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Leveraging Health through the Enhancement of Information Access Using Mobile and Service Oriented Technology

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Abstract: Kenya has a vision to create a globally competitive and prospective nation with a high quality of life by 2030. In order to achieve this, it developed a social pillar that aims at improving the quality of life through projects that are health related. We propose a project that aims at contributing to this vision by ensuring that health related information is accessible to all through an affordable and flexible solution.

This study sets out to find a flexible, adaptable, and cost efficient, approach for storing and accessing information from the government portal. We draw these benefits from using the concept of cloud computing. However, cloud computing is not a new concept. The use of popular and readily available technology such as the Mobile phone can aid in leveraging information access through cloud computing. The innovative aspect of this study is the proposal of a solution that is flexible through the concept of runtime software adaptation in Service Orientated Architecture.

An increasingly important requirement of software is ensuring that the system can adapt quickly and effectively to changing business and system needs. Several problem specific runtime adaptation techniques have been put forward. We propose a solution that is generic and hence can be used to address any challenge presented by information access on any information or sector represented on the government portal.

Keywords*:* Service-oriented Architecture, Adaptation, Information Access, Mobile Technology

1. Introduction

While the Kenya Government is doing a lot to ensure the provision of and access to health services for all, a lot still remains to be done to ensure the right services reach the right people in a timely manner. A major obstacle in achieving the government goal is a poor information and communications technology infrastructure. The Kenya government has recognized the need to improve the way information is disseminated to its citizens by making key government data and advice on health freely available to the public through a single online public information portal. However, the access and intended impact of this information is hampered by poor Internet access and information presentation. Over 79 per cent of Kenya's population resides in rural areas [1] where very little investment in Internet infrastructure has taken place. Furthermore, in rural areas where limited Internet access is available, connectivity costs are often prohibitively high for the local population. The other major problem relates to the way the health information is presented. For health information to have its intended impact, users must be able to find it, understand it, and adapt it to their specific needs. This may require pooling together of disparate data and information sources in order to 'construct' the right information package.

There is need to examine how we can ensure the health information supplied on the government portal reaches the right masses in the right form. At present, the information is

accessible via the website, limiting access to only those who have Internet connectivity. In addition, the data portal has no concept of contextualization (i.e. ability to tailor the information to reflect specific contexts).

African countries are yet to use ICT in order to achieve fast pace development. Isolated cases of the successful use of ICT have been documented in examples like the success of Mobile Money transfer in Kenya, Mpesa, which has positively contributed to the economy. The growth of such innovative concepts would fast pace economic development resulting in the overall development of the country at large. It then becomes apparent that investing in innovative ICT concepts could pave the way for development in a country. While a lot can be learnt from the success of other countries in using innovations in ICT, it is also worth noting that the success of ICT is influenced by various factors, most of which are far from technical. A similar model for money transfer, for example, was tried in the UK long before it was tried in Kenya and it was not successful due to government policies.

Therefore, there is a need to investigate how ICT can be used to leverage development in developing countries through innovative concepts. This is what motivated the researchers to submit a proposal to the Commission for Research, Science and Technology of Kenya (formerly National Council of Science and Technology) as a government agency concerned with funding research and innovations. The study focuses on leveraging access to health information as a key concern from the Millennium Development Goals as well as Kenya Vision 2030 development strategy.

2. Literature review

One of the world's main development challenges contained in the millennium declaration is combating HIV/AIDS, malaria and other diseases (the 6th MDG). According to Kenya National Bureau of Statistics [2], HIV prevalence among adults aged 15 to 64 years decreased nationally from 7.2%, as measured in 2007 to 5.6% in 2012. The campaign against malaria has resulted in a reduction by 54% for the homes using the insecticide treated net [3]. Although significant progress has been made, a lot still needs to be done.

Tipton [4] in his book "The Rise of Asia" explains how previously impoverished countries rapidly developed and attributes the key reason behind it as investment in education in various sectors such as agriculture (in South Korea and China) and technology (In India). The ability of information to fast pace development becomes evident from these examples. There is need to make information accessible to all and ICT can provide the solution. Unfortunately, poor Internet access has limited access to the wealth of information available on the Internet in remote areas. Identifying an alternative means of accessing this much needed resource that is readily available and accessible by a majority of people especially in rural areas (such as by the mobile phone) would go a long way in solving the current infrastructure challenges.

