MOBILE HEALTH (mHealth) DIGITAL PLATFORM FOR PRIMARY DATA COLLECTION FOR PROSTATE CANCER MONITORING AND SURVEILLANCE IN EMBU COUNTY

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DECLARATION AND RECOMMENDATION

I declare that this research thesis is my original work and has not been presented in any other University.

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ABSTRACT

In Sub-Saharan Africa (SAA) prostate cancer mortality is projected to double by the year 2040. Prostate cancer is the 4th cause of death after breast, cervical, and oesophageal cancer respectively with an estimated incidence of 3,412 (8.1%) and a mortality of 1,780 (6.6%) in Kenya. Despite cancer data being a fundamental component of a functional and objective cancer control approach, cancer registration and surveillance in Kenya currently cover an estimated 10% of the population. Most of the developing countries are grappling with insufficient or lack of government resources allocated to strengthen cancer registration. This poses a major impediment to cancer management and control due to the lack of reliable timely data for decision making. The study was conducted in Embu County, which does not form part of the areas covered by the three population-based cancer registries in Kenya. Hence ideal for illustration of innovative approaches to bridge the population-based prostate cancer data gaps. The research thesis aim was to demonstrate the use of a mHealth digital platform prototype in the collection of primary data for prostate cancer control and surveillance. Specifically, the study wanted to determine the data set required for cancer surveillance and decision-making, assess challenges faced in accessing prostate cancer data, and illustrate the use of the mHealth digital platform in real-time primary data collection. The study adopted a descriptive cross-sectional study design, utilizing a design science research (DSR) strategy. The target population was healthcare workers, including community health volunteers in Embu County due to their role in data collection and management. The purposive sampling technique was used to identify participants in different phases of the study, a total of (71) respondents for the inspiration Phase, (15) respondents for the ideation phase, and critical case sampling was used to identify (34) community health volunteers (CHVs) from different community health units. Surveys with structured questionnaires were used in data collection, with a response rate of 80.3%. The data collected from this research was subjected to quantitative-descriptive analysis. The questionnaire findings guided the requirement definition, design, and development of the prototype which was tested by the end users. The research established that the existing integrated disease surveillance and response system majorly covers communicable diseases. A gap was also identified in prostate primary data collection from the community. The study found that community reporting was mainly paper-based. Generally, cancer registration is at a rudimental stage majorly focusing on hospital-based data. The adaptability and scalability of the mHealth digital platform in a resource-constrained setup, in addition to real-time access to data was demonstrated through tests and implementation of the prototype application in the community. Finally, the research recommends the expansion of the existing disease surveillance system to include cancer surveillance.

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LIST OF ABBREVIATIONS AND ACRONYMS

AIDS	Acquired Immunodeficiency Syndrome
CHA	Community Health Assistant
CHFP	Community Health Focal Person
CHV	Community Health Volunteer
DHIS	District Health Information System
DSC	Disease Surveillance Coordinator
DSR	Design Science Research
GIS	Geographic Information System
GLOBOCAN	Global Cancer Observatory
HIE	Health Information Exchange
HRIO	Health Records and Information Officer
IAEA	International Atomic Energy Agency
IARC	International Agency for Research on Cancer
ICT	Information Communication Technology
ITU	International Telecommunication Union
KEMRI	Kenya Medical Research Institute
LMICs	Low- and Middle-Income Countries
mHealth	Mobile Health
MoH	Ministry of Health
NCD	Non-Communicable Diseases

PBCRs	Population Based Cancer Registries
SMS	Short Message Service
SSA	Sub-Saharan Africa
WHO	World Health Organization.

CHAPTER ONE

1.0 Introduction

The chapter gives the context of the research, the description of the problem, the purpose of the research, the objectives of the research, the research questions, the justification and significance of the study, limitations, delimitations, and assumptions of the study.

1.1 Background of the Study

According to global cancer statistics 2020 estimates, the burden of cancer continues to rise, with an estimated incidence of 19.3 million and a mortality of almost 10 million from cancer in 2020. Moreover, a global projection of about 47% rise from 2020 to 28.4 million cases is expected in 2040. World health organization 2019 estimates, rank cancer as the leading or second in 61.2% of 183 countries and third or fourth in an additional 23 countries. Generally, cancer is becoming a major health concern worldwide with the rapid growth in the burden of cancer occurrence and mortality, the trend has been attributed to the epidemiological transition of the populace in addition to changes in frequency and spread of cancer risk factors, a bulk of which are closely linked to socioeconomic development (World Health Organization. [WHO]& Global Health Estimates 2020). Global cancer statistics 2020 places cancer of the prostate as the second most predominant and fifth in mortality rate with an estimated incidence of 1.4 million and 375,000 mortality.

Hamdi et al. (2021) contend that cancer is posing a major health concern in Africa which calls for an effective strategy to improve access and affordability of cancer care. In Africa, the dedication and resources directed toward fighting cancer are unmatched, with cancer mortality rates exceeding that of HIV, TB, and Malaria combined. Predominantly more emphasis has been on infectious diseases due to long historical trends and donor focus with incomparable resources directed towards non-communicable diseases such as cancer. Cancer has been linked to genetic predisposition that combined with other risk factors determines a person's

susceptibility. Among the risk factors associated with cancer include changes in lifestyles leading to increased cancer risks and exposures to cancer-causing agents due to increased urbanization (Rebbeck. 2020).

Prostate cancer mortality has been on an upward trajectory in Africa which has been majorly attributed to delay in diagnosis. At the early stages prostate cancer does not present with noticeable signs and symptoms, this has largely been cited as the cause of late diagnosis and poor prognosis (Cassell., 2019). Reportedly, in many countries in sub-Saharan Africa prostate cancer is the most common cancer among the male. Also, cancer registration challenges remain a major impediment to access to reliable data with only 6% of the region currently covered by plausible accurate death registries and population-based cancer registries found in only four countries.(Bosland et al., 2023). Globally during the last ten years a decline and in some areas a stable trend of prostate incidence rates has been reported. However, this phenomenon has been prominent in high-income countries and has been associated with reviews in the direction concerning the use of prostate-specific antigen (PSA) screening of men without symptoms and resultant reduced use (Seraphin et al., 2021). According to the Global Cancer Observatory report (GLOBOCAN, 2020), prostate cancer is the 4th cause of death after cervical, breast, and esophageal cancer respectively with an estimated incidence of 3,412 (21.9%) and a mortality of 1,780 in Kenya. Ministry of health 2017 estimates about 80% of prostate cancer patients were diagnosed with advanced disease and more aggressive tumors leading to poor clinical outcomes because of limited options to improve the survival of the patients.

Mobile technology use in the medical field is continually expanding with significant contributions in improving access to evidence-based information to support decision-making and reduce errors, improving management of data and access, and facilitating timely communication and coordination among healthcare professionals (Hitti et al., 2021). Studies on health digital platforms deployed across the cancer care continuum, ranging from creating awareness, cancer screening, capturing information, monitoring compliance and management

progress, follow-ups, and knowledge sharing among professionals with a resultant improvement on the outcomes. Technological innovations such as health have been cited as viable solutions to addressing challenges experienced in the provision of cancer care in low-resource settings (Salmani et al., 2020a).

The use of technologies in the health sector has revolutionized the conventional healthcare system. The opportunities presented by mHealth include access to real-time data even from remote areas, improved data quality, health data management and medical information sharing, targeted health education, and informed decision-making. Regions experiencing resource constraints need innovative ways to improve access to modern healthcare services. The use of mobile applications in cancer screening has been proven to be a cost-effective and convenient strategy that is gaining recognition among the stakeholders and its prospects to improve the quality of care. Furthermore, mobile health applications have been shown to enhance ongoing health monitoring of both populations and individuals. (Quercia et al., 2018)

The importance of electronic health records as an integral part of an effective health care system has been widely acknowledged in its contribution to positive health outcomes. Electronic health records play a major role in reducing medical errors, improving coordination and efficiency in service provision, ensuring safety standards and quality is maintained, and overall reducing healthcare-related costs (Odenkule et al., 2017). In Kenya, the utilization of ICT in healthcare delivery at the lowest level is very low with the process of documenting largely being paper-based which is not only cumbersome but also prone to data quality issues (Bakibinga, 2020).

Surveillance is essential for policy and planning of health services. Remote areas with poor infrastructure can pose a major challenge to data collection, making it expensive. Mobile technology has made health reporting and surveillance substantially more plausible. There has been an exponential growth of digital solutions such as mUzima which is robust enough to make it possible to be adopted in resource-challenged settings and effective interoperability

(Were et al., 2021). The ministry of health in recognition of the important role played by mobile applications in the provision of care, embarked on the development of the Kenya mHealth standards and guidelines in April 2017 to provide a regulatory framework to support the coordination and implementation of versatile mHealth solution (Ministry of Health,[MoH] 2017a).

1.2 Statement of the Problem.

Prostate cancer was estimated to have an incidence of 1.4 million and 375,000 deaths worldwide making it the second most frequent cancer and fifth leading cause of cancer mortality among men in 2020. Notably, prostate cancer ranks top as the cause of cancer death among men in 48 countries, including many in sub-Saharan Africa. Paradoxically little is documented about its etiology, with known risk factors limited to age, family history, certain genetic mutations, and conditions such as lynch syndrome. Few lifestyle and environmental factors have been identified (Sung et al., 2021).

A working program for cancer control is needed to avert the upward trends of cancer burden in SSA. Arguably, reliable, and timely population-based data on occurrence, treatment, survival rate, and outcome are crucial for a rational cancer control program. (Omonisi et al, 2020a). Globocan (2020) statistics Kenya cancer data estimates were based on data from Eldoret and Nairobi cancer registries, thus the data reported does not represent the correct cancer situation in the country posing a challenge in planning and resource mobilization. The International Agency for Research on Cancer (IARC) underscores the importance of population-based cancer registries (PBCRs) are a unique source of information for research and monitoring public health programs (Bray et al., 2021).

To improve access to data and cancer surveillance in Kenya, the establishment of county-level registries is necessary to compliment the national registries. This will be critical in responding to the existing data gap on cancer incidence and mortality in Kenya (Makau et al., 2020).

Currently in Kenya cancer registration and surveillance covers an estimated 10% of the population which has been sub-optimal with three established and functional population-based cancer registries (WHO et al.,2016 a). The situation warrants a mHealth digital platform to facilitate primary data collection to inform sound cancer control programming in Kenya. Previous studies indicate that mHealth can facilitate timely data collection, manipulation, and sharing (Salmani et al., 2020).

1.3 Purpose of the Study

The purpose of the study was to demonstrate the use of the mHealth digital platform in primary data collection for prostate cancer monitoring and surveillance.

1.4 Broad objective of the research

To illustrate the use of a mHealth digital platform for primary data collection for prostate cancer monitoring and surveillance in Embu County.

1.4 Specific objectives

i. To identify challenges faced by disease surveillance officers in accessing prostate cancer data.
ii. To determine the data set required for prostate cancer surveillance and decision-making.
iii. To develop a prototype mHealth digital platform for primary data collection for effective monitoring and surveillance of prostate cancer.
iv. To demonstrate the use of the mHealth digital platform to improve real-time access to primary data for prostate cancer monitoring and surveillance.

1.5 Research Questions

i. What are the challenges experienced by disease surveillance officers in accessing prostate cancer data?
ii. What is the data set required for prostate cancer surveillance and decision-making?

iii. How to develop a prototype mHealth digital platform for primary data collection for monitoring and surveillance of prostate cancer?

iv. How mHealth digital platform can improve real-time access to primary data for prostate cancer monitoring and surveillance?

1.6 Justification

According to the WHO and Non-Communicable Diseases (NCD, 2018), country profile Kenya's cancer mortality rate is ranked first among the NCDs at 10%, and second after infectious, maternal, and nutritional conditions which are at 63%. Cancer registration and surveillance is vital in generating data necessary for targeted cancer control interventions; however, this has been suboptimal in Kenya with the country largely depending on GLOBOCAN estimates to inform policy framework and planning (Bakibinga, 2020).

The study demonstrated the use of the mHealth digital platform to bridge the gap in the access to real-time primary data required to run up-to-date population-based cancer registries, a prerequisite for a rational cancer control program.

1.7 Significance of the study

The partnership between WHO and ITU is an effort towards realizing universal access and quality healthcare for all. WHO notes that, closely linked to sustainable development goal 3, digital solutions present a great opportunity for countries to expand health coverage, even in remote areas, by 2030. Among the key areas of focus is to assist low-income countries to adopt proven solutions, and accelerate scaling and evaluation of digital health interventions, especially on mHealth for noncommunicable diseases (WHO&International Telecommunication Union [ITU], 2018).

The findings from the research are useful in cancer programming and interventions in suggesting conceivable mHealth solutions that can facilitate timely primary data collection for cancer monitoring and surveillance. This study also was essential in illustrating timely access

to quality cancer data by the policy makers for decision-making and scientists for research purposes and a premise for designing, implementing, and evaluating cancer prevention and control measures effectiveness.

1.8 Limitations of the study

This study faced the following limitations.

- The study utilized questionnaires only to collect data due to the geographical location of the participants, however, including interviews could have generated more data.
- The design science research strategy is iterative, which required continued engagement with participants that proved difficult due to competing tasks.

1.9 Delimitation of the study

- The study aimed to contribute to design knowledge and illustrate using a mHealth digital platform prototype the collection of prostate cancer primary data from the community.
- The study only covered the design, development, and implementation of the mHealth digital platform prototype to demonstrate the collection of prostate cancer primary data from the community.

1.0 Assumptions of the study

- The participants answered all the questions honestly.
- There was reliability and validity of the measuring instruments.

1.11 Operational terms.

- **Cancer –** Cancer refers to the uncontrolled growth of body cells and possible spread to other body parts.
- **Prostate cancer –** Uncontrolled growth of body cells in the prostate gland located in the male reproductive system.

- **mHealth –** the use of mobile technologies in the delivery of healthcare services at different levels.
- **Incidence –** the number of newly diagnosed cases of a disease.
- **Mortality –** number of deaths caused by health events under investigation.
- **Aetiology –** the cause or origin of a disease.
- **Tumor –** An abnormal mass or lump of tissue, which can be cancerous (malignant) or noncancerous (benign).
- **Surveillance –** the continuous, systematic collection, analysis, interpretation, and timely dissemination of health data for actioning.
- **Design science research-** the approach seeks to create an innovative solution to a real problem by analyzing any existing solution to improve it, creating a new logic, and expanding design knowledge, which constitutes problem, solution, and evaluation.
- **Inspiration phase –** the first step in the design process that entails learning directly from the people experiencing the challenge or the targeted users of the solution.
- **Ideation phase-** the next step after inspiration involves making sense of the insights gathered in the first step, evaluating different design logic, and developing the prototype of the proposed solution.
- **Implementation phase –** the last step which actualizes and brings the solution to life, linking the solution to the problem.
- **Critical case sampling-** a type of purposive sampling technique used when a very small case can be used to explain other similar cases.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This section explores the existing scholarly works related to the management of cancer in LMICs, the use of mobile technologies in the health sector, and applications used in cancer management, cancer registries, cancer control, and surveillance practices. The findings of the previous study on the benefits of mHealth digital platforms on cancer management and control and the unexploited opportunities. A combination of methods was adopted for the literature search which included peer-reviewed journals, electronic search of databases, tracking citations, reference chasing, and personal knowledge.

2.2 Cancer care in low- and middle-income countries.

Sub-Saharan Africa is facing unprecedented health challenges with ever increasing cancer burden, with projections pointing to worse times ahead in the absence of deliberate and concerted efforts to avert the trend. The International Agency for Research on Cancer in 2018 predicted a more than double mortality increase between 2018 and 2040 in Africa, that is 693,487 to 1429,812 (Ferlay et al., 2018). In comparison to other WHO countries, the cancer situation in Africa is serious and requires a context-sensitive approach. High-income countries substantially have a high cancer incidence rate, however, the cancer mortality rate in sub-Saharan countries is close to that of developed countries at (87.1 per 10000) and (98.7 per 100000) respectively (Bray et al., 2022).

The need for countries in Africa to invest in healthcare improvement was exposed by covid-19 pandemic. Morbidity and mortality in Sub-Saharan Africa have majorly been attributed to infectious diseases, maternal, and nutritional diseases. However, through concerted efforts from different stakeholders, there has been a gradual shift in disease burden from communicable to non-communicable such as cancer (Ngwa et al., 2022). Kenya just like other

SSA countries experiences a multifaceted challenge in cancer care. These include poor health education and health-seeking behaviors that contribute to the delay in diagnosis, the prohibitive cost of care which has impoverished many families, and access to the services with an official medical database showing a ratio of oncologists to patients at 1:540000 and about five comprehensive cancer centers in the country with nearly all of them in Nairobi (Abdihamid, 2022).

According to the KEMRI regional cancer registry, approximately 80% of reported cancer cases are diagnosed at advanced stages, when the chance for a curative treatment is not feasible. This is largely due to limited knowledge about cancer manifestation, inaccessibility or low uptake of screening services, scarce diagnostic centers, and lack of an elaborate and functional referral system. The report also highlights the shortage of cancer specialists in the country with the few available clustered within Nairobi, causing long waiting times and poor prognosis.

2.2.1 Prostate cancer incidence and mortality status.

Global statistics show that prostate cancer incidence was more than 1.4 million and 375,304 deaths making it the second most commonly diagnosed cancer and the fifth leading cause of cancer death among men in 2020. Since 1990's Prostate-specific antigen (PSA) based screening has been in use in a number of high-income countries and only a few have recorded a decline in the number of deaths. Prostate Cancer screening has remained a controversial issue due to the documented risk of over diagnosis and harm associated with biopsy and treatment (Wang et al., 2022).

In Sub-Saharan Africa (SAA) Prostate cancer-related deaths are estimated to almost double by the year 2040**.** This trend partly has been associated with low screening and barriers in treatment accessibility, unhealthy lifestyles linked to economic development and socio-demographic changes, and increased live expectancy. In some of the developed countries, there is still no consensus on the merit of using prostate-specific antigen (PSA) for screening. Due to inadequate registration of cancer in Sub-Saharan Africa and other developing, the

benefits of screening in SSA and other low-resource areas remain unclear (Makau et al., 2022)

Previous studies conducted in Kenya have highlighted delays in the presentation of prostate cancer patients in health facilities with advanced disease, a demonstration of low uptake of screening which has been attributed to low knowledge, lack of awareness, myths, and misconceptions. Early detection and treatment initiation before spreading to other body parts, has been recommended as an important strategy to reduce mortality since prostate cancer mostly does not present with a clearly defined symptom at early stages. Progress in prostate cancer management calls for prioritization of screen and early detection to improve prognosis. Health policy in Kenya recommended prostate cancer screening for men aged 40 years to 69 years. To increase the uptake of prostate cancer screening the current approach needs to be relooked and innovative ways incorporated to improve the outcomes (Humphrey & Isaac, 2023).

2.3 Health information technology

The emergence of electronic health records as a component of health information technology has improved population health management by ensuring quality and efficiency in healthcare. However, for these benefits to be realized it requires an organized implementation plan and proper capacity building. The importance of electronic health records in improving access to health data, sharing of medical information, chronic conditions management, supporting surveys and surveillance is well documented (Kruse et al., 2018). Government incentive schemes have played a key role in the adoption of electronic health records in developed countries. Through the support of partners linked to specified programs, a similar trend has been observed in developing countries despite the challenges of poor resourcing, capacity gaps among personnel, insufficient data collection systems, and stimulus towards health information improvement. In some programs such as HIV and tuberculosis (TB) digitization has been

implemented successfully improving patient management by tracking personalized data on compliance, follow-ups, and commodity management. However, some challenges in interoperability with other systems and data utilization by some service providers were identified (Muinga et al.,2018).

Healthcare systems in many low-and middle-income countries (LMICs) are still characterized by paper-based health records with compromised quality and efficiency in data organization and storage. An electronic health record is robust allowing for customization of the platform based on the data needs, features that make it possible for remote access by multiple users simultaneously, data manipulation options, and security features to control access and ensure data protection. (Sanna, 2015). Health system digitization in Kenya is on rapid growth replacing the paper-based system. There has been a notable success with the adoption and implementation of various digital initiatives such as DHIS2 which is a centralized, and open-source system used in specific health programs. Similar trends are evident in some subcounty, county referral, and national referral hospitals. However, there is a challenge of interoperability and integration among systems in different departments affecting data exchange and inadequate infrastructure (Muinga et al., 2020).

2.4 Cancer registry and surveillance global perspective

The WHO through a global action plan for the prevention and control of NCDs 2013-2020, championed for vital registration system reinforcement and cancer registries, integration of cancer surveillance into national health systems, designed a programmed risk factor surveillance tool, and the enhancement of technical expertise and institutional surveillance performance. The WHO underscores the importance of registry provision of quality epidemiologic data, which is essential in describing and monitoring the risk of cancer and conducting research. Particularly, the registries play a critical role in the calculation of national estimates of incidence, prevalence, and mortality and predict trends or mapping of cancers. In addition, survival rate trends are instrumental in assessing the contribution of clinical research

in improving therapeutic outcomes. Lastly, the analysis of the information at an individualized level can help in the identification of the role of risk factors.

The dynamics of health and epidemiological characteristics of populations determine the strategy used in disease surveillance, even though all such systems have some similarities in the key processes including data collection, analysis, and dissemination. Characterization of NCD control including cancer nationally is a daunting task for many LMICs, where public health surveillance efforts are inclined towards prioritization of communicable diseases and outbreaks with little attention given to chronic conditions. Moreover, the emerging focus on surveillance of chronic diseases has drawn attention to risk factor surveillance as opposed to the usual disease occurrence, thus highlighting the role of population-based cancer registries (PBCRs) within NCD surveillance (Piñeros et al., 2017).

