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mHealth Implementation in South Africa

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Abstract: Amid the rapid proliferation of first mobile devices and lately, mobile broadband, South Africa is uniquely situated to harness the promises that Mhealth have been reported to hold. Over the past years, Mhealth implementations have spread to incorporate a wide range of Mhealth applications to service the Health System information needs and end user needs. This paper aims to describe the current state of mHealth applications and implementation in South Africa by a review of reported MHealth Implementations and the stakeholders that collaborate in the space.

Keywords: Mhealth, Implementation, Stakeholders, Landscape

1. Introduction

This paper aims to describe the current state of mHealth applications and implementation in South Africa. The World Health Organization (WHO) [1] describes a health system as consisting of all the organizations, institutions, resources and people whose primary purpose is to improve health. A sound health information system depends on organized processes of gathering, analysing, sharing and using health-related data for decision making by a number of agencies. Shortliffe [2] describes health informatics as a discipline at the intersection of information systems, computer science and healthcare. Health informatics concerned itself with the use of information and communication technologies (ICTs) for the acquisition, storage, retrieval and use of information to improve healthcare delivery.

E-health is then the use of ICT to support the collection and exchange of healthcare information to facilitate efficient and effective delivery of healthcare services. The adoption of e-health offers several benefits, including improved patient safety, more accurate clinical data, better legibility of healthcare document and a reduction in overall costs of healthcare services [3-5]. However, despite its potential benefits, the adoption of e-health has been very slow due to several factors. Some of the barriers to the adoption of e-health are high costs of acquisition, lack of ICT skills, especially in developing countries, and concerns for the security and confidentiality of electronic healthcare information [6-8]. With the well documented spread of mobile technologies, health programs that utilize the near pervasive ubiquity of the devices have proliferated.

Mobile health or mHealth has firmly established itself within Health informatics. Mhealth as term is broadly designates to the use of mobile cellular communication devices, multimedia devices and sensor devices as they are integrated within increasingly mobile and wireless health care monitoring and delivery systems [9]. Mhealth is perceived to have a huge potential for benefitting the health service delivery processes, especially in resource constrained environments [10, 11].

South Africa, with its significant mobile penetration of over 120% [12], has benefited from numerous mobile health implementations [13] with multiple attempts to create a consolidated overview as an ongoing effort [14-16].

Fragmentation in the Health Information Systems currently being used in South African public health facilities is unmistakable as documented during a 2013 assessment of HISs [17]. The study showed that many different systems from different vendors were implemented and up to 31% of these systems were unable to exchange patient information. This paper aims to describe the current state of mHealth applications and implementation in South Africa and to identify ways to strategically link mHealth effort within the South African Health System.

The rest of the paper is structured as follows. Section 2 overview of Mhealth and related mhealth applications while section 3 outlines the methodology followed. Section 4 provides an overview of the South Africa implementation stakeholders and section 5 initiates a discussion on the results. Section 6 provides concluding remarks

2. mHealth Within the South African eHealth Landscape

The South African EHealth strategy proclaims its vision as ”enabling a long and healthy life for all South Africans” [18]. Healthcare in South Africa is distributed between the public and private sectors with evident disparity between the two systems [19]. The National Health Insurance Green Paper [20], reports that almost half the national expenditure is in the private sector, serving 16.2% of the population. The balance of the population is served by an under-resourced public health sector [21]. Currently there is a proposal to implement a National Health Insurance policy to deal with these inequalities in order to provide universal care across South Africa [22, 23]. It is envisaged that such a National Health Insurance policy will be supported by a Health Information Systems (HIS) that is applicable to the South African context and would enable a greater focus on primary healthcare and preventative care through the use of community outreach programs [20]. Health Information Systems (HIS) architecture would have to include provision for new and existing mobile health applications. Mobile technologies have shown that it can be used to improve service delivery in multiple pilot implementations [11, 24] using a variety of mobile channels.

