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Mobile Health (mHealth) Digital Platform for Primary Data Collection for Prostate Cancer Monitoring and Surveillance in Embu County, Kenya

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Abstract

The cancer situation in Africa is on an upward trajectory and requires a context-sensitive approach. Prostate cancer is the fourth cause of death after cervical, breast, and oesophageal cancer respectively with an estimated incidence of 3,412 (8.1%) and a mortality of 1,780 (6.6%) in Kenya. Currently in Kenya cancer registration and surveillance cover an estimated 10% of the population which is sub-optimal. The main aim of the study was to demonstrate the use of an mHealth digital platform prototype to improve the collection and real-time access to primary data for prostate cancer control and surveillance. 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. The purposive sampling technique was used to identify participants, a total population of (71) respondents, 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 was subjected to quantitative-descriptive analysis. The findings guided the requirement definition, design, and development of the prototype which was tested by the end users. A gap was noted in prostate primary data collection, documentation, and access from the community. We established the available data was mostly hospital-based. The study also, established that cancer was not covered in an integrated disease surveillance and response system. The mHealth digital platform was tested by the end users to illustrate primary data collection from the community and its real-time access. Finally, the research recommends the expansion of the existing disease surveillance system to include cancer surveillance.

Keywords: *mHealth digital platform; Primary data collection; Prostate cancer surveillance*

1.0 Introduction

In recent days focus has been drawn to the increasing burden of cancer with an estimated incidence of 19.3 million and a mortality of almost 10 million according to Global Cancer Statistics 2020. Moreover, a global projection of about 47% rise from 2020 to 28.4 million cases by 2040 is expected. Notably, 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.

Prostate cancer mortality is on an upward trend in Africa which has been majorly attributed to delays in diagnosis. Lack of noticeable signs and symptoms in the initial stages of prostate cancer has been largely cited as the cause of late diagnosis and poor prognosis (Cassell et al., 2019). According to Sung et al. (2021), prostate cancer is the fourth cause of death after cervical, breast, and oesophageal cancer respectively with an estimated incidence of 3,412 (8.1%) and mortality of 1,780 (6.6%) in Kenya. The Ministry of Health in 2017 estimated about 80% of prostate cancer patients were diagnosed with advanced disease and more aggressive tumors leading to poor clinical outcomes.

Emerging evidence indicates that technological innovations such as mHealth are a viable solution to addressing challenges experienced in the provision of cancer care in low-resource settings (Salmani et al., 2020a). The opportunities presented by mHealth include access to real-time data even from remote areas, improved data quality, health data management, medical information sharing, targeted health education, and informed decision-making. In addition to surveillance, which is essential for policy and planning of health services.

Arguably, reliable and timely population-based data on occurrence, treatment, outcome, and survival rate are crucial for a rational cancer control program (Omonisi et al., 2020a). There is a growing need to focus on strengthening primary data collection to improve access to population-based data for cancer monitoring and surveillance in Kenya. 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, IAEA, IARC 2016). Therefore, the study sought to establish the challenges in access to population-based prostate cancer data and the data set requirements from the stakeholders, to guide the designing and development of the mHealth digital platform prototype. The rationale of the study was to demonstrate the use mHealth digital platform to facilitate real-time primary data collection and sharing to inform a sound prostate cancer control and surveillance strategy and programming, to control the growing prostate cancer burden.

2.0 Materials and Methods

Study design and target population

The study adopted a descriptive cross-sectional research design, 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 with aim of improving it, creating a new logic, and expanding design knowledge, which constitutes problem, solution, and evaluation (vom Brocke et al., 2020). The study was guided by Brown and Wyatt's three phases that is, the problem influencing the search for a solution (inspiration), generation, development, and testing ideas (ideation), and a path that links the product and problem (implementation) (Petersen & Hempler, 2017).

The study targets healthcare workers, including community health volunteers working in Embu County who take part in community health data collection and management at various levels. The population was ideal based on their mandate and experience in community data collection, reporting processes, and use of data at various 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.

Sample size and sampling technique

The study used purposive sampling for inspiration phase and ideation phase, then critical case sampling for implementation Phase. It was applied to identify the total target population (71) as respondents for the inspiration Phase and a total of (15) respondents for the ideation phase.

Critical case sampling was used to identify (34) CHVs from different community health units equivalent to 60% number of CHAs who participated in the study.