Population-based registries play a fundamental role in the approximation of the population at risk of developing cancer, the determination of geographical distribution, and the impact of intervention strategies. This information is also critical in estimating resources such as personnel, services, and the supporting framework required to combat cancer (Piñeros et al., 2021). In the fulfillment of the international obligation of cancer incidence reporting by type, many national governments have misinterpreted the communicable disease surveillance approach as equivalent to the principle of PBCRs. Weisner (2018) further points out that, without following the required methodological requirements of PBCRs, such a strategy has provided incorrect estimates of cancer incidence burden and misleading cancer-control priorities.

Despite the evidence from various studies pointing towards the health threat posed by cancer, in many African countries, the burden of cancer remains unknown due to lack data gaps either lack of data or under reporting data. The paucity of reliable cancer data in several countries has resulted in reliance on modeled data for decision-making and informing policies. To run an

effective cancer control and management program both community and facilities require data. (Ayandipo et al., 2020).

2.5 Cancer registry and surveillance in Sub-Saharan Africa

According to the WHO Africa regional office, in sub-Saharan Africa, about half of the countries (25) have population-based registries, from which national cancer statistics estimates can be derived. Cancer profile estimates for approximately (21) countries are based on the available data from the neighboring countries or the use of simulation models. Omonisi et al. (2020) argue that undeniably a functional cancer registry forms an integral element of a logical cancer control strategy, however, most low-and-middle-income countries are struggling with limited or lack of resources set aside for cancer registries. This is largely due to the several challenges facing the health system in SSA countries and partly because the impact of cancer registries in the prevention of cancer is long term hence not attractive for those looking for immediate gains.

WHO, (2017), cancer resolution reinforced the need for sub-Saharan countries to have a strategic cancer control plan to address the rising cancer burden. The resolution further notes that an objective cancer control strategy must be premised upon up-to-date, quality population data on incidences, prevalence, therapy response, and sequela from within the region it serves, such data can be obtained from PBCRs.

Population-based cancer registration has been considered as the ideal source of information on cancer in a population, critical for identification of the possible causes and in assessing the impact of cancer control interventions (Bray et al., 2021). Population-based cancer registries collect information from different sources on all types of cancer occurring in a defined geographical population. The other two important cancer registries are hospital-based (HBCRs) which collates data on cancer cases diagnosed and/or treated in a particular facility or facility, and pathology-based cancer registries focused on cancer cases diagnosed in pathology laboratories. These two registries are important in the assessment of services given,

however, they cannot be used to determine regional or national cancer burden, as the data represent patient-given services in a facility or confirmed biopsy which is majorly determined by the level of facility and availability of expertise (Bray et al., 2014). Cancer registration and surveillance coverage in Kenya just like other countries in SSA has been inadequate, with three functional cancer registries and an estimated coverage of 10% of the population (WHO et al., 2016b). The ministry of health notes that,

> Efforts to establish new cancer registries have been ongoing, however, these efforts have been hindered by a lack of institutionalization and funding. There is a need to address inadequacies concerning human resources, equipment, and operational costs, as well as enforcing regulation of professional requirements for documenting and reporting cancer diagnoses. There is also a need to enhance efforts to support and coordinate county, national, and international cancer registration, and surveillance, and cultivate public-private partnerships (National Cancer Control Strategy 2017 – 2022 Nairobi, June 2017, p.24).

Multiple factors have been identified as a hindrance to cancer control in Kenya, among them constraints on cancer care infrastructure, availability and distribution of specialized healthcare services, delay in seeking care, and limited knowledge of cancer among health care providers and the general population. Additionally, cancer services financing challenges, limited studies, and insufficient cancer data to guide policy formulation and clustering of services in urban areas (Makau et al., 2018).

2.6 Background of Mobile Health (mHealth).

The WHO Global Observatory for eHealth defined mHealth as " medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless''(Bradway et al.,2017). The International Telecommunication Union (ITU) in 2018, estimated mobile network coverage to be at 95% and mobile cellular subscriptions to over 7 billion of the global population. Mobile phones

present an efficient and reliable option to connect almost everyone, including even the most disadvantaged people in remote areas, making it possible for them to equally benefit from mHealth services. As one of the few delivery approaches that is less demanding in terms of prohibitive investment in new infrastructure, mHealth has the potential to significantly transform healthcare services delivery. This presents a great opportunity that can be exploited to improve cancer services to overcome systemic structural barriers and resource limitations.

The third Global Survey on eHealth (WHO,2016) findings underscore the importance of mHealth as a key enabler towards achieving universal health coverage through its capabilities to avail services in hard-to-reach areas usually underserved, and a platform for health data exchange. The report also notes that mHealth has a unique advantage in bridging the gap in the provision of care in a resource-challenged setup since it doesn't require a lot of infrastructural investment to operate. Also, the fact that implementing a mHealth solution is cheaper in comparison to in-person services. According to Dabo and Ogoncho (2017), the emerging technological innovations in eHealth and particularly mobile health have been cited as a major pillar of the transformation agenda of the health sector by providing new alternatives and robust platforms for supporting healthcare service delivery in cost-effective, scalable, and sustainable ways, particularly in resource-limited settings.

The growing mobile phone penetration rate has made it possible to improve timely data collection from various sources, seamless transmission, and analysis of the data courtesy of mobile-based innovations. Therefore, mobile health innovations present a great opportunity that can be tapped into to improve health outcomes. Many mHealth interventions have been implemented focusing on health education and behavior change, health data collection and management, different level health registries, and electronic health records, along with, health provider training and education. Mobile health interventions' impact on improving clinical outcomes, treatment, care compliance, and health behavior changes among other areas in the health sector has been documented (Marcolino et al., 2018).

2.7 Mobile Health (mHealth) application use in cancer care

The WHO 2017 cancer resolution highlights key areas of focus, among them health promotion strategies, risk factor reduction, and improving access to the continuum of cancer care services. Salmani (2020) notes the important role of mHealth in improving access to quality and real-time data while maintaining the privacy and security of data. The use of technology has facilitated health records exchange and access to experts' services through telemedicine. However, the studies emphasize the importance of ensuring ethical legal considerations in data management. Along with the studies done previously, notably the use of mHealth digital platforms to improve cancer screening and related knowledge sharing, schedule reminders, monitoring the progress, and supporting service delivery.

Global health bodies recommend prioritization of cancer screening as a prerequisite for a responsive cancer care approach. Many countries have heeded the call and despite the success recorded population-based cancer screen services and preventive care favour urban settings in comparison to rural and resource constraints areas which are often characterized by access barriers. In countries where screening and preventive care has received as much attention as treatment, early detection and cancer survival rate has drastically improved. Mobile health innovations play a critical role in cancer patients' involvement in their care, given the increased connectivity mHealth solutions present real-time customized care support by facilitating communication with the healthcare providers and linkage to support groups. (Salmani et al., 2020).

The rapid growth of the cancer burden in Sub–Saharan Africa, with the existing weak and poorly funded health system requires an innovative approach to deal with the growing cancer problem. An estimated 80% of cancer cases in SSA are detected late which impacts the outcome, this is largely attributed to lack of awareness and poor access to healthcare services. Hence, palliative care needs are unmatched despite being a fundamental essential service in cancer management. The use of digital technology harnessing wide coverage of mobile use has

been demonstrated as a viable alternative to link health professionals with patients and caregivers (Nkhoma et al., 2021). The findings from a study on Smartphone apps for cancer highlight the use of apps in tracking appointments, medications, treatment progress, and side effects. Further, the findings point out that apps focused solely on creating awareness about cancer are not adequate in prevention. However, the effectiveness can be improved by integrating features aligned with lifestyle skills and the social support required for the maintenance of healthy behaviors. The study also identified features to support the sharing of medical records as a critical area not fully explored. (Charbonneau et al., 2020).

Cancer screening has been demonstrated as an effective way of increasing the opportunity for early detection and treatment and eventually survival. In many developed countries, cancer screening among the population has been promoted and accessibility improved targeting common cancers such cancer of breast, cervical, prostate, and colorectal cancer with a resultant reduced mortality. However, the situation is different in most developing countries cancer screening is low, partly due to challenges in availability and low uptake among the population even when the services are available leading to late diagnosis, treatment, and outcome (Schliemann et al., 2022).

The use of a mobile health app to support HPV screening using community health workers in western Kenya was appraised for its ease of use and usefulness in capturing data, offering health education, and tracking clients. The efforts aimed at reducing cervical cancer-related morbidity and mortality by promoting screening and HPV vaccination using cost-effective and culturally acceptable approaches. However, the study highlights the importance of contextualizing the application by acting on the user feedback is critical to improving user experience and sustainability (Stocks et al., 2022).

2.8 Theoretical framework

2.8.1 Health Believe Model

The Health Believe Model (HBM) was used to conceptualize the study because majorly the mHealth digital platform focused on collecting population-based health indicators on lifestyle, health-seeking behavior, incidence, prevalence, survival rate, and mortality to facilitate effective prostate cancer monitoring and surveillance. The epidemiological transition witnessed partly has been linked to the increase in lifestyle-related health problems which calls for a shift from curative care to interventions oriented towards the prevention and promotion of health behavior (Orji et al., 2012). The model posits that an individual's course of action is influenced by the perception of the benefits and barriers related to health behavior. The health belief model is based on six constructs: perceived susceptibility (subjective perception of the vulnerability of acquiring the health condition; perceived severity (perceived seriousness of contracting a disease and the consequence); perceived benefits (perception of the effectiveness of undertaking specific recommended behaviors to reduce the threat of developing a certain illness); perceived barriers (perception on impediments adopt a recommended health practices which involve analysis on effectiveness and related inconveniences); cue to action (presence of factors that stimulates decision making towards embracing a recommended practice) and self-efficacy (confidence in one's ability to execute successfully the new health behavior). (Wayne, 2022). The mHealth digital platform solution goal was to improve prostate cancer data collection and real-time access to population-based data which overtime could be used to demonstrate or identify patterns and trends among the eligible clients monitored. These findings are critical in the characterization of individuals and population health status based on the indicators present, the implication on their health, the actions that an individual can take, and the control one has over the prevailing situation.

2.8.2 Diffusion of Innovation Theory

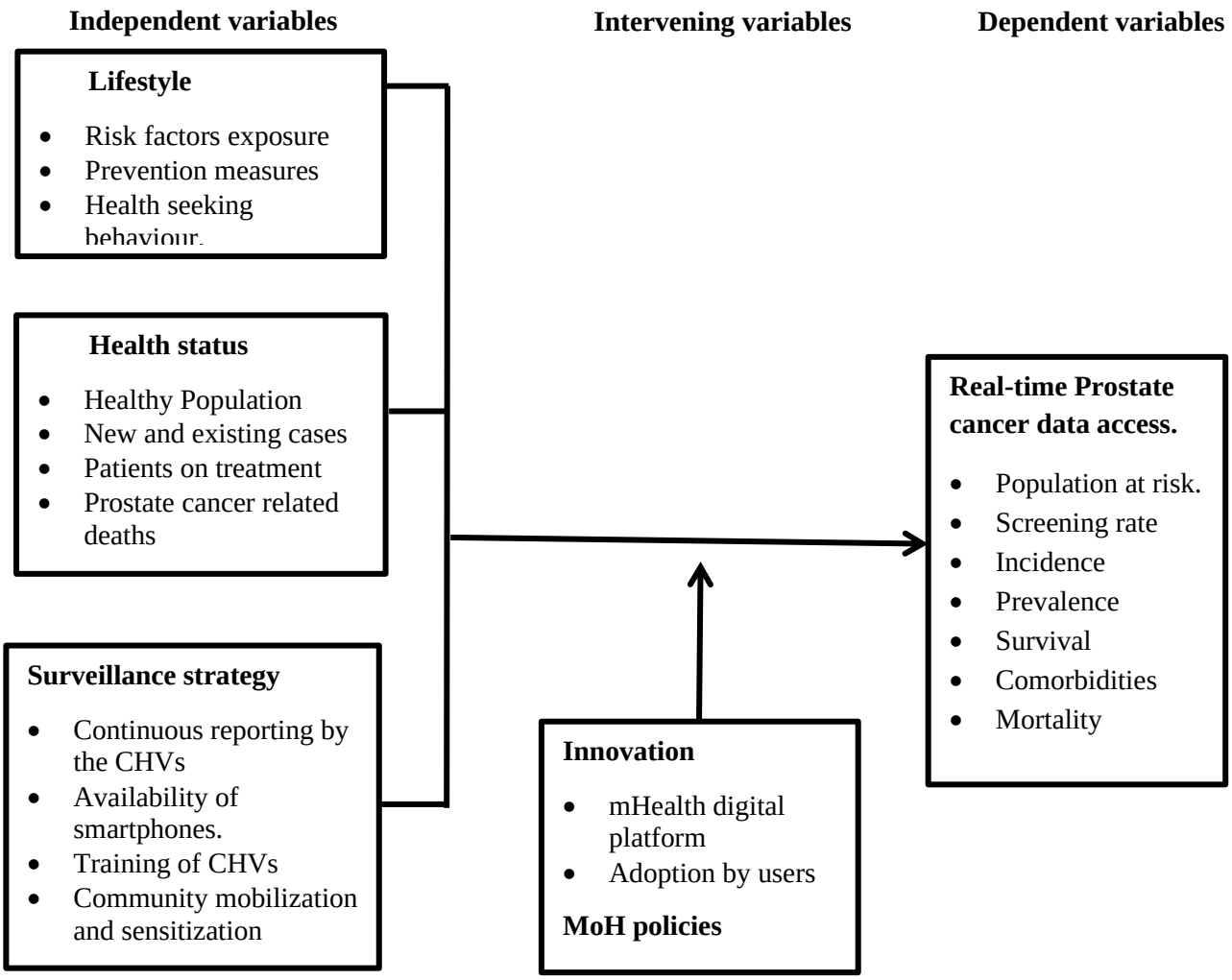
The diffusion of innovation (DOI)Theory explains the process that people go through in response to learning about a new idea or product in a social context. In a social setting, the introduction and adoption of a new idea, solution, or product necessitate adjustments and the response varies with some people quickly embracing the innovation and others taking time. Innovations in the health sector have impacted the delivery of services and interventions disproportionately because well-off communities are more exposed and in an advantageous position to adopt an innovation earlier in comparison to poor communities. This understanding guides the deliberate choice of employing diffusion principles in a way that stimulates the spread of innovation in a low-income setting. (Dearing & Cox, 2018)).

Exposure to an innovation that a person considers might have an impact on them or how they go about their routine activities, the response is to seek more information about the innovation and depending on the perceived importance in addressing their interests, ease of use, the costs, and risks just to name a few determine the uptake and spread. (Aral & Walker, 2012). The study was a problem-solving paradigm providing an innovative solution, human human-centred design was employed which is premised on the involvement of the targeted users in understanding the problem from their perspective, co-designing with the targeted users, user testing the product, and giving feedback to help improve the user experience. The approach seeks to incorporate users' requirements to ensure the product is responsive to their needs and to improve the acceptability of the product. A closely related concept is designing for diffusion which entails including other steps during the initiation of an innovation process to increase its chances of being recognized, perceived positively, tested, adopted, and implemented thus, becoming as solution. Understanding the diffusion barriers for the spread of innovation and addressing them is important as a stimulation process. (Dearing et al., 2010).

2.7 Conceptual framework.

Figure 2.1

Conceptual framework



CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Introduction

This section covers the research design, the target population, the sampling technique, research instruments, the method of data collection, methods of data analysis, findings presentation, and ethical considerations.

3.1 Research design

A research study design is a framework that integrates different components of the study logically to effectively address a specified research problem (Ranganathan et al., 2018). This study was a descriptive cross-sectional quantitative study, utilizing a design science research (DSR) strategy. The approach is considered appropriate since design science research seeks to create an innovative solution to a real problem by analyzing any existing solution to improve it, creating a new logic, and expanding design knowledge, which constitutes problem, solution, and evaluation (vom Brocke et al., 2020). The DSR framework focuses on an environment where the problem or phenomena of interest exists to analyze it contextually and understand stakeholders' perceived needs and culture. The information gathered is translated into an innovative solution to the problem. The study was guided by Brown and Wyatt's three phases that is, the stakeholders' needs and problems influencing the search for a solution (inspiration); data analyzes and transformation into insights that guide solution design, development, and testing (ideation); and lastly user testing, a path that links the product and problem (implementation) (Petersen & Hempler, 2017). It is fundamentally a problem-solving paradigm.

3.2 Study Area.

Embu County occupies an area of 2,821 km^2, with a population of 608,599 persons of which 304,208 are males, 304,367 females, and 24 are intersex. (Kenya National Bureau of

Statistics [KNBS], 2010). It borders Kitui County to the east, Kirinyaga County to the West, Machakos County to the South, and Tharaka Nithi County to the North. The county comprises of (4) Sub-counties namely, Manyatta, Runyenjes, Mbeere North, and Mbeere south. The county health infrastructure consists of (93) county public health facilities, (52) private facilities, and (26) faith-based organizations. Agriculture is the backbone and livelihood of the people of Embu County. The upper part of Embu County relies mainly on cash crops such as coffee and tea while the lower part mainly produces cash crops such as miraa(khat) and food crops. (Embu CIDP, 2019).

3.2 Target Population.

The target population refers to the specific group relevant to a particular study. According to Mugenda and Mugenda (2003), the target population is a total collection of people, institutions, things, or cases who share common characteristics, and the researcher wishes to generalize the results of the research. The research targeted healthcare workers, including community health volunteers of Embu County who are involved in community health data collection and management at different levels. The population was ideal based on their mandate and experience in community data collection, reporting processes, and use of data at different levels for decision-making. Their involvement in the study was determined by the three phases based on their level of interaction and knowledge of the data management process.

3.2.1 Inclusion criteria.

Phase 1: Inspiration.

The study participants included the current officers working in Embu County whose role involves supporting primary health data collection from the community, community health assistants (CHAs).

Community health data managers both at the County and Sub-county level who were willing to take part in the study were employees of Embu County, specifically the officers included community health focal persons, disease surveillance, health records, and information officers.

Phase 2: Ideation.

Community data managers at County and Sub-county levels whose role involves the use of the data generated from the community for decision-making, community health focal person, disease surveillance, health records, and information officer. Their level of interaction with data at the point of aggregation, verification, and utilization of data for decision-making, made the team appropriate to share detailed insights.

Phase 3: Implementation.

Community data managers both at county and sub-county, community health focal person, disease surveillance, health records, and information officers as administrators.

Community health assistants supervising community units with access to a smartphone.

Community health volunteers (CHVs) one per community health represented by a community health assistant (CHA) taking part in the study. The CHVs were involved in the last phase of testing the digital platform in the field.

3.2.2 Exclusion Criteria.

Phase 1: Inspiration.

The study did not include officers who did not have prior experience in supporting community data collection or management and officers who were not willing to take part in the study.

Phase 2: Ideation.

The phase did not include officers supervising community units and community health volunteers.

Phase 3: Implementation.

The community health assistants without functional smartphones and those who were not supervising community health volunteers were not included.

3.3 Sampling Procedure

Sampling is a process or technique of selecting a sub-sect of the population of interest, to participate in the study. In most undertakings, it is not feasible for the entire population to participate in the study, so a smaller group is actively involved during the study and relied upon to represent the population from which the sample was taken (Turner, 2020). The study used total population, purposive sampling for the inspiration phase and ideation phase, and then critical case sampling for the implementation Phase. This type of sampling technique focuses on identifying individuals considered knowledgeable about or have experience with the topic of interest, who are in the best position to answer the research questions, in addition to willingness to participate. According to the Embu County department of health at the county level, we have one disease surveillance coordinator, community health services focal person, health records, and information officer. The same cadres are represented at the Sub-county level and a total of (56) community health assistants.

Total population purpose sampling was applied to identify the total target population (71) as respondents for the inspiration Phase which involved questionnaire administration; a total of (15) respondents for the ideation phase which focused on a deep dive discussion of the findings and further refining the needs, constituting of county health management team representative and sub-county health management team representative who were part the (71) respondents in phase one. Critical case sampling was used for the implementation phase, to identify (34) CHVs from different community health units equivalent to 60% number of CHAs who participated in the study. This was considered more appropriate given the population size and

the group being well-defined by the shared characteristics. Also, being a homogenous group in terms of characteristics of interest non-response did not skew the findings.

Table 3.1

***Sample Frame*.**

County-level	Number of respondents
Disease Surveillance Coordinator	1
Health records Officer	1
Community focal person	1
Sub County level	
Disease Surveillance Coordinator	4
Health records Officer	4
Community focal person	4
Community health assistants (CHAs)	56
Total	71
Sub County	
Community health volunteers (60% of the # CHAs)	34

3.4 Research instruments

The research utilized questionnaires as the essential information-collecting instrument. Questionnaires provide a means of examining a population's characteristics, self-reported and observed behavior, obtaining data about a product, service, or process, knowledge of programs and needs (Ponto, 2015). A survey comprises a predetermined set of questions that is given to a sample to collect information on a given topic. Structured questionnaires were formulated following the research objectives, utilizing Google forms and regulated on the web. Surveys

were used because they are appropriate for gathering a large amount of data and providing a broad perspective. This information was critical in achieving the phase 1 and 2 objectives.

3.4.1 Validity of research instruments.

The validity of a research instrument assesses the extent to which the instrument measures what it is designed to measure (Robson, 2011). To enhance the validity of the instrument the questionnaire was reviewed with the support of the supervisors to determine its relevance to the study topic.

3.4.2 Reliability of research instruments.

Reliability measures the consistency, precision, repeatability, and trustworthiness of research (Chakrabartty, 2013). To ensure the reliability of the instrument, a pilot test was done by administering the questionnaires to (2) Subcounty health management team members and (6) CHAs within Embu County who were not part of the study sample, and the results were reviewed with the help of the supervisors and used to address any deficiencies of the instrument. The recommended sample size for piloting is one-tenth (Mugenda &Mugenda, 1999). Answers from the respondents on similar questions were analyzed to examine the association of the responses to ensure internal consistency.

