Experiences of healthcare workers using the AwezaMed translation application in antenatal settings

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by

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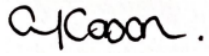
Declaration

I, Caroline Cason, declare that this research report is my own original work. Any research conducted by other persons has been fully referenced. This research report is submitted in partial fulfilment of the requirements for the Degree of Master of Public Health (MPH) with the University of the Witwatersrand, Johannesburg, South Africa. This work has not been submitted for any other degree or examination in this or any other University.

Signature: 

Date: 28 June 2023

Dedication

For Owen Daniel White. I hope that one day you “smug” me.

And

Mona Lisa Christina Mitchell Masoka. If the world were fair, *you* would have been *my* boss, but I hope we would still have been friends.

Abstract

Introduction: Language barriers impede quality health care service in South Africa. Trained interpreters could alleviate this problem, but they are not employed in public or private health settings. Health care workers rely on informal interpreters, who do not necessarily provide an adequate service, and may be resentful of this extra task. AwezaMed is a smart application developed by the Council for Scientific and Industrial Research (CSIR) with content developed for maternal health settings. The aim of this study was to assess usability and user experience relating to AwezaMed.

Methods: A user experience study was conducted using mixed methods. The systems usability scale (SUS) was employed, surveying 12 users, to generate a quantitative score, representing the overall usability of the system. Interviews were conducted with 14 users and analysed thematically to identify themes of usability and user experience, and recognise factors which contribute to use of the application.

Results: The application (app) achieved a total score of 66.25, rating it between 'OK/Fair' and 'Good'. Understandability, operability, attractiveness, and trust were important usability themes. Users also reported using the app as an aid to language learning. Factors which influenced the use of the app included previous experience with mHealth, experiencing a language barrier in health settings, and unavailability of, or problems with interpreters.

Discussion: While the app was received positively, it did not meet users' expectations, as two-way communication could not be achieved. Due to the often-strained relationship between healthcare workers and informal interpreters, there remains a demand for a usable, trustworthy mHealth solution. A framework is proposed, based on these findings, to evaluate mHealth translation applications in South Africa in the future.

Key words: Language barrier, translation, mHealth, user experience, language application, machine translation

Abstrak

Inleiding: Taalhindernisse belemmer kwaliteit gesondheidsorgdiens in Suid-Afrika. Opgeleide tolke kan hierdie probleem verlig, maar hulle word nie in openbare of private gesondheidsinstellings aangestel nie. Gesondheidsorgwerkers maak staat op informele tolke, wat nie noodwendig 'n voldoende diens lewer nie, en kan gegrief wees oor hierdie ekstra taak. AwezaMed is 'n slim toepassing wat deur die Wetenskaplike en Nywerheidsnavorsingsraad (WNNR) ontwikkel is met inhoud wat vir moedergesondheidsinstellings ontwikkel is. Die doel van hierdie studie was om bruikbaarheid en gebruikerservaring met betrekking tot AwezaMed te assesseer.

Metodes: 'n Gebruikerservaringstudie is uitgevoer met behulp van gemengde metodes. Die stelsel bruikbaarheidskaal (SUS) is gebruik, wat 12 gebruikers ondersoek het, om 'n kwantitatiewe telling te genereer, wat die algehele bruikbaarheid van die stelsel verteenwoordig. Onderhoude is met 14 gebruikers gevoer en tematies ontleed om temas van bruikbaarheid en gebruikerservaring te identifiseer en faktore te herken wat bydra tot die gebruik van die toepassing.

Resultate: Die toepassing het 'n SUS-telling van 66.25 behaal, wat dit tussen 'OK/Baie' en 'Goed' beoordeel. Verstaanbaarheid, bruikbaarheid, aantreklikheid en vertroue was belangrike bruikbaarheidstemas. Gebruikers het ook gerapporteer dat hulle die toepassing gebruik as 'n hulpmiddel vir taalleer. Faktore wat die gebruik van die toepassing beïnvloed het, sluit in vorige ondervinding met mHealth, ondervinding van 'n taalversperring in gesondheidsinstellings, en onbeskikbaarheid van, of probleme met tolke.

Bespreking: Alhoewel die toepassing positief ontvang is, het dit nie aan gebruikers se verwagtinge voldoen nie, aangesien tweerigting-interpretasie nie bereik kon word nie. As gevolg van die dikwels gespanne verhouding tussen gesondheidsorgwerkers en informele tolke, bly daar 'n vraag na 'n bruikbare, betroubare mHealth-oplossing. 'n Raamwerk word voorgestel, gebaseer op hierdie bevindinge, om mHealth-vertalingstoepassings in Suid-Afrika in die toekoms te evalueer.

Sleutelwoorde: Taalversperring, vertaling, mHealth, gebruikerservaring, taaltoepassing, masjienvertaling

(Translated into Afrikaans using Google Translate – 11 June 2023. Unreviewed.)

Okungathinteki

Introduction: Izingqinamba zolimi -ngahlanzekile bokunakekelwa ngezempilo Service eningizimu afrika. Baqeqeshwe interpreters nokusiza lokhu kungaba inkinga, kodwa uma usebenza endaweni yomphakathi noma ezimele yezempilo. Abasebenzi bezempilo ukwethembela emthethweni interpreters, akunjalo luhlinzeka okwanele, futhi kungaba yisiphi lokhu athe xaxa. Awezamed is ohlakaniphile isicelo developed by the council for ngezesayensi nezezimboni ucwaningo (csir) okuqukethwe amaphrogramu kumama impilo. Inhloso yalolu cwaningo ukuze bahlole futhi umsebenzisi ukusebenzisa ulwazi oluphathelene awezamed.

Izindlela: Umsebenzisi isipiliyoni kwenziwa ngokusebenzisa Mixed. Izinhlelo ukusebenzisa scale (sus) uyasebenza, ukuhlola indawo yesakhiwo 12, ukwenza inani Score, ukusebenzisa jikelele. Imibuzo khona with 14 abasebenzisa ambadlwana thematically ukuthi ingqikithi of ukusebenzisa futhi umsebenzisi isipiliyoni kanye nokwamukela izinto ezidala ukuba khona isicelo.

Imiphumela: The app ezenze an sus Uzolinganisa phakathi kuka-1 kuya ku- 66.25, ukukala izinga pakati â € ˜ OK / fairâ € ™kanye â € ˜ goodâ € ™. Understandability, operability, iwozawoza, Ukwethemba kubalulekile ukusebenzisa a. Abasebenzisi futhi ngokusebenzisa app uma ukufunda ngolimi. Amaphuzu influenced ukusetshenziswa app efakiwe nesipiliyoni njengoba mhealth, inazo ulimi, futhi izingqinamba lapho impilo yakhe, noma nezinkinga interpreters.

Nengxoxo: Ngesikhathi app etholwe kahle, wa Li usersâ € ukuhlangabezana nokulindelwe ™, ukuthwala ukuhunyushwa ngeke. Ngenxa often-strained phakathi zempilo abasebenzi kanye interpreters, there remains a isidingo esebenzisekayo, abakolekayo mhealth. Uhlaka is a, lokhu okusha, ukuhlola mhealth Translation izicelo eningizimu afrika.

Key words: Izingqinamba zolimi, ukuhumusha, mhealth, umsebenzisi, ulimi, zokuhumusha

(*Translated into isiZulu using Autshumato – 11 June 2023. The incompleteness of this translation is acknowledged, and it is included, unaltered, as an illustration of the limited resources available for machine translation of local languages. This is by no means intended as a complete isiZulu translation. The Autshumato platform offers users the option to review and improve translations*)

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Thank you to the Woods for your practical help and support. To my mother, Valerie, and my husband, Paul, thank you for sharing me with this project. I would not have managed without you.

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List of abbreviations

ASR	Automatic speech recognition
CPR	Cardiopulmonary resuscitation
eHealth	Electronic health services
ER	Emergency room
GPRS	General packet radio services
HIV	Human immunodeficiency virus
HITAM	Health information acceptance model
HLT	Human language technology
HREC	Human research ethics committee
ICT	Information and communications technology
ICT4H	Information and communications technology for healthcare
IEC	International electrotechnical commission
ISO	International organisation for standardisation
IVR	Interactive voice response
ITE	Integrated translation environment
MAMA	Mobile alliance for maternal action
mHealth	Mobile health
MT	Machine translation
NICU	Neonatal intensive care unit
NLI	Natural language interface
NMT	Neural machine translation
PDA	Personal digital assistant
PHC	Primary health care
QD	Quality descriptive
S2S	Speech to speech
SMS	Short message service
SMT	Statistical machine translation
SUS	Systems usability scale
TAM	Technology acceptance model

TB	Tuberculosis
UN	United Nations
UNPD	United Nations Procurement Division
USSD	Unstructured supplementary service data

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Chapter 1: Introduction

This chapter will provide a background to the language barrier in health services and introduces the concepts of machine translation and study of user experience. The setting and rationale for the development of an mHealth translation application are explained. The aims and objectives of this study are outlined.

1.1 Background

During twelve years as a midwife in South Africa, I have frequently found language limitations to be a hindrance to providing quality health services. This ranges from difficulty in greeting a client and establishing rapport, to being unable to provide appropriate health education to a new mother upon discharge from the facility. I have encountered these communication problems in antenatal settings, the labour and delivery unit, and the postnatal environment. Communication barriers exist between South Africans of varied cultural and language groups, including minorities, of which I am a part, and immigrants from neighbouring states and farther afield.

Language barriers are an established feature of the South African health system, and can negatively impact the quality of care experienced by patients and the quality of care delivered by healthcare providers (1). Communication barriers may result in avoidance behaviour, whereby patients delay seeking treatment, errors in diagnosis and treatment, and poor health education and compliance (1).

Obstacles to quality patient care created by language barriers, include reduced understanding of diagnoses, medication usage, and expectation of follow-up in both adult and paediatric settings (2). Larger studies have shown a reduction in the resolution of symptoms, reduction in emotional health, and poorer pain control as a direct result of poor communication between health care workers and health service users (2–4).

Saohatse (5) proposed that the health system may be studied as a proxy for the social situation and as a microcosm of the language situation in South Africa, and Bischoff (6) suggests that quality of communication may serve as a proxy for the assessment of quality of care. Post-apartheid researchers found that most non-nursing cadre health professionals could not speak the language of their patients,

and while English has long been regarded as the *lingua franca*, proficiency is limited, especially among the poor and marginalised users of public health services (1).

Roter and Hall state that "…talk is the main ingredient in medical care, and it is the fundamental instrument by which the doctor-patient relationship is crafted and by which therapeutic goals are achieved" (7). Communication between doctors (or healthcare workers) and patients (or clients) serves three distinguishable purposes: formation of an inter-personal relationship, exchanging information, and decision making (8). The interpersonal relationship is complex; it requires close co-operation, yet it is often involuntary and unequal in power balance, and as it may concern issues of vital importance, it is emotionally charged (8).

Poor communication causes a breakdown in the relationship between healthcare workers and healthcare users, which affects the morale and motivation of healthcare professionals, as well as the health outcomes of patients (4,8). Healthcare users blame themselves for their inability to adequately express themselves to doctors and nurses (4), and this imagined inferiority fuels medical paternalism further (9). Cultural differences continue to contribute to this; patients have reported not wishing to show disrespect to the doctor, by asking questions during consultations (9).

1.2 Problem Statement

Language barriers between healthcare providers and healthcare users negatively affect standards of healthcare delivery worldwide (3,10), and in South Africa (11).

During apartheid years, the dictatorial doctor-centred medical model of interpersonal communication dominated therapeutic interactions. The power balance rested firmly on the side of the (predominantly white, male) medical practitioner (9). While theoretical changes were effected during the 1980s and 1990s towards a more equal, interactive communication style in the medical sphere, even in the 2000s, the South African state healthcare user is all too often relegated to the submissive role (9). Inequalities, both real and perceived, in social stature, specialist knowledge, age, gender and power are exacerbated by differences in culture and language (9). This therefore begs the question: can communicative competence ever be achieved in

the South African healthcare environment (9)? “Linguistically adequate” care is achieved when health workers and healthcare users share language proficiency, or when trained interpreters are used (6).

In South Africa, no formal provision is made for interpreting nor translation in health care settings, leaving clinicians to rely on informal and ad-hoc interpreters. These may include nurses, cleaners, security guards, patients’ family members, and even members of the general public (4,12).

While mHealth applications have become increasingly popular in the last ten years (13), few studies have been identified in the context of machine translation of African languages (14). A need exists to measure the user experience and determine the value of a speech-to-speech translation application in a South African setting.

1.3 Rationale for the study

The negative effects of language barriers on health care may be as basic as the delays caused by mispronunciation when calling Xhosa names in a waiting room (2), or as dangerous as undergoing an unnecessary procedure (4). Patients are less likely to complete treatment as prescribed, adhere to health advice or follow up as scheduled, when they do not adequately understand their diagnosis (3,10). Families seeking care at a paediatric teaching hospital in the Western Cape found that the language barrier compromised the standard of health care they received, but tended to blame themselves for their own language inadequacies, rather than the healthcare workers (2). The use of medical jargon further impeded understanding (2).

1.3.1 The use of interpreters in health settings

The provision of skilled interpreters in health settings seems a logical solution. In practice, this does not happen. Despite assurances in the Freedom Charter that “all people shall have equal right to use their own languages” (15), the only practical stipulation relating to interlingual mediation in the Constitution is to be found in Section 35(3)(k):

> “Every accused person has a right to a fair trial, which includes the right to be tried in a language that the accused person understands or, if that is not practicable, to have the proceedings interpreted in that language” (16).

Task shifting is frequently employed in lower middle-income countries (LMIC) as a means of relieving healthcare workers of some of their burden (17). In 2011, fifteen first-language isiXhosa speakers were employed by the Western Cape Department of Health as interpreters, on a contract basis (18). By May 2013 the 11 interpreters who remained were permanently employed, but by 2016 this number had dwindled to nine (18). Interpreters do not form part of the staff complement in health facilities in the other eight South African provinces (18). This is unlikely to change in the face of resource limitations in the public sector.

In the absence of even trained lay interpreters, ad hoc interpreting is the norm, but it does not adequately bridge the gap. Health workers such as nurses, who are called upon to interpret for other (seemingly higher) cadres of workers, such as doctors, express frustration and resentment at being expected to perform this “invisible” (19) service at the expense of their own work (4,5).

When the needs arise, any person may be pressed into interpreting, including cleaners, security guards, patients’ family members and members of the general public (5,18,19). This raises ethical and legal concerns; when non-professional staff or members of the community interpret, confidentiality cannot be guaranteed (4). Concerns have been raised regarding the completeness of the information provided, and patients’ level of understanding when attempting to obtain informed consent for procedures (4).

1.3.2 Interpreting using technology

eHealth and mHealth technologies are used in other parts of the world to bridge language barriers, including those in health services (20). Unfortunately, in South Africa, most of the languages are regarded as under-resourced. This refers to a narrow presence on the internet, scarcity of linguistic skills, and limited availability of information technology (21), despite there being many native speakers of the languages (22). This contributes to the dearth of available eHealth technologies in local languages.

Systems and apps which have been developed locally have not undergone rigorous user experience testing. A need has been identified to test qualitatively. Poor quality of mHealth applications may (at best) result in slow adoption of technological health solutions, or (at worst) negatively affect health users (23,24).

1.3.1 Research question

What is the experience of healthcare workers using a locally developed speech-to-speech translation application in South Africa?

1.3.2 Aim of the study

To assess the usability and user experience of a speech-to-speech translation application among healthcare workers in South Africa.