In categorizing m-health applications Mecheal et al, the UN Foundation and UNPD [25-27] classify the types of m-health applications as those that are used in:

- Remote Data collection
- Communication and training for healthcare workers
- Remote monitoring
- Treatment and compliance/Telemedicine
- Access patients records

Labrique, Vasudevan, Kochi, Fabricant & Mehl [28], building on efforts from the WHO global survey on eHealth [29] and the mHealth Alliance’s mHealth services review for maternal and newborn health [11] propose 12 common mHealth applications as [28]:

- Client education and behaviour change communication;
- Sensors and point-of-care diagnostics;
- Registries and vital events tracking;
- Data collection and reporting;
- Electronic health records;
- Electronic decision support (information, protocols, algorithms, checklists);
- Provider-to-provider communication (user groups, consultation);
- Provider work planning and scheduling;

- Provider training and education;
- Human resource management;
- Supply chain management; and
- Financial transactions and incentives.

As a first step to interrogating the Mhealth implementation landscape in South Africa, these applications as described by Labrique *et al.* [28] are used to describe the domain in the following section. The reach of the mhealth applications as outlined leverages the high penetration of mobile devices. These devices are however by no means standardised. Despite the trend towards smartphone ownership, Pew Research Center [30] reports that 55% of the population still use feature and low end phones and implementers wanting to harness the personal communication capabilities of the established user base needs to consider access capabilities. The channels used for MHealth implementations are varied but tend to aim low end phones and feature phone access to lower the barrier of technology entry. The functionalities of the devices are alluded to in the discussion and outlined below in Table 1.

Table 1: Mobile Devices and Their Capabilities [31]

Device	Capabilities
Basic mobile phone	Network services, including: Voice telephony and voice mail SMS (short message service) USSD (unstructured supplementary service data) SMS-based services, such as mobile money USSD services, such as instant messaging
Featurephone	As basic mobile phone plus: Multimedia Messaging Service (MMS) Still picture camera MP3 music player 2.5G data access
Smartphone	As Featurephone plus: Video camera Web browser GPS (global positioning system) 3G+ internet access Mobile operating “platform” (such as iOS, Android, Blackberry) Ability to download and manage applications VoIP (Voice over Internet Protocol) Mobile TV (if available) Removable memory card
Tablet	As smartphone plus: Front and rear-facing video cameras (for video calls) Larger screen and memory capability Faster processor, enabling video playback Touchscreen with virtual keyboard USB (universal serial bus) port

Kahn, Yang & Kahn [32] argue that in addition to the device functionalities the following tools are available which can be used within the healthcare sector. The higher end mobile phone can therefore provide m-health users with the following capabilities:

- Social networking
- Browse sites through phones
- E-mail lists for communication
- Web based data
- Web based learning
- Data transmission

Despite the availability of these capabilities, among adult cell phone users in South Africa, sending text messages (95%) and taking pictures (60%). Access to social networks are reported at 31% and acquiring health information at 15% [30]. Given that this type of access can be seen as driven by smartphone access, it can be speculated that most users with access or ownership of smartphone technology participate in these activities. The rich device functionalities outlined by Kahn *et al.* [32] will in future be more relevant as smartphone ownership increases. Having overviewed the applications as described by Labrique *et al.* [28] and channels available in the Mhealth the following section overviews the methodology followed by an overview of MHealth Implementations in South Africa.

3. Methodology

Our main aim was to describe the current state of mHealth applications and implementation in South Africa. In order to achieve this we have gathered data based on mhealth implementation projects by different implementation stakeholders in South Africa (SA).

