. So if you design the data structures compatibly... in a compatible way, then I'm sure that you shouldn't have that many problems exchanging data with the national health information systems...

SVB: One of the issues is, for instance, if you have a patient file that is assembled by our system, and then there's a patient file that gets built up in the health services, what do you think is the best way to reconcile these two patient files? Because there might be a lot of overlap in them, or you might want to access them and read them as one rather than having two separate files, to improve efficiency.... If that makes sense...

ISP: okay, for that I would need to know a lot more about the medical side of your project or what type of records the healthcare professional would need to see, what type of records you are creating. Because I would feel that I think your app generates a lot more data than normally would be accommodated. Like diary entries recorded by the patient, I don't think are really compatible with what national health information systems would normally take.

SVB: So if you want to look that deep, you'd be willing to click on a different folder in a different system?

ISP: I think so, you probably would. So I think there would be relatively few records that are similar. Your visitations, the appointments that you have with the healthcare professional, the medication and those types of things probably would be the same. But a lot of your assessment instruments, your diary entries, your mood tracking things, even your sleep tracking – all those are unique to your app and probably unique to a whole lot of other mental conditions but I don't think they would be incorporated easily into patient files. The catch-all way in which we do that is using comment fields, long text comment fields. So as a worst-case you can export all those as a long text comment and they get attached. Because any visit, any system... medical system always have a text box for making notes about the visit. So that can always be incorporated... stored like that. But I doubt that the national health information system will actually have space for all those fields. But at that stage you're going to have to make a selection of the stuff that you could export easily as a comment for that visit, and then the rest would be up to the healthcare professional. If that person is for instance working a lot with depression, a person would probably want to see the whole file. But if it's a more general practitioner or a primary healthcare person, that person probably wouldn't be either interested or capable or skilled enough or knowledgeable enough about the particularities of the app, or even interested. So that would also then depend on if there are any other mental healthcare apps that use similar types of approaches, if they are, then you can standardise more along those lines.

SVB: If you look at the basic architecture of mine, we have community health workers, we have clinic interfaces, we have specialists interfaces, but then there are often a lot of levels in between, like NGOs that are working with people and GPs who are at the clinic sometimes and other times working at private practices. So each of these people should have different levels of access. I was wondering if there is there any way to make that an efficient system, or how to determine the levels of... the amount of access that people have, because obviously you don't

want community health workers having access to highly confidential files or data that they can't interpret...

ISP: There's again two ways of doing that. You can do a fine-grained access level or a more coarse-grained access level. A coarse-grained typical solution for that is by assigning roles. If you look at a learning management system at a university for instance, you have normal roles like tutors, lecturers, course administrators, students, observers, and so on. So each role gets access to certain sets of functionality and certain views of the data at different levels. So if you can find maybe an NGO, but the access that the NGO should have is pretty similar to about maybe a primary healthcare worker should have, then you define roles and you let people assign certain roles.

SVB: Can people have multiple roles in that?

ISP: Well, normally what you have is the sets of roles –

SVB: Have increasing levels of access –

ISP: Increasing levels of access. So like with a learning management system, you don't have combinations of roles. You can obviously assign – you would have to give people different accesses because you can only assign one role to any one system user. And then you'd want to have a system administrator, that is normally just administrator but you would also give that person the responsibility of modifying certain tools, then you actually grant them lecturer's role or the system administrator's role rather than a user administrator. So that's the one way. The other way is a fairly fine-grain control whereby each time a user accesses the system, that's used often in – at UCT for instance – whereby individual lecturers get given access to certain resources on the system depending on their need. They get more software, more advanced software, buy special licences. So you have a basic role of an academic but then depending on which department they are, and which software needs they have, they get given special privileges added on to. That's obviously a lot of work and you need a lot of human resource to do that. You can delegate some of that to the patients themselves. So allow the patient to choose who sees what and what is accessible.

SVB: But I think they would – the more technical details, they would be unable to define the boundaries. So they might want their community health worker to see everything because they don't know the limits of the roles themselves.

ISP: It's a bit like when you install an app on your phone. You typically have to give some leeway to the user. So dependent a bit on how really privileged the data is, privacy laws and ethical... ethics provisions tend to err on the conservative way, in practice most people don't abuse patient information. So we find that in practice for instance at the university, even though there's a whole lot of... the Poppy act [?] and so on...states that there are a whole lot of things that we should be safeguarding the information about students and so on... in practice on the ground, even administrators sometimes see information about students or tutors even, they see student information about colleague students, and most people are actually pretty good in using that. So even if the patient in ignorance waives some of their constitutional rights to privacy or whatever you would call it – patient privacy – you would find that in practice most healthcare workers or NGOs would deal quite conservatively with that. And again having a Cloud computing based model would be good because it would mean it's very difficult for let's say an NGO, to have a copy of the database and inadvertently it gets copied or gets hacked

into, because you've got to access each record at one, you wouldn't download the whole database at a time. So you would limit the amount of –

SVB: Going back to the conversation we were having earlier where most people will have access..., all the healthcare practitioners have access to the Cloud via a web-based interface. Would it be possible to have that going and then have an application on the healthcare user's phone which feeds into that system? So that's an app that they download, because that's the one where we want to limit data usage and want to have that can roam anywhere, maybe will be limited to certain areas.

ISP: I didn't quite get that... the healthcare user being?

SVB: So the healthcare user, we want to limit the amount of data that gets sent.