1.3.3 Study objectives

1. To measure the usability of the AwezaMed translation application among healthcare workers, in South Africa.

2. To describe the user experience of healthcare workers, using the AwezaMed translation to facilitate interactions with healthcare users in South Africa.

3. To explore factors which contribute to the usage of the AwezaMed application by healthcare workers.

1.4 Literature Review

1.4.1 Language barriers and interpreters

"We can't all understand the whites' language" (19)

Levin (2) investigated the impact of a language barrier as an impediment to quality health care in a Western Cape paediatric tertiary hospital. Surveyed parents and caregivers cited communication problems as a greater challenge to health than structural or socio-economic concerns (2). Despite most families speaking isiXhosa as a home language, 92% of preceding medical interviews had been conducted in English (2). Of these, only 21% were aided by an interpreter (formal or informal) (2). Few of the caregivers were satisfied with the duration and nature of their discussion with the doctor, and many believed that their inability to adequately explain themselves would impact negatively on the care their child would receive (2).

A qualitative study conducted at a Western Cape district hospital, found that ad-hoc interpreting was done mostly by nurses, although at times ancillary staff, patients' relatives and even other patients filled the role (4). Healthcare workers reported frustration and feelings of powerlessness at their inability to communicate effectively with healthcare users (4). Nurses and doctors spoke of patients being discharged without knowing their diagnosis, unsure of how and when to take their prescribed medication, and without knowing when or where to report for follow-up (4). Health workers believed that patients should make more effort to learn English or Afrikaans, but also expressed the desire to learn isiXhosa for the benefit of the community (4). Staff who had been required to interpret verbalised that providing this service interfered with their duties, and non-medical staff expressed reluctance to take on the responsibility (4). It was suggested that trained interpreters, with a medical background, should be appointed (4).

A comparison between trained interpreters and informal interpreters indicated that while errors were common to both, the errors made by informal interpreters were more likely to have clinical consequences for paediatric patients in the study (3). The most common error was omission, followed by false fluency, substitution, editorialization and addition (3). Such errors may impact clinical decision making and affect patient outcomes.

1.4.2 mHealth

The Information and Communication Technologies for Healthcare (ICT4H) model suggests a framework according to which the advantages and disadvantages of information and communication technologies (ICT) used in public health may be arranged (25). Advantageous themes in ICT use include the creation of opportunities, enhancement of existing capabilities, enabling of social relationships in public health, and generation of knowledge while barriers may be classified as infrastructural, social, technological, and economic (21, 22). Mobile phones have been identified as an important and rapidly expanding area of ICT in health (25).

mHealth is the component of eHealth (electronic health) which encompasses 'medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices' (27). mHealth may be used by healthcare workers or healthcare users to impact the health status of individuals or communities. These functions are dependent on a key characteristic of mobiles devices, namely connectivity, and may utilise general packet radio service (GPRS), third and fourth-generation mobile telecommunication systems (3G and 4G), and global positioning systems (27). Modes used by applications include short message service (SMS), interactive voice response (IVR) and others to perform health-related functions (28).

mHealth is not a new concept in public health. A 2010 review identified six major themes in mHealth, namely treatment compliance, data collection and disease surveillance, health information systems and point-of-care support, health promotion and disease prevention, and emergency medical response (29). The same study identified gaps in knowledge pertaining to the limited scale and scope of implementation and evaluation of mHealth initiatives, and suggested that mHealth be employed as a tool for extending and integrating existing health information systems along a health continuum, rather than as a stand-alone resource (29).

Subsequent to the above study, the rapid increase in the number of mHealth projects, encouraged by a large number of smart mobile devices in circulation (30), has generated much hype in the public health arena (24, 26). Prominent researchers in the mHealth sphere argue that mHealth should not be viewed as an end in itself; but rather as means to strengthen existing efforts to impact health (28).

Rather than asking whether or not mHealth “works” (28), the focus should be on identifying key areas of need, selecting the appropriate mHealth strategy which could potentially overcome constraints in the health system, and using recognised indicators to determine the impact of mHealth on health outcomes (28).

mHealth technologies can be viewed as tools which will make improvements to the performance of health systems, and enhance the delivery of needed interventions, by improving the quality, coverage, efficiency and equity of interventions (28).

Key classifications of mHealth recognised by the UN Foundation and the UNPD include remote data collection, communication and training for healthcare workers, remote monitoring, treatment compliance, and management of patient records (27,31).

Labrique et al (28) suggest twelve common applications of mHealth technologies:

- client education and behaviour change communication
- sensors and point of care diagnostics
- registries and vital events tracking
- data collection and reporting
- electronic health records
- electronic decision support
- provider to provider communication
- provider work planning and scheduling
- provider training and education
- human resource management
- supply chain management and financial transactions and incentives

Most technologies would employ at least two or more of these. mHealth offers a unique channel to deliver information intended to improve people’s knowledge, change attitudes, and alter behaviours. Interventions in this category capitalise on people’s access to mobile technology and may influence behaviours such as adherence to prescribed medication, and appropriate utilisation of health services (28,32). Examples include The Mobile Alliance for Maternal Action (MAMA) (28), and MomConnect in South Africa (33).

MomConnect is a well-known South African mHealth-based service, which was introduced in public antenatal clinics in 2014. The purpose of this SMS-based service is to link mothers to antenatal care and encourage early and frequent attendance, and to collect feedback from healthcare users, regarding of antenatal and post-natal service delivery (33,34). MomConnect grew to scale fast, and within three years of roll out had reached 1.7 million healthcare users, or 63% of women attending their first antenatal appointment (34). At the time of publication by Barron et al, the MomConnect helpdesk had received more than 9700 compliments regarding service, and 1300 complaints, boasting a resolution rate above 80% (34).

The MomConnect project has set precedents in terms of policies for mHealth, and management of confidential client data within a national digital system, and opened doors for projects supporting the management of chronic diseases including HIV, diabetes, tuberculosis and mental health (34). It is envisaged that in future, mHealth will focus on more affordable data service, with the shift from SMS and USSD service to smart phone use (34).

Nilsen et al (35) recognise the potential of mHealth strategies to positively impact the health of populations by increasing access to services, reducing disparities between groups, preventing disease, enhancing diagnostics, improving treatment and lowering costs of care. Also highlighted is the potential to advance research, both into the functionality of mHealth strategies, as well as utilisation of mHealth to strategies to further public health knowledge (35).

The authors acknowledge that the development of mHealth products outpaces evaluation, and identify a need to rigorously examine the potential of mHealth to improve health outcomes (35). It is suggested that mHealth science should adapt and develop methods of research and analysis to process the data which is generated by the field (35). These strategies should draw from clinical expertise, and social and behavioural science, to close the gap between technological develop and public health practice.

Anderson, Burford and Emmerton evaluated the user experience of various health apps using thematic analysis of semi-structured interviews (36). Data was analysed using the Technology Acceptance Model (TAM) and Health Information Acceptance Model (HITAM) which incorporates the Health Belief Model (36). These frameworks

effectively combine behavioural, personal, social and technological factors to evaluate acceptance of technology, and its impact on decision-making and intended behaviour (36). The Mobile Application Rating Scale was further used to appraise the quality and acceptability of the technological aspect of the mHealth apps (36). This tool is based on four scales, namely engagement, functionality, aesthetics and information quality (36). The findings of this study indicated that continued use of mHealth apps may support healthcare users in the self-management of chronic conditions (36). Fitness apps were found to be beneficial in the management of diabetes, depressions, obesity and sleep problems, and in-app gamification added a level of motivation, without trivialising the health problem being addressed (36).

The policy environment has been identified as an impediment to the adoption of larger-scale mHealth initiatives in lower middle-income countries; particularly policies which would link health objectives and indicators to available mHealth technologies (29). This may be due to the dearth of cost-benefit studies in the field of mHealth (29). The bulk of mHealth studies to date originated in the field of computer science rather than health (29). A need for leadership in this field has been identified, in order to scale up the development, testing, implementation and evaluation of mHealth technology (29).

Machine translation is an expanding area of mHealth.

1.4.3 Machine translation (MT) in healthcare settings

Google Translate is a readily available tool, that health workers, facing language barriers, may employ to facilitate communication in the absence of interpreters. A 2014 study evaluated the usefulness of Google Translate in medical settings, by determining the accuracy of the interpretation of medical phrases (37).

Ten commonly used phrases were translated using the app, and translations were forwarded to native speakers for evaluation. Serious errors occurred, including the mistranslation of ‘your child is fitting’ to “your child is dead” in Swahili (37). Google Translate uses statistical matching for machine translation, rather than grammar rules or a dictionary approach, and thus runs the risk of producing nonsensical results (37). The overall accuracy of interpretations was measured at under 58%, rendering it functionally unsafe for important medical communications (37).

Worryingly, this accuracy dropped to only 45% when translating African languages, which are historically under-resourced (37).

Before this, a statistical machine translation (SMT) system was developed for use in medical settings to bridge barriers between English speakers, and Spanish speakers (38). This system, S-MINDS, combined SMT with grammar rule-based translation for accuracy, and included automatic speech recognition (ASR) technology (38). For evaluation, three nurses were trained in the use of the system, and 11 Spanish-speaking clients received brief training and gave consent to participate in the study (38). Translation of over 500 utterances during nursing 95 interactions was evaluated remotely by fully bilingual researchers (38).

Nurse-generated phrases were found to be translated with 94% accuracy, however, the accuracy of translation of patients' utterances dropped to 90% (38). This may indicate that increased training of users may result in greater accuracy of machine translation (MT) systems in general.

MedSLT is a grammar-based, bi-directional translation system, developed for medical settings (39). Grammar based MT was chosen as accurate SMT would require the collection of a very large quantity of quality utterances, in order to provide a reliable base for translation, and in medical settings the quality and accuracy of translation is a safety critical point (39). The bidirectionality was considered essential by developers to maintain the patient-centred approach in health care, and shared decision-making (39). Provision is also made for yes/no, or non-verbal answers on the part of the patient. The study conducted by Bouillon *et al* focused on content specific to consulting a physician regarding a sore throat, and evaluated the system for accuracy of English/Spanish translations, rather than the user experience of either health workers or users (39). In this setting, MedSLT did not operate as an mHealth system.

MedSLT was expanded to include Arabic, in addition to Spanish, French and Catalan (39,40), and evaluated for the accuracy of translations by native Arabic speakers. Translations were rated for accuracy using a three-point scale, where translations which retained all meaning were categorised as "good", incomplete but understandable translations were categorised as "OK" and non-understandable or agrammatical translations were categorised as "bad" (40). It was found that good or

“OK” translations were dependent on good recognition and analysis of the (English) source utterance, and thus favoured physicians (users) who were well versed with the content (40).

Converser is an MT system designed for use in healthcare settings, primarily to bridge language gaps between English and Spanish speakers (41). Even though speech recognition and translation technologies are both error-prone, Converser aims to provide both accuracy and broad content and remain accurate (41). This is achieved by provision for real-time correction of translations when errors are detected through optional back translations, and use of translation shortcuts, and text-to-speech options (suiting both typing and handwriting inputs) (41). Converser version 3.0 was piloted in a large San Francisco medical facility, in a pharmacy department using a computer on a desktop or cart, and in in-patient nursing and ophthalmology departments using handheld tablets (41).

The system utilised Dragon NaturallySpeaking software, which required users to register their voices for adequate speech recognition (41). While this was no hardship for repeat-user healthcare workers, it was time-consuming and a challenge to Spanish-speaking users (41).

User experience of this Dragon NaturallySpeaking software-based system was evaluated by the observation of real-time interactions by an independent observer, and interviews with healthcare workers and health care users (42). Positive responses from patients included liking the idea, seeing the system as useful in emergencies, finding the system functional, and finding translations understandable, even if “not 100” (42). Negative feedback included concerns with literacy issues, the speed of the system, and the quality of translations (42). Feedback from healthcare workers indicated a preference for text (typing and handwriting) to speech over speech-to-speech, concerns regarding time efficiency and dissatisfaction with the target language (a preference for Cantonese was expressed) (42). Both groups agreed on the value of efficiency and reliability, while attractiveness was rated as least important (42). Recommendations were made for improvements including better functioning environments with variable noise and light. Preference was expressed for a system which could be fully portable (41).

The need to evaluate translation systems is evident, and Tsourakis and Estrella (43) suggest a quality model specific to mobile medical speech translation systems, based on the ISO/IEC 9126 quality framework. The authors regard the translation system as a software product, rather than a medical device (43), thus opting for a software or system evaluation framework. This framework was chosen as it is internationally recognised, and generic in that it could be applied to any software product (43). The study evaluated functionality, reliability, usability, efficiency, portability and compliance as quality characteristics (43). These were further decomposed into sub-characteristics. Participants, including physicians and patients, were presented with a questionnaire which paired sub-characteristics for comparison (43). Results indicated that physicians placed the highest value on functionality, followed by reliability and usability (43). Compliance (with hospital policy) was rated highest by patient users, and accuracy was deemed important by both groups, followed by security and exploitability respectively (43). Physicians placed value on the coexistence of the system with established systems, and patients valued replaceability (ease with which the system could be upgraded to a newer version when available). Both groups agreed on the value of efficiency and reliability, while attractiveness was rated as least important (43).

1.4.4 Human language technology (HLT) in South Africa

Makovhololo suggests that ICT solutions to language barriers are often unsuccessful, as they are developed and implemented without input from the patients (44). The semantics of African languages may have a marked effect on interactions between healthcare workers and healthcare users, and this should be carefully accounted for when developing translation systems for the local context (44).

Key moments of need for effective interpreting are identified and factors which will influence translation semantics are suggested (44). These include the nature and structure of hospital management, interactive systems within the health facility, the language barriers encountered, the presence or absence of formal or informal support groups, the technological know-how of healthcare workers, and the culture and traditional affiliation of both healthcare workers and healthcare users (44). The researcher proposes a framework explaining the relationships between factors which

influence the semantics of translation, in the hope that a greater understanding will contribute to greater success of ICT language solutions in South Africa (44).

The Autshumato project is an effort by the South African government to elevate the status of marginalised languages (45). The system was developed in 2009 with funding from the (then) Department of Arts and Culture, as an integrated translation environment (ITE) (45). Despite promises of the equal status of all official languages, English was the undisputed top of the language hierarchy (16,19,45). This was easily proven by the fact that transcripts of parliamentary proceedings were not available in ten of the eleven official languages (45). The Autshumato ITE was developed to assist government translators with this workload (45).

Autshumato exists currently as a free-to-use open-source online machine translation (MT) service, for text and documents (46). It provides high-speed translation from English to Xitsonga, isiZulu, Sesotho, Sepedi, Setswana and Afrikaans. A recent review of the system by Skosana and Mlambo identified a few shortcomings. These include the current absence of isiXhosa, Siswati, Tshivenda and isiNdebele, however developers indicate that these languages will be included as resources become available (46). When testing translations, some errors occurred – mostly grammatical errors such as incorrect capitalisation (46). The researchers suggest that the system be improved by adding data where possible, involving language specialists, and integrating other existing tools (46).

Neural machine translation (NMT) is a recent development in the sphere of machine translation MT (47). It differs from traditional statistical or phrase-based MT in that it attempts to build an artificial neural network, which can predict the likely sequence of words in a sentence or phrase (47). The encoding and decoding aspects of the system are trained simultaneously, increasing the likelihood of a correct translation for given word combinations (47). An attempt was made to create an NMT toolkit for the translation of South African official languages (48). The base phraseology was provided by an existing religious-based corpus, and the outputs were measured for accuracy using the Autshumato evaluation set, which is government document based (48). This indicates that the two language corpora are congruent. Results were generally favourable, except translations into isiNdebele, Northern Sotho, and Siswati – these were the languages with the smallest data sets (48).