Only mHealth implementations in South Africa were considered. Implementations were included in which the mobile cellular device was explicitly used. Past and current implementations were considered. Data from the HealthEnabled, USAID and GSMA mHealth Tracker [14-16] were consolidated. In addition a Google Scholar Search for Mhealth implementations in South Africa was done. Implementations identified and not part of the consolidated list was added. Studies that were once off academic interventions for a degree were disregarded. The collected data was reviewed to highlight the following per initiative:

- The implementing organization
- Other partners
- Users as
  - Consumers (general public or targeted segment of the general public
  - Patient (an individual that is being treated or monitored)
  - Community Health Worker
  - Health Care Professional (doctor, nurse etc)
  - Health Care Institution
- Project funding
- Synchronicity
- Disease coverage
  - General
  - Specific
- mHealth application (Labrique *et al.* [28])
- Technology channel utilized
- Technology software function
- Technology device

Not all information was available for all the initiatives but this did not exclude them from inclusion in the pool of initiatives. Implementing organizations and their partners were anonymized and numbered. These stakeholders (implementation and partner organizations) in the Mhealth implementation domain were mapped using GEPHI open source software.

The Fruchterman and Reingold [33] layout in GEPHI [34] was used for mapping the 117 stakeholders. We have selected this method because of its capability to draw graphs that are aesthetically accepted. The graph layout is based on principles which are: vertices connected by an edge should be drawn near each other and vertices should not be drawn *too* close to each other.

Figure 1 is an attempt to visualize the mHealth domain to show the very fragmented nature. There are multiple small one, two or three organization collaborations that exist and contribute significantly to the bulk of the Mhealth implementation environment. The lines drawn between the numbered stakeholders are an indication of their collaboration. The size of the number is relative to the amount of initiatives the stakeholder is involved in. These major implementing stakeholders dominate the Mhealth implementation landscape and are further outlined in more detail in Section 4.2.

The data used in this study emanates from secondary or tertiary sources as no direct accounts were sourced from stakeholders. A limitation is then that not all of the information could be verified from the sources. As such the data reported here is only as reliable as the reported and, in some cases, re-reported data. However, the study suggests that the *trends* identified are relevant and applicable within the Mhealth Implementation domain in South Africa and have been verified by independent practitioners.

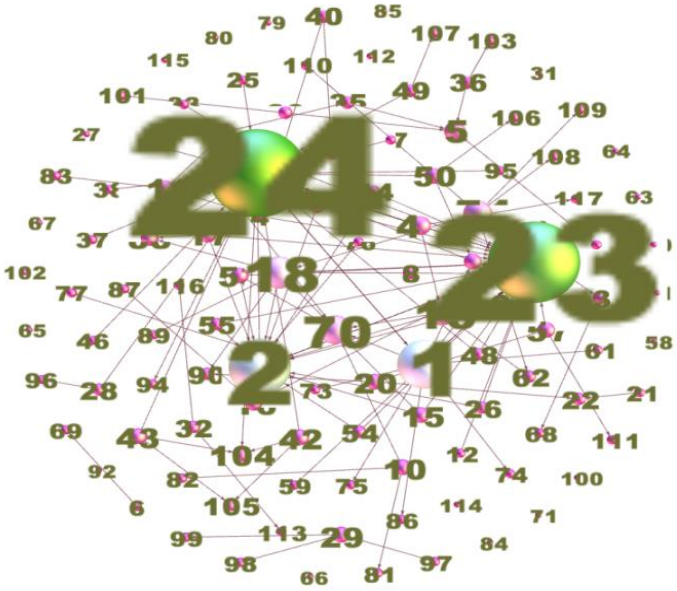

Figure 1. Fruchterman and Reingold (1991) Layout of South African mHealth Implementation Stakeholders

This study is then realized as a snapshot in time and does not insinuate to be a prescriptive review but lies in the realm of a broad contextualized description.

4. Results and Discussion

This section presents the analyses of the findings towards describing the current state of mHealth intervention strategies and implementation in South Africa. 85 initiatives and 117 stakeholders were identified as relevant to this study. The stakeholders assumed different roles and collaborative implementations were mostly structured to incorporate capabilities across the stakeholder spectrum. Stakeholders included Mobile Network Operators, Software Developers, Government Organizations (both provincial and national), Academia (Multiple Faculties), NGO's and Donors.

The following section outlines some of the characteristic trends of the South African Mobile Health domain.