ISP: The health care user being the professional... ?

SVB: No, being the patient.

ISP: Okay, the patient, yes?

SVB: Because they are the ones that use the healthcare services. Sorry, I should have defined that earlier. So they might have limited access to data. So we want to send packets of data when they do have access to networks and we also don't want it to be too high on expenditure, we want to have some of the processing on their phone perhaps, in the form of an app. So would it be able to reconcile an app with the web-based platform?

ISP: Because the healthcare user would then not have access to the web-based platform?

SVB: No.

ISP: So all that happen is –

SVB: They send the data –

ISP: Your app sends the data and that data is sitting in the Cloud somewhere and the practitioner in the healthcare system, they access the web. So their app is sitting on the web. So it's different apps. It's an app sitting on the mobile phone of the healthcare user, the patient, is a proper app. But the management system and the healthcare professionals, and they access that data through the web interface, which is sitting on the server which actually has the data... the server in the Cloud... so you're writing different systems.

SVB: I think the only problem in that would be the community healthcare worker because they might have similar limitations to the patient but they also need more access as their role as a bit more complex –

ISP: The one doesn't exclude the other. You can have two levels of access. You can have the web-based interface and then you can also translate that web-based interface into an app that is used by the healthcare professional, primary healthcare worker or whatever it is. But if the primary healthcare worker wants to access your system, they need a data connection anyway. If they have a data connection they have a web browser connection, so it doesn't make sense to give them an app... they have to have real-time access to the data and they can only have that if they're connected to the internet, so by definition then they have access to the web interface... so it... I wouldn't develop an app for the healthcare worker, for the primary –

SVB: The healthcare worker is a layman, a trained layman. So they're often working out in the field doing field work which is why – so they're not sitting in an office with necessarily a landline connection. They often come from limited resources.

ISP: Would they collect additional information and store it in the system?

SVB: Yes, so they would carry logbooks and you might want to track their mood as well because they're working with a lot of depressed patients but they don't necessarily have the full training –

ISP: So if your first line healthcare workers also need to capture data, maybe from interviews or whatever it is, then you should be looking at the system that's used by – what's it called, at UCT? – Because they have a similar problem and they basically sign in with an online and offline caching system... ach, what's it called... *[name omitted]* was involved. It's one of the best success... okay... the name escapes me, I'll get it to you later. So they've already worked out a platform and the system is generic enough, so you can customise... they've got basically a data-capturing information system platform that you can customise, and it works both with cached versions and online cached versions for healthcare workers, because they had the same thing... they've used it for HIV/AIDS but now it's use other platforms as well. *Cell-Life*. So *Cell-Life*... yes, so they have a spin-off project where they also tried to use expertise and make some money. So they have a spin-off for capturing of healthcare information using – and you can use various modules and there's an online mobile solution where it updates as soon as you have connectivity and so on. So you should look at that system, how it's both... the functionality and how it's structured and conceptualised. I can give you the links later.

SVB: In terms of outsourcing – not really outsourcing, but using work that's already done – so for instance, if we use an instant messaging platform in the service, one of my other interviewees suggested that we use ones that are already available, like WhatsApp.

ISP: Yes, don't reinvent the wheel, especially not for these complex technologies.

SVB: But for things like when you want to have certain group things – I suppose you can do that quite easily with WhatsApp. The one thing we were thinkin of doing is anonymous forums for in-between patients, but we don't think we're going to go that way because there are a lot of issues involved. I wonder if there's ways to limit that access, so if you're using WhatsApp, whether you can in any way specialise that further than using the basic thing.

ISP: First of all I'm a great believer in not developing what's already been developed somewhere else, especially in your case where you don't have a huge budget initially. So the only think you should be focusing on is really your own specific functionality, like the – so even a diarising functionality, there's already software out there that allows you to write diaries, so what you should just be doing is *[encapsulating?]*... so where you can collate information. So you should be looking – there's two ways of doing it. You can get commercial software that does provide a functionality and incorporate that. Like instant messaging... doing most of that, is actually commercial stuff like WhatsApp and whatever it is... so you can either incorporate WhatsApp or Gmail or whatever it is, or Hangouts, some of that, you can incorporate that into your app. Or you can make use of open-source software... so either like *Cell-Life* provides a platform for capturing data and basically what you do is customise it and you're going to have to subscribe to that one.... Sometimes it comes with – normally it comes with fees... so you pay somebody for incorporating that... not always... sometimes they provide some functionality for free or you can negotiate that, especially for trial versions. And then later on find another business model

that works, that provides – gives the money for that one... So there you call them (?) functionality modules... typically also services... So that's one way of incorporating functionality that's available, using services or whatever, or commercial apps inside your apps, imbed them. The larger functionality, like imbedding WhatsApp in your app is quite tricky... If it's a service-oriented architecture like *Cell-Life* it's a bit easier to do. But the better way is to use open-source software, and the code is then available and you then modify it to your use and (it sounds simple) in principle, in practice if you have different open-source software codes that you want to incorporate, it's not straightforward, because reading somebody else's code is quite tricky, although open source software often tries to be as readable as possible.

SVB: Another problem with using other people's technology is you need to be very careful about the business models that you're using and also I think the legal aspects in terms of the information that gets sent and stored, and maintaining control over your information.

ISP: Control of information is not that tricky. But yes, the business model underlying it... especially if you are using other people's functionality... that is tricky.