Speech has become increasingly important as an input modality for translation and interpreting systems, both for gathering data and use of the system (49). Automatic speech recognition (ASR) users and developers in the developing world and lower middle income-countries (LMIC), require a means to collect verbal data which does not rely on studio facilities or internet connectivity (49). Woefzela was developed as a means to collect utterances using a mobile device, in a variety of situations, to generate a corpus to enable the development of resources for under-resourced languages in South Africa (49). The application enabled the parallel collection of speech data from numerous speakers, with quality control in real-time, for upload at a later stage (49). Data generated using this app may have contributed to current ASR technologies (49).

1.4.4.1 AwezaMed

AwezaMed is a speech-to-speech (S2S) system, employing text-to-speech (TTS), machine translation (MT) and automatic speech recognition (ASR) technology (50). The application was funded by the National Department of Sport, Arts and Culture, and was developed by the Voice Computing Research Group at the Council for Scientific and Industrial Research (CSIR). AwezaMed was developed for use in maternal health care, specifically maternity care, and obstetrics. More than 3900 utterances in the source language (English) and target languages (Afrikaans, isiZulu and isiXhosa) are classified under the content medical history, general history, obstetric history and neonatal history (50). The system takes the format of an application for smart devices utilising the Android operating system (50). The source language is English, and target languages include Afrikaans, isiZulu and isiXhosa (50)

The application was developed over three stages, resulting in three different versions that were piloted in Gauteng, Western Cape, and Kwa Zulu Natal, over the course of three years. Most health care providers surveyed in the study provided generally positive feedback, stating that they were able to build rapport, bridge communication gaps, and treat all patients equally, regardless of their home language (50). The authors acknowledge that it could not be foreseen, at the outset of the study, what the impact would be of introducing technology into the health worker – patient/client interaction (50).

AwezaMed is the first smart application of its kind, developed and tested in South Africa. The project aimed to showcase the integration of the research group's technologies in a real-world application and only limited user experience testing was conducted (50).

This system was chosen as the basis for this research report, as the researcher was involved with content selection in the early phase. The researcher became aware of the possibility of further user-experience testing after the cessation of the initial project.

Table 1.1 Key characteristics of selected language technologies

System name	Setting	Languages	Characteristics	Suitability
Google Translate	Online or mobile application	Many	Utilises statistical machine translation	Unsuitable for medical settings
S-MINDS	Health care settings	English and Spanish	Grammar and rules based, utilises ASR	Greater accuracy in translation health workers' utterances
MedSLT	Health care settings	English and Spanish, Arabic, French and Catalan	Grammar based, bidriectional	Evaluated for accuracy, rather thab user experience
Converser	Portable system in health facilities	English and Spanish	Utilises Dragon NaturallySpeaking software	Translations found to be adequate
Autshumato	online	English, Xitsonga, isiZulu, Sesotho, Sepedi, Setswana and Afrikaans	Machine translation of text	Grammatical errors in translation
Woefzela	Mobile technology		System designed for collection of utterances	Not utilised for translation or interpreting

AwezaMed	Smart application purpose designed for maternal health settings	English, Afrikaans, isiZulu, isiXhosa	TTS, MT, ASR, S2S	A need for further testing identified

Chapter 2: Methods

This chapter explains the research methodologies employed in the design and execution of this study, management of data and analysis of data.

2.1 Study Design

The study was conceptualized as a concurrent-approach mixed-method user experience study of the AwezaMed translation application. The AwezaMed app was made available to the researcher by the developers, the Voice Computing Research Group and Aweza, from March 2020 until October 2022, and data were collected between June 2021 and October 2022.

Usability was measured quantitatively using the systems usability scale (SUS) (51) a validated tool, and narrative analysis of qualitative data. ISO 9241-11, ISO/IEC 9126-1, and ISO/IEC 25010 quality frameworks provided inductive themes for narrative analysis of usability (52–54). Further deductive thematic analysis of qualitative data allowed the exploration of user experience and factors which contributed to the use of the application. These themes were coded and analysed according to the qualitative descriptive (QD) theoretical framework, described by Sandelowski (55).

Qualitative description is characterised by simple descriptions which remain close to the data, presentation of findings in simple, everyday language and a focus on facts which allows for easy consensus among researchers (55). This framework is ideal for obtaining “minimally theorised” (55) responses to questions relevant to practice and policy, for example determining reasons for the usage or non-usage of a service or procedure, or establishing who the users of a service are (55). For these reasons it may be well suited to exploring user experience, and factors which contribute to the usage of a system.

The mixed method model employed is a concurrent triangulation strategy, as described by Creswell in 2002 (56). Quantitative and qualitative data were collected in a single phase of the study and analysed simultaneously using different methods (56) (figure 2.1). This allows strengths in each method to offset weaknesses of the other, and integration of data in the analysis phase may result in strengthened validity of findings (56).

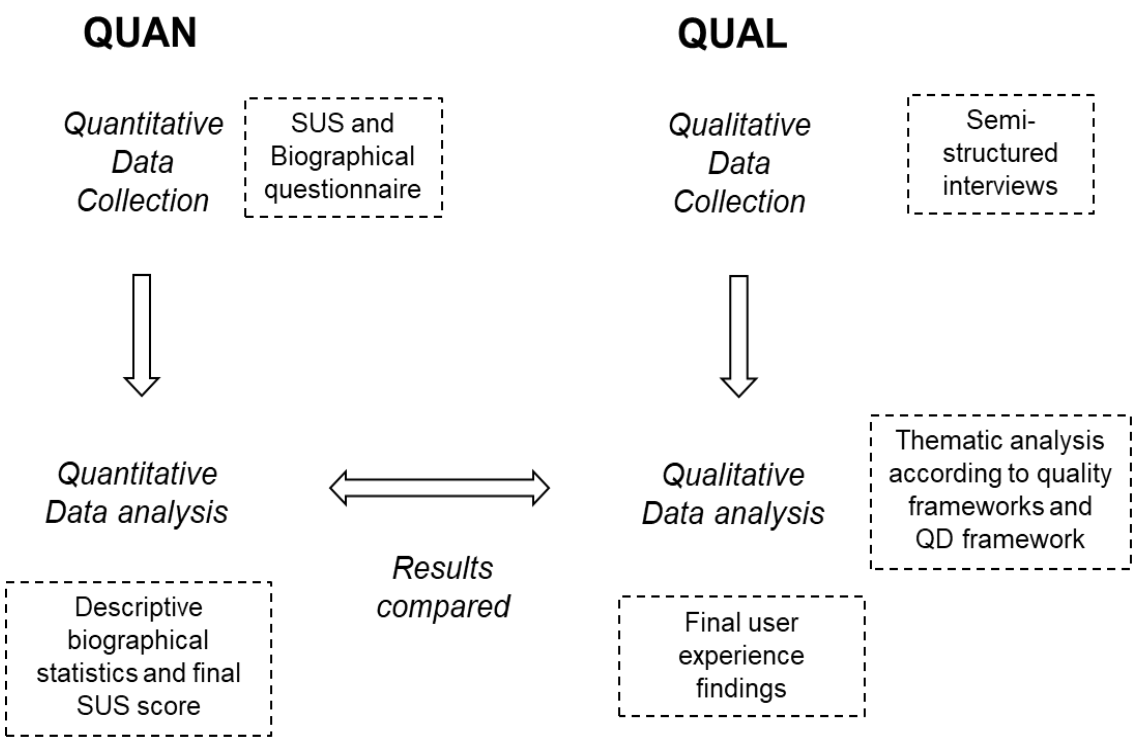

Figure 2. 1 The mixed-method research process utilised in this study (56)

2.2 Study sample

The initial target group for the study was fifth-year medical students at the University of the Witwatersrand. This group was chosen due to their diversity and perceived need for interpreting, and the fact that they would be undertaking training in obstetrics and gynaecology during this academic year.

Ethical clearance was sought and obtained from the Human Research Ethics Committee (Medical) of the University of the Witwatersrand, and permission to conduct the study was sought and obtained from the office of the deputy registrar, as well as the head of undergraduate medical education, and the head of undergraduate obstetrics and gynaecology education.

The researcher met with three consecutive groups of fifth-year students, at Charlotte Maxeke Academic Hospital during the orientation session for the obstetrics and gynaecology study block and introduced the AwezaMed app and the study. Students were informed that the app was suitable for Android devices. Interested students were invited to provide their telephone numbers and student email addresses, and the link to download the app was sent to them via WhatsApp message. Students were invited to use the app in their personal capacities, to facilitate interpretation

when language barriers were encountered during clinical sessions and were informed that feedback would be collected by conducting focus group discussions during the academic teaching week (when students would be on campus) scheduled for June 2021. When a fire disrupted teaching at Charlotte Maxeke Academic Hospital, students were approached during orientation at Rahima Moosa Mother and Child Hospital.

Nine students expressed interest and received the link to download the app via WhatsApp or email. These students were contacted via email before the spiralled week, to invite participation in focus group discussions. These focus groups would have been conducted remotely, since the structure of the spiralled week was changed under Covid19 regulations. None of the students expressed interest in participating in the User Experience study. The biographical questionnaire and feedback questionnaire were provided to the students, in the hope of collecting data explaining reasons for the non-use of the app. Two responses were received.

The researcher then sought an amendment to the ethical clearance certificate, to allow the expansion of the study to all healthcare workers.

2.2.2 Recruitment and sampling

Healthcare workers would be sampled purposively, according to their perceived need for interpretation or language support during their duties, with an option for snowballing. Health workers from various categories would be included. An amended ethical clearance for the expanded study was awarded, after discussion of the study with a (non-chair) member of the HREC (Medical) committee.

Five healthcare workers, known to the researcher were approached. Two of these were at a community health centre (CHC) known to the researcher in Ekurhuleni. One pre-hospital emergency care worker and one private pharmacist were also approached. Three referrals were made by social acquaintances of the researcher. These healthcare workers were approached directly and invited to use the AwezaMed app in their personal capacities, much as they would use any other mHealth application (for example gestational calculator or drug dosage reference guide) during their work. Users were invited to recommend the app to fellow

healthcare workers who could have benefitted from its use, and pass their contact details to the researcher, to receive the app. This was done to keep track of users, to facilitate the collection of feedback, and avoid dissemination of the app without appropriate tracking and monitoring. A further 19 potential users were identified by word of mouth, and received the link to download the app.

Information regarding the study and invitation to participate was posted to two nursing groups on Facebook and posted to LinkedIn. Three general enquiries were received by the researcher, but only one requested the app.

All healthcare workers who expressed interest in using the app whether directly to the researcher or indirectly via word of mouth received a link to download the app, and information regarding the study. It was made clear to all potential users that they were under no obligation to give any feedback.

In total, 38 invitations for participation were extended.

2.3 Study setting

The initial planned setting for the study was the various academic health settings on the Wits University training circuit. The app would have been used in these facilities, by the targeted users, in their personal capacities.

After the structure of the study was amended to include more categories of healthcare worker, the settings were expanded accordingly. The app was used CHCs, an academic hospital, pre-hospital emergency settings (including ambulances), private hospital settings, private pharmacies, and private maternity settings, which may have included clients' homes.

2.4. Data collection and analysis

2.4.1 Qualitative data collection

In total 14 interviews were conducted and recorded in English by the researcher between June 2021 and October 2022.

A minimum of two weeks after receiving the app for download, participants were approached and invited to provide feedback in the form of a semi-structured interview. Participants who indicated that they would prefer additional time to use the app were contacted again after a further two weeks. Those who did not respond

were contacted again after a two-week interval. Some users indicated via WhatsApp message that they did not wish to be interviewed. These users were invited to complete the questionnaire section of the study, and then their names were removed from the contact list for the in-depth interviews.

Appointments for interviews were scheduled at times convenient for the participants. Study information documents and informed consent forms were sent to participants via email or WhatsApp before the interviews, and participants were afforded the opportunity to ask questions and raise any concerns prior to being interviewed. Two participants were interviewed in person, and the remainder of the interviews were conducted remotely via Skype or WhatsApp voice call, according to the participants' preferences. In addition to written informed consent, all participants gave verbal consent for the recording of interviews.

During each interview, notes were taken by the researcher, who conducted all the interviews. This allowed the researcher to probe any areas of special interest and clarify concepts. The interview guide was amended iteratively; after each interview notes were made regarding which questions were most successful at eliciting strong narrative responses, and to compare users' experiences. In this way, the interview guide developed according to themes which emerged from the data.

Interviews were conducted for no more than 30 minutes via WhatsApp call and were recorded using the standard voice recorder app available as part of the Microsoft Windows Office suite, on an ASUS laptop computer. Interviews conducted via Skype were recorded using Voice Recorder, an app downloaded from the Play Store. Audio files were immediately transferred to a password-protected cloud storage file and deleted from the device.

2.4.2 Qualitative data management

To become familiar with the content, the first two interviews were transcribed verbatim by the researcher. Subsequent interview audio files were shared via email or Google Drive link (depending on the size of the file) with a professional transcript typist. The typist frequently transcribes medical reports for healthcare professionals and is thus fully conversant with confidentiality requirements. The typist signed a confidentiality agreement in accordance with the expectations of the HREC.

On receipt of typed transcripts, the researcher read through each interview while simultaneously listening to the audio recording, as a quality control measure. Any minor typographical or transcription errors were immediately corrected.

Transcripts were stored under password protection in a cloud storage file.

On receipt of each interview transcript, the researcher read through the material, whilst simultaneously listening to the recorded interview. This allowed for the correction of minor errors in transcription. Interview notes were consulted to ensure that transcripts were as complete as possible.

Interview transcripts were uploaded to MAXQDA 2022 (VERBI Software) for thematic analysis.

2.4.3 Qualitative data analysis

The quality and usability of systems are frequently measured using standards formulated and published by the International Organisation for Standardisation. These standards include ISO 9241-11, which measures usability under the headings of effectiveness, efficiency, and satisfaction (57). This formed the basis of the Systems Usability Scale (51). ISO/IEC 9126 provides characteristics and sub-characteristics for the measurement of product quality, of which usability is one; others include internal and external metrics as well as quality in use metrics (53). ISO/IEC 25010: 2011 supersedes this framework, and includes usability, among other characteristics.

Figure 2.2 illustrates the differences and similarities between the two frameworks, with the selected themes from each indicated in bold.

Due to the objectives of this study, the focus of the analysis remained on themes related to usability: understandability, learnability, operability, and attractiveness. An analytical framework (figure 2.2) was developed based on work by Estdale and Georgiadou (54) and Botella, Burgues *et al* (58).The first codes entered were themes suggested by keywords from the ISO/IEC 25010, ISO 9241-11 and ISO/IEC 9126-1 frameworks, specifically relating to the measurement of usability (52–54), namely effectiveness, efficiency, understandability, learnability, operability, attractiveness, trust, satisfaction and dissatisfaction. These were applied deductively to the transcripts.

Simultaneously, inductive coding took place as themes emerged when users described their experience of using the app. While transcripts were generally analysed in chronological order, once a theme was identified in a new interview, previous transcripts were reviewed and checked for those themes. In this way a comprehensive code book was generated. Codes are clearly defined in table 2.1.