Table 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 level	
Community health volunteers (60% of the # CHAs)	34

Data collection and analysis

A structured questionnaire was used for data collection. The questionnaire was administered to (71) respondents via a shared link. A total of 57 questionnaires out of 71 were filled and submitted. The study employed descriptive statistics for analysis such as frequency, percentages, and tables used for data presentation.

The ethical approval was obtained upon fulfillment of all the requirements from the Kenya Methodist Scientific and Ethical Review Committee (SERC) and the National Commission of Science, Technology, and Innovation (NACOSTI).

3.0 Results and Discussion

This section presents findings in response to research questions 1-“What are the challenges experienced by disease surveillance officers in accessing prostate cancer data?’’ and 2-“ What is the data set required for prostate cancer surveillance and decision making?’’

Data collection challenges

To establish the challenges in data collection from the community, the respondents were asked about cancer indicators reported from the community through the standard Ministry of Health reporting tools. We found out that only one indicator “known cases of cancer’’ was reported, which did not even specify the type of cancer. This indicated a gap in cancer data collection from the community and a lack of prioritization of population-based data. The results agree with reports from studies on coverage of population-based cancer registries which is estimated to cover 10% of the population in Kenya (WHO, IAEA, IARC, 2016).

The data collection method was majorly paper-based and without any digital solution currently in use in the provision of community health services and prostate cancer does not form part of the key focus areas. The findings are consistent with the national community health strategy observations on the utilization of ICT in healthcare delivery at the lowest level been incredibly low and the processes of documenting have largely been paper-based (National Community Health Digitization Strategy, 2020-2025).

Perception of the impact of mHealth digital platform in primary data collection

The participant's perception of the use and impact of a digital platform in data collection was an essential element in informing the design of the proposed solution. The results indicate that the majority of the respondents (89.5%) were positive the mHealth digital platform could be very instrumental in improving prostate data collection and accessibility.

Table 2: Respondent Perspective on the Impact of mHealth Digital Platform

Opinion	Frequency	Percentage
Yes	51	89.5
Maybe	3	5.3
No	3	5.3

The results in Table 2, by extension are an indication of how technology is gaining traction in the health sector as an alternative solution to improving services.

Data documentation challenges

The study sought to determine the challenges on documentation from disease surveillance coordinators and health records and information officers who were considered key informants based on their exposure to data. The results indicate that the available data was hospital-based mainly from clients who received services. However, documentation challenges affected the data quality that is, incomplete data and some important indicators missing especially on risk factors exposure, previous history of screening and other known chronic conditions that are considered critical for prostate cancer monitoring and surveillance.

Further, a follow-up question was posed to the respondents regarding data accessibility of the available data. The results are tabulated in Table 3 below.

Table 3: Prostate Cancer Data Accessibility

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

Based on the results, the majority of the respondents, 80% indicated that they can access the data at a specified time mainly after the monthly reports are submitted and the other 20% reported real-time access mainly sub-county health records and information officers who are based on within the facility premises where data is generated or referred to historical data already in their custody.

Important prostate cancer indicators.

The study 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 summarizes the findings.

Table 4: Important Indicators for Decision Making, Monitoring and Surveillance

Indicators	Frequency	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

According to the results contained in Table 4 above, information on known chronic conditions, prostate cancer screening, exposure to risk factors, and age topped the list. The results imply lifestyle, existing chronic conditions, and health behavior seeking were considered more relevant.

According to the WHO Global Action Plan for the Prevention and Control of NCDs 2013-2020, emphasis was on vital registration system reinforcement and cancer registries, integration of cancer surveillance into national health systems, and risk factor surveillance. The registries play a critical role in the calculation of national estimates of incidence, prevalence, and mortality, and predict trends or mapping of cancers.

Scope of integrated disease surveillance and response (IDSR).

To understand the scope of the integrated disease surveillance and response, the analysis considered responses from disease surveillance coordinators and health records and information officers from the county and sub-county due to their level of involvement with health data and their expertise. We found out that cancer is not currently included in the integrated disease surveillance and response, this is consistent with the findings that in many developing countries public health surveillance efforts are inclined towards prioritization of communicable diseases and outbreaks with little attention given to chronic conditions (Piñeros, et al., 2017).

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.

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 accessing 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 continued 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.

System Design

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

Overall system architecture

Figure 2 below shows the overall outlook of the solution and how different activities are linked to each other to deliver the outcome as specified by the requirements. The system organization column one constitutes all data generation activities, which begins with the registration of eligible men aged 40-70 years (clients), this section contains a detailed client profile. The next section that follows sequentially is 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 in form of reports.