SVB: Because you need to maintain that good relationship I guess. I don't know. Obviously it costs money but then –

ISP: They're normally in it for money as well. Like, they are using a business model to generate revenue and... if you're a user... for them it's a nice way to showcase what the software can do. It tends to be a professional business relationship. Again, you've got two schools of thought... you've got, in the medical world you've got some psychological instruments where people are ride... trying to make as much money out of their assessment forms, their validated assessment forms as possible, and they price it really highly. And then you have, on the other end, the people who really care about community development things and sort of practically give it away for as little as possible because they want to see it just improve other people's lives. Obviously preferably you will go with the second group, although the first group with more resources... typically produces a better product. So that's the same debate with open source software. Open source software depends on volunteers... It's free, you can access it, you can improve it... if you've got an active community development around it, it tends to be high quality. If you don't have an ongoing user group developing that then... you can expect bugs and...

SVB: On the idea of for profit, not for profit, one thing that I've decided is out of my scope but I think should be looked at in the future because especially the new NHI... policies look at collaboration between the public and private sector. This application is based on self-care, on doing a lot of the care and doing – so you're training yourself, you're doing your own CBT activities, you're monitoring your own mood and you only make appointments when actually necessary, obviously that doesn't fit with the private model where they get paid for face-to-face time. And they're not keen on preventative models, but they will want access to the data, but then they will probably want to use it for data farming and insurance companies would like to get their hands on the data as well...

ISP: Well, medical aids, where the members still belong to the medical aid company, they would have a benefit in self-care because that reduces their costs. So there are other stakeholders that would see benefits in this. The drug companies might potentially also see some benefit in that... self-health. So I think medical aids and health insurance companies and maybe some of the practitioners, because I don't think most of the individual practitioners are eyeing for the money. Community healthcare worker – it's the organisations they work for, if it's a public

healthcare information... then they tend to be supportive... but if it's a private healthcare institution then you obviously would like to see.... But even there, I'm not quite sure whether you can't enter into some... Other partnerships I would see would probably tend to be with the medical aid companies, but there's other business models as well that might work for that.

SVB: The other issue is, you're letting the public sector agree to having the private sector have access to their information but I feel like that won't be too much of an issue.

ISP: I would need to know more about what data you're trying to give access to. I would think it's quite rare that they would need global access to detailed data and you wouldn't release whole data sets...

SVB: You'd just do specific patients...

ISP: So it would normally relate to specific patients, or it would be aggregate data, which, for instance, your drug companies might be interested in, is the data at aggregate level.

SVB: And then you actually want the private input because it's a more complete –

ISP: Yes, they would probably do better data analytics on the data. They could see trends and so on. And that you could – then you would have to anonymise the data, so you'd take care of that... I'm not quite sure whether there's ethical issues involved again in sending the data... the patients would have to know up front... that you can anonymise their data.

SVB: I have looked at that.

ISP: So that is – I don't think it's a big revenue-generating model... but, you know... if it's supported by one specific drug company, maybe they could sponsor it by an ad or whatever it is... they have so much money but they tend to be quite – it's not because they have so much money that they're dishing it out easily. But yes, you might find one company, a drug company, sponsoring the app. Telecommunication companies also have lots of money. They're very stringent with their money. Like *Cell-Life* had a big problem trying to get the money... they were, I think, sponsored... But also the Bill Gates Foundation?

SVB: Yes, I was wondering about these international supposedly –

ISP: That's not a sustainable funding model either, but they –

SVB: Looking at these international companies looking to benefit the community, World Health Organisation, these international corporations that donate money. But I'm not sure how sustainable that funding is.

ISP: Well, you've got two big costs here. You've got the cost of developing the system and you've got the cost of running the system. The system running costs should be fairly low if the system is functional. Because running in the Cloud, so basically you have just your computing costs and your data storage costs. Your initial costs of developing the system are probably going to be quite big. Now for that development you could put in something for the Bill and Melinda Gates Foundation I think, or some similar NGO. So there might be money – or there could be even sort of in combination, with an academic institution as well, the academics help develop, students help develop this as a design science project. So that could be... so the development is a big investment, but that is a once-off... whereas the running cost of the system might be probably a lot less, if it's been fine-tuned, and that could be – because it's a much lower cost, that could be generated by sponsorship, by a drug company... or even the user could bear – I mean, if it

provides really good services then as a user you would tend to want... you will be prepared to pay a little bit for it.

SVB: Because it doesn't look like we'll get government funding because they just don't have the money.

ISP: But if you as a user, if you're saving lots of money by not having to go to a hospital or you save lots of time, or you feel you've got a lot more control over what's happening, over your destiny, you might be prepared to pay something for that.

SVB: In terms of running costs as well, in a lot of these mHealth projects, they end up supplying a tablet or something to the community health worker because they're these small pilot projects. But obviously if you're trying to scale it, that's not feasible. So we're thinking of having them use their own devices. But then if they incur data costs on their own mobile phone, it would be difficult. So we could either hand out data packages to them, but then they could use the data on private information. Is there a way to track the data usage and sort of have that data separated for that app and then it gets paid for by a separate organisation... I don't know if that makes sense...?