4.1 Mobile Health Initiative Trends

4.1.1 Funding

The first trend in the South African mHealth environment is that most of the initiatives are donor funded and no significant business model was identified that would ensure sustainability beyond a donor involvement.

Table 2: Funding of Mhealth Implementations

Funding	mHealth Initiative
Donor including MNO (11 initiatives), Business investment (4 initiatives)	78
Government	6

Most if not all the services are mobile services and facilitated through multiple Mobile Network Operators (MNO). This implies that it is not *free* although all of the applications were free to end user, thus implying a steady capital input. *Free* Wi-Fi mobile accesses needs infrastructural investment to provide and are only accessible to higher end devices. Advertising related revenues are the predominant sustainable business model that have been attempted but no evidence was found for any sustainable service that was covering its own costs without subsidy from a stakeholder as long term investor.

4.1.2 End User

The targeted end user of the identified mHealth applications are given below in Table 3.

Table 2: End User of the MHealth Implementations

User Group	mHealth Initiative
Consumers (General public or a segment of the public)	53
Patient	23
Health Professional	11
Community Health Worker	15
Institutional	3

The vast majority of Mhealth implementations in South Africa are aimed at the general public or a segment of the public with a specific health related need. These Mhealth implementations mostly provide text or voice based communication that is often geared towards a specific community or individual through sequencing and pacing. In the general population of South Africa, Mobile cellular technology provides the ability to connect rather than functions of mobility and utility. As such many of the devices in use are still feature phones and mHealth applications aim at the lowest barrier of entry frequently using voice or signalling channels.

Services for healthcare workers and institutions tend to provide a richer interaction through mobile data services utilizing apps or on-board applications. Institutional access and use of Mobile Health initiatives tend to facilitate *mobility*, extending the reach of the health system and mitigate contextual connectivity, electricity and PC availability through the use of mobile technology.

Health related applications extend the reach of the health care system as mentioned and in the case of South Africa, target specific sections of the population such as HIV patients and patients on TB drugs where drug adherence are paramount.

4.1.3 Health related focus of mHealth applications

Table 3: Health Related Focus of mHealth Applications

Disease Coverage	mHealth Initiative
Specific	73
General	21

Most of the health related services are targeted to a specific group of individuals. These are mostly *push* services that sequence and pace actions or activities and alert institutions and health care professionals. HIV antiretroviral distribution, drug adherence and information regarding pregnancy and prenatal care are some of the major targeted areas. General pull services such as discussion forums host large numbers and are more general in focus.

4.1.4 Mobile Channel

As the barrier to participation needs to be as low as possible most of the applications use mobile channels available on most phones that make economic sense.

Table 4: Mobile Device Channel Used

Mobile Channel	mHealth Initiative
Voice	1
SMS	43
IVR	1
USSD	11
QR code	0
IM	0*
MXit	3
Sensors	10
App	3

Most of the Mobile Health Implementations made use of the personal devices of the user. Barriers of access were mostly mitigated by targeting lowest common mobile channel and used Voice, SMS and USSD that are available on all devices. Mobile Network Operator's business cases cannot be ignored and cost remains an issue when scaling. The use of SMS despite the relatively high cost can be possibly be explained through the better bulk deals offered and the involvement of a local MNO as one of the major implementation participants.

Sensors could be considered emerging technology and would become increasingly relevant. MXit remains a channel to consider for access to Feature Phone devices. *The use of Instant Messaging has not been noted through publications but has been reported in informal discussions and from, as yet, isolated cases elsewhere in Africa.

The targeted devices are outlined below in Table 6.

Table 5: Mobile Device Used in mHealth Applications

Device	mHealth Initiative
Basic Phone	52
Feature Phone	49
Smart Phone	35
Laptop	6
Tablet	14
Embedded devices	5

The large installed user base associated with Mobile Cellular technologies remain an attractive option for communication and most of the mHealth implementations aim at Basic

Phone capabilities that would then also be available for higher end Cellular devices. The richer interaction tends to be made available to institutionally funded users.

