

Birth Notification Service for Civil Registration in Kenya - SOA Model

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Abstract

The aim of this study was to investigate application of modern ICT technologies in solving birth notification problems in rural communities and the sharing of birth information with various stakeholders. The specific objectives that study sought to address include; investigation of current birth notification system in Kenya, the processes, finding the appropriateness of application of service oriented architecture in designing and developing a prototype for birth notification solution. The intention was to allow real time pre-notification of birth events by parents, verification of that information by local agents, and sharing of that data for use by other government agents. The events that take place in hospitals were also included in a broad solution. The study used two approaches where case study of a remote Sub County of injara in Garissa County was used to study rural events and processes. In this approach interviews and questionnaires were used to evaluate current processes as well as enquire the applicability of intended solution. Then IT product design and development was used to develop prototype based on service oriented methodology [1]. This is an iterative and incremental process of transforming organizational business processes to services until services are developed, deployed and can execute as expected. The prototype was developed where parents and guardians would notify birth events as soon as they happen, using SMS, web portal or mobile application. The testing and evaluation findings revealed that application of integrated services of SMS, Web application and Mobile application have positive implications in birth notification process. Study also found that these integrated services can improve birth notification experience both for rural events and hospital events as well as provide real time data for other consumers such as national health care insurers as well as statistical data consumers.

Keywords: Birth Notification Service; Vital statistics; Registration Agents; Service Oriented Architecture.

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1. Introduction

Registration is key milestone towards gaining belonging, rights and access to services in any organization. When a child is born the first step towards recognition is usually naming, and thereafter entering the given name to a register. However this is not the case to many children in Kenya, whose existence is absent from any form of registration. A key human rights instrument includes but is not limited to: Universal Declaration of Human Rights in 1948 [2] states that “every person has the right to a nationality” and this depends on having each birth legally recorded. This was also reinforced in the Declaration of the Rights of the Child in 1959 that states that “every child is entitled from birth to a name and nationality”; and in the International Covenant on Civil and Political Rights in 1996 that also states that “every child shall be registered immediately after birth and shall have a name.” [2]. The problem of unregistered events in Kenya is accrual from various challenges and problems which include information gathering methods, transmission, processing procedures and legal structures. Some of the systems may be timeworn thus have difficulties matching modern needs in data management and requirements.

In any organization information communication technology is an important tool and also a key driver of doing business, and should therefore involve embracing best available practices. It's to the interest of any organization to conduct business using the best ICT models and paradigms to stay profitable and relevant in the market.

In recent times service oriented architectures has become a great business paradigm of constructing and integrating systems for cohesion, granularity and reuse. According to [1] SOA is a paradigm that provides strategies, principles and methods in which business processes, information and enterprise assets can in best practice be organized and deployed to provide and enable best business strategic plans. This results in productivity levels that are required by competitive business environment. In this manner, new business processes, components or services can consistently be added and mapped to service providers without affecting entire enterprise but providing ease of reuse and modifications.

1.1 Background of birth notification problems in Kenya

A key challenge experienced in Kenya according to civil registration and vital statistics report is that only 57% of all births and 49% of all deaths were being registered [3]. This clearly shows there is a problem when Kenyans undertake process of civil registration. The birth registration process which starts at the notification stage has several players who also have distinct roles and accompanying challenges.

This low coverage of birth events in Kenya is attributed mostly to the fact that the events that occur outside health facilities are rarely registered or numerated. This is a limitation in systems and structural processes of notification, information processing and legal structures of carrying out actual registration.

Registration officer in Kenya do rely on the office of the chiefs and medical institutions to carry out birth and death notifications accurately, timely and in a complete fashion. However this has not been attained after numerous attempts and the capture of birth events still remain low in rural communities. On the other hand in urban and semi urban communities not all the notified births events that end up being registered. This is because

road and process to birth registration is bumpy since does not use ICT technologies. Among the challenges that hinder adequate birth registration is the problem of initial data capture to the system, especially regarding the notification of community events which may occur in vast rural areas. In many areas across the country there are manual systems are still in use, with little or no modern technologies that are employed to enable rural or community events that occur at home and deep in the villages to be captured, timely and reliably. Lack of ICT applications to help in this process is a big gap towards achievement of counting every birth or event Kenya. According to UNICEF in developing countries there exist a number of challenges and opportunities for civil registration systems that include: scaling up, innovation, and integration of systems, business process streamlining and automation of CRVS processes [3].