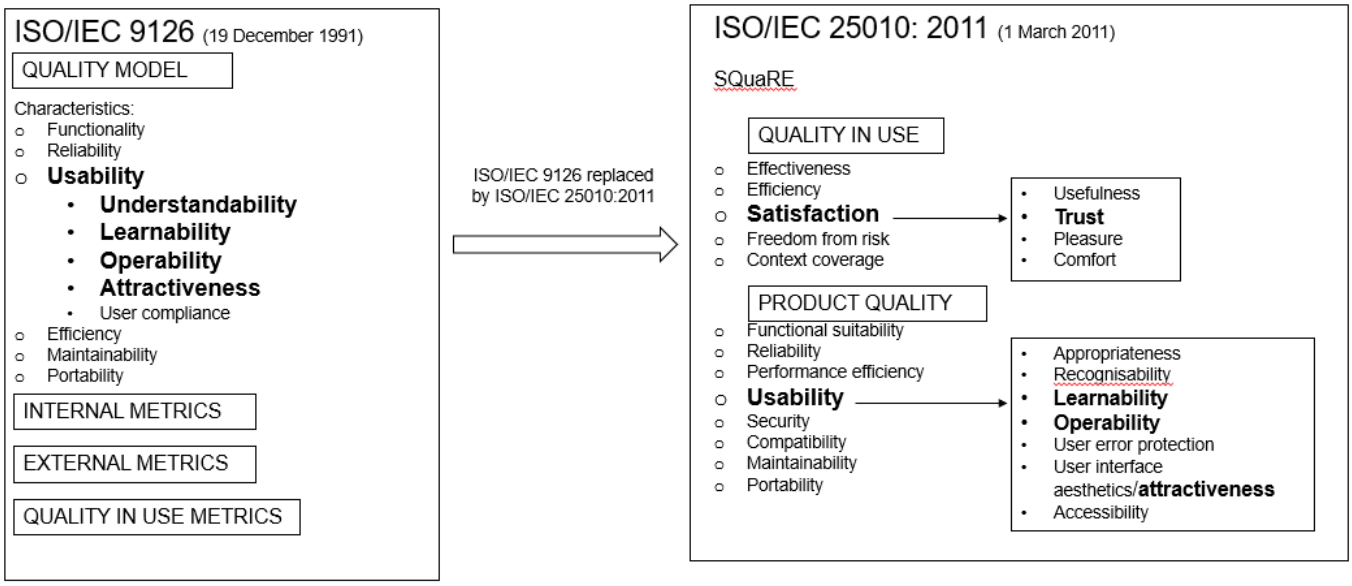

Figure 2.2 The ISO/IEC frameworks: an adapted analytical framework for qualitative data (54,58)

After the coding of each interview was completed, the code book was reviewed by retrieving transcript segments from each code and sub-code and comparing them. This allowed for the re-coding of segments where appropriate, removal of duplication and erasing of errors. The code book was amended by merging and redefining similar codes, refining definitions, and classifying codes according to broader themes.

Table 2.1 Definitions of key usability terms

Code/Theme	**Definition**
Attractiveness	The capability of the software product to be attractive to the user (53). In this study the focus of attractiveness is the visual appeal of a system.
Dissatisfaction	The lack, or absence of satisfaction (59)

Learnability	The quality of products or interfaces (systems) which allows users to quickly become familiar with them (60)
Operability	The extent to which a system can be operated or used. Fit, possible, or desirable to use (61)
Satisfaction	Fulfilment of wishes, expectations or needs, or the pleasure derived from this (59)
Trust	Firm belief in the reliability, truth, or ability of something (59)
Understandability	The degree to which attributes can be read and interpreted by users (62)
Usability	“The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use” (52)

2.4.4 Quantitative data collection

Quantitative data were collected in the form of a questionnaire generated in Google Documents (Google Form). The questionnaire was in English and would have taken no longer than ten minutes to complete. The link to this document was shared with participants via email on completion of their interview. After the collection of qualitative data from willing participants was concluded, the link to the questionnaire was sent to the remaining users who had not responded to requests for an interview but had not expressed unwillingness to be contacted or remain part of the study. These users received the link via WhatsApp, as it was thought that the convenience of using WhatsApp might improve the response rate.

2.4.5 Quantitative data management

Quantitative data were captured within Google Forms, as questionnaire responses. Socio-demographic data (which included biographical data) were entered into a Microsoft Excel spreadsheet, to be reported as descriptive statistics. Other information regarding the download and use or non-use of the app was also captured on a spreadsheet.

2.4.6 Qualitative data analysis

The second part of the questionnaire comprised the Systems Usability Scale (SUS). The SUS is designed to generate a single number score, representing the overall usability of the system under study (51). Scores are not used to generate descriptive statistics, and responses have no value in that respect (51). The scale is based on principles of usability expressed by ISO 9241-11, namely effectiveness (the extent to which users could complete tasks using the system, and the quality of the task outputs), efficiency (level of resource consumption required to complete the task), and satisfaction (users subjective response to using the system) (51). Thus the final score expressed would measure usability as the fitness of the system to its specific purpose, and not as a comparison between systems which may have little in common (51).

The SUS is presented as a 10-question Likert scale, in multiple-choice format. Each item on the scale will contribute a score between 0 and 4. For items 1, 3, 5, 7 and 9 the score is the item scale position minus one. Scores for even-numbered items (2,4,6 or 8) are calculated as 5, minus the item scale position. The sum of the items' scores is then multiplied by 2.5 to obtain the overall score. Final scores may range between 0 and 100 (51).

Individual responses captured in the Google Document were entered into an MS Excel spreadsheet, with the appropriate cells pre-programmed with the formulae necessary to calculate the final SUS score. The programming of the Excel spreadsheet and capturing of responses from the Google document was checked by a supervisor conversant with the SUS, and skilled in user experience measurement.

The SUS is the most frequently used questionnaire in the measurement of the usability of digital systems (63). An advantage of measuring user experience using the SUS is that it allows for comparisons between systems and products which differ widely from each other. While the systems themselves are not easily compared, due to the large variance in characteristics, what can be compared is quality in use, or the degree of "fitness for purpose" (51) of a system. Brookes' description of the SUS is a "quick and dirty usability scale" (51), and it was conceptualised as a cost-effective and reliable method of expressing subjective assessments of usability in a

simple, easy-to-interpret and compare format (51). This format is a single numerical score.

Despite its status as the preferred tool for measuring usability, the SUS is seldom used alone. Many studies which employ the SUS also use a qualitative measure to confirm, validate, or enhance the findings of the questionnaire (64–66).

Sauro and Lewis (67,68) have created a curved grading scale, based on the accumulated data from 241 SUS usability studies.

> "In a typical curved grading scale, the 50th percentile (median) corresponds to the centre of the range for an average grade (C). The highest and lowest 15 percentile points correspond to the A and F ranges, respectively. They further divided the top 15 percent of mean SUS scores into A+, A, and A-, and did a similar breakdown for B and C grades (providing similar distinctions for D and F grades did not seem as if it would be very useful)" (67,68).

It was suggested that the meta-analysis conducted by Sauro and Lewis may not be accurately representative of mHealth applications, thus a further study was conducted by Hyzy *et al*, comparing the SUS to the mHealth App Usability Questionnaire (MAUQ), a validated instrument (24). This analysis found that the distribution of SUS scores was skewed, with physical activity apps showing higher scores (24). Except for physical activity app scores, SUS scores in this meta-analysis followed the curve suggested by Lewis and Sauro (24). Although no language nor translation apps were evaluated in this analysis, this finding adds validity to the SUS scores rating the usability of mHealth applications.
According to standards suggested by Hyzy *et al*, the fact that the SUS scores evaluated the usability of AwezaMed were generated by representative users (belonging to the group for whom the system is intended, in this case health care workers), adds to the value of the findings (24).

Table 2.2 Curved grading scale for the SUS

Grade	SUS	Percentile Range
A+	84.1 – 100	96 – 100
A	80.8 – 84	90 – 95
A-	78.9 – 80.7	85 – 89
B+	77.2 – 78.8	80 – 84
B	74.1 – 77.1	70 – 79
B-	72.6 – 74	65 – 69
C+	71.1 – 72.5	60 – 64
C	65.0 – 71.0	41 – 59
C-	62.7 – 64.9	35 – 40
D	51.7 – 62.6	15 – 34
F	0 – 51.6	0 – 14

According to the curved grading scale (table 2.2), the SUS score of 66.25 achieves a "C" (table 2.3), and places in the 41st – 59th percentile range.

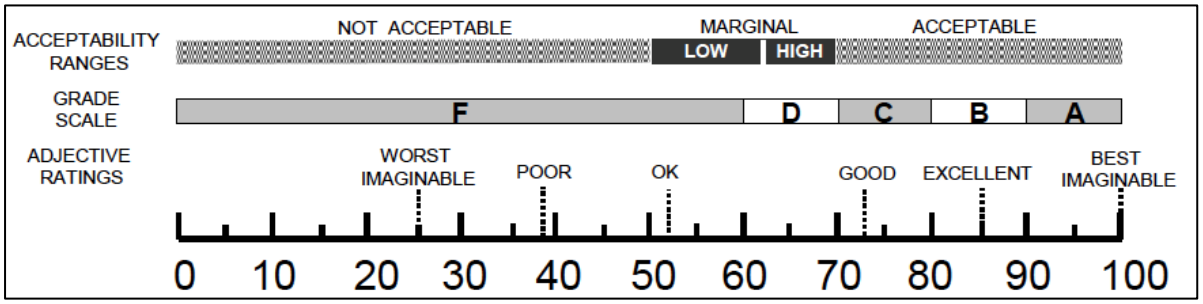

Figure 2.3 A comparison of ratings, based on average SUS scores (69)

Sauro and Lewis (68) developed regression equations to establish benchmarks for individual SUS items. Due to the limited scope of this study, these were not employed for the AwezaMed app. Sauro and Lewis also suggested that certain items measure constructs which relate most directly to usability (68).

2.5 Ethical considerations

This study was approved by the HREC (Medical) and conducted according to ethical principles prescribed by the committee.

All participants gave informed consent, in writing, before participating, and were given opportunities to ask questions regarding the study. Participation was entirely

voluntary, and participants were informed that they were free to withdraw at any stage.

All qualitative data was anonymised by removing names or identifying data when transcribing, and all recordings and transcriptions are stored under password protection.

Quantitative data was collected anonymously, with no names nor identifying information being captured. All Google forms and data capture spreadsheets are stored under password protection.

Chapter 3: Results

This chapter presents the quantitative and qualitative findings of the AwezaMed usability and user experience study.

3.1 Quantitative results

3.1.1 Response rate and description of the study sample

Twenty responses to the Google Form were received. Of these 20, 18 respondents downloaded the application; two respondents cited operating system incompatibility as the reason for not downloading the app. Of these 18 users, 12 stated that they used the app with patients (figure 3.1).

Six respondents stated that they had no need of translation, or the content of the app did not meet their translation requirements.

The overall response rate for the study was 51%.

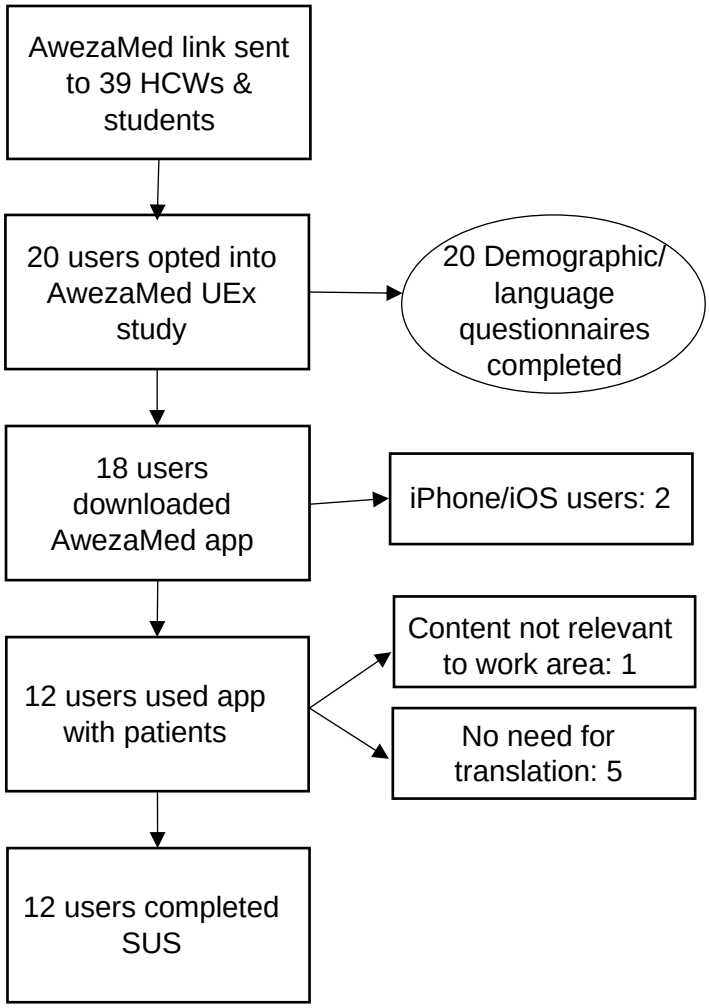

Figure 3.1 Responses and inclusion of quantitative respondents

Table 3.1 Socio-demographic data of quantitative respondents

Variable	**Number**
Gender	
Male	3
Female	17
Age (years)	
22-25 years	2
26-29 years	4
30 years and older	14
Nationality	
South African	19
British	1
Occupation	
Professional Nurse	11
Pre-hospital emergency care provider	4
Medical practitioner	1
Physiotherapist	1
Radiographer	1
Doula	1
Medical student	1

Table 3.2 Language competencies of respondents

Home language	
English	12
Afrikaans	6
Siswati	1
Italian	1
Additional language competencies	
English	8
Afrikaans	12
French	1

3.1.2 System Usability Scale (SUS) results

Table 3.3 Final System Usability Scale (SUS) results

Participant	Final SUS score
1.	67.5
2.	57.5
3.	67.5
4.	67.5
5.	82.5
6.	80
7.	55
8.	90
9.	22.5
10.	47.5
11.	82.5
12.	75
Total	66.25

Table 3.3 presents the total SUS scores attributed by each participant. These range from very low to high and reflect the range of user experiences. Table 3.4 presents the average score for each individual SUS item. This may reflect which aspects of the system were problematic, or which were regarded as successful.

Table 3.4 Individual Systems Usability Scale (SUS) item (mean) scores

SUS Item	Item definition	Mean score (all participants)
1.	I think that I would like to use this system frequently	2.17
2.	I found the system unnecessarily complex	2.67
3.	I thought the system was easy to use	3
4.	I think that I would require the support of a technical person to use this system	2.33

5.	I found the various functions in this system were well integrated	2.83
6.	I thought there was too much inconsistency in the system	3
7.	I would imagine that most people would learn to use this system quickly	2.92
8.	I found the system very cumbersome to use	2.33
9.	I felt very confident using this system	2.58
10.	I needed to learn a lot of things before I could get going with the system	2.75

The final score generated by the SUS is 66.25.