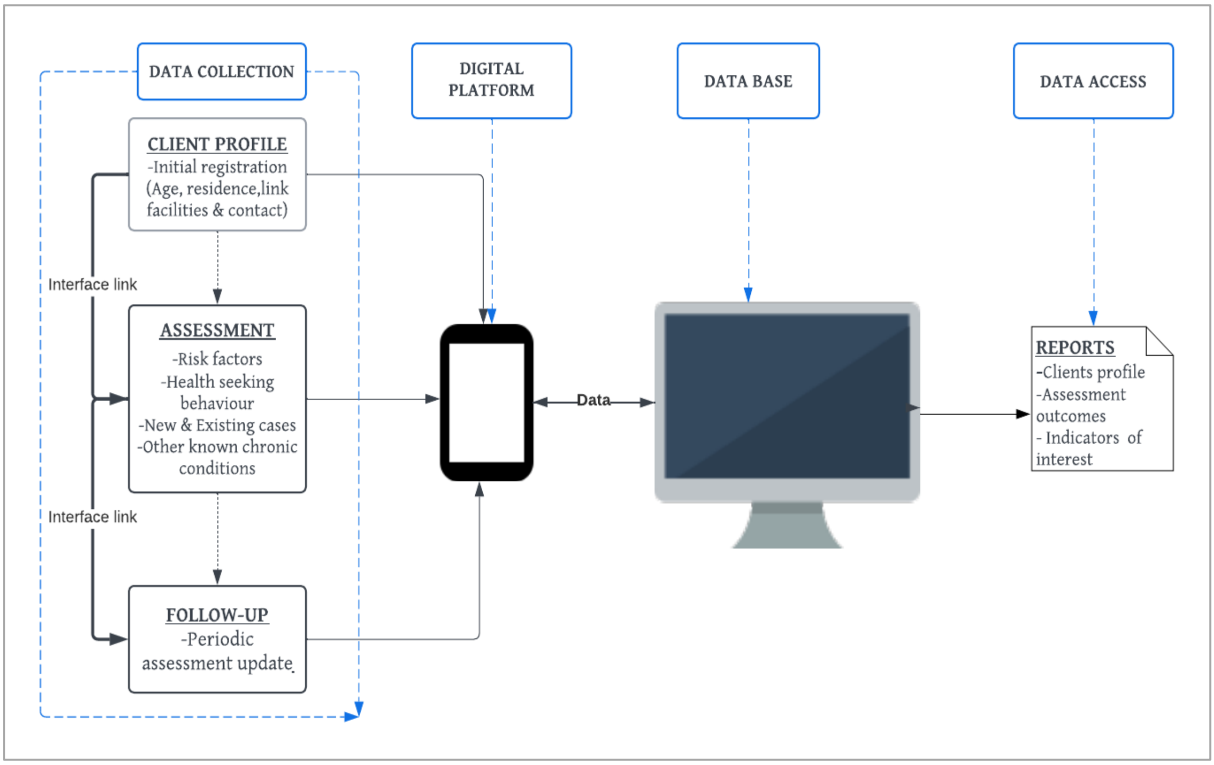


Figure 1: Overall system architecture

The scope of the study covered mHealth digital platform design, development, and illustrating its use in prostate cancer primary data collection and access.

Entity Relationship (ER) Diagram- User experience

Figure 2 shows a conceptual view of the system database, the data points as captured at the source, and how different sections sequentially relate to each other. The end user digital platform is operated from a tablet or smartphone which is linked to a central database hosted remotely.