3.5 Methods of data collection

The study relied on primary data collected from respondents through surveys. The questionnaire was administered to (71) respondents via a shared link, after receiving all the necessary authorization from the university, National Commission for Science, Technology, and Innovation (NACOSTI) and county government. The link was shared through email and WhatsApp for ease of resharing and access among the respondents. All the respondents were facilitated with data bundles for access and submitting of completed questionnaires. The questionnaires were presented in the form of structured questions. The questionnaire was preferred for this study since the data collected was primary, the same questions were

administered to all respondents therefore making it possible to do comparisons. The questionnaire consisted of two sections. In section one, the respondent was required to fill in background information, and the second section comprised of variables researched.

3.6 Analysis of data

The submitted questionnaires were processed for analysis. Completeness of the data collected was assured through the settings, where the respondents were required to answer all the questions before submitting. The submitted filled questionnaires were edited for consistency of the data and the data was keyed into the statistical package for social science (SPSS) software.

The study employed descriptive statistics to establish challenges faced by disease surveillance officers in accessing prostate cancer data, determine the data set required for prostate cancer monitoring and surveillance. The results were presented using frequency distribution tables and summaries. This was key to identifying congruence in the characterization of the current situation and gaps in the existing infrastructure which formed the premise upon which the prototype design was anchored. The findings from the analyzed data were outlined as per the research goals.

3.7 Ethical Considerations.

The ethical approval of the study was granted by the Kenya Methodist University Scientific and Ethical Review Committee and the National Commission for Science, Technology, and Innovation (NACOSTI) to conduct the study. Authorization was also granted by the ministry of health, Embu County which was the area of study. All the participants were explained to the study purpose, their rights to choose not to participate or stop participating in the study, and the requirement to give their consent, before administering questionnaires. To ensure anonymity and confidentiality the questionnaire did not include any personal identifiable information. The information collected was kept secure and confidentiality was maintained.

CHAPTER FOUR

DATA ANALYSIS AND INTERPRETATION, SYSTEM DESIGN AND DEVELOPMENT.

4.0 Introduction

This chapter covers data analysis and interpretations, system requirements specifications, an elaborate description of the design and architecture of the system premised on detailed analysis of the prevailing circumstances, data challenges and the findings, user case diagrams, and entity relationship diagrams. It also covers mHealth digital platform prototype implementation and testing.

4.1 Socio-demographic data

The research targeted a total population of (71) respondents as the sample for the inspiration phase, from which (57) questionnaires (15- county and sub-county data managers and 42-CHAs) were answered and submitted giving a response rate of 80.3%. According to Mugenda and Mugenda (2009), a response rate of 50% is adequate for analysis and reporting; a rate of 60% is good and a response rate of 70% and above is excellent.

The study sought to establish the background information of the participants which included gender, distribution, level of education, and designation as discussed below.

4.1.1 Distribution of respondents by gender.

The study included all participants who agreed to take part in the study irrespective of their gender, hence the study did not suffer from gender bias. The participants comprised 45(78.9%) females and 12(21.1%) males as shown in table 4.1 below.

Table 4.1

Distribution of Respondents by Gender

Gender	Frequency (n=57)	Percentage
Female	45	78.9
Male	12	21.1

4.1.2 Respondents distribution by level of work (County/ Subcounty)

Table 4.2 below shows the distribution of the respondent based on their level of operation either at county or sub-county. The subcounty includes both data managers and CHAs.

Table 4.2

Respondents Distribution by Level of Work

Staff	Frequency (n=57)	Percentage
County	3	5.3
Sub-county		
Manyatta	15	27.8
Runyenjes	14	25.9
Mbeere South	13	24.1
Mbeere North	12	22.2

The above results represent the distribution of participants across the county. Participants working at the county level included a disease surveillance coordinator, health records and information officer, and community health services focal person who were considered as key informants constituting 3(5.3%) and the remaining 54(94.7%) subcounty staff drawn from the three departments represented at the county level. The data demonstrate a fair regional representation that ensured the quality of questionnaire response and variance.

4.1.3 Education Level.

The study was interested in finding out the level of education of the participants because it is an important factor related to the capability of the individual respondent to interpret the questionnaire correctly.

Table 4.3

Distribution of Respondents by Level of Education

Education level	Frequency (n=57)	Percentage
Certificate	9	15.8
Diploma	39	68.4
1st degree	7	12.3
Master's degree	2	3.5

The majority of the respondents 39(68.4%) had a diploma, 9(15.8%) certificate, 7(12.3%) first degree and 2(3.5% masters). The findings show that all the respondents had at least attained post-high school education, a demonstration that they could interpret and respond to questions correctly.

4.1.4 Designation of the respondents.

The study considered key participant representation, who by virtue of their work were better positioned to give relevant insights on the current situation analysis, exploration of possible solutions, and requirements specifications.

Table 4.4

Distribution of Respondents by Designation.

Designation	Frequency (n=57)	percentage
Disease surveillance coordinator	5	8.8
Health records & information officer	5	8.8

Community health focal person	5	8.8
Community health extension workers	42	73.6

The results show that the majority of the participants 42 (73.6%) were CHAs the primary targeted users of the digital platform in data collection, with other cadres constituting a total of 15 (26.4%) equally distributed who are involved in data processing, sharing and utilization at different level as part of their roles.

4.2 Challenges in prostate cancer data collection, access, and utilization.

The study probed challenges faced in prostate cancer data collection, access, and the utilization of data in decision-making by different stakeholders within the county.

4.2.1 Cancer indicator reported from the community by CHVs.

The study sought to find out the cancer indicators reported through the MoH standard reporting tools from the community by the community health workers. The respondents confirmed only one indicator " Known cases of cancer " was reported from the community. The finding demonstrates the gap in cancer data collection from the community and the lack of prioritization of the population data which is key in developing effective cancer control strategies and decision making.

4.2.2 Existing methods of data collection in the community.

The study wanted to establish if there was a digital platform used in the community for data collection. The study noted that currently there is no digital solution in use in community health services. From the findings, it is apparent that community health services reporting tools were paper-based and prostate cancer services did not form part of the key focus area at the community level. Partly this explains the reason why most of the cases were diagnosed late leading to poor prognosis.

4.2.3 Respondent's perspective on the impact of mHealth digital platform.

The study wanted to assess the respondent's perspective on the impact of using a mHealth digital platform in the community in the collection of prostate cancer care data.

Table 4.5

Respondent Perspective on the Impact of mHealth Digital Platform.

Opinion	Frequency (n=57)	Percentage
Yes	51	89.5
Maybe	3	5.3
No	3	5.3

The majority of respondents 51(89.5%) were positive that the use of the mHealth digital platform could be very instrumental in improving prostate cancer care data collection and accessibility.

4.2.4 Data documentation challenges.

The research sought to find out if prostate cancer data was available to the relevant officers and the sources of the data. The question mainly targets responses from key informants that is, disease surveillance coordinators and health records and information officers. The respondents indicated they had access to prostate cancer data and the source of the data was hospital-based data mainly from clients who have received cancer-related services from different hospitals within the county offering cancer services. However, documentation challenges affected the data quality, incomplete data, and some important indicators missing especially on risk factors exposure, previous history of screening, and other known chronic conditions which are considered critical for prostate cancer monitoring and surveillance.

4.2.5 Challenges in access to data.

Further, the research also wanted to find out the accessibility of the available data by the relevant officers, that is disease surveillance coordinators as part of the data needed in their roles and health information and records officers based on reporting requirements or requests. This was a follow-up question, based on the response of the previous question the available data referring to hospital- based data.

Table 4.6

Prostate Cancer Data Accessibility.

Duration	Frequency (n=10)	Percentage
Real-time (Anytime)	2	20
Specified timelines (e.g., monthly, quarterly, etc.)	8	80

The majority of the respondents 8(80%), indicated that they can access the data at a specified time mainly after the monthly reports are submitted from different facilities and aggregated at sub-county to the county. The remainder of the respondents who reported real-time access were mainly sub-county health records and information officers who are based within the facility premises where data is generated or referred to historical data already in their custody.

4.2.6 Cancer data utilization.

Lastly, the research wanted to establish what informed decisions on cancer-related outreach services in the county. The question majorly wanted to find out if cancer care services provision beyond those offered at the selected facilities which are mainly client initiated are informed by data or other parameters.

Table 4.7

Utilization of Available Data in Decision Making.

Data	Frequency (n=57)	Percentage
Incidence rate	17	29.8
Prevalence rate	28	49.1
Proximity to facility	29	50.9
Partners support	16	28.1

The results indicate that the decision is majorly based on the proximity to a facility offering the services at 29(50.9%), and areas considered to have a high prevalence rate at 28(49.1%), with less reliance on incidence data and availability of partner support.

4.3 Important prostate cancer indicators.

The research sought to understand the data needs of different stakeholders which they consider important for decision making and effective prostate cancer monitoring and surveillance.

Table 4.8

Important Indicators for Decision Making, Monitoring and Surveillance.

Indicators	Frequency (n=57)	Percentage
Age	48	84.2
Location (residence)	31	54.4
Other chronic condition	50	87.7
Exposure to risk	48	84.2
Prostate screen rate	49	86
New cases	45	78.5
Individuals on treatment	41	71.9
Prostate related deaths	41	71.9

The findings show that information on known chronic conditions at 50(87.7%) was ranked top, the indicator was included since most non-communicable diseases share some risk factors especially lifestyle-related. Closely followed by prostate cancer screening at 49(86%), exposure to risk factors and age equally considered at 48(84.2%), new cases of prostate cancer at 45(78.5%), followed by information on individuals on treatment and prostate cancer mortality equally identified at 41(71.9%) which was considered as an indicator to monitor treatment outcome and survival rate. The residence of the client came last at 31(54.4%). The results imply lifestyle, existing chronic conditions, and health behavior seeking were more relevant.

4.3.1 The scope of integrated disease surveillance and response (IDSR).

The research wanted to understand whether the scope of the integrated disease surveillance and response included prostate cancer. The analysis considered responses from disease surveillance coordinators and health records and information officers from the county and subcounty due to their level of involvement with health data and their expertise. The findings pointed out that cancer is not currently included in the integrated disease surveillance and response.

4.4 Mobile Health (mHealth) Digital Platform Design

This section covers the requirements and specifications that were considered for the minimum viable product, system design, and architecture.

4.4.1 System Requirements Specifications

The system requirement specifications define the expected functionality of the system informed by the findings, the gaps identified in the existing hospital-based cancer register, and the challenges in access to population-based data. These include.

i. The platform should create a one-off profile for all eligible clients, with details of the client's current residence(Sub-county, CHU, village, and link facility), age, and primary contact.

ii. It should provide for an initial assessment for all newly registered clients, which serves as the baseline upon which subsequent follow-ups will be referenced to ensure continuous monitoring and surveillance of the clients.

iii. It should have a provision for an assessment update for all clients already registered to ensure all the changes are tracked and at all times the collected data is up to date.

iv. The platform should trigger specified periodic follow-up tasks for all registered clients based on the considered frequency to make sure all clients' data is regularly updated.

v. The system should be able to generate a report for all assessments which can be exported and manipulated by different stakeholders for use.

vi. The system should be able to limit access to data only to those authorized to ensure data security and avoid any data compromise.

4.4.2 System Design.

This section explains the design and architecture of the system. The unified modeling language (UML) diagrams were used to design the system and show the user interactions with the system. The use case diagram shows the interaction of users with the application and the system. Entity relationship (ER) diagrams demonstrate the conceptual view of the systems database as well as the interface link.

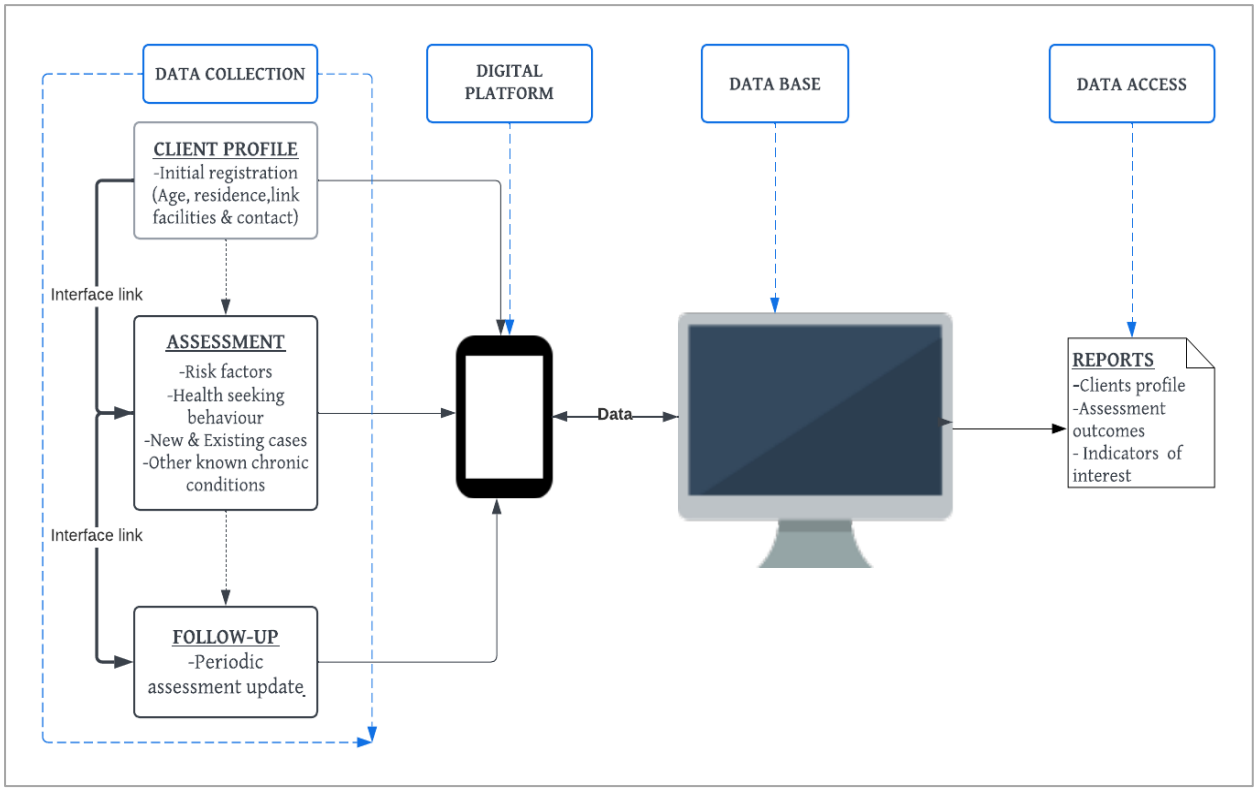
4.4.3 Overall system architecture.

Figure 4.1 below shows the overall outlook of the solution and how different activities are linked to each other to deliver the outcome as specified requirements. The workflow begins with the registration of eligible men (clients), this section contains a detailed client profile.

The next section that follows sequentially is an assessment which constitutes a standard set of questions logically structured with actions focusing on key thematic areas. The bottom section represents activities performed periodically to update the assessment section data to ensure the availability of up-to-date data as per the frequency set. The data generated from the application is stored in a database from which the various stakeholders can access information of reports.

Figure 4.1

Overall system architecture

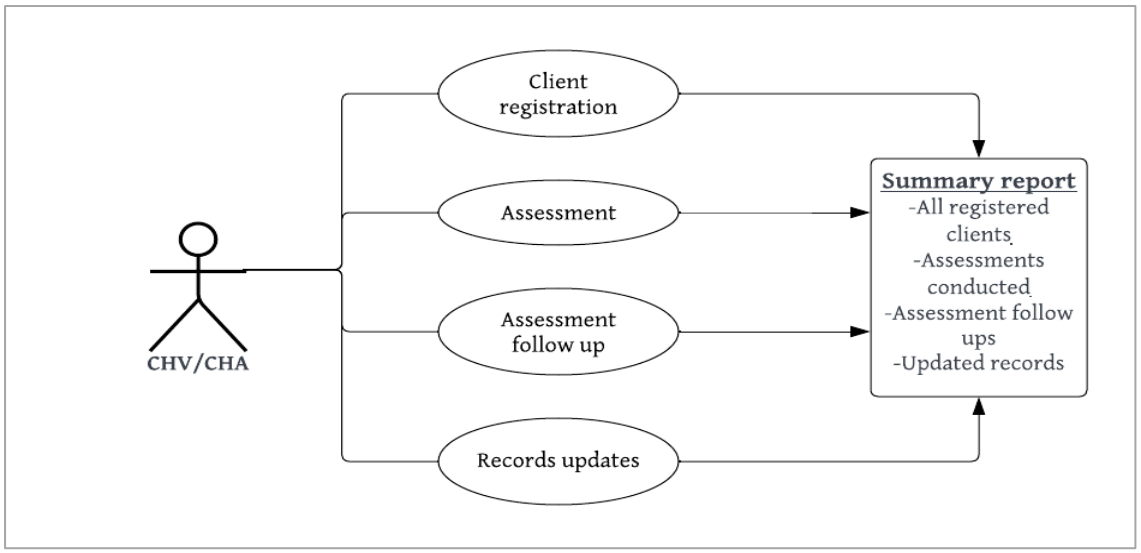


4.4.4 Use case - CHA/CHV

Figure 3 shows the interaction that the users have with the system at the point of data collection in the community. The user was identified as a community health assistant or community health volunteer.

Figure 4.2

Use case - CHA/CHV

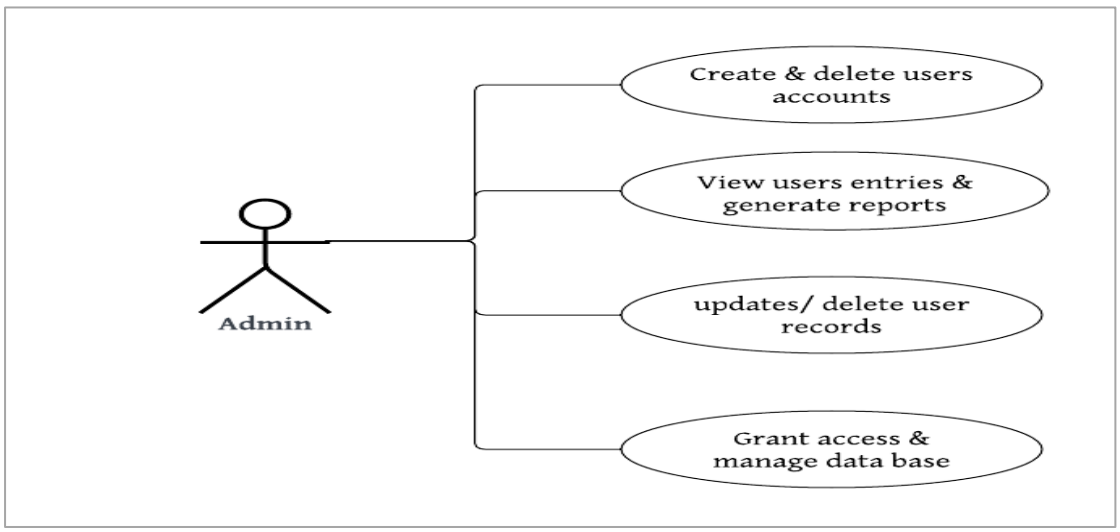


4.4.5 Use case – System Administrator

Figure 4.3 shows the interaction of the system and users granted rights as administrators. The users include different stakeholders involved in data management and the use of data in decision-making at the sub-county, county, national, and partners. The data security was guaranteed through the limited access granted to different users.

Figure 4.3

Use case – Administrator

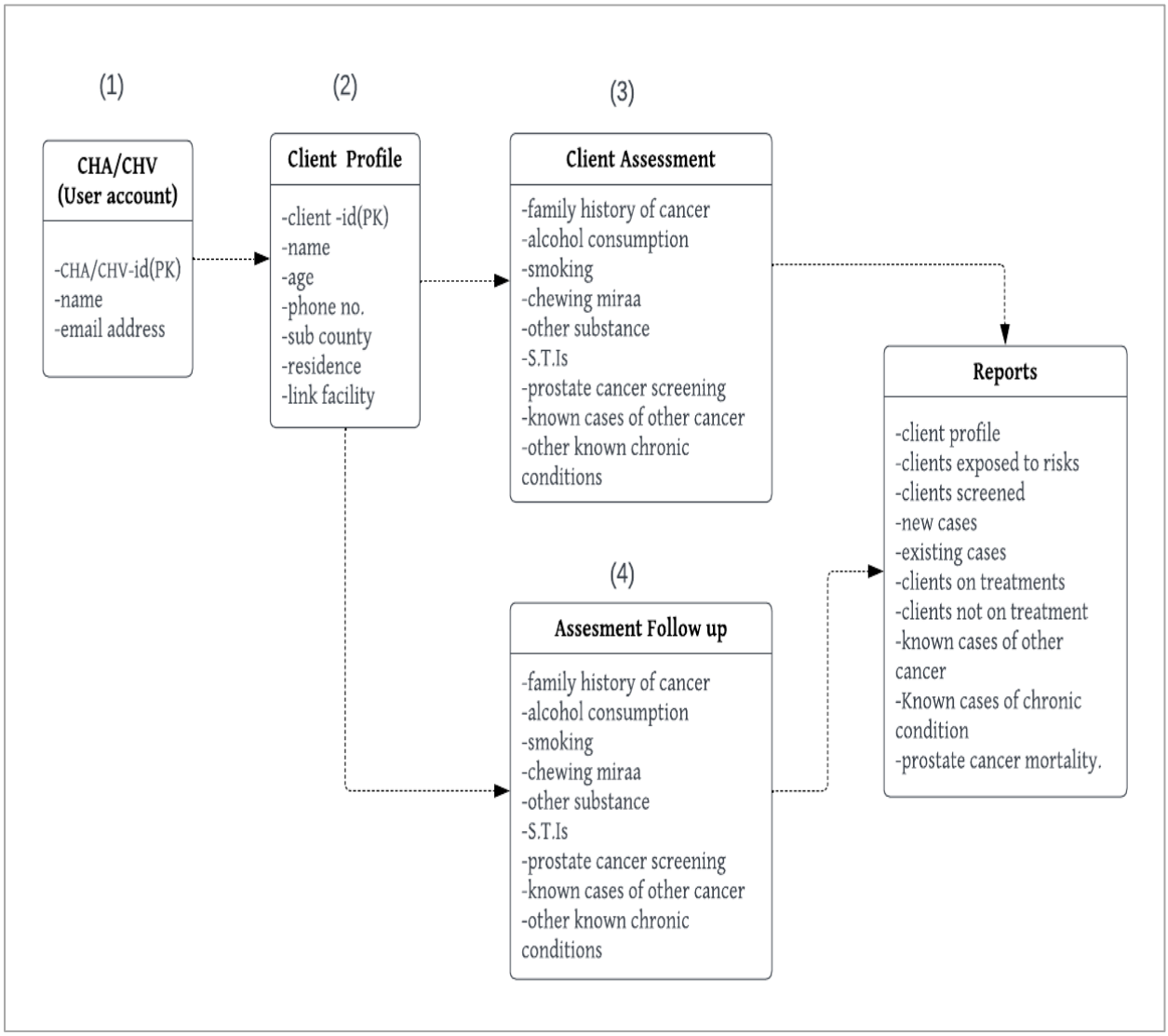


4.4.6 Entity Relationship (ER) Diagram- User experience.

Figure 4.4 shows a conceptual view of the system database, the data points as captured at the source, and how different sections relate to each other sequential manner. The end user digital platform is operated from a tablet or smartphone which is linked to a central database hosted remotely.