ISP: Okay, so *Cell-Life* had that very problem as well. You know, who pays for the data, and the healthcare worker. So it depends on whether your healthcare worker is entirely... for the *Cell-Life* project... all the healthcare worker was doing was working for that... on HIV/AIDS and capturing the data. So that sense it made sense for them to be issued sometimes with the devices and/or if they use their own devices, also to be paid for the data, because pretty much all of the data... . And there was quite a bit of abuse of them then using that data then for other things as well. In your case I would tend to think that the healthcare workers don't use just the app, they don't work full-time with your type of patients. So it's just one little small component in the rest of their work. So it would not make sense for them to issue a device just for the purpose of those few patients that are dealing with depression. And I don't think it would also – it would have to fit into their overall professional life. And if as part of their overall professional life they don't have a device, then I don't think it should be your role to issue those. And if it's part of their overall working environment they don't get occasional access to data, then also again... Normally they have a base at the hospital where there would be Wi-Fi, it would be free and that's where they would sync their data. So that's what I would think in terms of your app, where it should work. It should not be your ... unless you have special healthcare workers that work – day-in, day-out with depression and that's their only function – then you might want to look at possible interventions in your prototype... Do you have any of those?

SVB: Yes. Community health workers, they're lay-workers...

ISP: Do you have community health workers whose only role is to work with depression –

SVB: I'm not entirely sure but I really think they might be, because I mean some of them just do house to house check-ups on any chronic condition.

ISP: Well, in that case I think the department of health would have to budget for that. I don't think it's the role of the developer of the mHealth solution... I think that if the mHealth solution is so good that the government decides it is worth it then I think in the end the government would pay for that. But like if you're developing a really nice eLearning solution... that the government decides ... for maths ... for instance for learning maths or sciences... ooh this is a great one for all students and all students need to use it then you wouldn't be responsible, as the developer

of that to now try and get computers for learners in grade seven, for instance. The government, if they see there's value in that, they must provide the lab facility for learners. In the same way, if health workers are working exclusively with depressed patients, and they see the need for that, that they want to work with that then the Department of Health should budget for these health workers to have access to both tablets and data.

SVB: Just something that's completely unrelated... especially if we're looking at large-scale work... on a small scale it's not a problem... and I possibly shouldn't be addressing the scalability issues at this point

ISP: ...you've got to think about them...

SVB: But things like maintaining, first of all the security of the information that each person can see but then if you've gotten so many people accessing the data how do you maintain the system integrity... the data integrity of it, or is it beyond our control?

ISP: No, it's an important thing to do, is data integrity. But to me data integrity is different from the scalability... so the controls you put in terms of looking at the quality of data inputs, those measurements are quite easy to do – so you know what is valid data and what is not... and if one person suddenly starts inputting or changing huge sets of data records, you'd easily track that – a certain health care worker cannot access a thousand patient records per day... work with a thousand patients... so you can obviously put in [*forward*] limits to that one, but you would also have to put in some monitoring and statistical analysis elements separately from, because yes, indeed, if you have five or ten workers and they're all committed, then you know that they're putting in the right data, but when you scale it up to thousands of workers or hundreds of workers, some workers are just going to put in bad quality data and, you know, you can do some simple checks at the user end, so at the point of data entry, where you look at saying, "oh you've got to fill in this data field or you've been entering the same data each time for the last five patients, are you sure this is correct?" if they've copy and pasted..

SVB: I think that's also the role of the supervisor – so they can check the data that's coming in, they can check... they essentially have responsibility for the community health workers

ISP: Again, given the status of the public health system... you know, the supervisor may not have the time, or may not exist or not be motivated or qualified enough, or the position may be vacant or that person may be overloaded, so where possible I would institute both immediate data validation rules, but then also act on a sort of slightly... as a batch... every now and then do statistical analysis on the type of records that's being typed in. and that's true for any large organisation, if you're working for a life insurance company [*?*] quality checks. And in the *Cell-Life* project, again, you know, they probably have experience doing that one, so it would be useful to look at the practices that they've done. So they do exist, these controls, like I say you do them at point of data entry and the you can run tests later on – statistical tests and various other data quality validation tests... it's a problem that is ongoing – there's no easy solution to it, but there are tests that you can run – and you know, you would again go for the low-hanging fruit in that then – what I'm saying is, it is an issue – you should address some of that at the early stage, then do some more when you develop at a later stage, and then there will be some other issues that will never be resolved, but yes, identify it as a problem – put in data validation rules, and allow space for later on, saying "we can run tests by ourselves" looking at various health care workers and analysis at that level, with some human controls... so there's a whole subdiscipline in information systems that looks at controls and data quality measures.

SVB: So looking at that... making sure the right people have the right access to data, making sure that people are vetted by the system, so the people who are claiming to be specialists are specialised; to verify who they are... what are the best ways to do that? So obviously a health care practitioner will have a practice number that's issued by the Health Professionals Council of South Africa – but that's a very easily available number... so it would be very easy for someone to pretend to be that person... what ways can we control who is...

ISP: That is going to be a challenge... especially if they're private people, but even if they're related to public hospitals – so there... you can do it two ways – you can do it the hard way – which is the web of trust that's being used in digital validation where any new user to the system has to be validated by somebody with more rights than that user has as a person that should be having those rights... so like, again at the university... so any lecturer would have to be introduced to the system by the department, and the head of department would be instituted by the dean, and maybe the dean is introduced by a vice-chancellor. And then a student would be added, maybe by lecturers, at that level. Okay, so you would track, because obviously every now and then, there's sort of a rotten apple somewhere that adds users willy-nilly, so you would do some controls and you would then go back and this head of department added a whole lot of lecturers just by email and you'd have to check them if they're really his lecturers or not – if you track to see which users they've added, and delete all of those, and then request them to be re-added. So that's the one approach to do it – so [?] web of trust... it's probably the best way of doing it. Or it's to rely on another system – a user validation system that is introduced by the National Health so a common sign in, using their... if there's a National Health Information System, and that authorises them – that allows you then to reuse the same system. But that level of integration is never going to happen for a while. The other one is a manual process whereby instead of a web of trust where a higher level user authorises and signs on new users, is whereby every user gets, by a central authority, by, you know, whoever manages your system, and that person checks manually...