The use of popular and readily available technology such as the mobile phone can aid in leveraging information access through cloud computing. Statistics from CCK (Communications Commission of Kenya) show that the adoption of mobile phones has been rapid even among low-income earners with over 25 million mobile phone subscribers. Arunga and Kahora [5] attribute this rapid adoption to low cost and technical simplicity. Cellan-Jones [6] states that much of Europe is in the slow lane compared to some countries in the developing world such as Kenya, which have been quick to embrace mobile money transfer. He attributes this to the fact that the majority of people have mobile phones but lack bank accounts; thus the mobile phone technology provides the much needed service. The model was also tried in South Africa and failed to take off due perhaps to a similar reason like that in UK. Therefore, in addition to identifying technology that can address a challenge, it is equally important to explore the viability of the technology in the local scene before attempting to implement it.

Cloud computing can be seen as the provision of ICT services via the Internet. These services are the provision of PaaS[1], IaaS[2], or SaaS[3], collectively known as XaaS[4]. It offers several benefits such as responsiveness, effectiveness and efficiency as described by IBM [7]. An increasingly important requirement of software is ensuring that the system can adapt quickly and effectively to changing business and system needs. Rosen et al [8] identify key motivations for SOA as flexibility and reduced cost.

3. Objectives of the research:

The objective of this study was to develop a service oriented model that provides a flexible, adaptable and cost effective solution that makes basic health information accessible to all citizen irrespective of their social, location, economic, academic and cultural backgrounds. This entails:

(a) An evaluation of the current state of accessibility of health related information provided in the government portal;

(b) Investigation of how mobile phone technology and XaaS can be combined to enhance and sustain information access and utility;

(c) Development of a prototype XaaS platform for supporting the provision of health information services; and

(d) Conduct of a rural pilot study to evaluate the efficacy of the XaaS platform.

4. Methodology

4.1. Project Scope

The research focuses on the access to health related information from the government portal by people in rural areas where there is poor ICT infrastructure. The choice of this scope is driven by the fact that the largest population that suffers from the lack of proper health related information is in the rural areas where ICT infrastructure is also poor. Improving the access of health related information for this population will therefore improve the general health of the country thus bringing it closer to achieving Vision 2030 [9], by which time Kenya is to become a newly industrialized country, and in turn to have achieved the millennium development goal of combating HIV/AIDS, malaria and other diseases. The researchers will collect data from at least 1000 citizens in rural areas, i.e. 200 from 5 identified administrative regions (known as counties).

4.2. Data Collection Method

During the project, an extensive survey of the access of health related information will be conducted through questionnaires and interviews in selected rural areas across the country. The research will be qualitative and quantitative in nature with perception data being collected and analyzed. The total number of people who lack access to health related information is not documented in any official document so purposive sampling coupled by and supported with the snowball approach will be used. Piloting of the questionnaires and interview scripts has already been done in selected two (2) low-income rural areas with 60 respondents. In the main data collection exercise, 1000 respondents will be drawn from 5 counties in Kenya on the basis of multi-stage sampling.

[1] PaaS – Platform as a Service
[2] IaaS – Information as a Service
[3] SaaS – Software as a Service
[4] XaaS – Anything as a Service

4.3. Data Analysis

The data collected will then be analyzed with SPSS and Ms Excel. They will be used to analyze and correlate variables that impact on the access of health related information as well as ICT infrastructure. The aim is to come up with a framework for leveraging health through the enhancement of information access using mobile and service-oriented technology, and implement a prototype that can be used to evaluate the framework.

4.4. Activities

Stage I

(i). *Design data Collection Instrument* - Develop a data collection instrument for accessing the status of information access.

(ii). *Data Collection & Analysis* – Once the final questionnaire is developed it will be administered with the aim of identifying factors that influence health information access in rural areas.