4.1.5 Section Discussion

This section highlighted some of the most relevant mHealth application trends and outlines the following:

- The application of mHealth initiatives are mostly financed through donor funding.
- No sustainable business model for mHealth initiatives (targeting a community need) was identified.
- Relevant advertising was recognized as the most commonly used business model for community based mHealth applications.
- Most of the mHealth applications were aimed at the general public or segments of the public (such as pregnant women).
- Most of the mHealth applications were educational information or aimed at some type of behavioural change.
- The health focus of these applications tended to address specific health issues and these are aligned with the Millennium Development Goals.
- The basic phone capabilities are targeted to make maximum use of the existing mobile user base.
- South African mHealth applications mostly utilize SMS as broadcasting medium.

The following section looks at some of the major mHealth application implementers.

4.2 Mobile Health Stakeholders

Out of 117 stakeholders involved in the mhealth implementation domain collaborations in SA, this study has identified 5 stakeholders who were significantly more active. This *activity* was regarded as the number of mHealth initiatives they were active in. As previously stated, Stakeholder involvement was anatomized and the study identified stakeholders only with numbers from 1-117. The analysis below describes the most active to the least active stakeholder within the most active stakeholders.

4.2.1 Stakeholder 24

*Stakeholder 2*4 is local South African NGO and was identified as the most active stakeholder in the mhealth implementation domain in South Africa, having taken part, lead or otherwise collaborated in 25 initiatives. These collaborations include other NGO, government, universities and some corporate entities. Within all the collaborations the most used mHealth strategy was data collection and reporting which was used in 68% of the projects as shown in Table 6. Some initiatives used more than one mHealth strategy. The least applied strategies are supply chain management.

Table 6: mHealth Strategy Employed by Stakeholder 24

mHealth Strategy employed	**N_0 Strategy was employed**
Client education & behaviour change communication (BCC)	3
Electronic health records	16
Sensors and point-of-care diagnostics (& monitoring)	4
Data collection and reporting	17
Registries and vital events tracking	16
Provide work planning and scheduling	12
Electronic decision support	12
Supply chain management	1
Provider-to-provider communication - user groups, consultation service	4
Human resource management strategy.	16

Table 7: Stakeholder 24 Description

Technology Device/channel/ Software functions	Funding
Basic phone (2) Embedded device (3) Feature phone (15) Laptop (3) Desktop computer (2) Smart phone (12) Tablet (5) SMS(2) USSD (1) Internet/web (5) Installed application(5)	Business (2) Donor (12) Government (3) Service provider (1)

4.2.2 Stakeholder 23

Stakeholder 23 is a South African MNO and has interest in Shareholder 2. It is the second most active stakeholder in the mHealth implementation domain in SA. Stakeholder 23 has been involved in 23 mHealth collaboration projects. Table 8 indicates which strategies, funding model and technologies were used by Stakeholder 23.

Table 8: mHealth Strategy Employed by Stakeholder 23

mHealth Strategy employed	N_0 Strategy was employed
Client education & behaviour change communication (BCC)	5
Sensors and point-of-care diagnostics (& monitoring)	5
Registries and vital events tracking	23
Data collection and reporting	21
Electronic health records	21
Electronic decision support	14
Provider-to-provider communication – user groups, consultation service	8
Provider work planning and scheduling	13
Human resource management strategy.	20
Supply chain management	5

Table 9: Stakeholder 23 Description

Technology Device/channel/software functions	Funding
Basic phone (9) Embedded device(3) Feature phone (19) Laptop (3) Desktop computer (6) Smart phone (14) Tablet (5) SMS(4) USSD (2) IVR(2) Internet/web (22) Installed application(18)	Business (2) Donor (17) Government (7) Service provider (3)

4.2.3 Stakeholder 2

Stakeholder 2 is a local software development agency that delivers mobile enabled solutions to companies. It is suggested that their strategy employment is guided by the agendas of the participating collaborators