SVB: But on a large scale...

ISP: That's not feasible. So if you rolled it out on a large scale it would be a web of trust system, or fitting in with the national health information system and using their login details. At a small-scale system it would be...

SVB: Because a lot of... that's what happens on a small scale... is... you know all of the community health workers working with a specific clinic so it hasn't been a problem

ISP: When you're talking about the National Health Information System we would not talk about actually interfacing and using the same... I mean, that would be the ideal, you know, if you're in one organisation, use the same sign-on if you take on a new system. Like, for instance, at UCT, if I want to log in to learning management system, I can use the same password as to log in to my email – but that's because we have, again, trusted machines and trusted servers, and the one server trusts the other. So you can do that, but I don't think that, in the next ten years is going to happen. What you could do, though, is that the health worker- you will have access to their email address, for instance, and that health worker and the role, or the qualification of that health worker and that information will be public... your system would have access to that and so when a user lets their doctor who wants to get access to this, or a nurse... that you get at least their email address and their role... and then send a verification email with a password to them. Or that information might be available from the Department of Health of the province, the provincial government, for instance.

- SVB: And then there's also the problem of entering patients into that system... so that web of trust works very easily within a system, in the health system, and then perhaps community health workers can enter their patients into the system... but patients will also be using this app independent of the health system. So if they download it from Google Play and they're tracking their moods and then maybe after a while the app suggests... or sees a negative trend and then suggests that they.. well, not the app, but the database, the statistical analysis... suggests that they make contact with the local services... gives them the email address, there'll be a function of "find a doctor" – and they go for the first time to their clinic... how do we reconcile that patient identity with the clinic... so if the clinic wants to make a record of the patient on their system of that patient, how do we reconcile those two databases and those two systems.
- ISP: So isn't that the point at which it's important to know how you're going to identify, how the national health information system identifies patients and how [?] individuals... so all you then do at that stage is link the individual – that individual until then uses a pseudonym or their own password or email address – and at that stage they've got to enter their record number or ID number and that's when you link the system – and at that point you transfer that to the patient record.
- SVB: And then how would it work for the... so if the patient goes to a community worker or to a doctor, they want to be added onto the doctor's system... I think that would be the same sort of web of trust idea, I guess...
- ISP: Yes, so that's where it's important that you have those data standards... that the primary record... so until.... You may have to have – we call that the "primary ID", so when your app is running, I would assume already some of the data is already cached on your server, or not? Is all the data sitting just on the mobile phone – their mobile devices?
- SVB: No, it would go straight to the database
- ISP: Okay, so the database would have an ID to link the patient record – now at that moment you need to link the ID – so you would have two IDs – you will have the ID that is used in the National Health Information System and the ID that you use in your system, and at that stage you would do an equivalence of those two IDs.
- SVB: We touched on it earlier... but you have all these users and you have the levels of access and things... would it be easy to... so at the moment we have these non-categorised factors that I haven't really looked at, like NGOs and the public health system – I mean the private health system – so we may want to add levels with different levels of security later – is that easy to do that? So to create other users, to create other profiles?
- ISP: Yes it is because basically each role would be...
- SVB: You just have a checklist of what you can access?
- ISP: Yes so each role would have access to certain functionalities and certain data elements. So you can do the two independently you know... if your app is designed from a functional way, you can say, you know, is it service-based thing so you can access certain services and then the services access the data... if it's an access to the data levels then you would actually basically have... but yes, that's fairly easy to do, so you would have bundles of rights, and you can create new roles with new bundles of rights. It depends a little bit on how your system is configured or conceptualised – architecture. But it's good to try and minimise the number of different roles upfront, and that's where your list of users comes in... it's not so much users as user roles that

you want to have, and the way they interact with the system. And if you have more than five or six, then maybe you're designing something too complex.

SVB: Back to something we should have looked at almost at the beginning... so if you're looking at smartphone penetration statistics and they say between 40 and 50 percent – actually that was for 2014 I think – but I think a lot of that is concentrated in urban areas – and it depends of the quality, I guess of these surveys, but do you think it's realistic to think that people in rural areas have smartphones and that their computer literacy is sufficient to be able to use these systems...

ISP: What's the alternative? To develop something for feature phones? That doesn't work. So you don't have an alternative, basically... and you can't bridge the digital divide with your app... so basically, what you're going to have to decide is... is there a sufficiently large [*?install?*] base of smartphones, and that base is going to increase all the time... but you can't figure out the solution of crossing the digital divide with your app on your own terms, so it's basically sad for the people who don't have a smartphone. I mean a smartphone, these days, you can get smartphones for R600, so if their depression is of the nature that it influences... plays a major role in their life... you should be prepared to shell out on that... if not... that I think would be not your problem. It does introduce, indeed... it's another issue for the digital divide and there's an access issue for some people but you can't address that, unfortunately because there is no way to provide that functionality on a lower level type phone. Again, they might be able to use... if you have a web interface you might be able to get it to work at an internet café but I don't see that as a viable solution in the short run... so I would stick with a mobile app – and that... go for as generic as possible. You might have another issue which is the type of mobile app – are you assuming that everybody has Android, do you want the app on iOS – that's another thing you've got to think of

SVB: How difficult is it to programme apps for different operating systems?