(iii). *Model Development* – From the observations made of the analysis results, a framework will be derived to guide the development of a service oriented model that can be used to host Information and Applications on the cloud to leverage information access.

Stage II

(iv). *Prototype Development* - To evaluate the proposed model, a prototype will be developed. It will be based on the proposed framework.

(v). *Monitoring and Evaluation* – The developed framework will be tested on an identified population. It will be monitored for a specified period of time to evaluate its efficacy

5. Technology Description

Papazouglou [10] describes service oriented computing (SOC) as a new computing paradigm that utilizes services as the lightweight constructs to support the development of rapid, low-cost and easy composition of distributed applications. He illustrates an extended SOA Pyramid (Figure 1) that includes the service layers, functionality and roles of the service composition layer. The middle layer is the service composition layer, which encompasses necessary roles and functionality for the consolidation of multiple services into a single composite service.

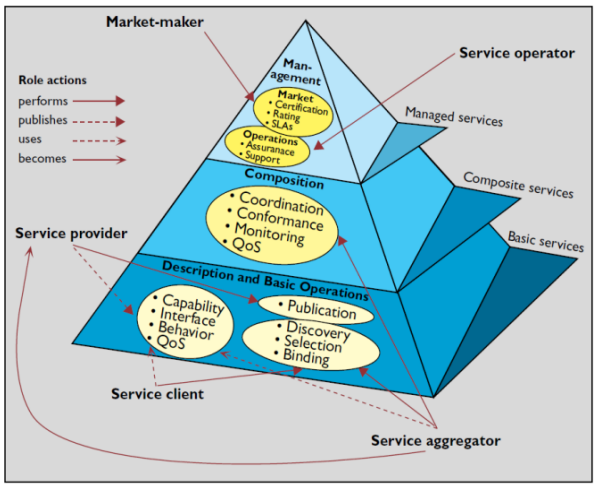


Figure 1: *Extended SOA Pyramid*
Source: communications of the ACM, October 2003/Vol. 46, No. 10

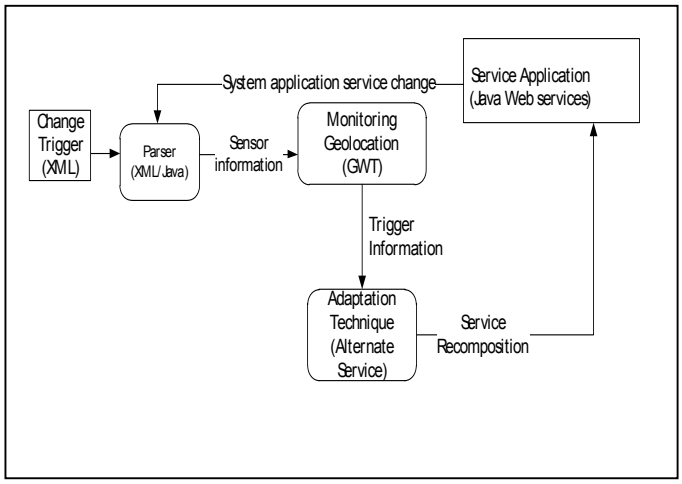


Figure 2*: A Framework for adaptive SOA*

The role of this middle layer is Co-ordination, Monitoring, Conformance and Quality of service. Our framework extends this further by incorporating an adaptive component as shown in Figure 2. The prototype will make use of XaaS services. Software as a Service (SaaS) reflects a "service-oriented" approach to software development that is based on the notion of composing applications by discovering and invoking network-available services to accomplish some task. With the data so far obtained, we have been able to implement the following services as depicted in Figure 2.

A service-oriented application has been developed using java web services and implements the client side of the application. Here, the user makes a query on a certain disease that he is seeking information on. This application retrieves data on symptoms of the disease, treatment available and prevention mechanisms from a java Data Base that is in the server side of the application. The information retrieved will vary depending on the user's location. As a result, we have developed a monitoring web service that will act as a sensor to detect the user location. The module was developed using Google Web Toolkit (GWT) to detect the location using Google maps. Data on the location triggers is stored using an XML file and parsed for dynamic monitoring of the service oriented application. The adaptation technique used in the prototype is a selection of an alternative service based on the trigger information received from the monitoring components. The monitoring and adaptation components are not embedded on the Application to facilitate scalability and generalizability of the proposed framework.