Figure 4.4

Use case – Administrator



4.4.7 System Administrators' levels of responsibilities

Table 4.9

Administrators' levels of responsibilities.

Administrator	Levels of Responsibilities
County	• Creating Subcounties administrator's user accounts. • Controlling the Subcounty users' rights. • Managing the overall database.
Sub-county	• Creating the end users' accounts. • Controlling the end-users' rights. • Management of respective Sub-county data.

4.5 System Implementation and Testing.

This section outlines the prototype implementation in the collection of primary data for monitoring and surveillance of prostate cancer. An illustration of how the application works and the interaction of the users with the system, is provided through screenshots.

4.5.1 System Implementation Environment

The Mobile application is a web-based application developed in the World Wide Web platform, hosted on a cloud server accessible from a browser. MYSQL database was used to develop the system database which was remotely hosted.

4.5.2 Functionality of the system.

A web-based application was considered due to its ease of access from multiple browsers and various platforms such as desktop, laptop, and mobile phone depending on the convenience.

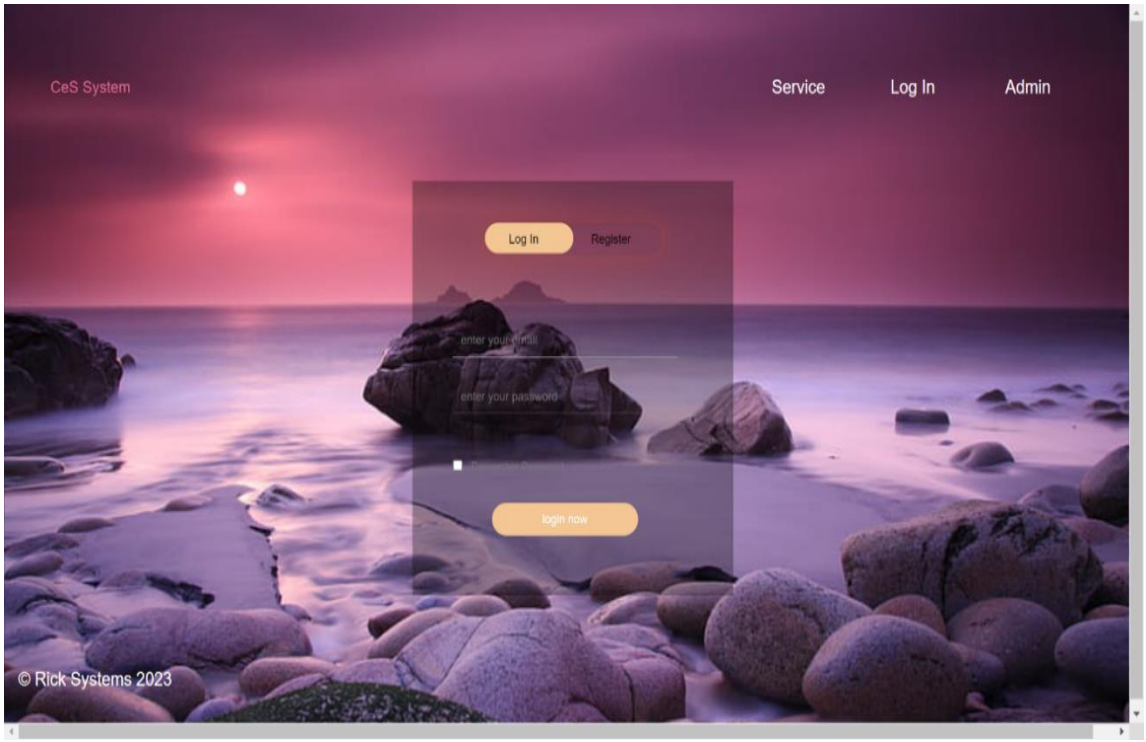
Also, the users do not need to install the application, which means the application will work on different platforms regardless of the space.

4.5.3 System login screen

All the users must have an account and login details for them to access the system. The default setting is for the CHA/CHV login without switching when the link opens, however, the administrator needs to select the Admin option first then login.

Figure 4.5

User login screen

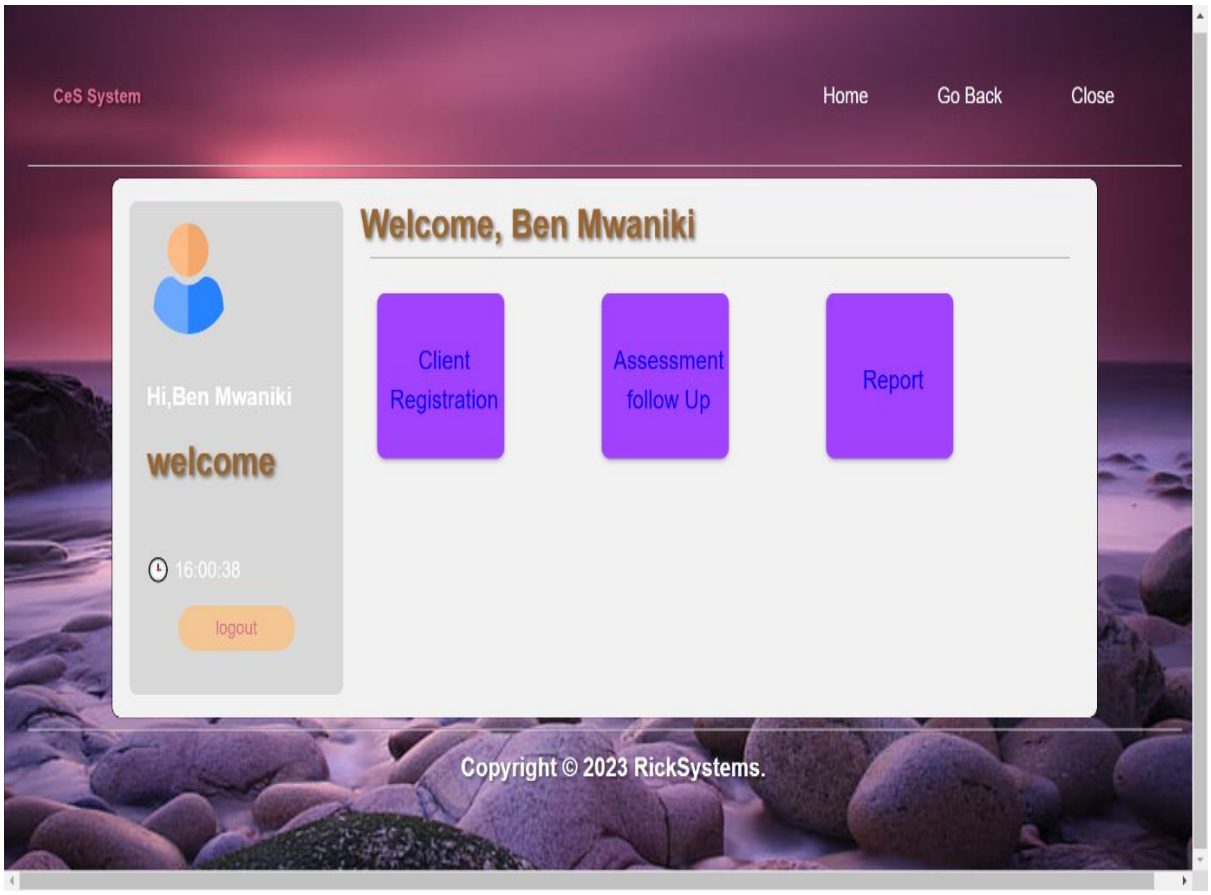


4.5.4 Admin home page

The home page shows different menus that the administrator can use to navigate and access different services.

Figure 4.6

Admin home page



4.5.5 User Home page and client registration page.

The user home page shows the menu that the CHA/CHV uses to select the service they want to offer to the clients. The client registration page shows all the client details captured once to create a client profile at the initial contact. The client registration for submission automatically links to the first assessment form and the next form sequentially.

Figure 4.7

CHA/CHV home page

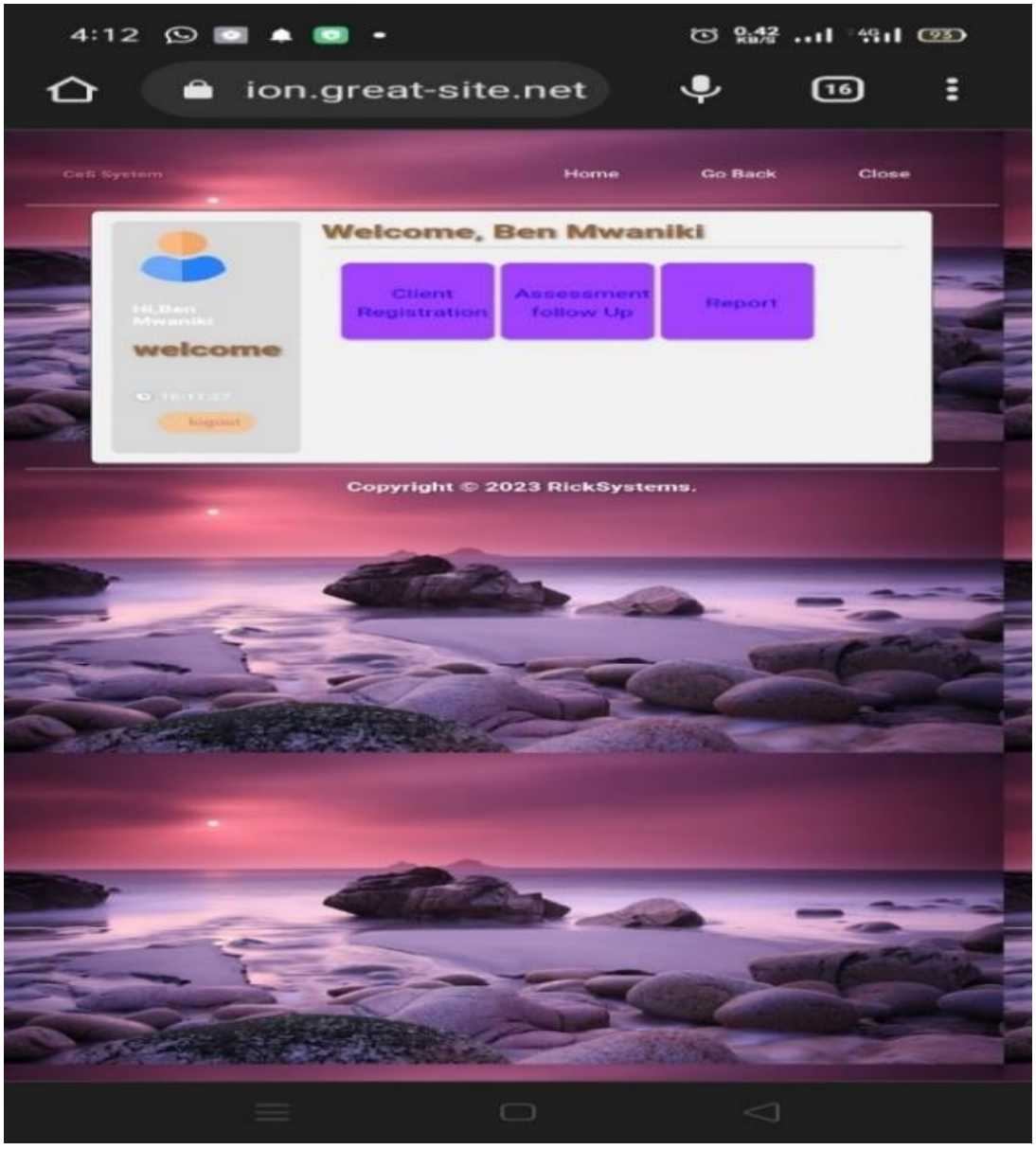
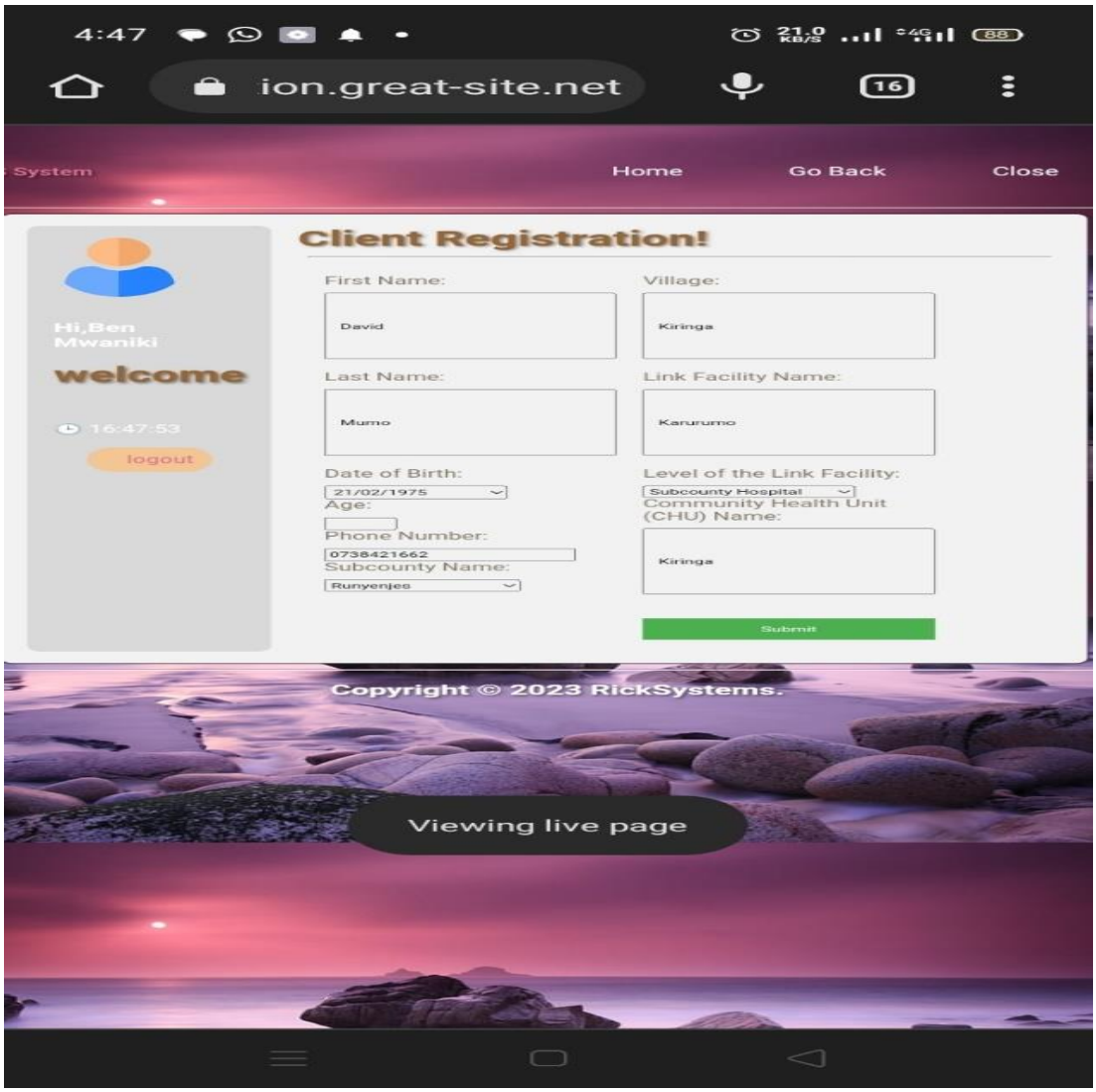


Figure 4.8

Client Registration



4.5.6 Client Assessment Forms.

All the forms are linked sequentially right from client registration, which is the first form, and upon its filling and submission automatically it leads to the next form all through to the final Successful submission confirmation message. The questions displayed for each sub-heading are determined by the response to the previous question. To improve the user experience the applications display only the relevant follow-up questions based on the answers filled. However, all the entry questions per thematic area will be displayed on each page.