ISP: People keep saying that you have packages that generate apps for multiple platforms: in theory that is true, in practise that is not.

SVB: So it's better to programme an entirely separate.

ISP: Yes, so the amount of effort designed in iOS apps... iOS apps are not easy to... it costs quite a bit of money to port the same app to a different platform – it's almost double the [*?*]. Again... that's one of the reasons why I say... look at to see if it's not possible to develop it as a dynamic HTML page so you look on the browser. ... but it will get better by the time you actually get the money to develop your app in two years' time lead towards more cross-platform development may be cheaper. They typically bloat the application, because they install whole sets of libraries – but we will get tools that actually develop an unbloated app for each platform specifically

SVB: So, we touched on it briefly... the security of information: so the security of a database, the security at each of the access points – so especially if you have a clinic level terminal, or if you have epidemiologists accessing data, making sure that it's anonymous... can we just use standardised security solutions to these?

ISP: I would think yes. Because the biggest worry with your security... the technical securities are fairly straightforward and are not different from any other health app, I think.

SVB: Sorry, technical securities...?

- ISP: How you protect the data, how you anonymise it, how you limit downloads, how you back it up... all of those things. So that is the same for any health app. Your specific issues will be... the easiest way to break, if you have designed an app with proper, normal security protocols, and they will be encryption, storing your primary key separate from the data and so on... and for anonymising... you often would give them a... store the user data - the individualisation/personalisation data – that's sort of like your name and so on – separate from the data records, on a different database and we link them by a key code, so a number – so that people don't find the names – the log in names or the password, or whatever it is – or you can store passwords but not the password hashkeys – so they would be stored in separate databases. So you store those things separately. The typical way in which the data gets accessed, is by typically when a high level user that's got access to the entire database rather than just individual records – someone who requires more than say a hundred user records, okay, so where... because in your system somewhere you would link which healthcare professionals have access to which patient data... so you would limit – so no primary healthcare worker would download hundreds and hundreds of records. So it would only be for higher level users or certain... like epidemiologists... and there the weakest link is indeed the authentication of those people and the care that they take in terms of their password... and that's usually a human issue... called social engineering – if I want access to the data I would just pretend to be you as a system administrator and say “you seem to have problems with the system with your access” and try to hijack the person's password and login details and thereby download the whole database. So the human controls would be much more critical there. So you should be very, very careful before you allow access to the entire database. But again the protocols and guidelines for that would be the same as for any national health database, but because you're a private individual... I'm not sure if you quite have the resources for ensuring that control
- SVB: Two last questions... one we've touched on is the design team... you mentioned that this idea of having a team of developers, but then you've got a couple of people in control of the project – so those people who have the dream and in a way you want some people working close together and achieve... so people who know what you need for depression app so a psychologist or a psychiatrist; and someone who knows their way around health information systems – or maybe as a consultant - so you're very aware of any ways to make it useful for health practitioners... making sure that you're keeping things compatible... and then obviously people who are designing it want to have conversations or very near links with someone who knows the legal aspect, who knows their way around the legal terms... how big/small do we want to keep it?
- ISP: You're going to have two phases – you're first going to have the proof of concept phase, where you want to show that this is possible and maybe you want to roll it out to a small group of people – so for that you can keep it a fairly small team. Unfortunately you need coders for that that have got experience in coding robust applications. Those skills are currently very scarce in South Africa. They're quite widely available in countries like India and China – so I'm not quite sure how you're going to address that scarcity of good mobile apps... you can go the academic route where you get students to develop these apps but those apps in practise are very fragile and fall over, they're not well designed, because a lot of students develop – they think they're good programmers but they have no experience in building industry strength things... so it pays to... so you may have to outsource the coding to India and China – but the people who write the app and conceptualise the app should be very small. Having said that, if you're going to go and build a system that is going to be used by... not hundreds or thousands of users but by tens of

thousands of users... I'm not quite sure... what's the incidence rate of depression in South Africa?

SVB: It can be up to twelve percent

ISP: Twelve percent... so we're talking about five million potential users... so if you want to reach a sizable fraction of that with your app... let's say even ten percent of that – so five hundred thousand users – if you're developing an app for five hundred thousand users, it's very different than if you're developing the app for a few hundred users. For a few hundred users, those users will be... so the first phase you will be able to do with a small team of six or so, and there will be... well, probably two contract developers. If you want to roll it out to five hundred thousand, then you need to have really industry strength controls and so on and scaling a system from that... real industry strength typically means that you scale up the resources by almost a factor ten – five to ten – instead of having five people work on an app – you'd be looking at a team of twenty to thirty... so it's a scary move to that one. But the first thing is just to show it's possible... maybe ideally roll it out to one province... you know, but again... I suggested earlier on that you phase it when you... you first have the depression app and roll it out to individual users with the backend functionality maybe just available in that province and then when that works you create... there's both a better incentive to track the funds to scale it up and then there's also better experience to extend the functionality and have a better understanding of the requirements and the functions required and what the system issues are and security around that one. But yes, if you were to focus on one province with a couple of thousands of users – then I think you can work with a team of five or six, excluding the developers – that would depend on the functionality.