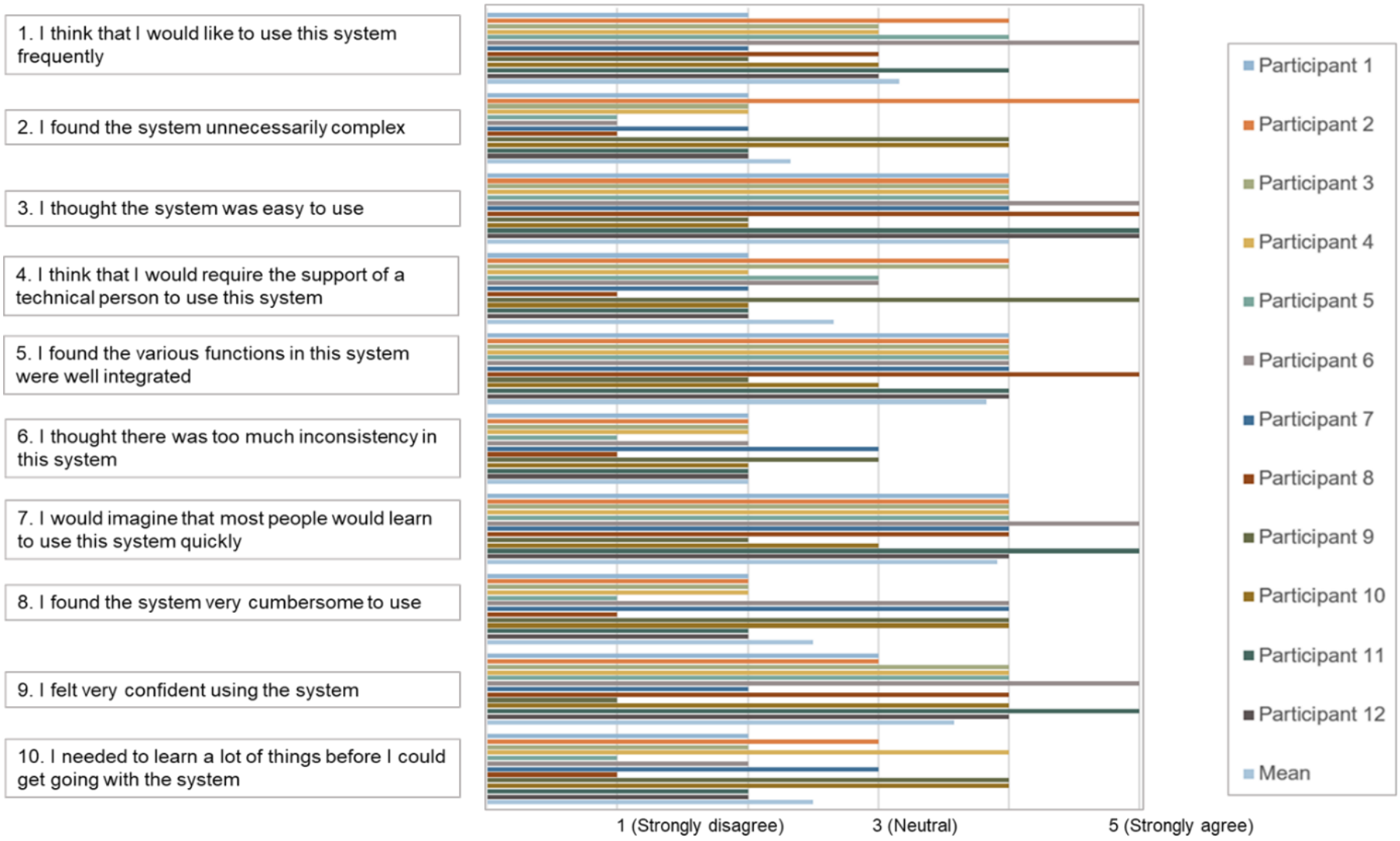

Figure 3.2 Systems Usability Scale (SUS) results by individual respondents

3.2 Qualitative findings

3.2.1 Description of the sample

Table 3.5 Characteristics of qualitative respondents

Variable	Number
Gender	
Male	3
Female	11
Occupation	
Professional Nurses/Midwives	8
Pre-hospital emergency care provider	2
Medical practitioner	1
Physiotherapist	1
Pharmacist	1
Doula	1

3.2.2 Qualitative themes – Usability

3.2.2.1 *Understandability of the workings of the AwezaMed app*

None of the users reported any difficulty in understanding the layout or use of the app. They found the app easy to navigate and the functions intuitive, thus not requiring any additional guidance on how to use the app.

"Very easily understandable" (Professional nurse - PHC)

"I mean you just press the speaker, it's not, it's not hard." (Physiotherapist)

"It's very easy to, to understand it. I think that once you know exactly where the answers and questions are, if you're dealing with a patient, you'll be able to navigate quite quickly." (Doula)

3.2.2.2 *Learnability of the AwezaMed app*

All users reported that they achieved familiarity and competence in operating the app with relative ease. Most used the tutorials and felt that they were pitched at the right level for first-time users. It should be noted that all the users of the app were already smart phone users, most were already employing one or more mHealth or general apps to make their work easier. This may have impacted the ease with which they could both understand and learn to use the app.

"And I probably could have used it, even without the tutorial." (Paramedic)

"So, I did initially [use tutorials], but then, to be honest, no. I just skipped them, umm, and then went into the actual App. And like I say, it was very easy to try and navigate and try and figure out … obviously what information there was, and how to use it." (Private midwife)

"And then I managed to like, kind of see how it works on my own." (Physiotherapist)

"Umm, but I also, I just, I just played and figured it out." (Professional nurse)

3.2.2.3 *Operability*

Users reported aspects of the app which they found contributed to operability. As operability refers to fitness for use or desirability to use, some of these factors made the users more likely to use the app and continue to use it. It was found that the simplicity and organisation of the design contributed to use.

"Otherwise the simplicity of it I think it's, I think, from an Auxiliary nurse to an RN could use it." (Professional nurse – NICU)

"I thought that it was a really easy, convenient tool, that I would like to use in practice." (Pharmacist)

"I like the categories it's placed in. So you don't have to go through the, a whole long list looking, eh, eh, I like the, the different categories. Like the symptoms, the general history." (Physiotherapist)

"…like I say, I like that there was a favourites section" (Paramedic)

"I knew exactly where to push, and it's not a, it's not a, … a very difficult App to navigate." (Paramedic)

"…my favourite thing about the app, is hearing the voices come. Ping! And listening to it, and, and the fact that I can, I can listen" (Professional nurse – midwife)

Several users reported technical challenges to operability. Reportedly, the S2S feature seldom worked correctly. The feature would have allowed users to translate predetermined phrases using only verbal inputs. In practice users experienced problems with speech recognition and reverted to using the text to speech feature.

"Well the only problem I had was the, the voice recording going over to uhm, another language, that didn't work." (Professional nurse – PHC)

"I used the text to speech; I could never use the audio." (Doula)

"I had a pop-up every now and again that it was unable to, I think, retrieve audio? or something like that. And I think that was, it was data related. So I think…possibly, a data glitch could have been the issue." (Professional nurse – NICU)

"I did have a struggle in downloading it with a Huawei phone." (Professional nurse – NICU)

"I mean I think the theory of it is great, and maybe it's partly my fault, maybe it's operator error on my side." (Professional nurse – PHC)

Some users accepted the technical glitches as inevitable or assumed that the problems were user or device related and continued using the text to speech feature. For one user, the technical issues negated the purpose or potential benefits of the app.

"So, then I quickly got, disheartened with it, and then I just tend to not to use it because…it was like, oh, it's not working, I can't get it open, I can't get it to do what I need to do and it needs to be quick and efficient" (Professional nurse – PHC)

3.2.2.4 *Attractiveness*

The app was described as attractive by users, with positive feedback regarding the specific design features of the app. Since there were no negative comments regarding the visual appeal of the app, it is difficult to say if any improvements could have been made which would have increased the use of the app.

"…visually I thought the design was very clean. Umm, you know, even just the icons on point, I liked the colours, subtle, very nice." (Doula)

"I liked all the, the fonts and the colours and this was very nice and simple. You know, you sort of knew where you were wanting to go. There weren't too many different tabs that you had to open to find the information you wanted." (Professional nurse – NICU)

Aspects of the visual design of the app contributed to its ease of use.

"I liked the icons, the pictures, that show you, like where to go in for, for which um… hoe Engels?... like for general history, the little icons that break it up for you." (Professional nurse – PHC)

"I like… the blocks. It sounds very simple, but I like the fact that there's… the way it's designed, is that it got these little blocks out there, and what I liked is, I immediately saw the obstetric section: yes!" (Professional nurse – midwife)

3.2.3 Qualitative themes – User experience

3.2.3.1 *Responses of patients*

The app was generally well-received by users and patients. Some users reported that initially patients may have been wary, and even amused by the concept of the app, but they quickly warmed to the idea.

"Some of them were a little bit, um, what's the word? A little bit suspicious?" (Professional nurse – midwife)

"So, it was… ja, they were surprised." (Paramedic)

"I mean, it's South Africa, so generally, they gave me a good laugh or a good giggle." (Professional nurse – NICU)

The impression among users was that patients appreciated the effort to bridge the communication gap by using technology. This contributed to the building of rapport and may have added to the therapeutic relationship.

"They were receptive to it… Because then they, they knew I was trying" (professional nurse)

"Whereas if you meet them in their own language, then I … find that, that they, they appreciate you for doing the effort to try and, you know, like accommodate them in their own language." (Professional nurse)

3.2.3.2 *Challenges with elaborate answers*

The design of the app does not make provision for two-way translation or interpreting. Questions are closed-ended and designed to elicit only a yes or no answer from patients. This proved to be a limitation, and clients would frequently

respond with narrative answers, and questions of their own. This resulted in frustration, for both health workers and patients.

"…was not getting yes or no, but getting now, ok so I play this app for you, and you give me three sentences of Zulu, and I, like… I haven't a clue what you said. That was my, that was the most difficult part for me, was like ok, this is a yes/no question. And here you go, carried away, and now I don't know what you've said at all." (Professional nurse – midwife)

Health workers were able to adapt their communication style, to accommodate the limitations of the app.

"So, I was wondering, how will I know if I ask this question in Zulu and they start just to talk in Zulu back to me. I won't be able to understand. But I saw on the App, like most of it is yes, no questions. So you will be able to get some information. Even though they can't elaborate a lot." (Physiotherapist)

"…in the beginning, the yes and no was a bit difficult, because they would elaborate, And I, I would have to stop her, and like, say to her, remember yes or no" (Professional nurse)

"And then, ja. They, they answered. They generally could say yes or no. Sometimes, it, it, felt a little like broken, because you don't explore things as quickly as you should." (Professional nurse – NICU)

3.2.3.3 *Responses of peers*

Users of the app spoke about the responses of workplace peers to the app, many of whom were expected, on occasion, to act as informal interpreters. The medical practitioner is aware that expecting nurses to interpret is an imposition, and yet often health workers have no option other than to rely on the good nature of vernacular speakers in the workplace. These speakers may take on the additional duty of interpreting, for the benefit of the patients, who would otherwise receive sub-par (or no) service.

"So, to be honest, I don't think she would want to use it. She would want doctors to use it, because you know, it's always a difficult thing, and I don't really think nurses… you know, it's technically not their job to interpret for us, but by default they do, and I know it's not… you know, it's something that annoys them a little bit. So, I think

they'd be much more interested that doctors use it, so that they can carry on with their, with their other many, many duties." (Medical practitioner – ED)

"Often, often we do just grab whoever there is and generally, like sometimes, you even have to go, like, a few wards down in the hospital because it's a Shangaan person, so yes, you do have to, I think, try (your) best with what you have. But, ja. I don't know if they always are that willing, but … they help. It's the Ubuntu side of South Africa, maybe." (Professional nurse – NICU)

"… she could do it better. You know that... obviously wanting to help. Being a helpful sort, her approach was: let me just jump in and help you rather. (Other staff members) they just, just didn't say their impressions, but by not saying and simply, 'I'll ask the question instead of you', you know?" (Professional nurse – midwife)

On occasion, peers in the workplace may voluntarily take on the role of interpreter. Continuing to do so in the presence of mHealth interpreting, may be the result of habit or concerns for the quality of the translation, or due to the nature or character of the individual person (or people) involved.

3.2.3.4 *Transferability of the app*

The AwezaMed app was designed with content specific to maternal health settings. For this study, the app was provided to a variety of healthcare workers. Several of these health workers then recommended the app to friends and colleagues, for whom they thought it might be useful. This action indicated that health workers believed the utility of the app would be transferable to a variety of different health settings.

"It's portable, uh, so I can use it across a range of patients." (Paramedic)

"That is mostly for maternity and TB… and HIV. Whether pregnant or not…And it's for male and… both male and female you can use… ja. For them both." (Professional nurse)

All categories of health workers indicated a desire for expanded content, to enable them to use the app more, however it was found to be more useful and transferable in general settings (emergency care and primary health) than in specialised settings (physiotherapy and pharmacy). During interviews, users expanded on which aspects were useful to them, and where they found gaps.

"That's where I stopped using the App. Like I ask the general health question with the app … and then I wanted to rule out red flags to ask, 'Do you sometimes can't feel your leg? Can you sometimes feel like you're gonna fall?', things like that." (Physiotherapist)

"I think the App is perfectly suited for a, umm, for a counselling type of setup. So pharmacy, I think, in health care, is pretty fast-paced" (Pharmacist)

3.2.3.5 *Efficiency and use of time*

Users generally found that the app was efficient, i.e., made good use of time when compared with the alternatives (finding an informal interpreter or doing without any interpreting or translation).

"…the alternative would be for me to use somebody else in my environment, so, somebody else in the ambulance, or in the hospital to translate for me, uh, and they're not always available. so yes, I think it would save me time." (Paramedic)

While the app was found to be quick and easy to learn, users reported that it was somewhat cumbersome to use, but expected that it would become more efficient the more they used it, and the more familiar they became with the content.

"You don't, you mustn't sit there in the, umm, interview and page through it, and see if you, umm… Where is that question? I want to ask this. So that will definitely waste time. But I think maybe if you, very up to date with where what is, then, it, it might just take the same time, but I don't think it will save you time." (Physiotherapist)

"I need to do things quickly and accurately. So, yes. Once I was used to it, and I just opened it up and used it." (Professional nurse)

3.2.3.6 *Learning a new language*

While the app was not designed specifically to teach languages, several users reported that they had found the app to be a useful tool for language learning.

"I was learning Zulu." (Professional nurse)

"And then I can… I can go from perhaps, um, having the question on audio to being able to ask the question myself." (Professional nurse – midwife)

The audio aspect of the app was found to be useful as an example of pronunciation, and a user, who was busy with a basic isiZulu course, used the app to compare phrases and add to what she was learning.

"I think it can actually be beneficial in that way… like I did see overlaps from what I already learned and others I was thinking, 'oh ja, that's a nice one that I haven't learned', umm, that is quite useful." (Physiotherapist)

"…made my ear more used to sounds" (Professional nurse – midwife)

"I think I would definitely be able to, to learn more of the language, especially also because the pronunciation of the words are so clear and correct." (Professional nurse – midwife)

One user felt that using the app would indicate an intention to learn a language, and this would be appreciated by the healthcare user, adding to the therapeutic relationship.

"They felt like if I've got his type of app, I'm gonna learn their language faster" (Professional nurse)

3.2.4 Factors contributing to the usage of the AwezaMed app

3.2.4.1 *Experiences with mHealth use*

Most participants interviewed were familiar with the concept of mHealth, and reported utilising one or more apps on a regular basis, for very specific functions.

*"You know, the Apps that I use, I'm generally using it for a very pointed reason… calculating an age, it's a very specific thing, you know" (*Medical practitioner - ER)

A physiotherapist reported using a specialised app named *Orientate* to measure spatial awareness, specifically recognition of left and right, when determining neurological response to pain. Pre-hospital emergency workers reported using apps as references for correct drug dosing, particularly for paediatric patients. One paramedic mentioned using an app to keep a record of events during the resuscitation of patients. This was also mentioned by neonatal intensive care (NICU) nurses. A NICU nurse, who also provides private CPR and resuscitation training, uses an event tracking app as a training tool. A nurse employed in the private sector uses an app to upload details of clinical assessments to a central database.