Figure 4.9

Risk assessment

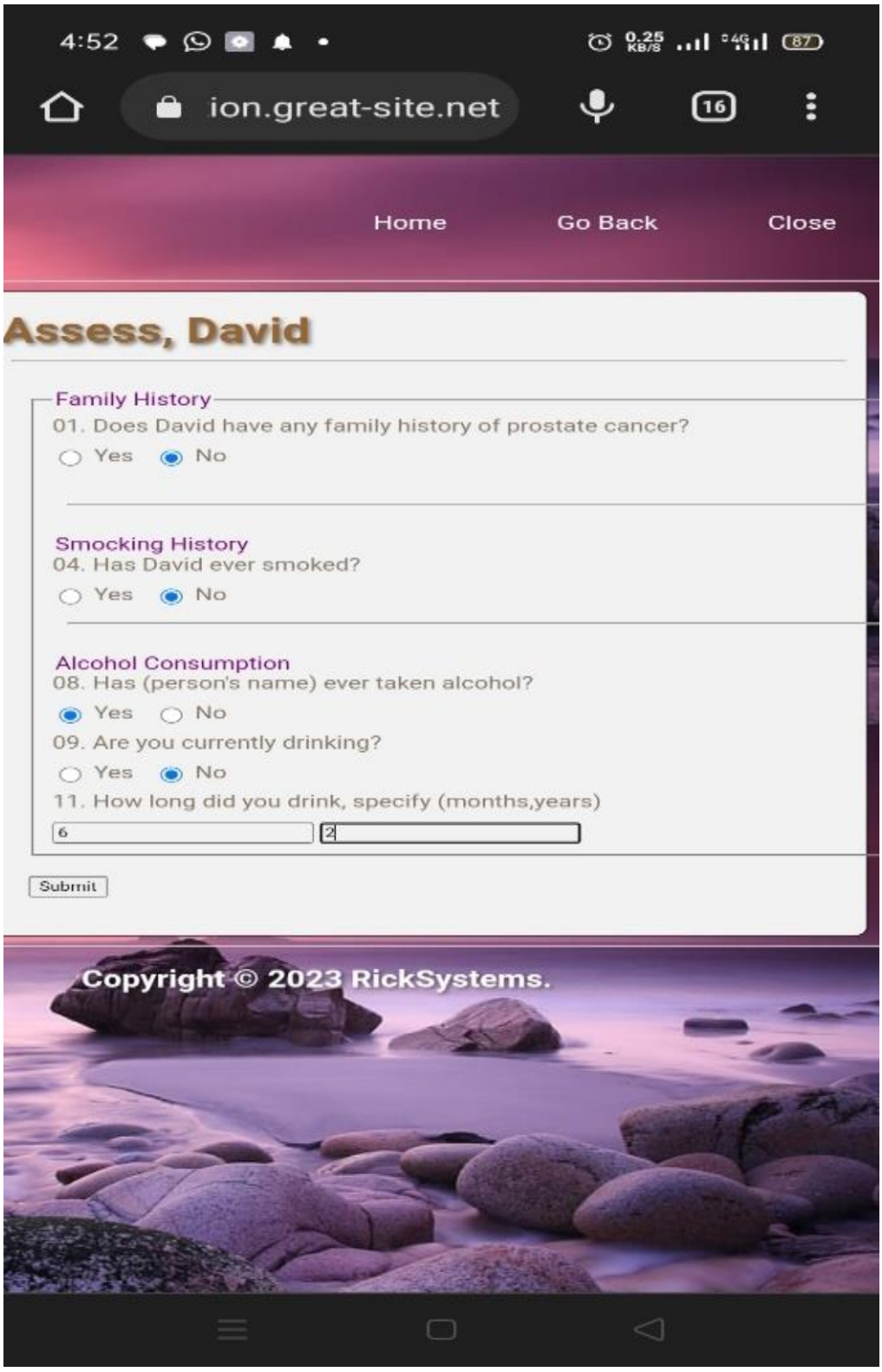


Figure 4.10

Risk assessment

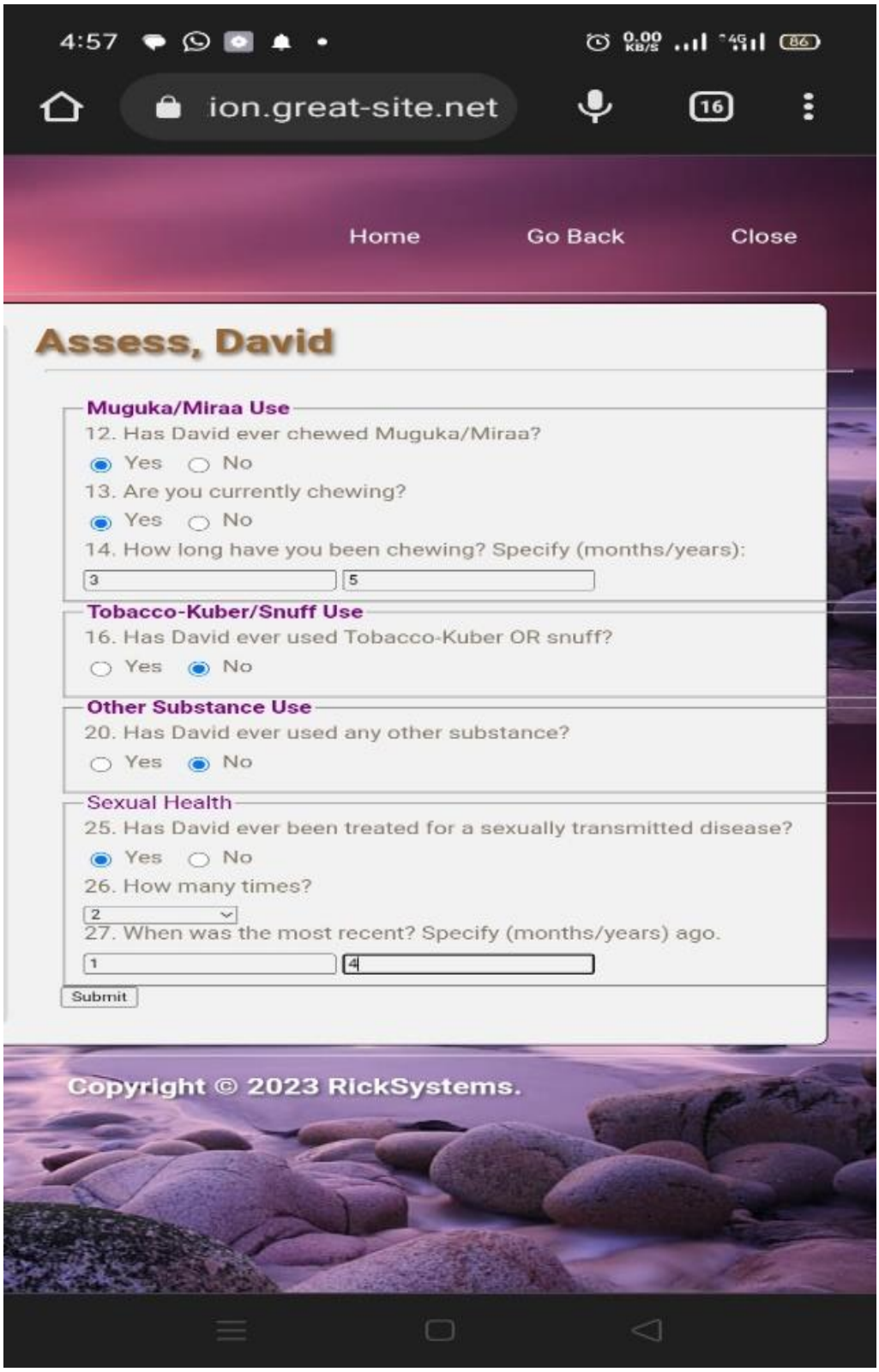


Figure 4.11

Health seeking behavior

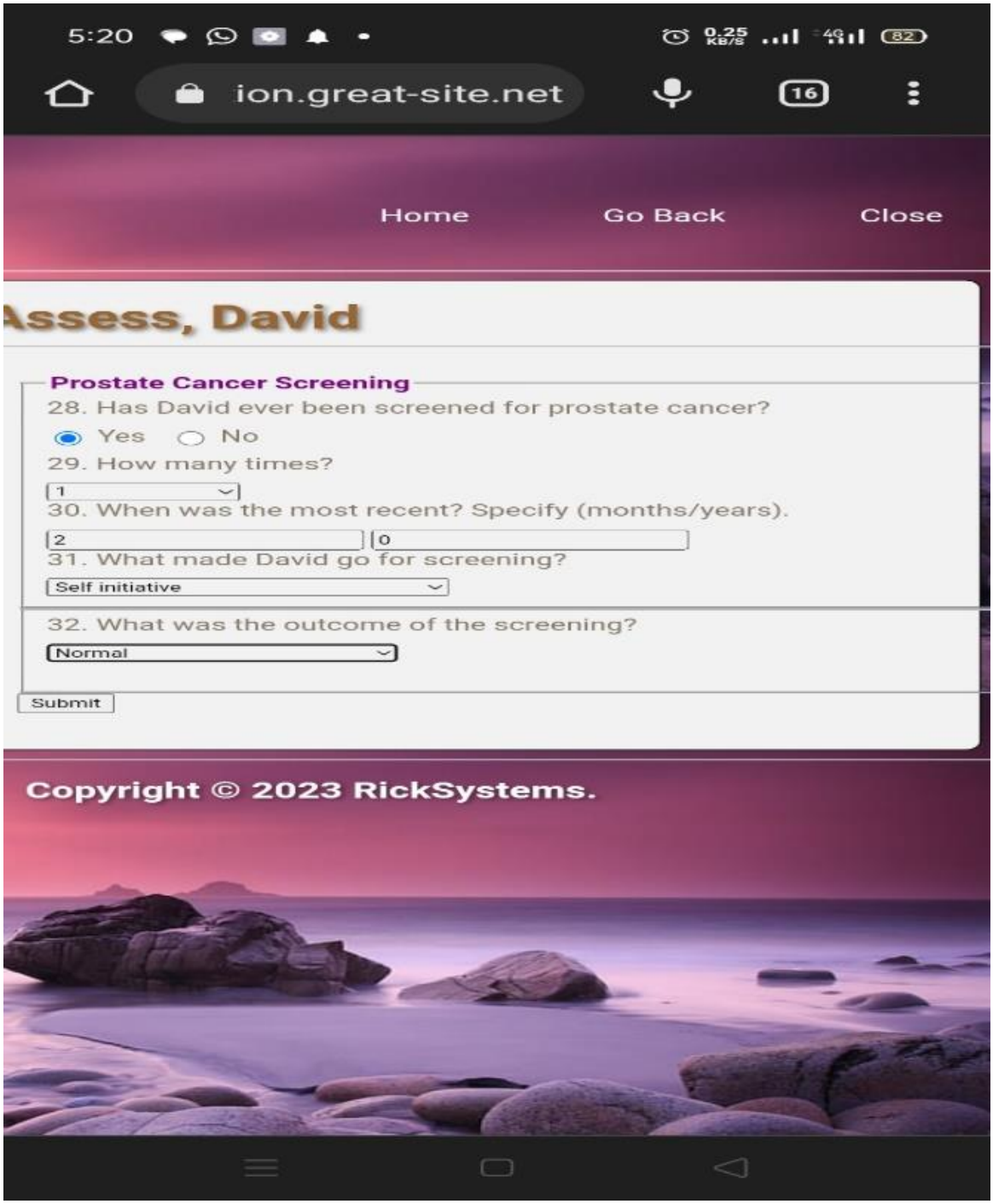


Figure 4.12

Comorbidities screening

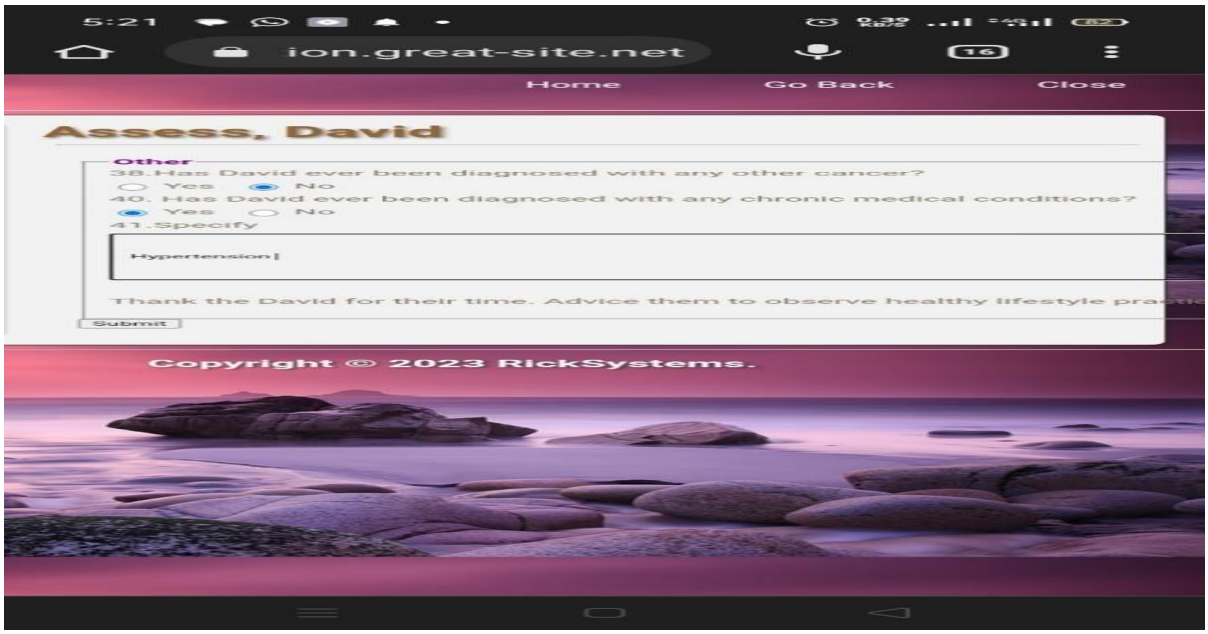
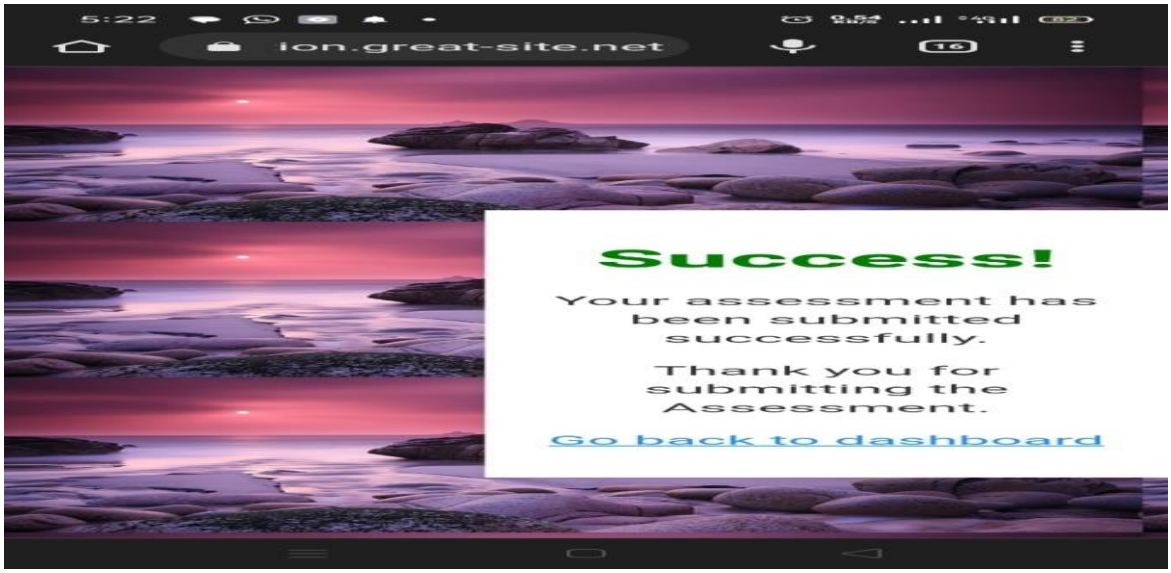


Figure 4.13

Complete assessment confirmation



mHealth digital platform video demonstration link:

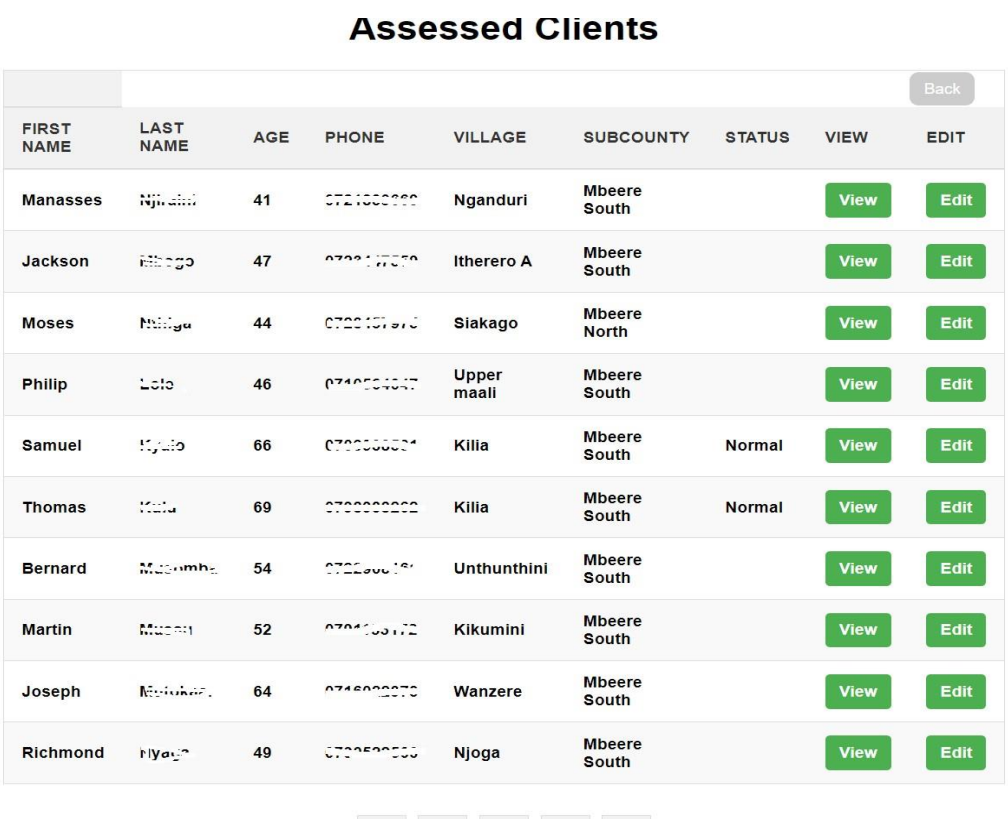
https://drive.google.com/file/d/1oLl2lL1NWE4q0WT9Ka0raCTxNerIDwSj/view?usp=drive_link

4.5.7 Admin Dashboards

The dashboard shows profile data for all registered clients. The administrator can be able to make corrections on the various entries subject to rights granted.

Figure 4.14

Client profile details



Figures 4.15 to 4.18 show the various indicators assessment data for all clients, which can be exported for analysis and sharing. Also, from the dashboard, the administrator can be able to view individualized data by selecting the view and one can be able to make corrections for erroneous data entry.

Figure 4.15

Assessments data.

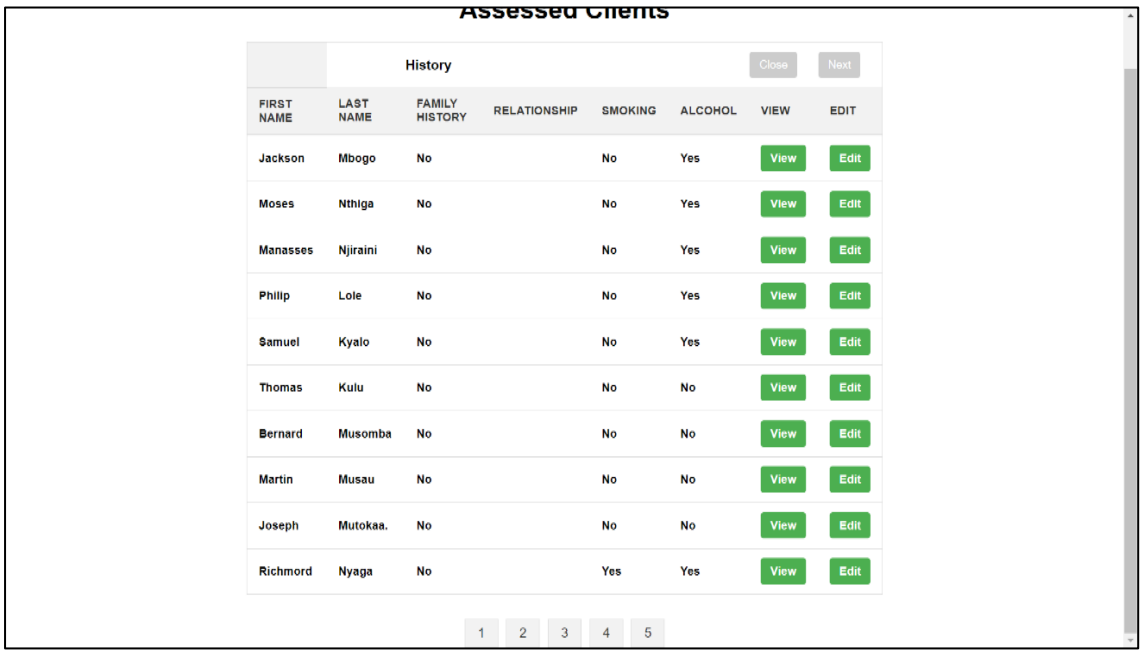


Figure 4.16

Assessment data.

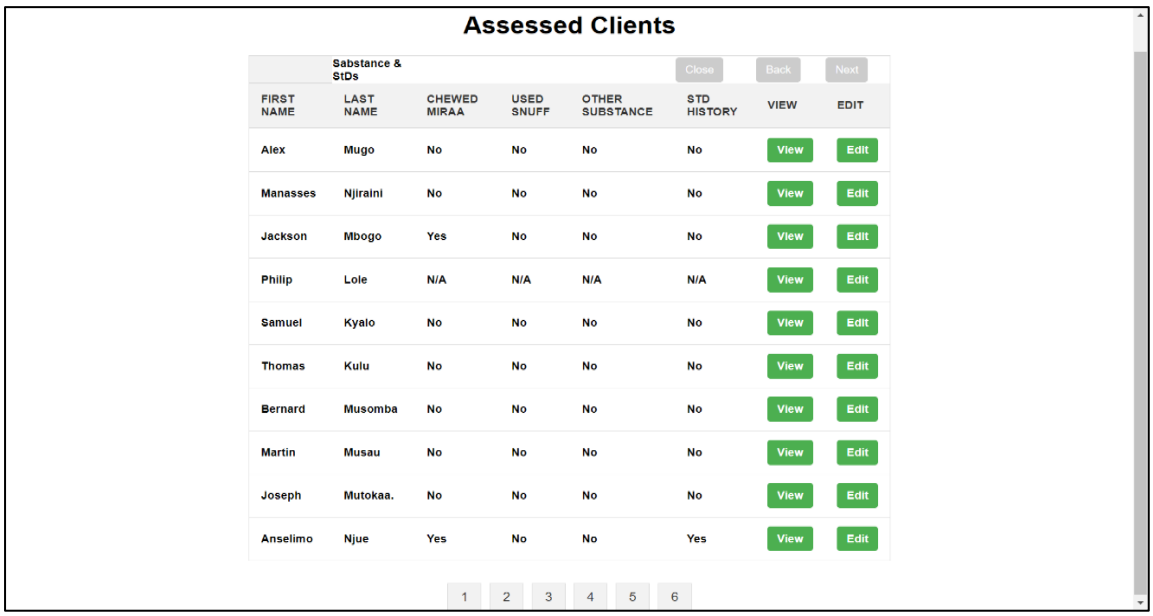


Figure 4.17

Assessment data

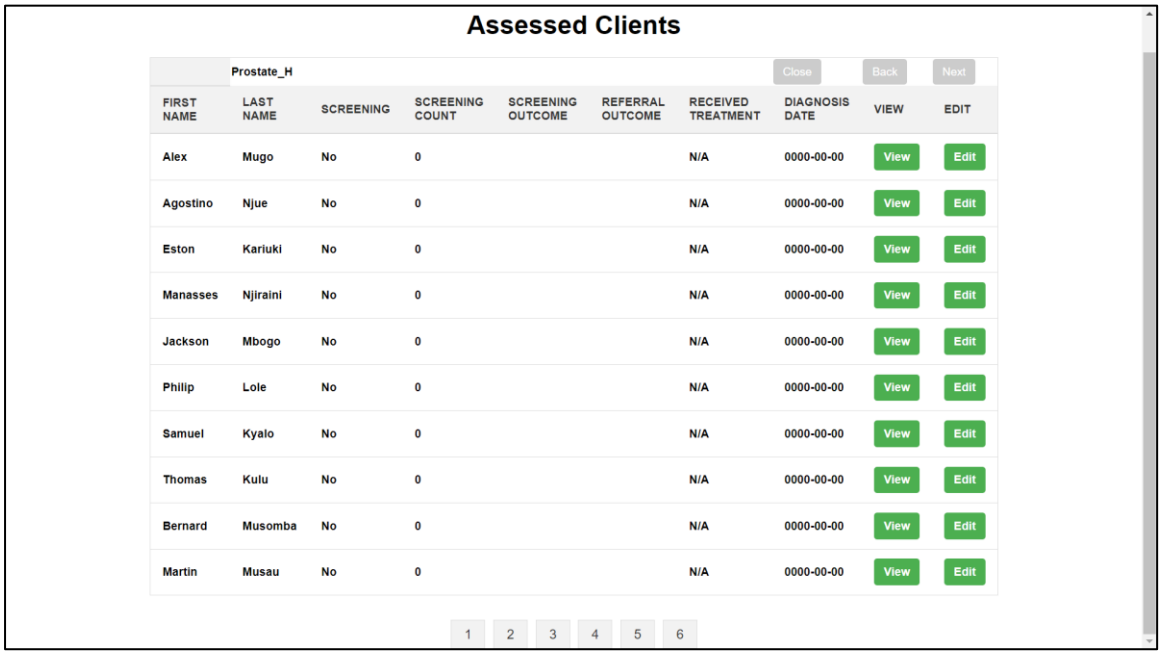
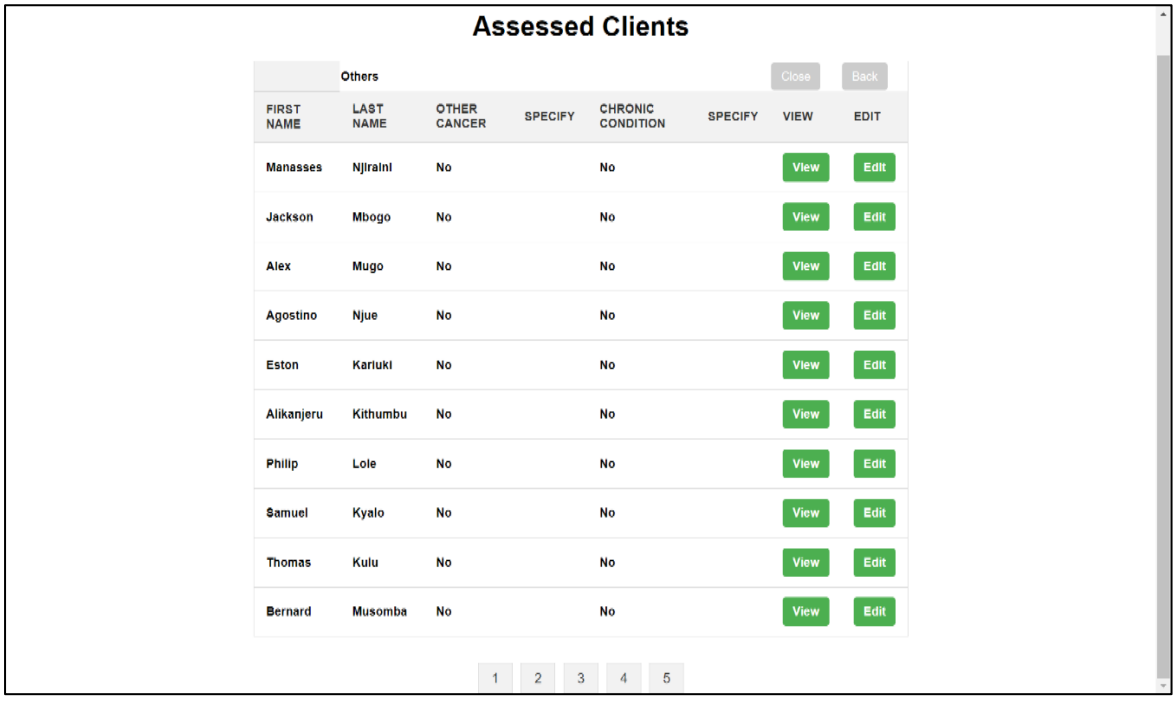


Figure 4.18

Assessment data



4.6 System testing

4.6.1 Functional testing

Functional testing was done to ascertain that the prototype digital platform meets the requirements specified to deliver the expected results. The following test cases were carried out.