6. Developments

This paper presents the results of the initial part of the project, namely, the pilot phase. The countrywide survey will target a study sample of 1000 citizen which has been arrived at using the following equation.

$$n = \frac{z^2 xp(1-p)}{m^2}$$

Where:

n = required sample size
z = confidence level at 95% (standard value of 1.96)
p = Kenyan mobile penetration according to CCK
m = margin of error at 3% (standard value of 0.03)

$$\therefore n = \frac{1.96^2 \text{ x } 0.479(1-0.479)}{0.3^2}$$

$$n = 1067.1 \approx 1067$$

We chose to use a sample size of 1000.

Similarly, the pilot sample, from which we derived the results for this paper was given by 5% of the sample acceptable [11].

$$0.05 \text{ x } 1067 = 53$$

We chose to use a pilot sample size of 60.

The project has been running for one year now and pilot data has been collected and analysed to aid in the development of the model. The project is due for completion in June 2014

The results obtained so far have revealed the status of health information access in rural environments. These are described in the result section. Final results should reveal which information needs to adapt to various environments. The remaining part of the project will focus on the development of the proposed framework, its implementation and evaluation as well as the dissemination of results obtained.

However, we envisage implementation challenges arising from the digital divide in Kenya where mobile phone usage is hampered by the unavailability of grid power in most rural areas since 47% of the time the phone is switched off to preserve battery power. Illiteracy among the rural populace also contributes to low utilization of mobile phone.

7. Results

7.1. Demographics

The data collected was analyzed to reveal demographic features of the data sampled as shown in Figure 3

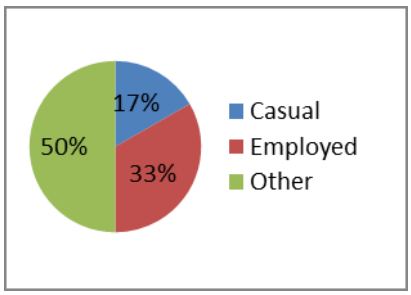
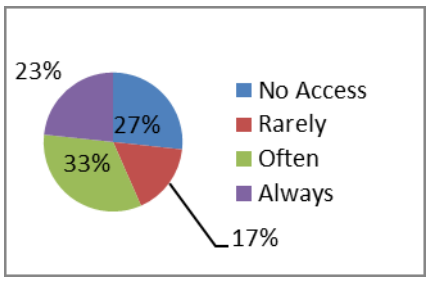
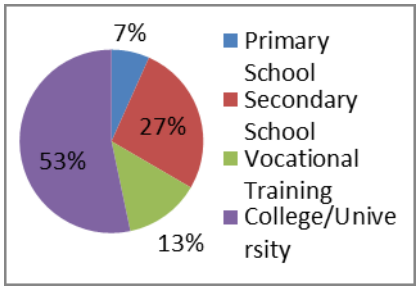


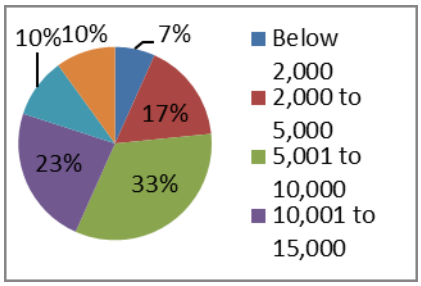
Figure 3: (a) Employment Status



(b) Internet Access



(c) Education Level



(d) Monthly Income

In this pilot study, key demographic findings reveal that the majority of the populations, (33%), are employed. Almost half the population does not have access to the internet which makes the government portal out of reach for them. It is also worth noting that a majority of the population has at least completed secondary education which means that they are capable of or can be trained to use mobile technology as they have basic literacy skills. The majority of the population has a monthly income of less than Ksh15000.00 which means that smart phones and personal computers are not the norm in most rural households. This further establishes the case that there is need for a cost effective method of information access.