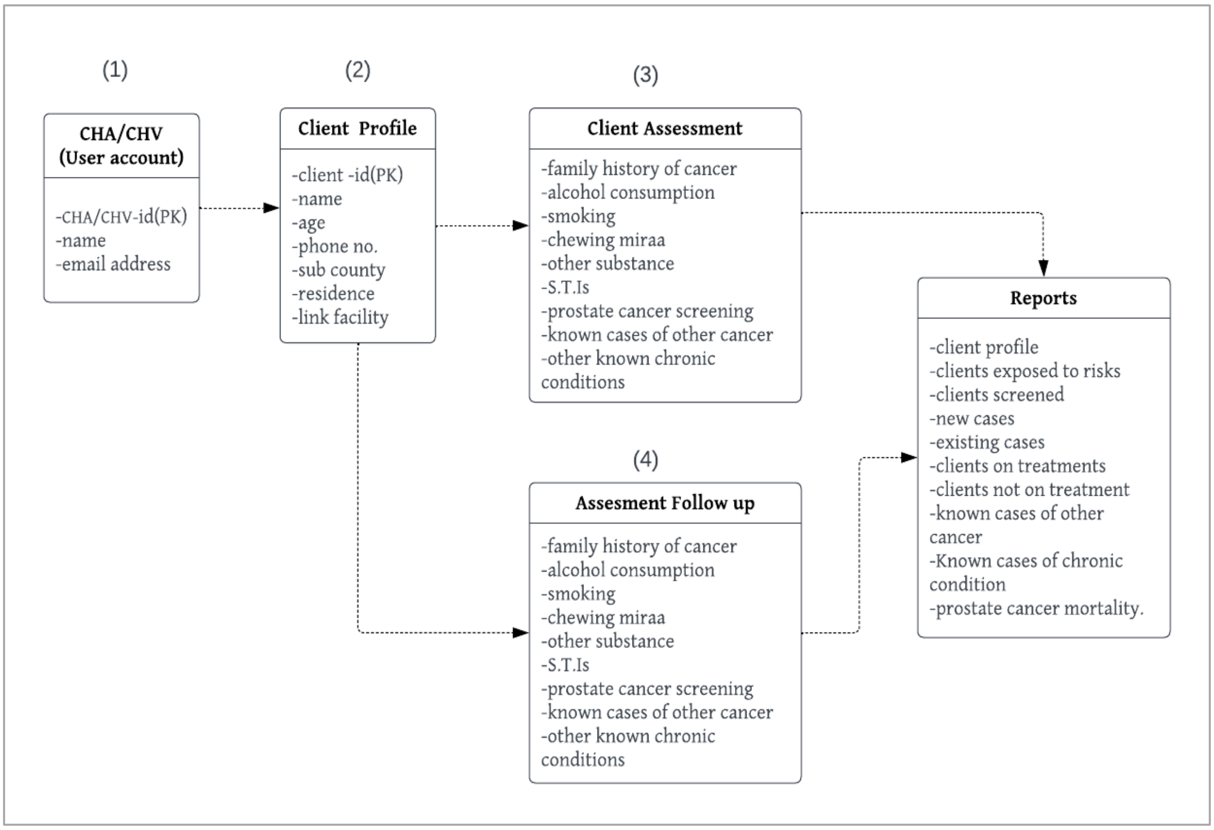


Figure 2: Entity Relationship (ER) Diagram- User experience

System Implementation and Testing

This section outlines the prototype implementation in a 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. It also covers the Mobile application 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.

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 and then login.