Table 4.10

Functional Test Cases

Test case	Test description	Expected results	Pass/ Fail
One	A user login using an incorrect email or password	The login attempt should fail and an error message pop up.	Pass
Two	The admin can create or delete user accounts and login credentials	The system should allow the admin to create accounts for users and login credentials.	Pass
Three	The admin can edit or delete entries.	The admin should be able to edit or delete submitted entries.	Pass
Four	The application only allows the registration of clients as the first service.	The application should only allow users to assess clients after registration.	Pass
Five	The user can move to the form after completing and submitting the current form.	The user has to complete the current form and submit it to view the next form	Pass
Six	The user can move back to view and edit previous forms before completing the assessment.	The application has the option to move back to the already filled form and edit the data.	Pass
Seven	Once a complete assessment is submitted successfully the application takes the user back to the home page.	The application should provide an option to automatically move the user back to the home page	Pass
Eight	The admin can view, and export submitted data.	The system provides for individualized data view and data export option.	Pass
Nine	The user can conduct periodic client follow-ups without registering afresh and referring to the most recent assessment data.	The system should allow users to conduct periodic follow-ups by selecting the clients' names and checking through prefilled forms with the previous data for any change to update.	Pass

4.6.2 User testing.

The user testing was conducted in two sessions, one with the HRIOs, CCHFPs, and DSCs and two with the CHAs. The users were taken through the application virtually to understand the login process and how to navigate and access data for the HRIOs, CCHFPs, and DSCs, and for the CHAs the session focused on the use of the application in collecting data. The participants willing to take part in testing the application in the field were requested to share their email addresses to be used in creating the user accounts and login credentials. The link and login credentials were shared with the CHAs and the instructions guide on how to login and navigate. Also, I shared my contact for troubleshooting in case one encountered a challenge while in the field.

Each CHA identified a CHV whom they accompanied in the field and offered their phone to be used for the exercise by the CHV in assessing at least two male clients aged between 40 and 70 years. A total of 22CHAs and 22 CHVs took part in end-user testing representing 52% of the CHAs who took part in the first phase. The other users classified as administrators were able to monitor and access the data as it was filled in the field in real time.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION.

5.1 Introduction

The chapter outlines the summary of the research findings, conclusions, and recommendations. The conclusions and recommendations are based on the study findings which are organized as per the study objectives and overall goal.

5.2 Summary

A working and rational program for cancer control is needed to avert the upward trends of cancer burden in SSA. This is possible through access to reliable and timely population-based data on risk factors, screening rate, occurrence, treatment, survival rate, and outcome. Hence, a growing need to focus on strengthening primary data collection from the population by embracing technological solutions to replace the predominant paper-based data collection methods.

The purpose of the study was to demonstrate the use of the mHealth digital platform in primary data collection for prostate cancer monitoring and surveillance.

5.2.1 Challenges faced by disease surveillance officers in accessing prostate cancer data.

The study wanted to identify the challenges faced by disease surveillance officers in accessing prostate cancer data. From the results, cancer is not among the diseases tracked in the integrated diseases surveillance and response which is majorly aligned to communicable diseases. In addition, the findings show that access to cancer-related data is limited only to hospital-based data generated by hospitals offering cancer services. Also, the findings indicate a lack of focus on cancer-related indicators at the community level with only one indicator captured on official MoH reporting tools 514 and 515. A demonstration of a clear gap in population-based data which critical for a rational cancer intervention program. The findings concur with the WHO

Africa regional office report on population-based cancer registries and KEMRI which estimates cancer registration and surveillance coverage at 10% coverage of the population. The lack of prioritization in the collection of population-based data, coupled with inadequate funding to increase coverage and maintenance of functional cancer registries is a demonstration of the slow response of the health system in the face of an epidemiologic transition.

5.2.2 The data set required for prostate cancer surveillance and decision-making.

The second objective of the study was to determine the data set required for prostate cancer surveillance and decision-making. The variable was important to identify the data needs as expressed by the respondents who were among the targeted consumers of the data. Secondly, after a period of time monitoring the eligible clients the data collected would be instrumental in future research seeking to establish a correlation between the risk factors and prostate cancer occurrence. The findings show that information on age, lifestyle, especially exposure to risk factors associated with increased chances of developing prostate cancer, existing chronic conditions, and health behavior seeking that is prostate cancer screening for those within the eligible age category was more relevant. Closely followed by prostate cancer incidence, individuals on treatment, and mortality. The findings largely agree with the WHO cancer resolution which highlights the need for quality population data on incidences, prevalence, therapy response, and sequela from within the region it serves as a prerequisite for an objective cancer control strategy. Despite the deliberate efforts by global health bodies to highlight the need to focus on non-communicable diseases the knowledge even among health care workers is limited. Cancer information is majorly skewed towards the type of cancer which has received substantial funding such as cervical and breast cancer, with scanty information about other cancer types.

5.2.3 Development of a prototype mHealth digital platform.

The third objective was to develop a prototype mHealth digital platform for primary data collection for effective monitoring and surveillance of prostate cancer. The research found out that in Embu County no mHealth solutions are currently used in the community targeting cancer interventions. However, the participants expressed confidence that mobile applications can improve prostate cancer data collection. The study findings were critical in specifying the system requirements and data needs for effective prostate cancer monitoring and surveillance. The application design and development focused on a product that can strengthen primary data collection, improve real-time access to reliable and quality data, and provide relevant data. The inspiration was drawn from the third global survey report on eHealth report which underscores the unique advantage of mHealth in bridging the gap in the provision of care in a resource-challenged setup since it doesn't require a lot of infrastructural investment to operate. A similar finding has been advanced by a study carried out by Dabo and Ogoncho, (2017), the emerging technological innovations on eHealth and in particular mobile health. The importance of mobile applications in the provision of health care services has been recognized by the Ministry of Health in Kenya which has developed a regulatory framework to support the coordination and implementation of versatile mHealth solutions.

5.2.4 Use of a prototype mHealth digital platform to improve real-time access to primary data.

The fourth objective was to demonstrate the use of a prototype mHealth digital platform to improve real-time access to primary data for prostate cancer monitoring and surveillance. The end users tested the digital platform in the field and the users assigned administrator rights were able to visualize the data in real time. Affirming the functionality of the mobile application to provide relevant, timely, quality, and reliable data for prostate cancer intervention programming and decision-making. A previous study by Salmani, H. underpins the important role of mHealth in improving access to quality and real-time data while

maintaining the privacy and security of data. An intervention aimed at supporting HPV screening in western Kenya, using a mobile health app by community health volunteers, was appraised for its ease of use and usefulness in capturing data, offering health education, and tracking clients. As the country is grappling with the implementation of universal health coverage with limited resources and accountability challenges, the mHealth digital platform prototype gives an efficient and effective alternative to advance the agenda which can be expanded to cover other noncommunicable diseases.

5.3 Conclusions

The main purpose of this study was to illustrate the use of a mHealth digital platform for primary data collection for effective prostate cancer monitoring and surveillance. This purpose was achieved by the researcher and validated by the users. Despite the growing burden of cancer in the country, cancer registration and surveillance have been an integral part of a logical cancer control strategy, it is at a rudimental stage mainly focusing on hospital-based data. The existing integrated disease surveillance and response is inclined towards communicable diseases and outbreaks, with minimal prioritization of non-communicable diseases including cancer.

The research identified the gap in the collection of population-based data critical for prostate cancer surveillance which is more focused on risk factors and outcomes surveillance as is the case with other NCDs. The mHealth digital platform prototype developed was able to demonstrate the collection of prostate cancer primary data from the community and its real-time access, including information on exposure to risk factors, existing known chronic conditions, prostate cancer screening, incidence, prevalence, clients on treatment, and mortality. This research is supported by previous studies that have demonstrated the use of various innovations on mHealth solutions across the cancer spectrum ranging from creating awareness, screening, early diagnosis, treatment, survivorship, and end-of-life care with a remarkable improvement in cancer interventions and outcomes.

Finally, an important feature of the mHealth digital platform prototype developed is the capacity to allow for an update based on the need to include other important indicators, tailored health messages where the changes can be implemented, and the updates pushed to the application in different location remotely without any interruptions to the services. The system is adaptable and scalable making it possible to evolve with time and increase coverage without necessarily developing a new system.

5.4 Recommendation on Research Findings

The research recommends that the integrated disease surveillance and response mandate be expanded to not only focus on communicable diseases and outbreaks but also to include cancer which is essential for a sound cancer control strategy.

The Ministry of Health and county government to work with different stakeholders involved in community health services digitization agenda to include cancer indicators in their mHealth digital platform to improve primary data collection and access for decision making and improving prostate cancer interventions.

All stakeholders involved in cancer resourcing and interventions need to prioritize prostate cancer to create awareness, screening updates, and early diagnosis. In Kenya, an estimated 80% of prostate cancer patients are diagnosed with advanced disease and more aggressive tumors leading to poor outcomes.

5.5 Recommendation for Further Research

Research on factors contributing to prostate cancer, with a focus on local context. Most of the available data is from studies conducted mostly in developed countries.

Research to determine the interoperability of the mHealth digital platform with the existing integrated disease surveillance and response system.

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APPENDICES

Appendix 1: CONSENT FORM (County Staff & CHVs)

Title: Mobile Health (mHealth) App for primary data collection for prostate cancer monitoring and surveillance.

Sponsor: Self

Principal Investigator: Benard Ndwiga Mwaniki.

Address: Kenya Methodist University

P.O Box 267 -60200, Meru, Kenya.

1. Introduction

This Consent Form contains information about the research named above. To be sure that you are informed about being in this research, we are asking you to read (or have read to you) this Consent Form. You will also be asked to sign it (or make your mark in front of a witness). We will give you a copy of this form. This consent form might contain some words that are unfamiliar to you. Please ask us to explain anything you may not understand.

2. Reason for the Research

You are being asked to take part in research to:

- Determine the data set required for cancer surveillance and decision-making.
- Identify challenges faced by disease surveillance officers in accessing prostate cancer data.
- Explore the application of the mHealth digital platform in real-time primary data collection for prostate cancer monitoring and surveillance.
- Develop a prototype mHealth digital platform and demonstrate primary data collection for effective monitoring and surveillance.

3. General Information about Research

The research involves collecting your views by filling out a questionnaire that covers current interventions in the community targeting cancer, data requirements, availability, and

accessibility. This information will be critical in the design and development of a mHealth prototype seeking to improve primary data collection and access for proper prostate cancer monitoring and surveillance.

4. **Your Part in the Research**

If you agree to be in the research, you will be involved at the initial stage in filling out the questionnaire, testing the prototype before implementation, and supporting implementation in all sub-counties in Embu County.

5. **Possible Risks**

Taking part in the research has not anticipated risks since it involves sharing your views and exchanging ideas.

6. **Possible Benefits**

The research findings will help demonstrate primary data collection and improved access can help in making informed decisions regarding responsive prostate cancer care.

7. **If You Decide Not to Be in the Research**

You are free to decide if you want to be in this research. Your decision will not affect your involvement later if the mHealth digital platform is adopted for use.

8. **Confidentiality**

We will protect information about you and your taking part in this research to the best of our ability. You will not be named in any reports. may sometimes look at your research records. Someone from the IRB might want to ask you questions about being in the research, but you do not have to answer them.

9. **Compensation**

You will not be paid since you do not have to take part in this research. However, logistics support will be provided to facilitate sharing of data.

10. **Leaving the Research**

You may leave the research at any time. If you choose to take part, you can change your mind at any time and withdraw.

11. **If You Have a Problem or Have Other Questions**

Please call Benard Ndwiga, Phone number 0711969957 at any time during the research, if you have questions about the research.

12. **Your rights as a Participant**

This research has been reviewed and approved by the IRB of Kenya Methodist University. An IRB is a committee that reviews research studies to help protect participants.

VOLUNTEER AGREEMENT

The above document describing the benefits, risks, and procedures for the research titled Mobile Health (mHealth) App for primary data collection for prostate cancer monitoring and surveillance has been read and explained to me. I have been given an opportunity to have any questions about the research answered to my satisfaction. I agree to participate as a volunteer.

_____ _____

Date Signature or mark of volunteer

I certify that the nature and purpose, the potential benefits, and possible risks associated with participating in this research have been explained to the above individual.

_____ _____

Date Signature of Person Who Obtained Consent

Appendix 2: CONSENT FORM (Clients)

Title: Mobile Health (mHealth) App for primary data collection for prostate cancer monitoring and surveillance.

Sponsor: Self

Principal Investigator: Benard Ndwiga Mwaniki.

Address: Kenya Methodist University

P.O Box 267 -60200, Meru, Kenya.

13. **Introduction**

This Consent Form contains information about the research named above. To be sure that you are informed about being in this research, we are asking you to read (or have read to you) this Consent Form. You will also be asked to sign it (or make your mark in front of a witness). We will give you a copy of this form. This consent form might contain some words that are unfamiliar to you. Please ask us to explain anything you may not understand.

14. **Reason for the Research**

You are being asked to take part in research to:

- Determine the data set required for cancer surveillance and decision-making.
- Identify challenges faced by disease surveillance officers in accessing prostate cancer data.
- Explore the application of the mHealth digital platform in real-time primary data collection for prostate cancer monitoring and surveillance.
- Develop a prototype mHealth digital platform and demonstrate primary data collection for effective monitoring and surveillance.

15. **General Information about Research**

The research involves using the mHealth digital platform to record the client's brief health history and behavioral practices that can increase the risk of prostate cancer, to demonstrate

real-time access to data for proper prostate cancer monitoring and surveillance. To help decision-makers to improve prostate cancer care.

16. **Your Part in the Research**

If you agree to be in the research, you will be involved in sharing your brief health history and behavioral practices that affect your health, especially prostate cancer.

17. **Possible Risks**

Taking part in the research has not anticipated risks since it involves sharing your health status history and health behavior practices.

18. **Possible Benefits**

The research findings will help demonstrate primary data collection and improved access can help in making informed decisions regarding addressing the challenges in access to prostate cancer care.

19. **If You Decide Not to Be in the Research**

You are free to decide if you want to be in this research. Your decision will not affect you later if the mHealth digital platform is adopted for use in prostate cancer care.

20. **Confidentiality**

We will protect information about you and your taking part in this research to the best of our ability. You will not be named in any reports. Someone from the IRB might want to ask you questions about being in the research, but you do not have to answer them.

21. **Compensation**

You will not be paid since you do not have to take part in this research.

22. **Leaving the Research**

You may leave the research at any time. If you choose to take part, you can change your mind at any time and withdraw.

23. **If You Have a Problem or Have Other Questions**

Please call Benard Ndwiga, Phone number 0711969957 at any time during the research, if you have questions about the research.

24. **Your rights as a Participant**

This research has been reviewed and approved by the IRB of Kenya Methodist University. An IRB is a committee that reviews research studies to help protect participants.

VOLUNTEER AGREEMENT

The above document describing the benefits, risks, and procedures for the research titled Mobile Health (mHealth) App for primary data collection for prostate cancer monitoring and surveillance has been read and explained to me. I have been given an opportunity to have any questions about the research answered to my satisfaction. I agree to participate as a volunteer.

_____ _____

Date Signature or mark of volunteer

If volunteers cannot read the form themselves, a witness must sign here:

I was present while the benefits, risks, and procedures were read to the volunteer. All questions were answered, and the volunteer has agreed to take part in the research.

_____ _____

Date Signature of Witness

I certify that the nature and purpose, the potential benefits, and possible risks associated with participating in this research have been explained to the above individual.

_____ _____

Date Signature of Person Who Obtained Consent

Appendix 3: mHealth digital platform for primary data collection for prostate cancer questionnaire.

The questionnaire is part of research on the use of mobile health digital platform for primary data collection by CHVs from the community to facilitate real-time access to data for prostate cancer surveillance and monitoring.

INSTRUCTIONS: Please do not put your name on the questionnaire. In every part, select the or fill in the blanks with the correct answers. Kindly answer as truthfully as possible

1. Gender:

[] Male [] Female

2 (a) Are you a County or a Subcounty staff?

[] County []Subcounty

2 (b) If the answer to (a) above is sub-county please indicate which one.

[] Embu East [] Embu West [] Mbeere North

[] Embu North [] Mbeere South

3. Indicate your highest academic level.

[] Certificate. [] Diploma. [] First degree.

[] Master's degree. [] Ph.D. [] others (specify)---------

4. What is your designation?

[] County Disease Surveillance Coordinator.

[] County Community Health Focal Person.

[] County Health Information Officer

[] Subcounty Disease Surveillance Coordinator.

[] Subcounty Community Health Focal Person

[] Sub-county Health Information Officer

[] Community Health Extension Worker (PHO, CHO, CHA, Others).

5. How is the routine data collection from the community conducted by the CHVs?

[] Electronically

[] Manually

[] Both

6. (a)Apart from "cases of cancer referred" reported by CHVs as per standard MoH community reporting tools, is there another cancer indicator reported by CHVs that you are aware of?

[] Yes

[] No

6. (b) If the answer to (a) above is yes, kindly specify ----------.

7(a) Do you have any software application that is used by CHVs in the community to target cancer-related interventions?

[] Yes [] No

7 (b) If the answer is yes in (a) above, which intervention areas are targeted?

[] Creating awareness [] Cancer screening [] Palliative care

[] Prevention of cancer [] Cancer treatment [] others (specify)-------

7 (c) If the answer is yes in (a) above, which cancer does the intervention target?

[] Prostate cancer [] Breast Cancer [] Others (specify)-----

[] Cervical cancer [] Colorectal cancer

[] Oesophageal cancer [] General

7 (d) If the answer to (a) above is No, do you think a mobile health digital platform can have an impact on early diagnosis and treatment outcomes?

[] Yes [] No.

8 (a) Does the scope of integrated disease surveillance and response (IDSR) include Prostate cancer?

[] Yes [] No

8. (b) If No in (a) Is there an alternative surveillance mechanism for cancer within the county?

[] Yes [] No

9. (a) Currently do you have access to cancer data that can be used for surveillance?

[] Yes [] No [] Not applicable

9. (b) If yes to (a) what is the source of the data?

[] Hospital-based data.

[] Community-based data.

[] Regional registries

9. (c) If yes to (a) above, is the available data sufficient?

[] Yes [] No

9. (d) If yes to (a) how accessible is the data?

[] Real-time (Anytime)

[] Specified timelines (e.g. monthly, quarterly e.t.c)

10 Which indicators would you consider important to facilitate prostate cancer surveillance? Please select all that apply.

[] Age of the client.

[] Location (residence) of the client.

[] History of other chronic conditions.

[] Exposure to risk factors known to contribute to prostate cancer.

[] Prostate cancer screening rates.

[] New cases of individuals diagnosed with prostate cancer.

[] Number of individuals on prostate cancer treatment.

[] Deaths related to prostate cancer.