7.2. Technology Use

The study further set out to find out the current status of technology use in these rural areas. The results revealed that half of the population sampled rarely or never used the phone to access the Internet as illustrated in Figure 3.

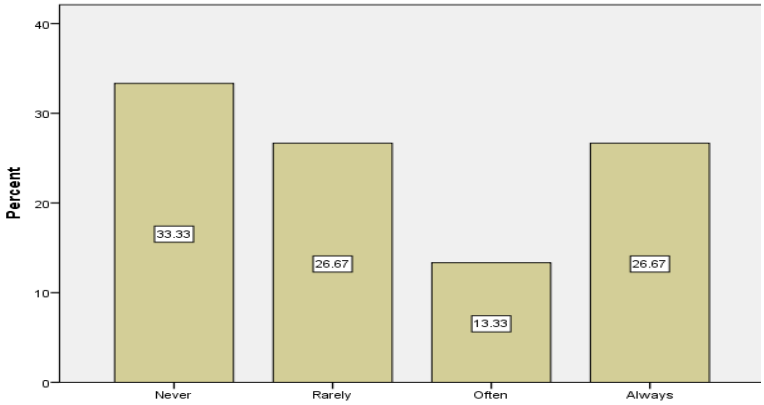


Figure 3: Use of mobile phone for Internet Research

Further, the population that used the mobile phone to access information used it to access Education and Business related information and not for health, agriculture or news purposes as illustrated in Figure 4.

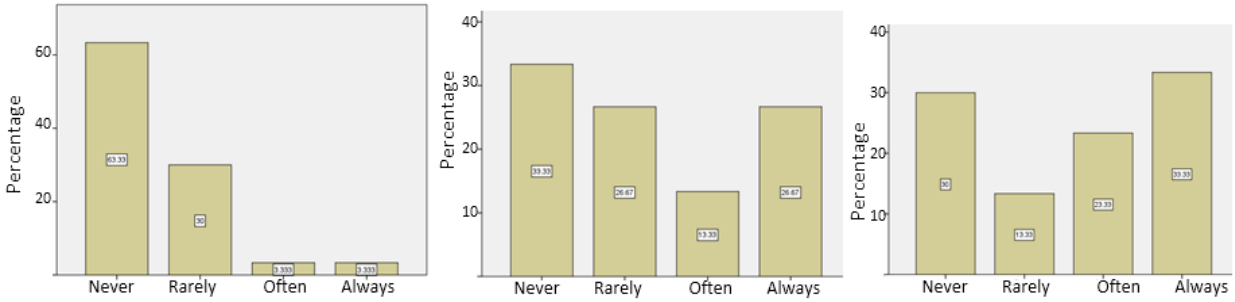


Figure 4: (a)Health information **(b) Education Information** **(c) Business Information**

From the findings, it becomes evident that the respondents felt that the information on health available on the Internet was not worth using airtime (credits) on. This is because while respondents were willing to spend credits to access education and business related information, they were not willing to do the same for health or agriculture related information. There is need therefore to adapt the information available on health in order to make it more relevant to the population. The proposed framework would provide this much needed solution.

7.3. Information Access

Finally the research set out to investigate the need for health information access. Key findings indicate that different environments required different types of information e.g. on Diabetes, High blood pressure, and cancer; the results appeared to be split as illustrated in Figure 5. This could be an indication that while all the information is important, not every piece of information is important to everyone.