1.2 Problem of Informers and System

The local registration agents are the first authorized points of contact that provide legal witness and notification of the birth occurrences and events. The civil registration officers (CRO) are reliant on the assistant chiefs and medical institutions to carry out birth notifications in an accurate, timely and complete fashion. The registration officers mainly wait for these agents to supply the notification data which is the key for any registration to take place [4].

The assistant chief works for the office of the president and are not employees of the Civil Registration Department (CRD), they are therefore not directly supervised by or responsible to the civil registration department. Where the local registration agents do not or cannot perform notification tasks adequately, it is less likely that there is any corrective measure or sanctions that can be taken if they remain passive on notification process. This leaves the community in a big problem of registration since some agents (assistant chiefs) are not housed in offices which are known or accessible.

1.3 Social Problems

Some single parents may fear questions of paternity during notification through chief or community agents. Therefore due to such reasons as stigmatization, culture and religious settings they choose to stay with unregistered children. Other scenarios still are underage girls who are in dire needs of assistance but due to fear of stigma and discrimination by community they will not come out to report or notify about birth to chief. In community some people may not be in good relationship with the chiefs and thus may be unwilling to report any matter to them whatsoever. An innovation solution that can be designed to notify birth events within existing legal structures would be an asset not only in the process of registering every birth but also rendering of maternal care and services to such under privileged.

1.4 Challenge of data transmission

The notification of birth may reach the agents and record it down for onward transmission to CRO. However in that process it may get lost or damaged if recorded manually before it get to the CRO for registration or even further get there beyond acceptable set time. In most parts of the country the unregistered populations reside in the rural areas. These area mainly lack in good road network and reliable transport means to registration centers.

Rural and remote folk also have challenge with transport fees to the centers and in most cases immediate returns of birth notification or registration are not visible. This decelerates the efforts of birth registration and this study explores, can innovation rescue communities from this bumpy route to birth registration?

1.5 Problem of porous borders

According to the United Nations children fund, the ability of the civil registration service to function is highly affected by certain special circumstances, such as natural disasters and conflict. Nationals may need to flee from emergency situations, and vital events among refugees and displaced people may go unregistered [4]. During civil war or unrest certain areas of a country may be inaccessible or unsafe for government officials such as civil registrars. Similar challenges can also apply in countries with large numbers of refugees and migrants. Therefore innovative ICT solutions in vital events registration should have wide scope to cover such circumstances and work toward availing dependable information under strenuous circumstances. In Kenya we have had a wide share of problems brought by refugees trying to register as citizens and migrants from neighboring countries acquiring citizenship illegally, this is all attributed to weak birth registration systems which does not capture those details early enough in life.

2. Related work

2.1 Background on Service Oriented Architecture

SOA is an approach of solving problems where technical capabilities are organized in standardized principles that can enable elastic performance of continuously shifting requirements and demands. Services are envisioned as capabilities performed by one component for another to accomplish the expected outcomes and goals. SOA institutes services as the mechanism by which needs, capabilities and solutions are tied together. Its orientation implies that its capabilities are autonomous and self-governing so that several services can be connected together to solve various business challenges. SOA therefore seeks to standardize the interface so as to support enable seamless communication of various actors.



Figure 1: Interactions between service requester and service provider in SOA model [5]

2.2 Existing birth notification solutions

(a) Manual systems of birth notification

In Kenya manual notification of birth events is still highly used. The event is recorded by an agent and family issued with duplicate slip. To follow up on registration is by going to the nearest registration center. Some

hospitals have been installed with system for filling vital events. This system is still being rolled out in the country. It is expected to capture vital events into databases. These solutions still require improvement because, one, not every birth event occurs in the hospital and two they don't offer participatory of people served, in notifying and following up birth registration through distributed system access. These are the areas that this study intends to evaluate and propose suitable solution.