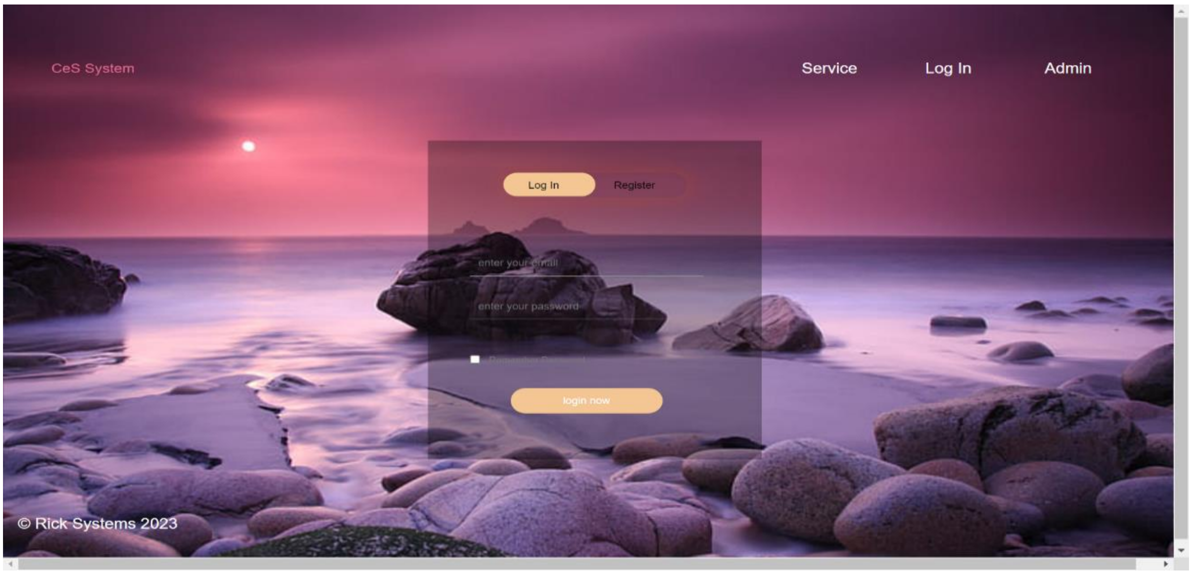


Figure 3: User login screen

Admin home page

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

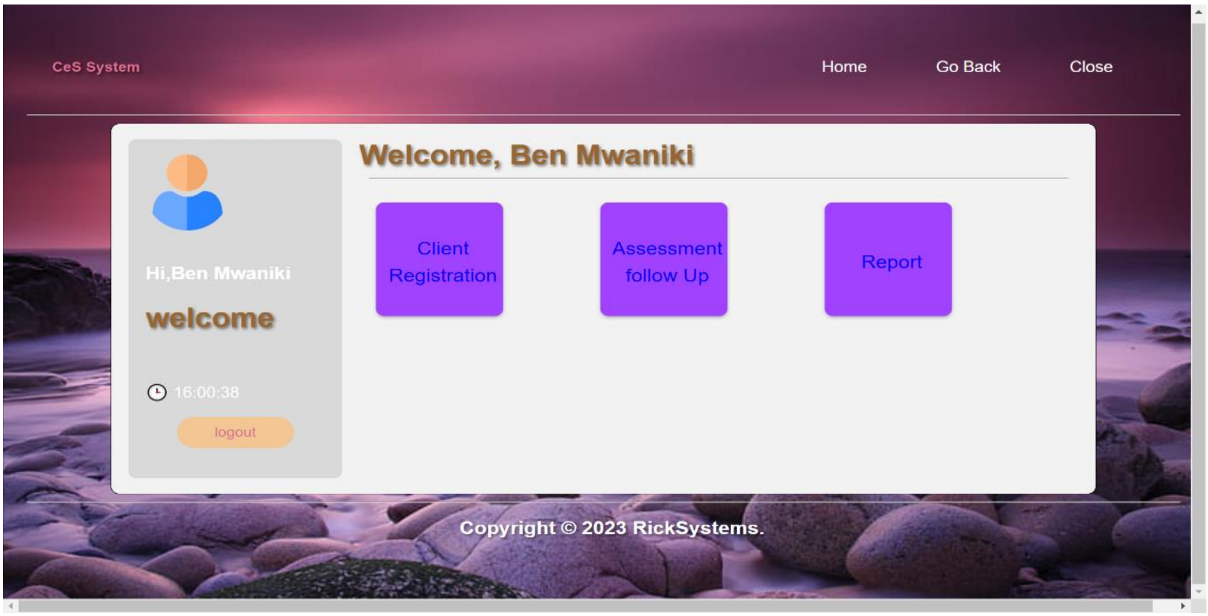


Figure 4: Admin home page

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 form submission automatically links to the first assessment form and the subsequent forms end-to-end for each client.