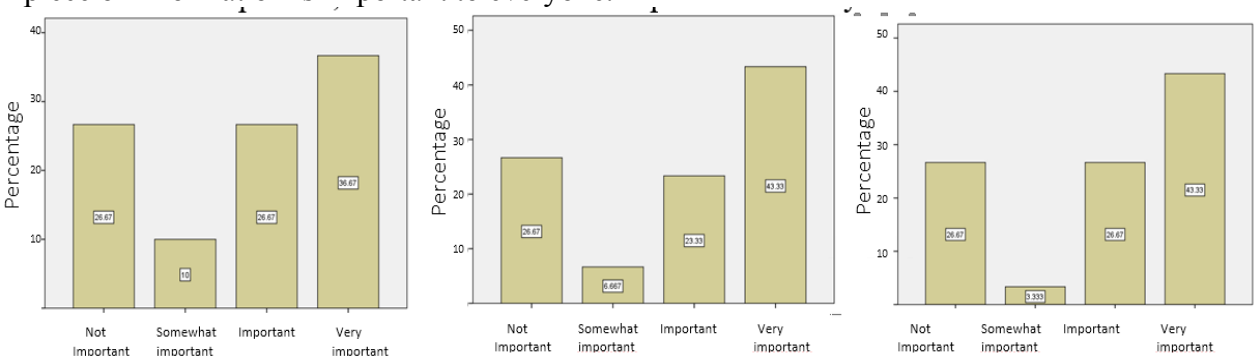


Figure 5: (a): Diabetes *(b): High blood pressure* *(c): Cancer*

The researchers further performed correlational analyses to investigate factors influencing the type of information accessed. They calculated Pearson's, Kendall's and Spearman's rho coefficients; the results were consistent. Specifically, Table 1 shows the results for Pearson's correlation coefficient.

Table 1: Pearson's

	High Blood Pressure	Diabetes	Cholera	Typhoid
Income	0.405	0.205	0.738	0.743
Education	0.227	0.294	0.309	0.470
Mobile Expenses	0.736	0.690	1.0	0.892

From Table 1, there is a significant correlation for some diseases such as Cholera and Typhoid and weak correlation for others such as High blood pressure and Diabetes. This shows that the respondent background and status influence the type of information they consider relevant. In view of this, the researchers have developed a solution that can dynamically adapt depending on the users' environment (e.g. geographical location, among others), to provide information that is relevant to the user.

8. Business Benefits

It is envisaged that the outcome of this research will greatly benefit the citizen and Government alike. In the case of the citizens, the benefit of the use of mobile technology to access relevant health information is that it will aid them in retrieving relevant information that is essential for their daily needs such as disease prevention measures, diagnosis of symptoms and basic treatment at very low costs. This will have a great social impact. It is a known fact that .in order for development to occur and foster a working nation, a government needs to invest in the health of its citizens. However, when the system is fully developed, it will find applications in other areas such as agriculture and livestock information access from the Government portal. Ultimately, when the product is developed, it needs to be availed to the public. This calls for patenting of the product, publishing of the results, and hosting it in the public domain. The IaaS has become a popular platform for information dissemination. With the growing interest in e-learning, academic institutions and organizations can use the Service Oriented model as a platform for implementing online courses for health.

In the ICT Industry**,** a popular emerging trend today is outsourcing of services. ICT providers are outsourcing software and infrastructure. The use of PaaS and IaaS will enable such providers to be able to extend their services globally or to remote locations that have previously been marginalized.

9. Conclusion

So far, the pilot study has pointed to the need for accessibility of health related information provided in the government portal and the need to investigate how mobile phone technology and XaaS can be combined to enhance and sustain information access and utilization. The remainders of the project calls for cross tabulations to reveal the factors that influence the relevance of health Information access and the development of a framework to leverage the access to this information

From these initial results, the researchers have been able to gain an insight into some of the challenges they would be addressing when designing a solution to the problem. For instance, it has become clear that there is need for a cost effective way of accessing information that is flexible. In rural areas, people have low cost phones. While the use of mobile apps to access and store data in the cloud would solve this problem, use of adaptation techniques of web services would ensure that the solution is flexible. The dynamic adaptation of technology is currently an area of research interest in developed

countries and as such the findings of this research could form a basis for establishing research collaborations between developing countries such as Kenya and developed countries such as the European countries on health issues. For example, the European Union is a major contributor to the Global Fund to fight AIDS, Tuberculosis and Malaria – a fund that supports the purchase of key commodities necessary for control of these 3 killer diseases. Being able to track information on these commodities by the beneficiaries, and accounting for the same requires a strong ICT component such as the one being proposed by this research. Such accountability is critical for continued funding.

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