SVB: Completely unrelated again... adoption by health systems, and especially increasing acceptance to users especially health professionals you'd need to... or clinics... making it appealing... you'd need to prove its efficacy, possibly by helping show that it's... that they have more patients and that patients are statistically looking better, but we have very little data on... especially things like mental health care illnesses, we've got very little data on that, how can we make our app look appealing to them?

ISP: 'Kay, I think scientific data, and with an evidence-based motivation for convincing them to use the app... you would need huge data sets, which you can't have in the beginning anyway, and so it wouldn't be convincing, so I wouldn't spend too much of my energy at the beginning on trying to garner evidence, in order to promote the uptake of the app... you can do that as a separate research project later on as the app has been in use – it's chicken and egg situation, a little bit... so I think initially the app would go through...you'd would convince them by either convincing one or two high level people... like working in the Department of Health and saying.. and convincing them of the potential of the app... that would be very much, I think... convincing not much evidence-based argument but on theoretical or maybe authority – maybe the people involved have got a good relationship – so do your human convincing... a pitching thing... marketing... sales spiel, rather than evidence-based... I think once it's rolled out in the province and you've had it for a year or so... then, rolling it out to other provinces, would require they step up both in the marketing spiel thing but also in terms of then you would actually have some evidence base... whether you can ever prove... because you can... it's not easy to laboratise... so the evidence base there... I don't think you can do... what do you call it... the control group and the... because you wouldn't have a control group really to work with... you may have some generalised data... but as you know the data on depression and treatment and efficacies of traditional methods in South Africa is very scarce... so it would be very hard to work on a strict

scientific thing. You would have hard data on how the app performs – who is using it and what the rates are and what strengths in there – but, yes, you wouldn't have the comparative data of the people who are using the app with that. So there, again, it would still remain motivational, but you would have some better statistics, and maybe just the fact that you have those data statistics would be a good reason, or a good motivation argument

SVB: The fact that it's a data collecting tool...

Okay. Do you have any last comments on interoperability... either within the system... or external... because it's a big thing for government policy that it's interoperable...?

ISP: I would... you have so many other issues to look at... so to me, I would just make sure that the data model that you use is compliant or is compatible with current data models of National Health Information Systems overseas, and beyond that I would not worry about it. I would also, I think if you building a Cloud computing system, I would try and go for a service-orientated architecture, as far as possible, if you can – especially for the health professional side, which is going to be your dynamic health... I would worry about the interoperability later; but make sure that your data forms are proper data structures – because often for mobile health people don't think about data. So as long as you've got a person who knows what data national health data will look - could look like – then you could worry about that interoperability at a later stage.

SVB: I think that the whole point of this is that there have been lots of isolated mobile health projects but they all remain isolated – and we want this to start building... almost a collection of apps that... so later we can look beyond depression and start adding other functionalities... a medication tracking functionality that possibly links into pharmacy systems...

ISP: But even there... you're never going to... I think it's unlikely that you ever going to share that functionality in the next five or seven years... but it's important that you have access to the data – so being able to share the data and that the data is compatible, which I think is a prime – the first prime thing. Who knows what smartphones will look like in seven years... who knows what the web-page interface will look like... so as long as that data is proper, you probably going to go through at least one or two, three major revisions of the entire software base in the next five years before even the national health information system becomes a reality. So you can address the interoperability at a functional level at a later stage. But you can't do that if your data standards have been incorrect. So make sure that the data is compatible... 'cause if you find out that the data standards were wrong and you can't separate certain things... then it's quite tricky to change that...

SVB: Okay... do you have any other comments?

ISP: No, I wish you good luck one... don't try and scope too large... so make sure that you scope it... yes... I would really go for a phased approach, where you start small with maybe no more than three roles... the patient, one particular group of health care ... primary health care workers... and then maybe a professional, so higher level, high skilled health care professional that's specialised in mental health... and then you can run ad hoc statistics for informational purposes... I would not implement too much functionality on that... that could be done as a research project on top of it... but I would only start looking for instance at developing a multiple... NGOs that want to use the data... so that I think you can develop at a later stage... so I would try and develop... three, maybe maximum four roles, and leave the other ones as the next phase of the project. Good luck.... You'll need it!

9.9 APPENDIX 9: ETHICAL CONSIDERATIONS

9.9.1 *Ethics Approval*

Ethical approval for this study was obtained from the University of Cape Town's Faculty of Health Sciences Human Research Ethics Committee on 6 August 2015 (see below).



UNIVERSITY OF CAPE TOWN
Faculty of Health Sciences
Human Research Ethics Committee



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06 August 2015

HREC REF: 518/2015

Prof E Weimann
Public Health & Family Medicine
Falmouth Building

Dear Prof Weimann

PROJECT TITLE: MOBILE HEALTH OPTIONS FOR DEPRESSION: EMPOWERING THE PATIENT AND THE PRACTITIONER (SSM PROJECT)

Thank you for your response to the Faculty of Health Sciences Human Research Ethics Committee received on 5 August 2015.

It is a pleasure to inform you that the HREC has **formally approved** the above-mentioned study.

Approval is granted for one year until the 30th August 2016.

Please submit a progress form, using the standardised Annual Report Form if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed within the approval period.

(Forms can be found on our website: www.health.uct.ac.za/fhs/research/humanethics/forms)

Please quote the HREC REF in all your correspondence.