(b) Mobile phones to improve registration of births and deaths in Kenya.

WHO Country Office, Kenya; and the Millennium Development Goal (MDG) Central, East and Southern Africa, embarked on a project named: Introduction of mobile phone technology to speed up and improve the registration of births and deaths [6].

The main objective was to integrate MHealth (mobile technology for health) within the existing civil registration system to demonstrate that infrastructural barriers that impede the registration of births and deaths could be overcome by the use of mobile phones and transmission of data over phone lines allowing real time reporting and monitoring of events. The solution was based on RapidSMS platform within an automated System for notifying of births and deaths by community health agents and local authorities. According to Monitoring of Vital Events with IT component (MoVE-IT), a project where community health workers use mobile phones with RapidSMS to notify births and deaths was piloted in two districts Naivasha and Gilgil. One lesson learned using mobile phone technology was that notifying the assistant chief with an SMS did not necessarily result in the event getting legally registered through the civil registration officers [6]. This is because the solution focused singular notification but not entire architecture of notification and other legal processes. That solution was tested in comparison to manual systems and was found to be better for health workers to send notifications they capture on "real time" to centralized systems. However their solution did not focus on parents or communities in vast areas as crucial source of that data and the need to involve them in the study. The project primarily focused on easing the work for agents, on how to capture and send data as soon as they find it. This therefore did not cater for rural communities who live in remote areas where registration agents may not even access. It is notable that this process did not explore on how parents and guardians can be part of notification process without necessary covering long distances to look for agents or health workers physically. Solutions therefore need to be expanded within current and future legal frameworks to involve those who have the vital events to be part of notification process using technology. The other limitation of that system was their "real time" capture of vital data could only apply to events within health facilities which in our case under current circumstances are easily recorded. The events that happen outside medical centers have highest probability of missing on registration. These events can be captured on real time if system allows participation of local population or individual families which actually form the greatest statistic of unregistered civil data. One of the aims of this study is to find prudent avenue of using services and notify each birth as soon as it happens (real time).

(c) The use of Mobile Application to Improve flow of Birth data in Tanzania and Malawi.

This study centered on finding methods for improvement of birth registration in communities by facilitating communication of birth information between community health workers' (CHWs) in their communities, the

health facility workers and district health officials in the republic of Tanzania and Malawi [7]. Their findings revealed there were viable opportunities in use of mobile phones in improving the communication of health information systems that would greatly augment provision of reliable and timely supportive supervision and significant feedback in their work progress. They noted this would help in improving the collection, recording and transmission of birth information. The Provision of support was observed as one of the key factors for motivating CHWs to improve on their duties and performance. In that sense, a mobile phone could therefore be adopted as a tool to strengthen the structure in the HIS. This in turn would motivate the CHWs to collect and report accurate and complete information timely .This study therefore was a milestone in digitization and transmission of collected data departing from manual systems. The limitation of this study is that it bordered on improving working conditions for the CHWs and their motivation without exploring a solution for rural communities to participate in notification and registration process. The community health workers learning of new events which they could report was not also addressed by this study. The transmission of noted events to district registrars also does not give the served person avenues of following up their registration process remotely. These are the gaps this study seeks to address in the process of developing solution for counting every birth event in Kenya. The study mentioned that consumers and generators of vital statistics (VS) are different organizations but their focus was health system. There is a need therefore for a broader solution that can allow for system integration of various notification and registration processes in vital statistics generation. Such a solution can be expanded to cover several services to communities.