Healthcare workers also adopt general, non-mHealth apps to suit their line of work. A midwife in private practice recommends a specific pregnancy journey app to her clients, to provide information regarding their stage of pregnancy, and to assist in preparing for birth, and a physiotherapist uses a digital stopwatch to time activities, and a digital metronome app to provide the timed rhythm needed to complete some client assessments.

"So, the only other App that I use is called the My Pregnancy Journey. Which is what I suggest… which gives then, like, information on a weekly basis as to what to expect in their pregnancy, umm, and how to prepare for the upcoming birth, things like, what to pack in your hospital bag, that sort of thing." (Private midwife)

"Well, I just use… There's a fitness test that I do, that I use a metronome for, that gives you the beat that they must do the test on. I just use a timer a lot of the time for balance testing and things like that." (Physiotherapist)

3.2.4.2 *The language barrier and unmet need for interpreting*

When asked during an interview what the most attractive thing was about the app, several participants responded with 'the whole idea'.

"I liked the whole idea of the App" (Pharmacist)

"I thought it was a great idea" (Professional nurse – NICU)

"I was very excited to try it, because communication is a big problem in the workplace" (Professional nurse – PHC)

"I actually think the idea… is the thing that is the favourite part for me. Umm, because the language barrier is a… massive thing." (Medical practitioner – ER)

Participants reported being excited at the prospect of an app which could assist with translation in the workplace and cited the language barrier as a great challenge to providing quality healthcare.

"You end up just sort of guessing or just writing on your recording, "unknown information". Just saying/writing there unknown, medical history unknown." (Professional nurse – NICU)

Most participants recounted difficulties in communicating with patients or clients, some as frequently as once or twice a week.

"I would say most of the people that we see don't have English as their first language" (Professional nurse – PHC)

"I certainly have had the frustration of not being able to express what I wanted to express and get the answer." (Professional nurse - midwife)

Even those who admitted not experiencing this frequently in their current work situation, remembered incidents where they felt frustrated and powerless due to their inability to effectively communicate with clients.

"Like, you sit there with the patient. You can't even write down the history. You have no idea even where the pain is. You, you just feel lost. And in that setting where I was as a student, umm, people are too busy to help you, they are... there's no cleaners in the area and you just sit there. You don't know how you're gonna get the hour to go past. And the patient came for help, and you can't. So, in that sense definitely, the App is going to help you." (Physiotherapist)

"…just to stop that frustration in, trying to obtain information from the client, when there's other things to be done." (Professional nurse – NICU)

The need for interpreting is obvious, with (informal) human interpreters regarded as the default option.

"So we forever grabbing an informal… and that's the problem. An informal… interpreter." (Professional nurse - NICU)

"…having to go and find someone who is on duty that's able to translate" (Professional nurse – NICU)

"… there's having to rather phone er, er one of their family to get the information and, er you know it takes a while, cause you got to try and explain and re-explain." (Professional nurse)

3.2.4.3 *Challenges surrounding the use of interpreters*

While the assistance of informal interpreters is regarded as the norm, this practice is not without its challenges.

Informal interpreters are not always available.

"…because the alternative would be for me to use somebody else in my environment, so, somebody else in the ambulance, or in the hospital to translate for me, uh, and they're not always available." (Paramedic)

Attempts are made to formalise the system, but this does not guarantee availability.

"We have like, sort of like a list of staff that speak those languages, and just hopefully one of them is on duty at the time that you need them." (Professional nurse – NICU)

"We have interpreters. *Some of them are auxiliary nurses, so they have a background in medical terminology. Umm, and then we have one of our nurses worked in Mozambique for a while, so she can speak Portuguese, and then we sometimes use other patients, which isn't ideal"* (Professional nurse – PHC)

Increasingly complex systems of interpreting are utilised, in an attempt to successfully communicate with patients.

"one of our nurses worked in Mozambique for a while, so she can speak Portuguese, and then we sometimes use other patients, which isn't ideal, if there, umm some of the local languages in, in Mozambique that nobody knows…then we set up a 3-way, umm, interpreting going on into Portuguese and then into English…So it, it's complicated." (Professional nurse - PHC)

3.2.4.4 *Users' preference for mHealth interpreting*

Several users indicated that quality mHealth interpreting would be their first choice in facilitating communication with patients, and the reasons presented included concerns regarding confidentiality, rapport with patients, and the ability to work more independently, without needing to rely on others.

"I'd probably still use the App to be honest with you because, umm, obviously it's just between you and the client. You not having to bring in a third party. And I think often patients maybe open up a bit better, umm, with one-on-one care versus having to explain to multiple people. Umm, obviously what's happening and what their concerns are etc. So, I'd probably still use the, the App." (Private midwife)

"So, when I do use the interpreter, they take the connection. They make the connection. They're all basic life support trained. They then usually form that bond with the patient, and, so then, I'm almost pushed out … almost push me out of the, the sequence" (Paramedic)

"…in the past, you know I used a person to interpret for me, uhm, the patients would start talking to the interpreter, and, you know, there would be no connection between me and patient" (Professional nurse – PHC)

"You're in a room by yourself, and you haven't got people hearing your attempts to communicate and interrupting your attempts." (professional nurse – midwife)

"So it's nice to have a tool to help, and not have to try and find a translator." (Professional nurse – NICU)

"Just the fact that I don't need to call a nurse to translate and wait for her" (Medical practitioner – ED)

Users reported concerns with informal translations, such as the trustworthiness of the information received by both patients and healthcare workers.

"And I've seen it … when we use translators as well … there's a back and forth. You know I would … that's quite easy to say, it's a easy question, do you have a fever, but then there's a back and forth, so most phrases, umm, you know, there seems to be a little bit of confusion" (Medical practitioner – ED)

"But informal ones sometimes they make up their own little story of what they think you want to hear from the patient, not then the actual truth from the patient." (Professional nurse - PHC)

"But, then again, uhm, the interpreter sometimes decides what to ask and what information to give us." (Professional nurse - PHC)

3.2.4.5 *A reduced need for mHealth assistance*

Users who reported less need for mHealth interpreting were those who felt that they had adequate access to interpreters in their work environments, and it was noted that users felt that the app would be better suited to some environments than others.

"But, there's also a wide variety of nurses that speak the same lang- different languages…So it's not always a cleaner or a, a receptionist, or something like that.

You actually got access to, across the board, umm, health care professionals." (Professional nurse - NICU)

"I think it would be very useful, especially if you're in a situation where you don't have, have many staff members. Umm, you know, if you're in a small clinic and you have, you know, more people than nurses or doctors. I think it could be very useful, and er, it would be a good thing to supply to your, to your staff." (Doula)

The appropriateness of the environment was not always determined by the availability of staff to act as informal interpreters. Other factors included the pace of work required, where the need to act hands-on would not be conducive to using the app.

For some, the app was regarded as a nice-to-have backup, with in-person interpreting still their first choice.

"…if there's one not immediately available, yes. So, I mean, if I had somebody available, I'd rather use a human translator." (Paramedic)

Two users also mentioned the use of gestures to communicate with clients, across a language barrier.

"Otherwise…showing of the products, or, you know, gesturing where you could be sore - head, stomach, umm, also helps." (Pharmacist)

"But most of the time I find that if you show them, and you correct… hands-on what they are doing wrong. They usually get it even if there is a language barrier." (Physiotherapist)

It is important to note the gestures mentioned were specific to the work environments of the healthcare workers. Product sales are central to retail pharmacy services, and physiotherapy is frequently a hands-on health domain.

3.2.4.6 *Preferences for human interpreters*

Human interpreters are regarded as a quick solution to the problem of a language barrier, while the mHealth interpreter is seen as more time-consuming.

"I work with umm, with crew that speaks approximately 9 different languages… so that did make it easy to quickly translate whatever they were saying" (Paramedic)

"But if I was alone in an area, so in a rural area where I'm in a clinic base, then I think that it is worthwhile if you do not have someone to translate to you." (Paramedic)

It was also suggested that human interpreters can engage on a deeper level with patients, allowing the health worker to receive more information. In some instances, this is seen as preferable, even considering the disconnection which occurs between health worker and patient. The information which informs quality care and ensures the safety of the patient was seen as more important than the relationship.

"I can hear they explain, like, very broadly or so to the patient because they can speak fast and they can speak, umm, explaining exactly what's going on, and I feel like, umm… you get a more detailed answer umm, from the interpreter, because they explain it a lot more than when you use the App." (Physiotherapist)

"Umm, I think there would be a place for it. I-I think, umm, I think maybe formal interpreters that can ask detailed questions and give accurate answers, are maybe better." (Professional nurse – PHC)

While healthcare workers place significant value on rapport and the interpersonal relationship with their patients, the comfort of patients was their primary concern. In many cases, a human interpreter was seen as the preference of the patient.

"Because this person can do a more detailed… into their own language, in the comfortable position." (Professional nurse)

"At times, you know, it is nice to have one of the other nurses there that, that the patient is then familiar with." (Professional nurse)

3.2.4.7 *Trust in the application*

The healthcare workers interviewed placed great value on the trustworthiness of interpretations. One participant expressed hesitancy in using the app, due to an inability to check or confirm the accuracy of the information conveyed to clients.

"The thing is, when we use the app, we don't actually know what we've translated it to, so, we don't know if there's like some weird grammar error or something like that, something that could be miss interpreted. So that's a fear of using the App." (Pharmacist)

More than one participant reported using their knowledge of one of the other languages available to check the content or quality of the interpretation. This added to their trust in the system.

"But I at least speak both languages. I tried it in Afrikaans too, but I mean … your heart feels more at ease when you can double-check it (laughs). So, like I'm trusting the machine to convey the right message, so, so Afrikaans when I used that, at least I could know that I'm saying the right thing. Does that make sense?" (Professional nurse – NICU)

"It was easy for me to understand. When it translated my question, I could actually understand what was being asked."

"I think because I do understand Zulu. Umm, a fair understanding of it." (Professional nurse)

Another user expressed trust in the app, based on its development for a specific purpose. This was based on a comparison with a previous experience with a commonly used translation application. It could be assumed that since the content was pre-established, it had been checked for accuracy.

"I think that, because you have the set questions as well, you know when you're asking the question, you're asking the right questions. Cause I've had situations with Google Translate where you ask somebody something and then they just sort of stare at you because you've asked them something, you know, completely different to what you think, because Google Translate doesn't always keep context when you're, when you're doing direct translations. So, I think this might be a little bit safer, especially culturally. That you're not going to ask somebody something inappropriate, without knowing." (Doula)

"I think uhm, I trusted the content of the App, uhm, cause the, the patient answered all the questions. Uhm, she understood all the questions, even though I couldn't understand what the App was saying, she understood it and answered it immediately. So, uhm, ja. So I, I think it asked what I wanted to ask her." (Professional nurse – PHC)

Table 3.6 Qualitative findings

Theme	Sub-theme	Description	Example of participant quote
Considerations which affect usage of the app	Experiences with mHealth use	The user's previous or current experience with other mHealth applications	*"You know, the Apps that I use, I'm generally using it for a very pointed reason… calculating an age, it's a very specific thing, you know" (*medical practitioner - ER)
	The language barrier and unmet need for interpreting	Language barriers between healthcare workers and healthcare users result in compromised communication	*"I was very excited to try it, because communication is a big problem in the workplace"* (professional nurse – PHC)
	Challenges surrounding the use of interpreters	Problems experienced by participants when relying on interpreters to facilitate consultations	*"…because the alternative would be for me to use somebody else in my environment, so, somebody else in the ambulance, or in the hospital to translate for me, uh, and they're not always available."* (paramedic)
	Users' preference for mHealth interpreting	Participants verbalized a preference for an mHealth solution, over informal or ad hoc interpreting	*"You're in a room by yourself, and you haven't got people hearing your attempts to communicate and interrupting your attempts."* (professional nurse – midwife)
	Reduced need for mHealth assistance	Participants felt that sufficient informal or ad hoc interpreters were available in their work environment, and could be relied upon	*"But, there's also a wide variety of nurses that speak the same lang- different languages…So it's not always a cleaner or a, a receptionist, or something like that. You actually got access to, across the board, umm, health care professionals."* (Professional nurse - NICU)

	Preference for human interpreters	Participants felts that human interpreters were more reliable and efficient	*"I work with umm, with crew that speaks approximately 9 different languages… so that did make it easy to quickly translate whatever they were saying"* (paramedic)
Usability	Understandability	The level of difficulty or ease with which the workings of the app could be understood	*"Very easily understandable"* (professional nurse - PHC)
	Learnability	The degree of ease with which participants were able to feel comfortable and confident in using the app	*"And I probably could have used it, even without the tutorial."* (D, paramedic)
	Operability	The perceived level of difficulty or ease with which the app could be operated by users	*"Otherwise the simplicity of it I think it's, I think, from an Auxiliary nurse to an RN could use it."*
	Attractiveness	The visual appeal of the app	*"…visually I thought the design was very clean. Umm, you know, even just the icons on point, I liked the colours, subtle, very nice."* (doula)
	Trust in the application	The extent to which health professionals were willing to rely on the accuracy of the app's translations	*"The thing is, when we use the app, we don't actually know what we've translated it to, so, we don't know if there's like some weird grammar error or something like that, something that could be miss interpreted. So that's a fear of using the App."* (pharmacist)
User experience	Responses of patients	Feedback from participants, referring to the reactions of patients/clients when the app is used to facilitate interactions	*"Some of them were a little bit, um, what's the word? A little bit suspicious?"* (professional nurse – midwife)

	Challenges with elaborate answers	Communication problems stemming from the natural tendency to answer questions in full sentences	*"…in the beginning, the yes and no was a bit difficult, because they would elaborate, And I, I would have to stop her, and like, say to her, remember yes or no"* (professional nurse)
	Responses of peers	Feedback from participants, referring to other HCWs reactions when seeing the app	*"… she could do it better. You know that... obviously wanting to help. Being a helpful sort, her approach was: let me just jump in and help you rather. (Other staff members) they just, just didn't say their impressions, but by not saying and simply, 'I'll ask the question instead of you', you know?"* (professional nurse – midwife)
	Transferability of the app	The perceived success of the app in healthcare settings other than that for which it was designed (maternity/obstetrics)	*"It's portable, uh, so I can use it across a range of patients."* (paramedic)
	Efficiency and use of time	The perceived or measurable time saving attributable to the use of the app	*"You don't, you mustn't sit there in the, umm, interview and page through it, and see if you, umm… Where is that question? I want to ask this. So that will definitely waste time. But I think maybe if you, very up to date with where what is, then, it, it might just take the same time, but I don't think it will save you time."* (physiotherapist)
	Learning a new language	The value of the app as an aid in learning a new language	*"And then I can… I can go from perhaps, um, having the question on audio to being able to ask the question myself."* (professional nurse – midwife)

Chapter 4: Discussion

This chapter will elaborate on the findings reported in the previous chapter and relate them to several studies in the field. The relationship between the quantitative results and qualitative findings is discussed, and themes which emerged deductively are discussed in detail.

4.1 Introduction

This study aimed to assess the usability and user experience of healthcare workers using the AwezaMed speech-to-speech translation application. Recruitment of study participants was challenging, but those who did join the study were generally positive and enthusiastic. This was echoed in the findings which indicated a need for interpreting in health settings.

Objectives included measurement of the usability of the AwezaMed translation application among healthcare workers in South Africa, description of the user experience of healthcare workers using the AwezaMed translation to facilitate interactions with healthcare users in South Africa, and exploration of factors which contribute to the usage of the AwezaMed application by healthcare workers.