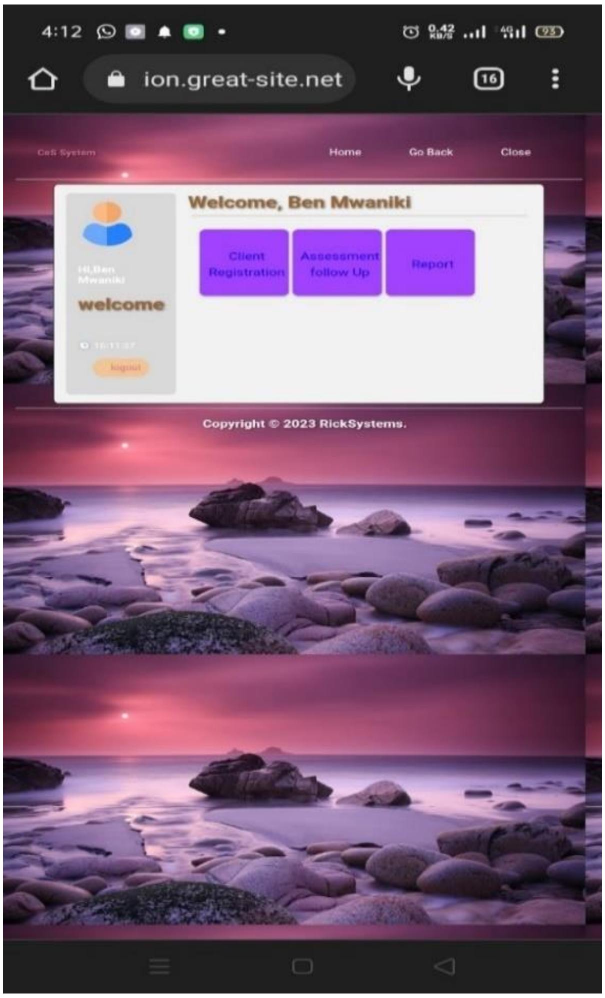
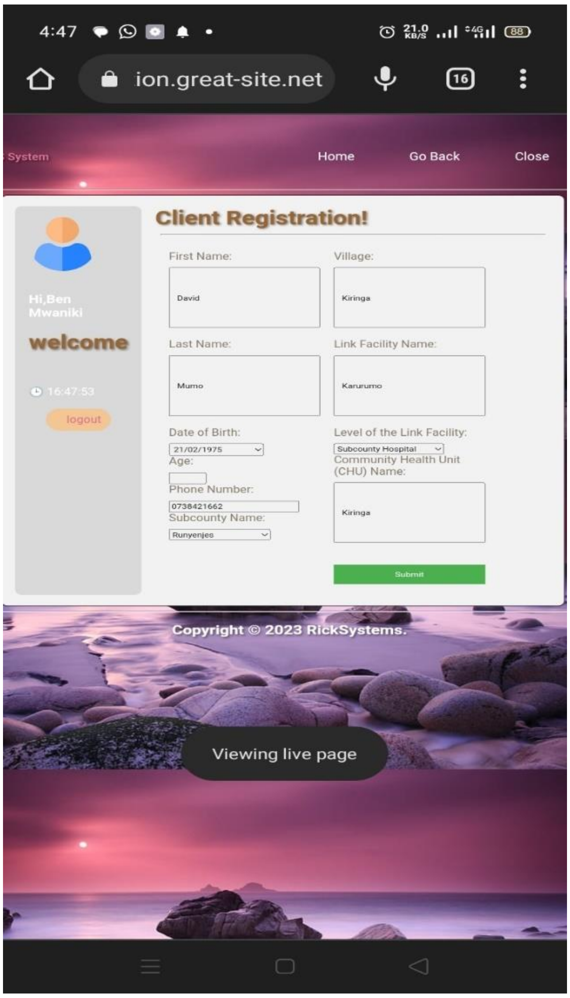


Figure 5: CHA/CHV home page



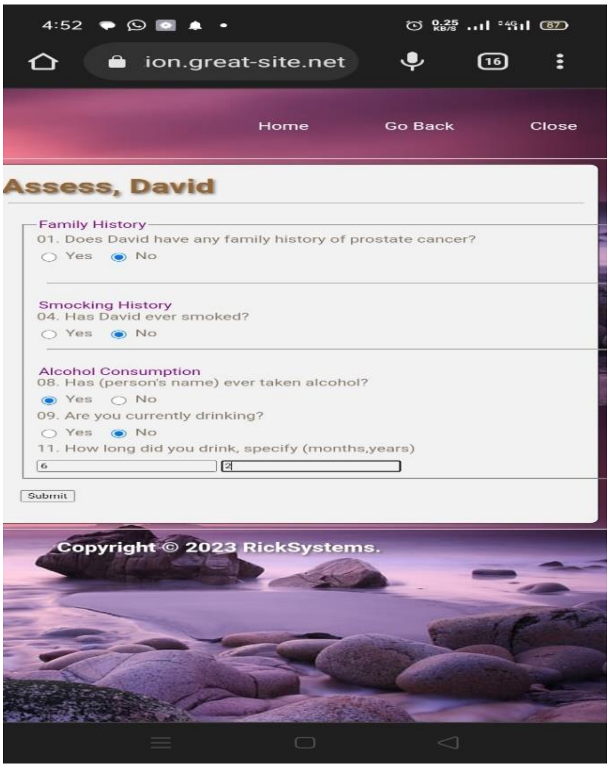
Client Registration!

First Name: David
Village: Kiringa
Last Name: Mumo
Link Facility Name: Karurumo
Date of Birth: 21/02/1975
Level of the Link Facility: Subcounty Hospital
Age:
Community Health Unit (CHU) Name: Kiringa
Phone Number: 0738421662
Subcounty Name: Runyenjes

Figure 6: Client Registration

Client Assessment Forms

All the forms are linked sequentially right from client registration, which is the first form to fill, the submission automatically opens the next set of forms 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 application displays 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.