11. Within the county what informs decisions on cancer services such as screening outreach services?

[] Cancer incidence rate

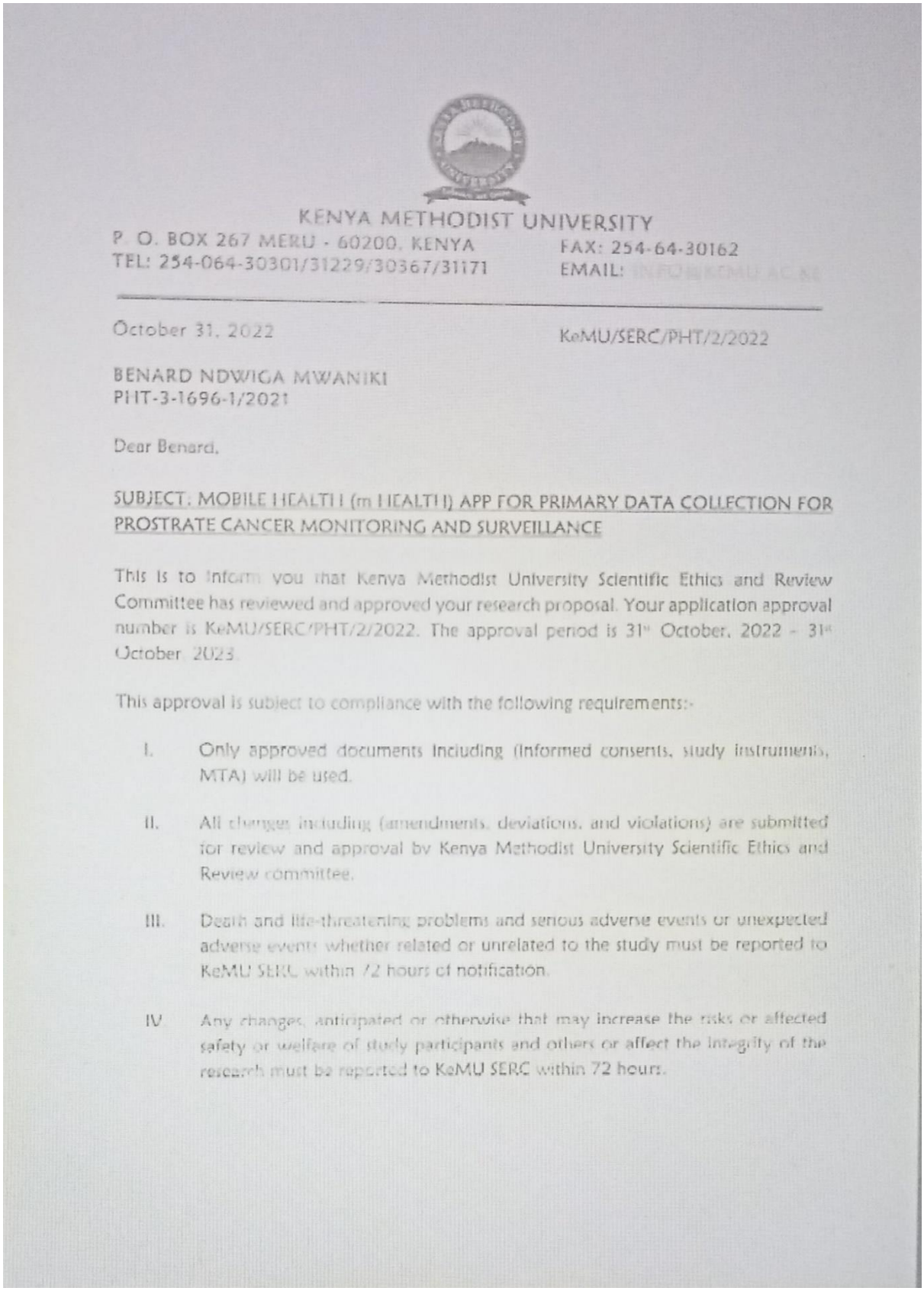
[] Cancer prevalence rate

[] Administration decision not necessary based on data.

[] Partners area of coverage.

Thank you for your participation.

Appendix 4: KEMU Scientific Ethics and Review Committee Approval



KENYA METHODIST UNIVERSITY
P. O. BOX 267 MERU - 60200, KENYA
TEL: 254-064-30301/31229/30367/31171
FAX: 254-64-30162
EMAIL: INFO@KEMU.AC.KE

October 31, 2022

KeMU/SERC/PHT/2/2022

BENARD NDWIGA MWANIKI
PHT-3-1696-1/2021

Dear Benard,

SUBJECT: MOBILE HEALTH (m HEALTH) APP FOR PRIMARY DATA COLLECTION FOR PROSTRATE CANCER MONITORING AND SURVEILLANCE

This is to inform you that Kenya Methodist University Scientific Ethics and Review Committee has reviewed and approved your research proposal. Your application approval number is KeMU/SERC/PHT/2/2022. The approval period is 31st October, 2022 - 31st October 2023.

This approval is subject to compliance with the following requirements:-

I. Only approved documents including (informed consents, study instruments, MTA) will be used.

II. All changes including (amendments, deviations, and violations) are submitted for review and approval by Kenya Methodist University Scientific Ethics and Review committee.

III. Death and life-threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to KeMU SERC within 72 hours of notification.

IV Any changes, anticipated or otherwise that may increase the risks or affected safety or welfare of study participants and others or affect the integrity of the research must be reported to KeMU SERC within 72 hours.

V. Clearance for export of biological specimens must be obtained from relevant institutions.

VI. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal.

VII. Submission of an executive summary report within 90 days upon completion of the study to KeMU SERC.

Prior to commencing your study, you will be expected to obtain a research license from National Commission for Science, Technology and Innovation (NACOSTI) https://oris.nacosti.go.ke and also obtain other clearances needed.

Yours sincerely,

KENYA METHODIST UNIVERSITY
KEMU SERC
31 OCT 2022
P.O. Box 267 - 60200 MERU

DR. HERBERT KIDEBE
SECRETARY, SERC

Appendix 5: Research License

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR
SCIENCE,TECHNOLOGY & INNOVATION

Ref No: 678382

Date of Issue: 05/December/2022

RESEARCH LICENSE

This is to Certify that Mr.. Bernard Ndwiga Mwaniki of Kenya Methodist University, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Embu on the topic: MOBILE HEALTH (mHealth) APP FOR PRIMARY DATA COLLECTION FOR PROSTATE CANCER MONITORING AND SURVEILLANCE. for the period ending : 05/December/2023.

License No: NACOSTI/P/22/22157

678382

Applicant Identification Number

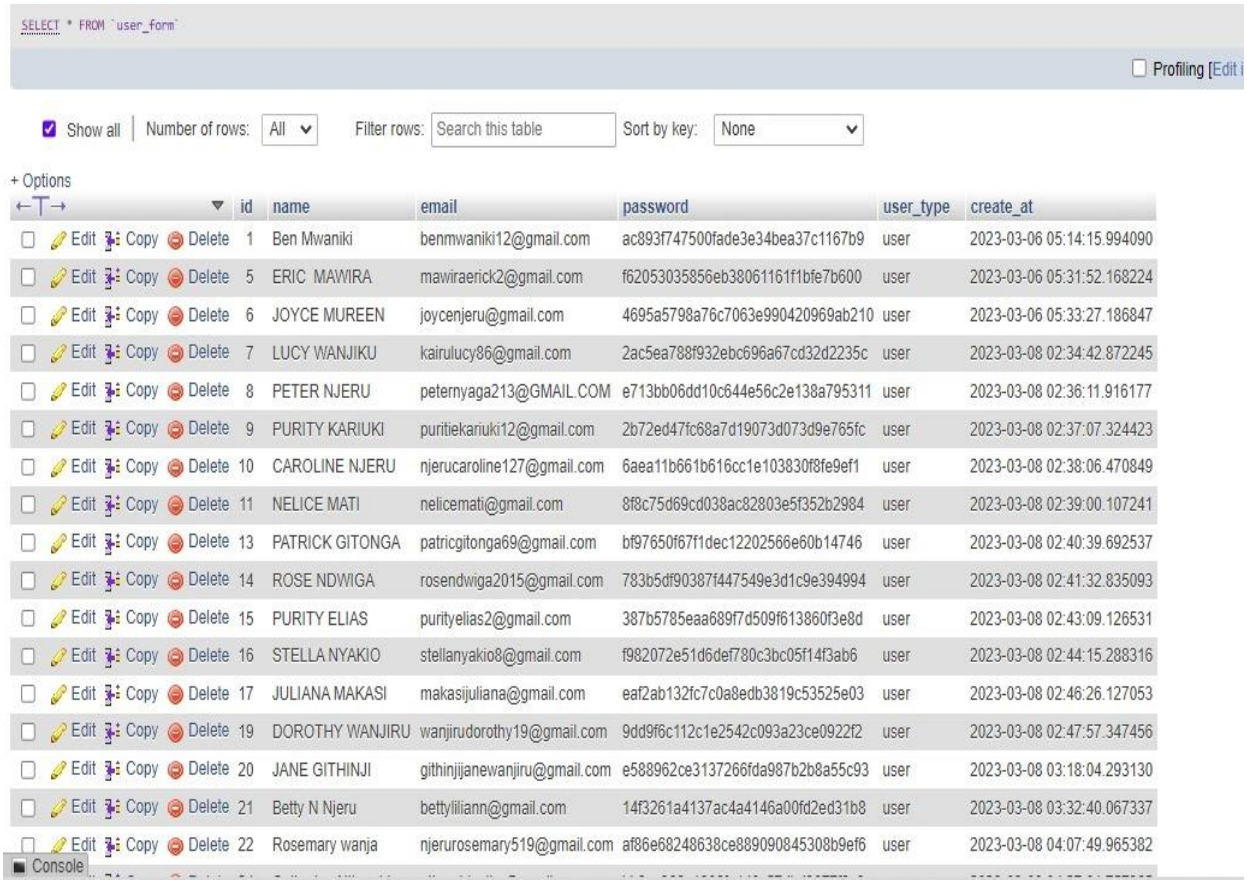
Director General
NATIONAL COMMISSION FOR
SCIENCE,TECHNOLOGY &
INNOVATION

Verification QR Code

NOTE: This is a computer generated License. To verify the authenticity of this document, Scan the QR Code using QR scanner application.

See overleaf for conditions

Appendix 6: Sample back-end system user data



```
SELECT * FROM `user_form`
```

Profiling [Edit i

Show all | Number of rows: All | Filter rows: Search this table | Sort by key: None

+ Options

	id	name	email	password	user_type	create_at
Edit Copy Delete	1	Ben Mwaniki	benmwaniki12@gmail.com	ac893f747500fade3e34bea37c1167b9	user	2023-03-06 05:14:15.994090
Edit Copy Delete	5	ERIC MAWIRA	mawiraerick2@gmail.com	f62053035856eb38061161f1bfe7b600	user	2023-03-06 05:31:52.168224
Edit Copy Delete	6	JOYCE MUREEN	joycenjeru@gmail.com	4695a5798a76c7063e990420969ab210	user	2023-03-06 05:33:27.186847
Edit Copy Delete	7	LUCY WANJIKU	kairulucy86@gmail.com	2ac5ea788f932ebc696a67cd32d2235c	user	2023-03-08 02:34:42.872245
Edit Copy Delete	8	PETER NJERU	peternyaga213@GMAIL.COM	e713bb06dd10c644e56c2e138a795311	user	2023-03-08 02:36:11.916177
Edit Copy Delete	9	PURITY KARIUKI	puritiekariuki12@gmail.com	2b72ed47fc68a7d19073d073d9e765fc	user	2023-03-08 02:37:07.324423
Edit Copy Delete	10	CAROLINE NJERU	njerucaroline127@gmail.com	6aea11b661b616cc1e103830f8fe9ef1	user	2023-03-08 02:38:06.470849
Edit Copy Delete	11	NELICE MATI	nelicemati@gmail.com	8f8c75d69cd038ac82803e5f352b2984	user	2023-03-08 02:39:00.107241
Edit Copy Delete	13	PATRICK GITONGA	patricgitonga69@gmail.com	bf97650f67f1dec12202566e60b14746	user	2023-03-08 02:40:39.692537
Edit Copy Delete	14	ROSE NDWIGA	rosendwiga2015@gmail.com	783b5df90387f447549e3d1c9e394994	user	2023-03-08 02:41:32.835093
Edit Copy Delete	15	PURITY ELIAS	purityelias2@gmail.com	387b5785eaa689f7d509f613860f3e8d	user	2023-03-08 02:43:09.126531
Edit Copy Delete	16	STELLA NYAKIO	stellanyakio8@gmail.com	f982072e51d6def780c3bc05f14f3ab6	user	2023-03-08 02:44:15.288316
Edit Copy Delete	17	JULIANA MAKASI	makasijuliana@gmail.com	eaf2ab132fc7c0a8edb3819c53525e03	user	2023-03-08 02:46:26.127053
Edit Copy Delete	19	DOROTHY WANJIRU	wanjirudorothy19@gmail.com	9dd9f6c112c1e2542c093a23ce0922f2	user	2023-03-08 02:47:57.347456
Edit Copy Delete	20	JANE GITHINJI	githinjijanewanjiru@gmail.com	e588962ce3137266fda987b2b8a55c93	user	2023-03-08 03:18:04.293130
Edit Copy Delete	21	Betty N Njeru	bettyliliann@gmail.com	14f3261a4137ac4a4146a00fd2ed31b8	user	2023-03-08 03:32:40.067337
Edit Copy Delete	22	Rosemary wanja	njerurosemary519@gmail.com	af86e68248638ce889090845308b9ef6	user	2023-03-08 04:07:49.965382

Console

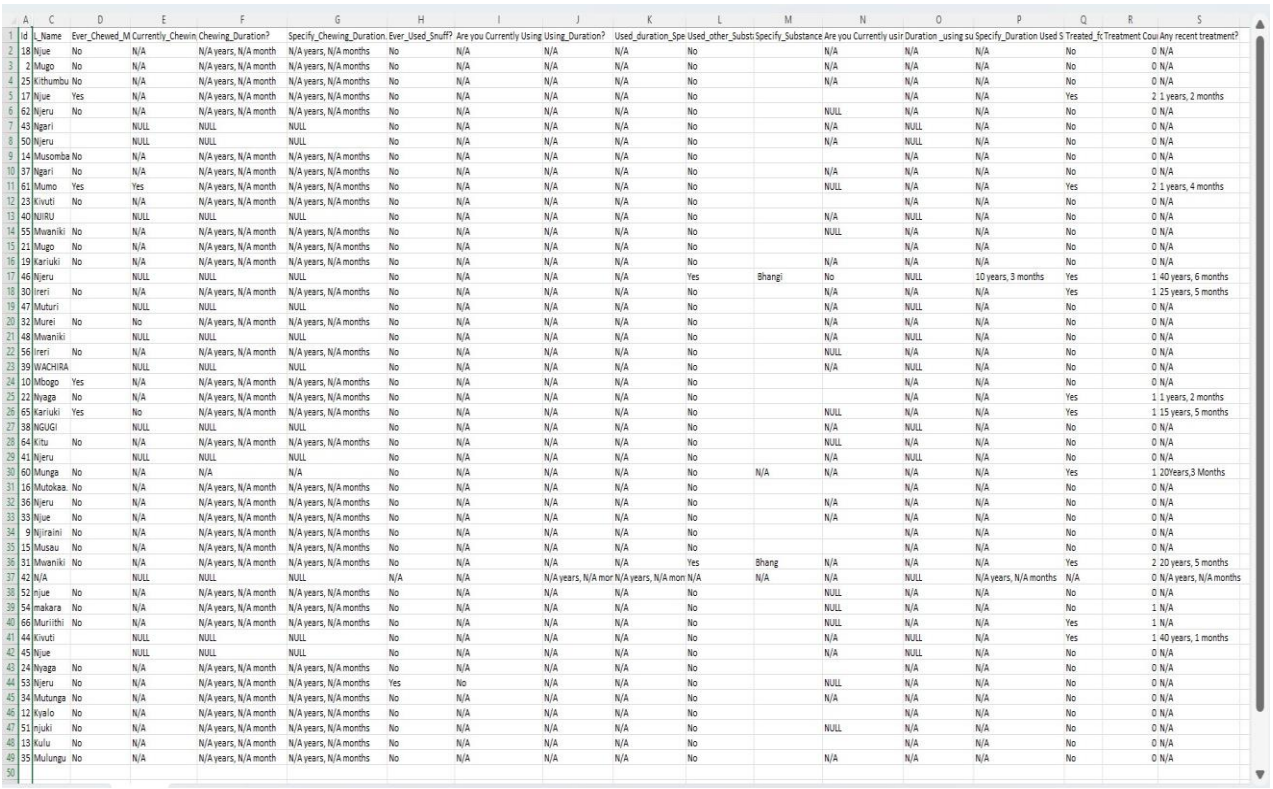
Appendix 7: Sample of client profile exported data

	A	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	id	L_Name	D.O.B	Age	Phone	Subcounty_Name	Village	Link_facility_Name	Link Facility Level	CHU_Name	Status	Create_a	Asigned by		
2	53	Njue	09/03/1960	62	7.1E+08	Mbeere North	Kianthawa	Mbeere level 4 hospital	Subcounty Hospital	Siakago community health unit		41:41.4	14		
3	52	Mugo	07/01/1976	47	7.2E+08	Mbeere North	siakago	siakago	Subcounty Hospital	siakago	Normal	45:07.9	13		
4	55	Kithumbi	15/06/1962	60	7E+08	Mbeere North	Magacha	Riandu Dispensary	Dispensary	Riandu CHU		42:49.5	33		
5	19	Njue	15/06/1965	57	7.2E+08	Mbeere North	Muguko	Muchonoke Dispensary	Dispensary	Gitiburi Community Health unit		15:15.8	9		
6	90	Njeru	04/04/1968	55	7.2E+08	Runyenjes	Kiangucu	Mufu dispensary	Dispensary	Mufu CHU		41:55.1	45		
7	88	Njeru	04/04/1968	55	7.2E+08	Runyenjes	Kiangucu	Mufu dispensary	Dispensary	Mufu CHU		21:26.7	45		
8	70	Ngari	10/03/1963	60	7.2E+08	Mbeere North	Kangai	Ishiara	Subcounty Hospital	Evurore		08:08.5	41		
9	78	Njeru	24/05/1971	51	7E+08	Mbeere North	Mukororia	Kirie dispensary	Dispensary	Kirie community health unit		08:08.5	28		
10	15	Musomb	12/06/1968	54	7.2E+08	Mbeere South	Unthunthini	Karaba Dispensary	Dispensary	Karaba		15:15.8	7		
11	67	Ngari	09/01/1986	69	7.2E+08	Mbeere South	kambura	gacabari	Dispensary	gacabari	Normal	24:53.4	16		
12	22	Kivuti	09/03/1980	42	7.9E+08	Mbeere South	Mumburi	Machanga	Dispensary	Machanga		15:15.8	11		
13	59	NJIRU	15/06/1961	61	7.2E+08	Mbeere North	KIANYONGA	KAMUMU	Dispensary	KAMUMU		01:42.4	15		
14	84	Mwaniki	07/08/1979	43	7.3E+08	Mbeere North	NGOCE	Kiogogo	Dispensary	NGOCE UNIT		08:08.5	24		
15	20	Mugo	09/03/1959	64	7.2E+08	Mbeere South	Kathuri	Machanga	Dispensary	Machanga		15:15.8	10		
16	54	Kariuki	22/04/1966	56	7.1E+08	Mbeere North	Gatitu	Riandu Dispensary	Dispensary	Riandu CHU		44:06.5	33		
17	72	Njuki	01/12/1948	0	7.2E+08	Mbeere North	Muriri	Kamugu	Dispensary	Thura		08:08.5	10		
18	73	Njeru	01/12/1957	65	7.2E+08	Mbeere North	Muriri	Kamugu	Dispensary	Thura		08:08.5	27		
19	60	Ireri	20/01/1962	61	7.3E+08	Mbeere South	Karura	Karura dispensary	Dispensary	Karura		50:04.1	19		
20	75	Muturi	10/03/1969	54	7.3E+08	Mbeere North	Marirui	Kanyuambora	Dispensary	Rwiria		08:08.5	20		
21	62	Murei	06/12/1982	40	7.8E+08	Mbeere South	Kanyonga	Makima	Dispensary	Makima		20:49.0	30		
22	76	Mwaniki	17/01/1958	65	7.1E+08	Mbeere North	Ngiiri north BB	Kiambere dam dispensary	Dispensary	Cieria community unit		08:08.5	27		
23	85	Ireri	01/01/1976	47	7.1E+08	Mbeere North	NGOCE	Kiogogo	Dispensary	NGOCE UNIT		21:00.8	44		
24	58	WACHIRA	02/08/1984	41	8E+08	Mbeere North	KAMACURA	KAMUMU	Dispensary	KAMUMU	Normal	03:41.1	15		
25	9	Mbogo	11/02/1976	47	7.2E+08	Mbeere South	Itherero A	Nganduri dispensary	Dispensary	Nganduri		15:15.8	7		
26	21	Nyaga	15/06/1973	49	7.1E+08	Mbeere North	Kavingori	Muchonoke Dispensary	Dispensary	Gitiburi Community Health unit		15:15.8	10		
27	94	Kariuki	15/06/1970	52	7.3E+08	Runyenjes	Mufu	Mufu dispensary	Dispensary	Mufu CHU		10:05.9	45		
28	57	NGUGI	01/06/1978	44	7.3E+08	Mbeere North	KAMUMU	KAMUMU	Dispensary	KAMUMU		00:49.5	15		
29	93	Kitu	03/12/1974	48	7.9E+08	Manyata	mufu	manyata	Dispensary	mufu		42:50.2	1		
30	68	Muturi	24/05/1978	44	7.3E+08	Mbeere North	Kianjogu B	Kirie dispensary	Dispensary	Kirie community health unit		08:08.5	41		
31	77	Muturi	24/05/1978	44	7.3E+08	Mbeere North	Kianjogu B	Kirie dispensary	Dispensary	Kirie community health unit		08:08.5	20		
32	69	Njeru	05/03/1982	41	7.2E+08	Mbeere North	Kangai	Ishiara	Subcounty Hospital	Evurore		08:08.5	42		
33	89	Munga	03/02/1970	53	7.4E+08	Runyenjes	Gatura	Kianjokoma	County Hospital	Gatura		38:25.0	1		
34	17	Mutokaa	20/12/1958	64	7.2E+08	Mbeere South	Wanzere	Wachoro	Dispensary	Wachoro community unit.		15:15.8	8		
35	66	Njeru	01/04/1973	49	7.2E+08	Mbeere South	mugaari	mutuobare	Dispensary	Mutindwa		48:59.9	16		
36	63	Njue	18/02/1958	65	7E+08	Mbeere South	Mashamba	Makima	Dispensary	Makima		51:01.2	30		
37	7	Njiraini	26/09/1981	41	7.2E+08	Mbeere South	Nganduri	Nganduri dispensary	Dispensary	Nganduri		15:15.8	7		
38	16	Musau	01/07/1970	52	7.9E+08	Mbeere South	Kikumini	Wachoro	Dispensary	Wachoro community unit.		15:15.8	8		
39	61	Mwaniki	04/04/1958	64	7.4E+08	Mbeere South	Kiruriri	Riachina	Dispensary	Riachina		29:36.3	19		
40	11	Nthiga	02/06/1978	44	7.3E+08	Mbeere North	Siakago	Mbeere level 4 hospital	Subcounty Hospital	Siakago community health unit		40:56.4	13		
41	80	njue	30/03/1964	58	7.3E+08	Runyenjes	kararari	Karurumo RHTC	Health Centre	Karurumo		58:37.0	37		
42	83	makara	18/03/1973	50	7.1E+08	Runyenjes	gititu	kigumo model	Health Centre	kigumo		18:02.6	42		
43	95	Muriithi	15/08/1983	0	07E4 038(	Runyenjes	Mufu	Mufu dispensary	Dispensary	Mufu CHU		04:16.2	45		