Usability, as measured using the SUS, was found to be fair. The user experience, while generally positive, did not live up to the expectations of users. Health workers had expected complete S2S capability, and content which would have completely replaced a human interpreter, which the app could not do. Factors which contributed to use of the app included a need for interpreting, which was expected. A general familiarity with technology and mHealth among health workers contributed to use of the app, and a complex relationship between health workers and ad hoc interpreters emerged.

4.1. Socio-demographic data

All AwezaMed users were employed as healthcare workers and used the app for a comparable time. While it could have been useful to measure the effects of demographic factors on usage and usability rating of the app, the sample size was not adequate for statistical analysis. The AwezaMed users made up a relatively homogenous group, as all were working age, and were purposively selected due to their perceived need for language support.

Biographical data have been linked to usability in South Africa; a usability study focused on digital platforms in the South African Banking industry used inferential statistics to evaluate the influence of certain characteristics (gender, age, employment status, income, choice or number of devices, years of experience) on SUS scores evaluating the usability of digital banking platforms (70).

No significant differences were noted in SUS scores between genders, but it was shown that older users tended to rate usability more highly (70). Other factors such as income and the number of devices were not enumerated in the AwezaMed study, and their impact on perceived usability could not be determined.

4.2 Usability of the AwezaMed app

While the SUS is the most frequently used questionnaire in usability evaluation, it is seldom used in isolation. The SUS has been used to evaluate various language-based systems for usability, often with a qualitative component in the study. This is the approach utilised in this study.

The SUS score achieved by the AwezaMed app is 66.25. This would rate it between “OK/Fair” [52] and “Good” [72], according to Bangor, Kortum and Miller (69). Lewis and Sauro (68) argue that the stand-alone score has minimal value, and that judgement of quality requires comparison.

Kaufman and Bernstein (66) used the SUS to evaluate the usability of natural language interfaces (NLIs). NLIs are systems which facilitate interaction (especially data query) between end users and ontological databases (71). This mixed-method study collected biographical data, evaluated the efficiency and accuracy of queries experimentally and with statistical analysis, and employed the SUS and a comparison questionnaire with a qualitative component (66). The findings of the qualitative component validated the SUS scores for the various NLIs [56.72, 75.73, 55.10 and 36.09] (66). In addition, the finding that reduced linguistic variability in queries facilitated greater accuracy in retrieval (66) supports the design of AwezaMed, which uses pre-determined structured utterances for translation.
The SUS result enumerating the usability of AwezaMed compares well with the Various NLIs and is validated by the qualitative findings of this study.

Keet and Khumalo used the SUS to evaluate a spell-checker system for isiZulu, an under-resourced South African language (65). This was also a mixed methods study, using open-ended survey questions and follow-up interviews with stakeholders to determine whether or not the spell-checker could conceivably contribute to the intellectualisation of isiZulu (65).
This study is compared with AwezaMed because it was conducted in South Africa, involved an under-resourced language, and employed mixed methods (SUS plus qualitative data collection and analysis) (65). By contrast, the spell-checker is neither health related nor a mobile system (65).

AwezaMed represents a novel concept in mHealth and is unique in southern Africa. Thus, no *truly* comparable usability studies have been conducted. The findings of the AwezaMed study can be considered an example of an SUS result as originally intended by Brookes: a “quick and dirty” (51) measure of usability.

Usability was explored qualitatively, according to themes of usability suggested by the ISO/IEC 9126 framework, namely understandability, learnability, operability and attractiveness (53). Trust is included, as it emerged inductively as a sub-theme of usability.

These themes were found to relate primarily to the design or layout of the app, and the feedback was favourable. No problems were noted with understanding the format or workings of the app. All users were able to learn to use the app in a short amount of time, with or without using the tutorials included in the app.
The app was generally found to be easy to operate with no confusion reported. Challenges to operability were related to technical problems; specifically downloading the app or accessing specific utterances. Users had difficulty accessing the S2S capability, and most reverted to using text-to-speech. This almost certainly affected usability. While users continued to use the app by selecting text from the drop-down menus, they did not enjoy the full capability of the app as intended by the developer. It is difficult to say whether the feedback would have been more positive if users had been able to fully use the S2S function.

4.2.1 Attractiveness

Jakob's Law of usability (24) states that users spend more time using sites (or systems or apps) other than the one which is the subject of the study, and therefore familiarity has a positive correlation with usability: "users spend most of their time on other sites. This means that users prefer your site to work the same way as all the other sites they already know" (24,72).

Very little was said regarding the attractiveness of the app, other than generally positive comments, referring to the ease of navigating the app. This may indicate that the developers of AwezaMed have achieved an appealing level of familiarity. Users did not find anything offensive in the appearance of the app, nor could they suggest any improvement which may have increased their usage. This could indicate that the appearance of an mHealth system is no longer a primary enticement to use and that users are more output and functionality-focused, or that developers of apps have attained acceptably high standards of attractiveness in general.

4.2.2 Trust

Participants placed great value on the trustworthiness of the app. Previous experience with commonly used translation applications has led to a degree of suspicion among users, with one user citing concerns regarding the reliability of translations as a factor which may have limited use of the app. Other users mentioned having checked translations into the target language they did understand (Afrikaans, for most study participants) for accuracy, and then basing their trust in other translations on this.

The value placed on the trustworthiness of translations may be due to the professional accountability of healthcare workers in South Africa. All health professionals are held responsible by the respective regulatory bodies for their acts and omissions. This may be implied, but it was not mentioned as a concern by any of the participants. Rather, the general standpoint was understood to be one of care and concern for the healthcare user's understanding and wellbeing, on the part of the healthcare worker providing the service.

This perspective was also noted in conversations regarding the use of informal interpreters. More than one participant mentioned the disconnect in the therapeutic relationship between the healthcare worker and the healthcare user when an

interpreter is involved in the interaction. While adequate information may be gathered to provide an acceptable standard of care, the rapport between provider and user is missed.

4.3 User Experience

User experience encompasses the inductive themes raised by users when describing their own experiences of using the AwezaMed application.

4.3.1 Reactions of healthcare users and peers

While the participants, as primary users of the app, were generally *au fait* with smartphone use and mHealth technology, the healthcare users were not necessarily so. A difference was noted between healthcare users in public and private health sectors regarding their general awareness of mHealth, with users of the public health system being generally less accustomed to technology. This may also have differed between older and younger healthcare users, although participants mentioned that older healthcare users were receptive to the technology, once they understood its use and potential benefits.

The response of healthcare users to the app was generally positive, with many immediately providing elaborate answers to the translated questions posed by the app. This may reflect a sense of relief on the part of the patients, and a general desire on their part to effectively express themselves to healthcare providers. While the technology does not currently provide for effective and reliable two-way translation of speech, the tendency on the part of patients to elaborate must be noted and could be construed as a call for this technology to be developed.

Users reported that peers generally responded positively to the app. Those who saw the appeal of incorporating the technology into their own practice were offered the opportunity to use the app. The positive reaction of vernacular speakers – who do not need the app themselves – could be a function of frustration at interpreting out of obligation.

4.3.2 Transferability

The app was used in a variety of health settings, despite originally being intended for maternal and obstetric settings. Healthcare workers found that much of the general content was easily transferable. This indicates that the need for interpreting is felt in all spheres of the health service. It could also indicate that some of the content

presented in the app, for example the material on HIV and TB, is relevant in all areas of health service.

Some users reported using the app up to the point where more specialised or subject-specific content was required and verbalised their hopes for more content to be developed. This transferability of the basic content may suggest that much of the developmental groundwork has been done, and AwezaMed may present a promising foundation for the future development of a translation corpus.

4.3.3 Learning a new language

Several apps have been developed and marketed as aids to language study. AwezaMed was not designed with this aim in mind, and yet it emerged as an additional benefit of using the app. Almost all the participants expressed (in some way) a wish to be able to converse freely with healthcare users, and a desire to improve their own language skills.

Use of AwezaMed in clinical practice is unlikely to provide enough exposure to language material for users to achieve fluency. Unfortunately, neither is completing a mandatory additional language module at tertiary education level (73).

Levin found that healthcare users blamed themselves for their own linguistic inadequacies (2), and some participants in this study seemed acutely aware of their own linguistic inadequacies. If, as Saohatse (5) suggests, the health system could be seen as a microcosm of society, then the language barrier is a severe problem in South Africa – too large, perhaps to be solved by employing trained interpreters in health facilities, using mHealth translation apps, or introducing mandatory communicative language modules in degree courses.

Participants indicated that the most appealing aspect of the app was the concept, or idea of having an mHealth application to bridge language barriers. While the feedback regarding the app was generally positive, the overall impression was that it did not quite meet the expectations of users, nor fulfil all their language interpreting requirements. This aligned with the findings of Seligman and Dillinger when testing the Converser system: It was found that praise for the “idea” was “higher than the actual experience” (42).

4.4 Factors which contribute to the usage of the AwezaMed app

Key factors emerged, which significantly contributed to usage of the AwezaMed app, positively or negatively.

4.4.1 Experiences with mHealth

All participants were competent smartphone users, and most were already mHealth users, even if they were not familiar with the term at the outset of the study.

Using an mHealth app to bridge language barriers is a relatively new concept in South Africa. Labrique mentions 12 common applications of mHealth, none of which are facilitation of interpreting in interactions between healthcare workers and healthcare users (28).

None of the mHealth apps mentioned by participants was language orientated. Familiarity with the technology may have contributed to the willingness to participate in the study and may also suggest openness to using a technological solution to a language problem.

4.4.2 The language barrier in healthcare

The impact of language barriers on the quality of health care services rendered is well documented, and all participants expressed having experienced challenges in this regard.

All categories of healthcare workers expressed frustration at the inability not only to provide a quality service within an acceptable timeframe, but also at the failure to establish rapport and build a therapeutic relationship with healthcare users. The positive response of some participants seemed to stem from desperation to overcome this.

4.4.3 The role of interpreters

Challenges surrounding reliance on untrained or informal interpreters (compromised confidentiality, interpreting errors including as omissions and additions, and resentment at the additional workload) (4,5,19,74) are well documented in the literature, and yet interpreters remain the default solution to language barriers in South Africa. The ability to circumvent these risks contributed largely to the appeal of the app. Unfortunately, the inherent limitations of the app, primarily the restriction to pre-selected and pre-translated questions or statements, and yes/no answers, led

some users to retain a preference for a human interpreter. It seems that healthcare workers would weigh the cost of compromised confidentiality against the benefit of flexible interpreting in situations where a choice is perceived.

The study findings suggest that a complex relationship exists between healthcare workers with limited language proficiencies, and their colleagues who are called upon to act as ad hoc interpreters. The request to interpret is an imposition, and healthcare workers acknowledge this, yet they continue to make the request for the benefit of the patient or client. The interpreter is inconvenienced, yet they continue to assist, for the benefit of the patient or client. While AwezaMed does not provide a complete solution to this problem, its existence, and the willingness of healthcare workers to use it and alleviate the burden on colleagues may go some way towards building better working relationships in health settings in South Africa.

Chapter 5: Conclusions

The final chapter acknowledges the strengths and limitations of the study and makes suggestions for policy and practice in response to the findings of the study. A quality framework is introduced, for evaluation of future mHealth language translation applications developed in South Africa.

The quality framework was developed by the researcher in response to the usability study undertaken. Usability themes are represented, categorised as technological (relating to the development of the mHealth platform) or relating to the language content of the system. The interrelationship between these two aspects is shown graphically.

This framework may be used to evaluate mHealth language translation applications in the South African context, in the future. It is based on the themes identified in this mixed-methods study and would allow future mHealth developers or researchers to focus their assessments on aspects which have been shown to be critical to South African Health care workers, according to their specific value system.

5.1 Strengths and Limitations of the study

AwezaMed is unique in South Africa. The literature search yielded no similar mHealth apps in Southern Africa, and very few translation apps worldwide which focus on health settings, and under resourced languages. Thus, the novelty of this study is a major strength.

While many apps and systems are tested using the SUS, few studies employ a robust mixed-methods design. The methodology employed in this study is a strength. The analysis of qualitative data in this study allowed for identification of unique contributing or hindering factors, based on the value systems of south African health workers, which may not have emerged through testing by purely quantitative means (e.g., the SUS alone).

Due to the difficulty encountered in recruiting users and research participants, the app was tested in a limited number of settings. No feedback was received from surgical settings and no comment can be made regarding using the app to obtain informed consent for procedures.

No data was collected regarding app users' language translation needs which were not met by the AwezaMed application.

While the app was used by midwives and professional nurses with other specialities, no medical specialists (for example paediatricians nor gynaecologists) participated in the study, and their feedback may have been valuable.

Participants in the study represented a homogenous sample, in terms of language competencies, with English and Afrikaans reported by most as either their home language or only additional language.

This study focused on user experience and impressions of usability; no experimental testing was conducted; this has been employed in other studies to confirm findings of efficiency and effectiveness (64), and may be of value in future studies.

A discrepancy occurred between the number of interviews conducted, and the number of SUS questionnaires completed. Despite reminders, not all users who participated in interviews opted to complete the SUS. While the numbers of both quantitative responses and qualitative participants were adequate to generate an SUS result and reach data saturation respectively, no statistical analysis could be completed on the limited sample.

The study focused on the experiences of app users, with healthcare workers regarded as primary users. No comment could be made regarding healthcare users' experiences of clinical interactions facilitated using the AwezaMed application.

5.2 Recommendations for research, policy, and practice

This study highlights the presence of the language barrier in South African Health settings, from the perspective of various categories of healthcare workers. This demonstrates the need for intervention; either by recognising the need for formal interpreters in health settings or making usable, reliable trustworthy mHealth solutions available.

The findings of this study, including a framework developed by the researcher, may lead to improvements in the development and testing of future MT systems in South Africa.

5.2.1 Policy and practice

Policy makers should note the impact of the language barrier on the quality of healthcare service offered and consider the provision of measures to mitigate this. The language barrier, and its negative effect on health service delivery in South Africa is well documented. This research study confirms the frustration experienced by healthcare workers, and their concern for the quality of service and care they can provide with the limited resources available to them. The absence of formal interpreting services in healthcare settings in South Africa is a threat, not only to quality of care, but also to health users' constitutional rights. The solution does not lie in depending on ad hoc or informal interpreting from other healthcare workers or the community.

Employment of interpreters may be the obvious choice, and further research may be conducted into the level of training required to make this feasible. This study indicates that mHealth translation applications should also be considered as an option. While a mHealth translation app is not without challenges and disadvantages, it is potentially an accessible and cost-effective step in the direction of improved communication between healthcare workers and healthcare users. Should applications such as AwezaMed become more commonplace in health services, a policy or guideline would need to be developed and adopted to incorporate this into health services in an ethical and professional manner.

Mobile data usage did not emerge as a factor limiting use of the app, but should use of translation apps, and other mHealth applications become more widespread, the provision of Wi-Fi to healthcare workers in their workplaces should be considered.

5.2.2 Future Research

This study focused only on the user experiences of healthcare workers. Future research should investigate South African healthcare users' experiences of accessing services across a language barrier, experiences of services facilitated by both formal and informal interpreters, and their experiences of interactions facilitated by this (and future) mHealth translation applications. The SUS has been shown to be valuable in the measurement of usability of this app, as the 'quick and dirty' system originally proposed by Brooke (51), however should future studies of AwezaMed or

other translation apps be of sufficient scale, the statistical regression benchmarks proposed by Sauro and Lewis (68) should be studied.