Assess, David

Family History
01. Does David have any family history of prostate cancer?
○ Yes ● No

Smocking History
04. Has David ever smoked?
○ Yes ● No

Alcohol Consumption
08. Has (person's name) ever taken alcohol?
● Yes ○ No
09. Are you currently drinking?
○ Yes ● No
11. How long did you drink, specify (months,years)
6 | 2

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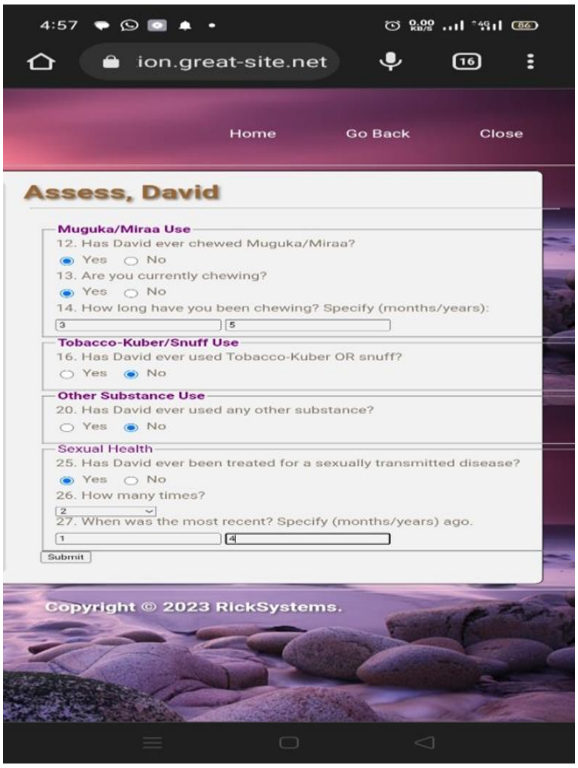
Figure 7. Risk assessment



Assess, David

Muguka/Miraa Use
12. Has David ever chewed Muguka/Miraa?
● Yes ○ No
13. Are you currently chewing?
● Yes ○ No
14. How long have you been chewing? Specify (months/years):
3 | 5

Tobacco-Kuber/Snuff Use
16. Has David ever used Tobacco-Kuber OR snuff?
○ Yes ● No

Other Substance Use
20. Has David ever used any other substance?
○ Yes ● No

Sexual Health
25. Has David ever been treated for a sexually transmitted disease?
● Yes ○ No
26. How many times?
2
27. When was the most recent? Specify (months/years) ago.
1 | 4

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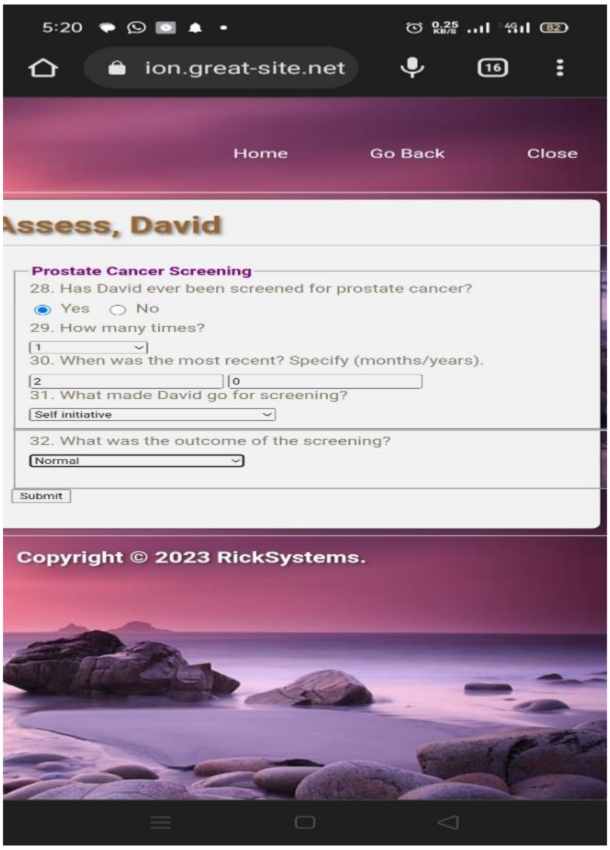
Figure 8. Risk assessment