Table 10: mHealth Strategy Employed by Stakeholder 2

mHealth Strategy employed	N_0 Strategy was employed
Client education & behaviour change communication (BCC) strategy	8
Sensors and point-of-care diagnostics (& monitoring)	1

Registries and vital events tracking	4
Electronic health records	5
Provider-to-provider communication - user groups, consultation	2
Human resource management	4

Table 11: Stakeholder 2 Description

Technology Device/channel/software functions	**Funding**
Basic mobile phone (6) Feature phone (1) Smart phone (1) SMS (6) IVR (1) Internet/web (1)	Donor (5) Service provider (4)

4.2.4 Stakeholder 1

Stakeholder 1 is a local foundation linked to a corporate and is the fourth most active stakeholder in the mhealth implementation domain in SA. Stakeholder 1 has been involved in 9 mhealth collaborations with client education & behaviour change communication (BCC) as the most used strategy.

Table 12: mHealth Strategy Employed by Stakeholder 1

Strategy	**N_0 Strategy was employed**
Client education & behaviour change communication (BCC)	1
Sensors and point-of-care diagnostics (& monitoring)	5
Registries and vital events tracking	6
Data collection and reporting	8
Electronic health records	6
Electronic decision support	7
Provider work planning and scheduling	7
Human resource management strategy.	6

Table 13: Stakeholder 1 Description

Technology Device/channel/software functions	**Funding**
Feature phone (8) Smart phone (8) Tablet (6) SMS (7) IVR(2) Internet/web (1) Installed application(8)	Business (5) Donor (5) Government (1)

A review of the mHealth Implementations with reference to the identified 12 [28] common mhealth applications is outlined in Table 11below.

Table 11: mHealth Implementation Strategies

mHealth Implementation Strategies	**Collaborations**
Registries and vital events tracking	52
Data collection and reporting	50
Electronic health records	51
Electronic decision support	44
Provider work planning and scheduling	36
Human resource management strategy.	33
Client education & behaviour change communication (BCC)	19
Provider-to-provider communication – user groups, consultation service	16
Sensors and point-of-care diagnostics (& monitoring)	15
Service use supply chain management	6
Provider training and education	0
Financial transactions and incentives	0

From the Table 11 it can be seen that the most commonly used mHealth application is registering and vital event tracking, closely followed by data collection and reporting, and the creation and updating of electronic health records. It becomes imperative that the Stakeholders in general and specifically those that were identified as most active be made part of a consulting process to incorporate the already fragmented Mobile Implementation domain into the proposed South African Health Information System. This system will have to facilitate the functionalities and functions of existing Mhealth applications to harness the learning done and gains made towards realizing the South African EHealth strategy vision as ”enabling a long and healthy life for all South Africans” [18].

This section highlighted some of the most active Mhealth stakeholder trends and outlines the following:

- Although there are many stakeholders doing MHealth implementations in the South African Mhealth domain, there are major players that are responsible for the bulk of the implementations.
- As implementers lessons learned and research focused successes are seldom captured.
- Very little evidence of integration amongst Mhealth implementations were found and most of the integration took place within a single collaboration.
- Evidence for community benefits remains anecdotal.
- Little or no information was available on where the data that was collected from individuals were stored and what security and access was facilitated.

The following section offers some concluding remarks

5. Conclusion

The use of mobile technologies in the health domain is by its very nature a parasitic endeavour. As such the economic realities of MNO and providers need to be considered and proactively navigated. The economic unsustainability of implementations needs to be addressed in parallel to any attempts to incorporate mhealth initiatives into a larges eHealth system. The gains made by some of the stakeholders towards patient centric services and Health system administration contain significant contextual learning towards a wider adoption.

The Mhealth Applications potentially show the gaps that have not adequately been explored and lack local context with little evidence of training and education as well as the application of financial transactions and incentives in the Mhealth domain in South Africa. The effectiveness of these strategies in the South African context needs to be explored to effectively provide guidance on their possible impact for implementations.

In conclusion this study would be amiss if it does not recognize the efforts and dedication of the many passionate individuals in the Mhealth Domain in South Africa.

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