Future research and development should aim to expand the mHealth translation applications in terms of language content, and technology. True speech-to-speech machine translation should be the goal of language technologists. Any offerings to this effect will need to be rigorously evaluated for efficiency, effectiveness, reliability, trustworthiness, cultural appropriateness, and transferability.

It may be valuable to pilot the app in a specific geographic area, or facility, across various disciplines.

Based on the findings of this study, a basic framework is proposed for evaluating mHealth translation applications.

5.3 A Quality framework for the evaluation of translation-focused mHealth apps

Any mHealth platform (or operating system) used to develop a translation application must be efficient, i.e., make good use of the users' time resources. It must be effective; in that it must achieve what it is designed to achieve (effective translation). The system must be reliable (relatively error-free).

Any language corpus facilitating machine-translation must be robust and allow for quick and complete translation or interpretation. It has been shown that users in medical settings place significant value on the trustworthiness and cultural appropriateness of translations. Since healthcare workers often work in various settings within the healthcare space, language content should be developed with transferability in mind.

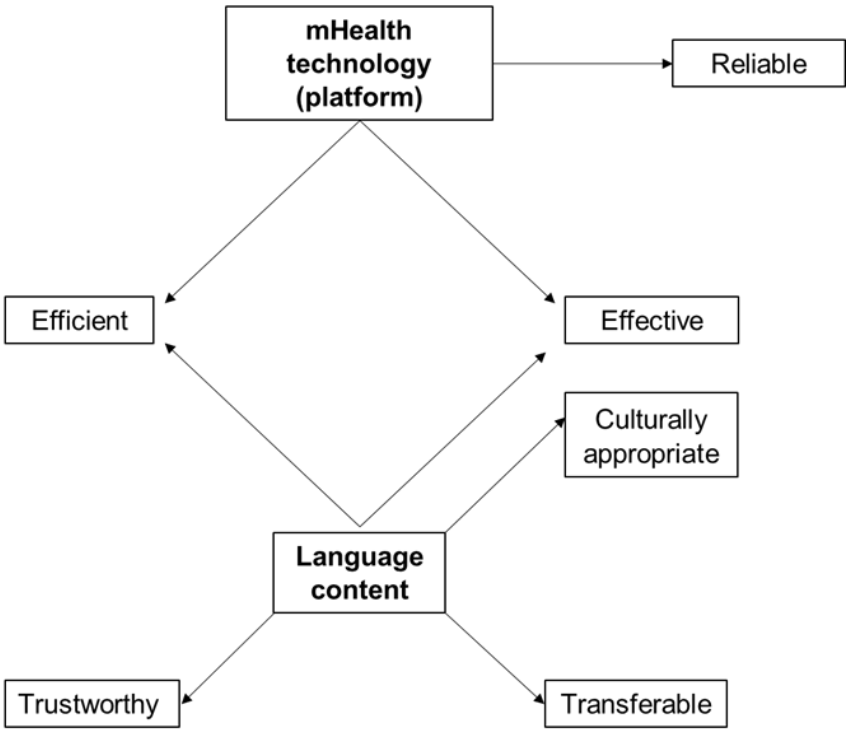

Figure 5.1 Quality framework for evaluation of translation-focused mHealth apps – designed by the researcher.

The quality framework for evaluation of translation-focused mHealth apps (figure 5.1) shows the interrelationship between usability aspects relating to the mHealth technology platform used to design the application, and those relating to the language content of an application.

It is important that the system works reliably (consistently and without errors), and that it is efficient (making good use of time) and effective (adequately performs the functions which it is designed to perform).

The HLT or language corpus must also be efficient (translations must be accessible or be generated in an acceptable amount of time) and be effective (high quality translations which can adequately convey meaning).

Translation generated by the HLT or drawn from the language corpus must be trustworthy, and culturally appropriate (taking cultural norms into account, and not causing offense despite presenting a semantically accurate translation). Language content should be transferable (applicable to a variety of health settings).

5.4 Conclusion

All participants admitted that language barriers impacted their ability to provide quality health services, and therefore the concept of the translation app held great appeal.

Informal interpreters are used regularly in pre-hospital settings, primary healthcare, neonatal units, and maternity units, and users were keen to try a new, self-sufficient method of communicating with patients and clients.

Study participants were well acquainted with the concept of mHealth, and readily accepted the AwezaMed translation app. Preference for mHealth interpreting was driven by the desire to work independently, ensure confidentiality and build stronger therapeutic relationships with healthcare users. Healthcare workers also place value on time - their own and their clients' - and hoped that the app would allow more efficient use of this.

Some users expressed a preference for human interpreters, including informal interpreters, despite the obvious challenges of availability, unreliable and inaccurate interpreting, and compromised patient confidentiality and privacy. This was more likely when an interpreter was perceived to be the choice of the patient or client, indicating that healthcare providers probably value the reassurance of their patient over the convenience of other healthcare workers. The resentment caused when other healthcare workers are called away from their own duties to provide ad hoc interpreting may not always be apparent to health care workers requiring assistance.

The app was found to be sufficiently attractive, and easy to learn and operate. The limitation of patient responses, to yes/no answers, was found to be a limiting factor affecting the use of the app.

Users placed value on the trustworthiness of the language content presented by the app; this was evidenced by the tendency for users to cross-check translations, by comparing them to a language with which they were familiar (Afrikaans). The cultural congruency of translations was also a point of care and concern among users.

Usage of the app would be increased in areas where there are no informal interpreters to fall back on, and work situations which allow time to develop rapport

between healthcare workers and healthcare users i.e., not life-threatening emergencies.

A need exists for continued research and development to make language and translation apps available, and to rigorously test these apps, ensuring mHealth-based interpreting is of a high standard.

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Appendix I – Plagiarism and Turnitin report

University of the Witwatersrand, Johannesburg

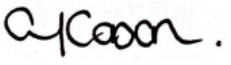
School of Public Health

SENATE PLAGIARISM POLICY

Declaration by Student

I Caroline Marian Cason (Student number: 1923104) am a student registered for Master of Public Health in the year 2023. I hereby declare the following:

- I am aware that plagiarism (the use of someone else's work without their permission and/or without acknowledging the original source) is wrong.
- I confirm that ALL the work submitted for assessment for the above course is my own unaided work except where I have explicitly indicated otherwise.
- I have followed the required conventions in referencing the thoughts and ideas of others.
- I understand that the University of the Witwatersrand may take disciplinary action against me if there is a belief that this is not my own unaided work or that I have failed to acknowledge the source of the ideas or words in my writing.

Signature:  Date: 23 January 2023

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Appendix II – HREC Approval Certificate & Permission Letter

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG	HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

Office of the Deputy Vice-Chancellor (Research & Post Graduate Affairs)

TO: Ms C Cason
School of Public Health
Medical School
University

E-mail: 1923104@students.wits.ac.za

CC: Supervisor: Dr W Slemming <Weidaad.Slemming@wits.ac.za>
and <HREC-Medical.ResearchOffice@wits.ac.za>

FROM: Iain Burns
Human Research Ethics Committee (Medical)
Tel: 011 717 1252

E-mail: Iain.Burns@wits.ac.za

DATE: 2020/07/07

REF: *R14/49*

PROTOCOL NO: **M200243** *(This is your ethics application study reference number. Please quote this reference number in all correspondence relating to this study)*

PROJECT TITLE: *Experiences of medical students using the Awezamed translation application in antenatal settings in Gauteng*

Please find attached the Clearance Certificate for the above project. I hope it goes well and that an article in a recognized publication comes out of it. This will reflect well on your professional standing and contribute to the Government funding of the University.

MSWorks2000/Iain0007/Clearscan.wps

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

OFFICE OF THE DEPUTY REGISTRAR

08 June 2020

Caroline Cason
Student number 1923104
Master's in Public Health
School of Public Health

TO WHOM IT MAY CONCERN

"**Experiences of medical students using the AwezaMed translation application in antenatal settings in Gauteng**"

This letter serves to confirm that the above project has received permission to be conducted on University premises, and/or involving staff and/or students of the University as research participants. In undertaking this research, you agree to abide by all University regulations for conducting research on campus and to respect participants' rights to withdraw from participation at any time.

If you are conducting research on certain student cohorts, year groups or courses within specific Schools and within the teaching term, permission must be sought from Heads of School or individual academics.

No research can commence before ethical clearance has been obtained. Kindly forward a copy of the clearance certificate to this office.

Nicoleen Potgieter
University Deputy Registrar

Appendix III – Participant Information Sheet

STUDY INFORMATION DOCUMENT

Study title: Experiences of healthcare workers using the AwezaMed translation application in antenatal settings

Good day!

Introduction:

I, Caroline Cason, am an MPH candidate, with the University of the Witwatersrand School of Public Health. In fulfillment of the research requirements of this degree, I am conducting a user experience study for a translation application for smart devices. In this study I wish to measure and explore the experiences of healthcare workers using a translation application to bridge language barriers in healthcare settings.

I am inviting you to take part in this research study.

1. The developers of the application will make it available for download, free of charge, to healthcare workers.
2. Please, feel free to use this application in your interactions with clients and patients.
3. Between August and October, you will be contacted to invite your participation in the user experience study. Your formal agreement to participate will be

sought. There will be two parts to the study. Firstly, I will ask you for limited biographical information and quantitative feedback using simple online questionnaires. Secondly, I will solicit your qualitative feedback in an interview. This will be done by whatever remote means is most convenient to you (telephone, Zoom, Skype etc), at a time of your choosing. With your permission, I would like to record the discussion for completeness. I will not be recording your name and the recordings will be erased after transcription.

4. All data will be collected electronically. Completion of the biographical questionnaire and measuring should take no longer than ten minutes, the interview make take between 30 minutes and one hour.

5. Interview questions will be related to your experiences of using the application and generating feedback as to how similar applications could be improved. All biographical data and questionnaire responses will be kept confidential and analyzed and reported anonymously. All qualitative data collected in the interview will be anonymized for reporting and analysis. Confidentiality will be assured.

6. If results are published, individual identification is unlikely. All data collected during the study will be securely retained for two years if a scientific publication arises from the study and six years if there is no publication. Thereafter it will be destroyed accordingly.

7. Participation is voluntary, and you may withdraw your participation at any time with no penalty. Should participation in this study cause you any distress or discomfort, referral will be made for counselling at the Counselling and Careers Development Unit (CCDU) at the University of the Witwatersrand. Should you choose to withdraw, you may request that any information you have provided be excluded from the study and destroyed.

8. While there is no direct benefit to participating in this study, you will be assisting in increasing knowledge, and furthering development in the field of Health.

9. There is no financial reward or cost for participating in the study.

10. I will be pleased to provide a summary of the study results on request.

This study has been approved by the Human Research Ethics Committee (Medical) of the University of the Witwatersrand, Johannesburg ("Committee"). A principal function of this Committee is to safeguard the rights and dignity of all human subjects who agree to participate in a research project and the integrity of the research.

If you have any concern over the way the study is being conducted, please contact the Chairperson of this Committee, Professor Clement Penny, who may be contacted on telephone number 011 717 2301, or by e-mail on Clement.Penny@wits.ac.za. The telephone numbers for the Committee secretariat are 011 717 2700/1234 and the e-mail addresses are Zanele.Ndlovu@wits.ac.za and Rhulani.Mukansi@wits.ac.za

Any further information regarding the study may be obtained from myself:

(email) 1923104@students.wits.ac.za, (cell) 0834045917

or my supervisor, Dr Wiedaad Slemming:

(email) Wiedaad.Slemming@wits.ac.za, (tel.) 0114815197

Thank you for your consideration!

Caroline Cason

August 2021

Appendix IV – Consent Form
Project: Experiences of healthcare workers using the AwezaMed translation application in antenatal settings.

Researcher: Caroline Cason

I, _____(please print) agree to participate in this research project.

(please tick)

- I have read the information sheet provided and have been given an opportunity to ask questions. Any questions have been answered to my satisfaction □
- I agree that audio recordings will be taken of interviews. □
- I understand that information shared will be anonymised for reporting and publication. □
- I understand that the research may use anonymous quotes in the write-up of the research project. □
- I understand that any personal information will be treated confidentially. □
- I understand that I may withdraw at any time, with no penalty. □

_____ signature of participant

_____ (please print) name of participant

_____ date

Enquiries:
Caroline Cason (principal investigator):
(email) 1923104@students.wits.ac.za (cell) 0834045917

Dr Wiedaad Slemming (supervisor)
(email) Wiedaad.Slemming@wits.ac.za (tel.) 0114815197

Clement Penny (ethics committee chairperson)
(email) Clement.Penny@wits.ac.za (tel.) 011 717 2301

Appendix V – Biographical Questionnaire

1. Gender:
    - Male
    - Female
    - Other
2. Age:
    - 22-25 years
    - 25-29 years
    - 30 +
3. Category of Healthcare worker
    - Medical Student
    - Prehospital emergency care provider
    - Nurse
    - Allied health worker
    - Medical practitioner
4. Nationality
    - South African
    - Other SADC region
    - Other (please specify)
5. Home language
    - English
    - Afrikaans
    - isiZulu
    - isiXhosa
    - Sotho
    - Sepedi
    - Tshivenda
    - Setswana
    - Xitsonga
    - siSwati
    - isiNdebele
    - French
    - Portuguese
    - Shona

- Chewa
- Makhuwa
- Sena
- Swahili
- Other (please specify)

6. Other language proficiencies

- English
- Afrikaans
- isiZulu
- isiXhosa
- Sotho
- Sepedi
- Tshivenda
- Setswana
- Xitsonga
- siSwati
- isiNdebele
- French
- Portuguese
- Shona
- Chewa
- Makhuwa
- Sena
- Swahili
- Other (please specify)

Appendix VI – Interview Guide

Themes	Probe questions	Follow up questions
Attractiveness	• What did you find attractive in/about the app? • What did you find unattractive in/about the app?	• How could it be made more appealing? • How did that impact/affect your use of the app?
Understandability	• How easily understandable was the app? • What was difficult or confusing about the app?	• What would make it easier?
Learnability	• How long did it take to feel comfortable/confident in using the app? • What made it easier/ more difficult to navigate using the app?	
Usability	• Would you describe the app as user friendly/unfriendly?	• What does user friendly mean to you? • What do you mean by unfriendly? • What would have made the app more usable? • What would make you more/less likely to use the app? • What could increase your usage of the app?
Efficiency	• Did/could the app save you time?	• Did you find the output/outcome worth the extra time? • Does the app make good use of your time?

Effectiveness	• Can you give an example of an interaction where the app was effective/ineffective?	• What was the outcome? • What outcome might have been averted?
Satisfaction	• Would you recommend the app to a friend or colleague? • Would you use an app like this in another area of your life? • Would you be prepared to pay for the app? • What advice would have for the developer of this app?	• Why/ why not? • Where might it be useful? • Who should pay for the app?

Appendix VII – Systems Usability Scale

1. I think that I would like to use this application frequently.				
Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
1	2	3	4	5

2. I found the application unnecessarily complex.				
Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
1	2	3	4	5

3. I thought the application was easy to use.				
Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
1	2	3	4	5

4. I think that I would need the support of a technical person to be able to use this application.				
Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
1	2	3	4	5

5. I found the various functions in this application were well integrated.				
Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
1	2	3	4	5

6. I thought there was too much inconsistency in this application.				
Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
1	2	3	4	5

7. I would imagine that most people would learn this application very quickly.				
Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
1	2	3	4	5

8. I found this application very cumbersome to use.				
Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
1	2	3	4	5

9. I felt very confident using the application.				
Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
1	2	3	4	5

10. I needed to learn a lot of things before I could get going with this application.				
Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
1	2	3	4	5