Assess, David

Prostate Cancer Screening
28. Has David ever been screened for prostate cancer?
● Yes ○ No
29. How many times?
1
30. When was the most recent? Specify (months/years).
2 | 0
31. What made David go for screening?
Self initiative
32. What was the outcome of the screening?
Normal

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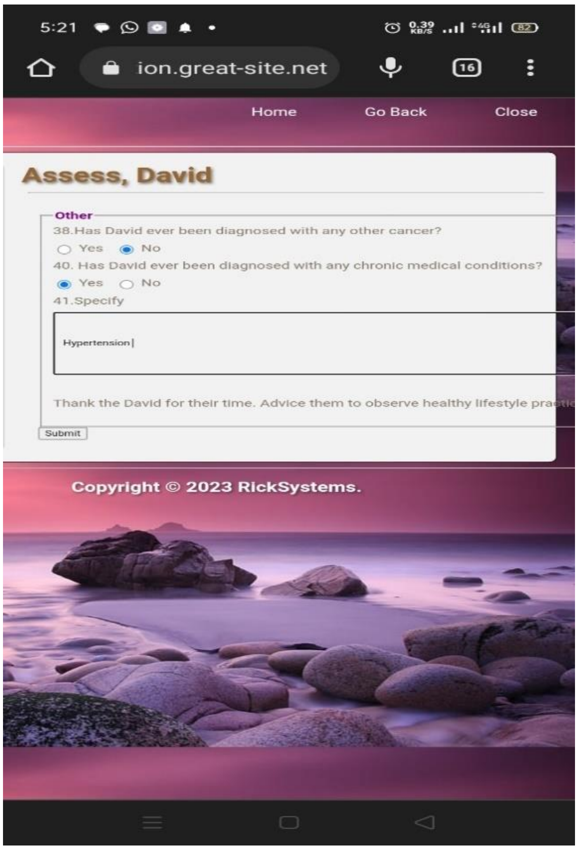
Figure 9: Health-seeking behaviour



Assess, David

Other
38.Has David ever been diagnosed with any other cancer?
○ Yes ● No
40. Has David ever been diagnosed with any chronic medical conditions?
● Yes ○ No
41.Specify
Hypertension

Thank the David for their time. Advice them to observe healthy lifestyle pra

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Figure 10: Comorbidities

mHealth digital platform video demonstration link:
https://drive.google.com/file/d/1oLl2lL1NWE4q0WT9Ka0raCTxNerIDwSj/view?usp=drive_link

System testing

Functional testing

Functional testing was done to ascertain that the prototype application meets the requirements specified to deliver the expected results. The following test cases were conducted.

Table 5: 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 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 changes to update.	pass

User testing

The user testing was conducted in two sessions, the initial test with the HRIOs, CCHFPs, and DSCs and the second 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 users willing to participate in testing the application in field, user accounts, and login credentials were created. The link and login credentials were shared with the CHAs, and the instructions guide on login and navigation procedure. Also, a contact was shared for troubleshooting any challenges encountered 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 remotely monitor and access the data as it was filled in the field in real time.

4.0 Conclusion

The main aim of this study was to illustrate the use of a mHealth digital platform for primary data collection for effective prostate cancer monitoring and surveillance. Cancer registration and surveillance coverage remains exceptionally low with minimal resources allocation. Notably, the existing integrated disease surveillance and response system was predominantly inclined toward communicable diseases and outbreaks.

We identified a gap in the prostate cancer population based on primary data collection and real-time access. The paper-based reporting tools presented a challenge with the existing hospital-based data having quality issues such as incomplete and missing indicators. Lack of prioritization of prostate cancer among the key focus areas in community health services was noted.

The mobile (mHealth) digital platform developed was tested by the end users to illustrate the capability of improving primary data collection from the community and its real-time access from a centrally managed database. The digital platform incorporated a feature to ensure periodic updates of the data of all registered clients for effective monitoring and surveillance.

The study concludes that the mHealth digital platform provides a sustainable solution to improve prostate cancer registration and surveillance coverage in the country. This will be critical in availing real-time relevant epidemiological data essential for monitoring the risk factors, mapping prostate cancer, and therapeutic outcomes, and conducting research.

5.0 Recommendations

The epidemiological transition being witnessed requires the redesign of the integrated disease surveillance and response system to expand the scope to include non-communicable diseases such as prostate cancer.

Further, the study recommends the Ministry of Health, county government, and other stakeholders involved in community health services digitization agenda to include prostate cancer indicators in the electronic community health information system to improve primary data collection and access for decision making.

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