We acknowledge that the student, Sylvia van Belle will also be involved in this study.

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

Yours sincerely

PROFESSOR M BLOCKMAN
CHAIRPERSON, FHS HUMAN RESEARCH ETHICS COMMITTEE

Federal Wide Assurance Number: FWA00001637.

Institutional Review Board (IRB) number: IRB00001938

This serves to confirm that the University of Cape Town Human Research Ethics Committee complies to the Ethics Standards for Clinical Research with a new drug in patients, based on the Medical Research Council (MRC-SA), Food and Drug Administration (FDA-USA), International Convention on Harmonisation Good Clinical Practice (ICH GCP), South African Good Clinical Practice Guidelines (DoH 2006), based on the Association of the British Pharmaceutical Industry Guidelines (ABPI), and Declaration of Helsinki guidelines.

HREC 518/2015

9.9.2 *Ethical and Regulatory Compliance*

This protocol complies with the latest version of the **Declaration of Helsinki²³** and **The Department of Health: Ethics in Health Research: Principles Structures and Processes²⁴, 2004**.

This study does not require approval from any other body besides the University of Cape Town's Faculty of Health Science's Human Research Ethics Committee.

9.9.3 *Description of risks and benefits*

Potential risks and discomforts: As the questions were non-sensitive and professional, the risk of discomfort during an interview was minimal. In order to reduce any concerns about time constraints, interviewees were asked at the start of the interview how much time they had available, and the interview was tailored to suit the participant's schedule.

Risk classification: Minimal risk study

Semi-structured interviews were undertaken with health professionals and field experts. As fully qualified professionals who were being questioned about their field of expertise, it was unlikely that the study touched upon any group vulnerabilities.

It is unlikely that the questions asked during the semi-structured interviews triggered cognitive or emotional stress – there was no evidence of discomfort during the interviews. As it is a purely observational study, there was no experimental risk and as the research did not include questioning of vulnerable groups, it is unlikely that there would be any socio-economic or legal consequences.

Minimising Risk: In the consent form (see **ERROR! REFERENCE SOURCE NOT FOUND.**, p**ERROR! BOOKMARK NOT DEFINED.**), participants are informed that, should they at any point feel any discomfort, they could stop the interview and withdraw from the study with no adverse consequences (no participants took the interviewer up on this). Participants were also free to express an unwillingness to discuss a topic, which would have been respected. Occasionally participants did not wish to answer questions because they professed a lack of knowledge, but otherwise they did not seem to feel that the information they were imparting was sensitive.

Potential benefits: study participants were offered the option of being kept up to date with the findings of the study (one participant stated a wish not to be contacted further). Participants, as experts in their field, were willing to share knowledge freely and happy to support the author's enthusiasm.

This research will hopefully serve as a point of departure for future initiatives in this direction which may hopeful result in an intervention to increase the quality of care provided to those suffering with mild to moderate depression.

Alternatives to participation: As there is no significant benefit associated with participation in the study, there is no need to offer an alternative to participation.

Harm:benefit ratio: N/A – no substantial harm or benefit is foreseen for participants in this study.

9.9.4 *Conflict of interest and stakeholder participation*

No conflict of interest is declared, and there were no major stakeholders participating the study. Interviewees are not anticipated to participate in any further research

9.9.5 Privacy and confidentiality

Health professionals and other advisors were asked to provide an identifier according to their field of expertise, although generally the identifier was created by the author. Interviews were personally transcribed by the investigator (SVB). Names and transcribed interviews/audio files are kept on separate password-protected computers in folders that are not synced to the Cloud or otherwise uploaded to unsecure networks. Original, unprocessed interviews have not and will not be emailed or distributed in any way.

Because information is not sensitive, names will be put on the consent forms, should they wish to be contacted for follow-up studies. With the same justification, interview recordings will also not be destroyed, as they can be used to ascertain validity.

9.9.6 Reimbursement for participation

There is no reimbursement for participation in this study, and no incentive was offered to interviewees.

9.9.7 Informed Consent Process

9.9.7.1 Process:

During initial contact, it was stressed that participation would be strictly voluntary, and only if the participant had the time and desire to participate. The consent form was sent via email after the participant had agreed to be interviewed. The researcher (SVB) brought a copy of the consent form to the interview location, ensured that the participant understood all relevant points and the consent form was signed by the participant before the interview process was started. It was made clear that consent could be withdrawn at any point.

At the end of the study, all participants were sent a copy of the final draft and asked to comment on the way they are identified by the study and to review all opinions ascribed to them by the author and were given the opportunity to object to phrasing/wording or withdraw any comments.

9.9.7.2 Capacity to consent and comprehension of information:

All participants were adults who had the capacity to consent as educated, qualified professionals, many of whom have had to apply for ethical approval themselves and understand the implications of an interview for research purposes.

All participants were asked whether clarification was required before signing the consent form.

9.9.7.3 Withholding information:

No information was or will be withheld from interviewees, except for the identity of other interviewees. A full description of the project was given. Those that requested it will receive the full report on submission, as well as updates of any further publication.

One interviewee (PSRT) requested to view the transcribed interview to ensure that all identifying information had been removed. All recommendations and requests from the interviewee were followed through.

9.9.7.4 Consent and assent forms

All consent forms are adult consent forms and will be written only in English, as the interviews were conducted in English, a language in which the interviewer and all interviewees were competent. The copies of the signed consent forms are supplied below

9.9.8 *Consent forms*