Appendix 7: Sample of client assessment exported data

id	L_Name	Family_History	Relationship	Relationship_othe	Smoking	Currently_Smoking	Smoking_Duration	Smoking_Duration_Quit	Alcohol	Drinking	Drinking_Duration	DrinkingDuration_past	Create_at
26	Njue	No			No	N/A	N/A	N/A	Yes	Yes	N/A	N/A	31:38.9
21	Mugo	No			No	N/A	N/A	N/A	No	N/A	N/A	N/A	02:11.8
29	Kithumbu	No			No	N/A	N/A	N/A	Yes	Yes	N/A	N/A	59:09.3
22	Njue	No			No	N/A	N/A	N/A	No	Yes	N/A	5 years, 5 months	14:57.5
79	Njeru	No			Yes	Yes	N/A	N/A	Yes	No	N/A	N/A	42:23.3
46	Ngari	No			No	N/A	N/A	N/A	No	N/A	N/A	N/A	27:21.9
53	Njeru	No			No	N/A	N/A	N/A	No	N/A	N/A	N/A	38:37.2
15	Musomba	No			No	N/A	N/A	N/A	No	N/A	N/A	N/A	19:09.2
40	Ngari	No			No	N/A	N/A	N/A	No	N/A	N/A	N/A	02:17.5
25	Kivuti	No			Yes	No	N/A	1 years, 2 months	Yes	No	N/A	5 years, 2 months	38:46.7
32	NJIRU	No			No	N/A	N/A	N/A	No	N/A	N/A	N/A	12:28.4
43	NJIRU	No			No	N/A	N/A	N/A	No	N/A	N/A		12:28.4
72	Mwaniki	No			No	N/A	N/A	N/A	No	N/A	N/A	N/A	50:25.6
23	Mugo	No			No	N/A	N/A	N/A	No	N/A	N/A	N/A	17:32.6
27	Kariuki	No			No	N/A	N/A	N/A	No	N/A	N/A	N/A	36:54.7
49	Njeru	No			Yes	No	N/A	10 years, 3 months	No	N/A	N/A	N/A	01:46.6
33	Ireri	No			No	N/A	N/A	N/A	Yes	Yes	37 years, 2 months	N/A	51:44.1
50	Muturi	No			Yes	No	N/A	N/A	Yes	No	N/A	N/A	16:04.7
35	Murei	No			Yes	No	N/A	4 years, 6 months	Yes	Yes	15 years, 3 months	N/A	22:07.3
51	Mwaniki	No			No	N/A	N/A	N/A	No	N/A	N/A	N/A	29:27.9
73	Ireri	No			No	N/A	N/A	N/A	No	N/A	N/A	N/A	21:27.8
42	WACHIRA	No			Yes	Yes	N/A	N/A	Yes	Yes	N/A	N/A	04:27.4
31	WACHIRA	No			Yes	Yes	5 years,8 months	N/A	Yes	Yes	N/A	N/A	04:27.4
6	Mbogo	No			No	N/A	N/A	N/A	Yes	No	N/A	5 years, 2 months	32:25.0
24	Nyaga	No			No	N/A	N/A	N/A	No	N/A	N/A	N/A	31:50.7
83	Kariuki	No			Yes	Yes	N/A	N/A	Yes	No	N/A	N/A	10:46.1
30	NGUGI	No				N/A	N/A	N/A	Yes	No	N/A	N/A	19:04.3
41	NGUGI	No			No	N/A	N/A	N/A	Yes	No	N/A	N/A	19:04.3
82	Kitu	Yes	Siblings		No	N/A	N/A	N/A	No	N/A	N/A	N/A	43:08.1
44	Njeru	No			No	N/A	N/A	N/A	No	N/A		N/A	17:01.6
78	Munga	No			No	N/A	N/A	N/A	No	N/A	N/A	N/A	38:45.9
17	Mutokaa.	No			No	N/A	N/A	N/A	No	No	N/A	N/A	09:27.2
39	Njeru	No			No	N/A	N/A	N/A	Yes	No	N/A	N/A	49:46.1
36	Njue	No			Yes	Yes	35 years, 4 months	N/A	Yes		N/A	20 years, 3 months	51:59.2
9	Njiraini	No			No	No	N/A	N/A	Yes	Yes	11 years, 5 months	N/A	25:41.1
16	Musau	No			No	N/A	N/A	N/A	No	N/A	N/A	N/A	41:32.4
34	Mwaniki	No			Yes	No	N/A	20 years, 2 months	Yes	No	N/A	20 years, 2 months	04:53.0
7	Nthiga	No			No	N/A	N/A	N/A	Yes	No	N/A	5 years, 6 months	52:06.7
67	njue	No			No	N/A	N/A	N/A	No	N/A	N/A	N/A	58:51.5
70	makara	No			No	N/A	N/A	N/A	No	N/A	N/A	N/A	18:30.8
84	Muriithi	No			No	N/A	N/A	N/A	No	N/A	N/A	N/A	04:31.0
47	Kivuti	No			No	No	N/A	N/A	Yes	No	N/A	61 years, 2 months	42:37.5
12	Lole	No			No	N/A	N/A	N/A	Yes	No	N/A	N/A	25:41.9
48	Njue	No			No	N/A	N/A	N/A	No	N/A	N/A	N/A	01:41.0
18	Nyaga	No			Yes	No	N/A	3 years, 5 months	Yes	No	N/A	7 years, 6 months	00:51.1
68	Njeru	No			Yes	No	N/A	N/A	Yes	Yes	N/A	N/A	51:28.5
37	Mutunga	No			No	N/A	N/A	N/A	No	N/A	N/A	N/A	32:06.3
13	Kyalo	No			No	N/A	N/A	N/A	Yes	Yes	N/A	N/A	41:06.2
66	njuki	No			No	N/A	N/A	N/A	No	No	N/A	N/A	54:29.5

Appendix 8: Sample of client assessment exported data



Id	L_Name	Ever_Chewed_M	Currently_Chewin	Chewing_Duration?	Specify_Chewing_Duration	Ever_Used_Snuff?	Are you Currently Using	Using_Duration?	Used_duration_Spe	Used_other_Substi	Specify_Substance	Are you Currently usir	Duration _using su	Specify_Duration Used S	Treated_fc	Treatment Cou	Any recent treatment?
18	Njue	No	N/A	N/A years, N/A month	N/A years, N/A months	No	N/A	N/A	N/A	No		N/A	N/A	N/A	No	0	N/A
2	Mugo	No	N/A	N/A years, N/A month	N/A years, N/A months	No	N/A	N/A	N/A	No		N/A	N/A	N/A	No	0	N/A
25	Kithumbu	No	N/A	N/A years, N/A month	N/A years, N/A months	No	N/A	N/A	N/A	No		N/A	N/A	N/A	No	0	N/A
17	Njue	Yes	N/A	N/A years, N/A month	N/A years, N/A months	No	N/A	N/A	N/A	No			N/A	N/A	Yes	2	1 years, 2 months
62	Njeru	No	N/A	N/A years, N/A month	N/A years, N/A months	No	N/A	N/A	N/A	No		NULL	N/A	N/A	No	0	N/A
43	Ngari		NULL	NULL	NULL	No	N/A	N/A	N/A	No		N/A	NULL	N/A	No	0	N/A
50	Njeru		NULL	NULL	NULL	No	N/A	N/A	N/A	No		N/A	NULL	NULL	No	0	N/A
14	Musomba	No	N/A	N/A years, N/A month	N/A years, N/A months	No	N/A	N/A	N/A	No			N/A	N/A	No	0	N/A
37	Ngari	No	N/A	N/A years, N/A month	N/A years, N/A months	No	N/A	N/A	N/A	No		N/A	N/A	N/A	No	0	N/A
61	Mumo	Yes	Yes	N/A years, N/A month	N/A years, N/A months	No	N/A	N/A	N/A	No		NULL	N/A	N/A	Yes	2	1 years, 4 months
23	Kivuti	No	N/A	N/A years, N/A month	N/A years, N/A months	No	N/A	N/A	N/A	No			N/A	N/A	No	0	N/A
40	NJIRU		NULL	NULL	NULL	No	N/A	N/A	N/A	No		N/A	NULL	N/A	No	0	N/A
55	Mwaniki	No	N/A	N/A years, N/A month	N/A years, N/A months	No	N/A	N/A	N/A	No		NULL	N/A	N/A	No	0	N/A
21	Mugo	No	N/A	N/A years, N/A month	N/A years, N/A months	No	N/A	N/A	N/A	No			N/A	N/A	No	0	N/A
19	Kariuki	No	N/A	N/A years, N/A month	N/A years, N/A months	No	N/A	N/A	N/A	No		N/A	N/A	N/A	No	0	N/A
46	Njeru		NULL	NULL	NULL	No	N/A	N/A	N/A	Yes	Bhangi	No	NULL	10 years, 3 months	Yes	1	40 years, 6 months
30	Ireri	No	N/A	N/A years, N/A month	N/A years, N/A months	No	N/A	N/A	N/A	No		N/A	N/A	N/A	Yes	1	25 years, 5 months
47	Muturi		NULL	NULL	NULL	No	N/A	N/A	N/A	No		N/A	NULL	N/A	No	0	N/A
32	Murei	No	No	N/A years, N/A month	N/A years, N/A months	No	N/A	N/A	N/A	No		N/A	N/A	N/A	No	0	N/A
48	Mwaniki		NULL	NULL	NULL	No	N/A	N/A	N/A	No		N/A	NULL	N/A	No	0	N/A
56	Ireri	No	N/A	N/A years, N/A month	N/A years, N/A months	No	N/A	N/A	N/A	No		NULL	N/A	N/A	No	0	N/A
39	WACHIRA		NULL	NULL	NULL	No	N/A	N/A	N/A	No		N/A	NULL	N/A	No	0	N/A
10	Mbogo	Yes	N/A	N/A years, N/A month	N/A years, N/A months	No	N/A	N/A	N/A	No			N/A	N/A	No	0	N/A
22	Nyaga	No	N/A	N/A years, N/A month	N/A years, N/A months	No	N/A	N/A	N/A	No			N/A	N/A	Yes	1	1 years, 2 months
65	Kariuki	Yes	No	N/A years, N/A month	N/A years, N/A months	No	N/A	N/A	N/A	No		NULL	N/A	N/A	Yes	1	15 years, 5 months
38	NGUGI		NULL	NULL	NULL	No	N/A	N/A	N/A	No		N/A	NULL	N/A	No	0	N/A
64	Kitu	No	N/A	N/A years, N/A month	N/A years, N/A months	No	N/A	N/A	N/A	No		NULL	N/A	N/A	No	0	N/A
41	Njeru		NULL	NULL	NULL	No	N/A	N/A	N/A	No		N/A	NULL	N/A	No	0	N/A
60	Munga	No	N/A	N/A	N/A	No	N/A	N/A	N/A	No	N/A	N/A	N/A	N/A	Yes	1	20Years,3 Months
16	Mutokaa	No	N/A	N/A years, N/A month	N/A years, N/A months	No	N/A	N/A	N/A	No			N/A	N/A	No	0	N/A
36	Njeru	No	N/A	N/A years, N/A month	N/A years, N/A months	No	N/A	N/A	N/A	No		N/A	N/A	N/A	No	0	N/A
33	Njue	No	N/A	N/A years, N/A month	N/A years, N/A months	No	N/A	N/A	N/A	No		N/A	N/A	N/A	No	0	N/A
9	Njiraini	No	N/A	N/A years, N/A month	N/A years, N/A months	No	N/A	N/A	N/A	No			N/A	N/A	No	0	N/A
15	Musau	No	N/A	N/A years, N/A month	N/A years, N/A months	No	N/A	N/A	N/A	No			N/A	N/A	No	0	N/A
31	Mwaniki	No	N/A	N/A years, N/A month	N/A years, N/A months	No	N/A	N/A	N/A	Yes	Bhang	N/A	N/A	N/A	Yes	2	20 years, 5 months
42	N/A		NULL	NULL	NULL	N/A	N/A	N/A years, N/A mor	N/A years, N/A mon	N/A	N/A	N/A	NULL	N/A years, N/A months	N/A	0	N/A years, N/A months
52	njue	No	N/A	N/A years, N/A month	N/A years, N/A months	No	N/A	N/A	N/A	No		NULL	N/A	N/A	No	0	N/A
54	makara	No	N/A	N/A years, N/A month	N/A years, N/A months	No	N/A	N/A	N/A	No		NULL	N/A	N/A	No	1	N/A
66	Muriithi	No	N/A	N/A years, N/A month	N/A years, N/A months	No	N/A	N/A	N/A	No		NULL	N/A	N/A	Yes	1	N/A
44	Kivuti		NULL	NULL	NULL	No	N/A	N/A	N/A	No		N/A	NULL	N/A	Yes	1	40 years, 1 months
45	Njue		NULL	NULL	NULL	No	N/A	N/A	N/A	No		N/A	NULL	N/A	No	0	N/A
24	Nyaga	No	N/A	N/A years, N/A month	N/A years, N/A months	No	N/A	N/A	N/A	No			N/A	N/A	No	0	N/A
53	Njeru	No	N/A	N/A years, N/A month	N/A years, N/A months	Yes	No	N/A	N/A	No		NULL	N/A	N/A	No	0	N/A
34	Mutunga	No	N/A	N/A years, N/A month	N/A years, N/A months	No	N/A	N/A	N/A	No		N/A	N/A	N/A	No	0	N/A
12	Kyalo	No	N/A	N/A years, N/A month	N/A years, N/A months	No	N/A	N/A	N/A	No			N/A	N/A	No	0	N/A
51	njuki	No	N/A	N/A years, N/A month	N/A years, N/A months	No	N/A	N/A	N/A	No		NULL	N/A	N/A	No	0	N/A
13	Kulu	No	N/A	N/A years, N/A month	N/A years, N/A months	No	N/A	N/A	N/A	No			N/A	N/A	No	0	N/A
35	Mulungu	No	N/A	N/A years, N/A month	N/A years, N/A months	No	N/A	N/A	N/A	No		N/A	N/A	N/A	No	0	N/A

Appendix 9: Sample of client assessment exported data

Id	L_Name	Prostate_Screening?	Screening_count	Screening_Recent	Reason_for_screening	Screening_Outcome	Hospital_Visit	Referral_outcome	Receive_treatment?	Currently_on_Medication?	Prostate_Cancer_Diagnosis_date?	Submission_Date
3	Njue	No	0	N/A			N/A		N/A	N/A	0000-00-00	09/03/2023 05:32
2	Mugo	No	0	N/A			N/A		N/A	N/A	0000-00-00	09/03/2023 05:05
19	Kithumbu	No	0	N/A			N/A		N/A	N/A	0000-00-00	09/03/2023 05:59
14	Njue	No	0	N/A			N/A		N/A	N/A	0000-00-00	09/03/2023 10:17
57	Njeru	No	0	N/A			N/A		N/A	N/A	0000-00-00	11/04/2023 06:43
38	Ngari	No	0	N/A			N/A		N/A	N/A	0000-00-00	10/03/2023 01:27
45	Njeru	No	0	N/A			N/A		N/A	N/A	0000-00-00	12/03/2023 04:38
11	Musomba	No	0	N/A			N/A		N/A	N/A	0000-00-00	08/03/2023 15:19
31	Ngari	No	0	N/A			N/A		N/A	N/A	0000-00-00	11/03/2023 08:02
32	Ngari	No	0	N/A			N/A		N/A	N/A	0000-00-00	11/03/2023 08:02
17	Kivuti	Yes	1	6 years, 2 months	self-initiative	normal	N/A		N/A	N/A	0000-00-00	09/03/2023 10:46
22	NJIRU	No	0	N/A			N/A		N/A	N/A	0000-00-00	09/03/2023 06:13
35	NJIRU	No	0	N/A			N/A		N/A	N/A	0000-00-00	09/03/2023 06:13
51	Mwaniki	No	0	N/A			N/A		N/A	N/A	0000-00-00	04/04/2023 05:51
18	Mugo	Yes	1	N/A	provider-recommendation	further-assessment	Yes	sick	N/A	Yes	09/03/2022	09/03/2023 10:34
4	Kariuki	No	0	N/A			N/A		N/A	N/A	0000-00-00	09/03/2023 05:38
41	Njeru	Yes	1	55 years, 2 months	provider-recommendation	normal	N/A		N/A	N/A	0000-00-00	10/03/2023 08:05
23	Ireri	No	0	N/A			N/A		N/A	N/A	0000-00-00	09/03/2023 10:54
24	Ireri	No	0	N/A			N/A		N/A	N/A	0000-00-00	09/03/2023 10:54
42	Muturi	No	0	N/A			N/A		N/A	N/A	0000-00-00	10/03/2023 08:16
26	Murei	No	0	N/A			N/A		N/A	N/A	0000-00-00	10/03/2023 05:24
43	Mwaniki	No	0	N/A			N/A		N/A	N/A	0000-00-00	12/03/2023 04:29
52	Ireri	No	0	N/A			N/A		N/A	N/A	0000-00-00	04/04/2023 06:21
34	WACHIRA	No	0	N/A			N/A		N/A	N/A	0000-00-00	09/03/2023 05:05
21	WACHIRA	No	0	N/A			N/A		N/A	N/A	0000-00-00	09/03/2023 05:05
7	Mbogo	No	0	N/A			N/A		N/A	N/A	0000-00-00	08/03/2023 11:33
15	Nyaga	No	0	N/A			N/A		N/A	N/A	0000-00-00	09/03/2023 10:32
59	Kariuki	No	0	N/A			N/A		N/A	N/A	0000-00-00	11/04/2023 12:19
20	NGUGI	No	0	N/A			N/A		N/A	N/A	0000-00-00	09/03/2023 04:20
33	NGUGI	No	0	N/A			N/A		N/A	N/A	0000-00-00	09/03/2023 04:20
58	Kitu	Yes	2	1 years, 2 months	self-initiative	normal	N/A		N/A	N/A	0000-00-00	11/04/2023 11:44
36	Njeru	No	0	N/A			N/A		N/A	N/A	0000-00-00	10/03/2023 01:18
53	Munga	No	0	N/A	N/A	N/A	N/A	N/A	NULL	NULL	0000-00-00	11/04/2023 12:15
13	Mutokaa.	No	0	N/A			N/A		N/A	N/A	0000-00-00	08/03/2023 18:10
30	Njeru	No	0	N/A			N/A		N/A	N/A	0000-00-00	11/03/2023 07:50
27	Njue	Yes	1	1 years, 6 months	self-initiative	normal	N/A		N/A	N/A	0000-00-00	10/03/2023 07:53
6	Njiraini	No	0	N/A			N/A		N/A	N/A	0000-00-00	08/03/2023 11:26
12	Musau	No	0	N/A			N/A		N/A	N/A	0000-00-00	08/03/2023 17:42
25	Mwaniki	No	0	N/A			N/A		N/A	N/A	0000-00-00	09/03/2023 11:08
47	njue	No	0	N/A			N/A		N/A	N/A	0000-00-00	18/03/2023 03:59
50	makara	Yes	1	N/A	self-initiative	normal	N/A		N/A	N/A	0000-00-00	18/03/2023 14:20
60	Muriithi	Yes	1	N/A	self-initiative	normal	N/A		N/A	N/A	0000-00-00	11/04/2023 13:06
39	Kivuti	No	0	N/A			N/A		N/A	N/A	0000-00-00	10/03/2023 05:45
8	Lole	No	0	N/A			N/A		N/A	N/A	0000-00-00	08/03/2023 13:26
40	Njue	No	0	N/A			N/A		N/A	N/A	0000-00-00	10/03/2023 08:02
16	Nyaga	Yes	1	N/A	provider-recommendation	further-assessment	Yes	sick	N/A	Yes	09/03/2022	09/03/2023 10:34
48	Njeru	No	0	N/A			N/A		N/A	N/A	0000-00-00	18/03/2023 13:52
49	Njeru	No	0	N/A			N/A		N/A	N/A	0000-00-00	18/03/2023 13:52
28	Mutunga	No	0	N/A			N/A		N/A	N/A	0000-00-00	11/03/2023 07:32