(d) Mobile Birth Registration in Sub-Saharan Africa

In Senegal, an NGO called (Aide & Action) whose activities focused on facilitating access to education, had already identified the comparative lack of birth certificates as a barrier to education, and was working to improve registration efficiency by raising awareness amongst village chiefs [8]. It appeared to them that the best way to improve registration rates was to make it easier for village chiefs to inform regional and national registration offices about new births. The solution was deployed by Orange where mobile phones were equipped with specific java software. They were then distributed to 30 village chiefs. The chiefs are responsible for capturing information regarding births in their village, and transferring that information to the Senegal State Registrar [8].The registration office is equipped with a mobile phone in order to receive the information sent by village chiefs. Once received, this information is checked and the birth is registered both physically in the registry, and electronically in a database. A registration number is then sent back to the village chief, who communicates it to the parents. This registration number means that the child has been registered. Using this number, parents can collect a birth certificate from the registration office at any time, provided that they pay the corresponding fee.

In Uganda, a dual solution was rolled out to:

- (a) Hospitals are equipped with a 3G connection (when necessary) to access a web-based application to register births.
- (b) Registration agents (village chiefs, regional administrators) are given SIM cards mapped to their names, so

as to be able to send USSD codes to register births occurring locally. In Uganda Telecom used USSD codes on mobile phones, and a web-based application on computers. USSD may be less “user-friendly” than a customized Java applet, but has the advantage that it can work on any phone; this is according to [8]. Limitations of the solutions in Senegal and Uganda were:

- The solutions were based on specific mobile networks thus limiting users of other network or forcing users to have multiple SIM cards. This creates an issue of interoperability with other mobile networks and also with legacy systems.
- The solution required creation of unified database of all network providers for the registration birth events, with subscribers of any and all networks being able to use the system, this is a difficult task to attain.
- The solution also did not focus on local population being active participant except through local chiefs which creates a disjoint in real time notification of vital events.

These are the gaps that the proposed study wants to look into by proposing a solution that can allow individuals irrespective of system architecture to access birth notification and registration services.

2.3 Envisioned Solution

This study envisions a mobile; web and SMS based solution where individuals or parents can play active role in notification process especially of rural and home events. Instead of physically looking for the agents, they can be a part of multi-level service oriented notification and registration service which can also be integrated with various vital data consumers. In the intended solution a multi-stage verification is proposed, actors are notified via emails and SMS alerts (short message services) and records validated accordingly.

3. Methodology

This section is divided into design and location of study, sampling and research instruments and data analysis.

3.1 Design and location of study

The design used in this study was informed by the specific objectives of the study and so is the overall approach. One segment of this study aimed to understand and describe what parents and guardians go through in notification and registration process. This called for finding the improvements that can be done to give them best services during this process and increase overall birth registration. To gather such information the study relied on multiple designs to meet the objectives. A case study design was carried out in rural selected area to analyze and evaluate the notification process and system in rural setting, which is also closer to a country border region. In this case Injara Sub County in Garissa County was selected for studying the rural events in birth registration. This design is seen by the researcher as a crucial in studying the operations of civil registration department. The study was also carried out in key institutions of interest that include; civil registration department (CRD), health facilities and birth data consumers like NHIF (National Hospital Insurance Fund). This was geared towards evaluating the current systems of notification and registration, and data sharing

mechanisms. The other segment of the study was developing a prototype that can reliably be used to report birth events as soon as possible and improve the notification, registration and data sharing procedures. IT product design and development methodology was then employed to construct the proposed prototype based on service oriented architecture (SOA).

3.2 Sampling and research instruments

According to [9] emphasizes that purposive sampling can be very useful for situations where one needs to reach a targeted sample quickly and where sampling for proportionality is not the primary concern. A purposive sampling technique was used because main areas with low birth registration are marginalized areas. The sample size has to be optimum to fulfill the requirements of efficiency, representativeness, reliability and flexibility [10]. A sample of at least 132 persons was used as proposed by Mugenda[11].The researcher employed focused interview so as to get as much information as possible. This also granted interviewees freedom to answer question broadly. Parents who have vital statistics were interviewed using a structured interview. This instrument was chosen for the parents because a considerable number of individual’s in the targeted rural population may not be able to read and write or fill questionnaire appropriately. In some sampled areas where accessibility is a challenge researcher employed telephone interview instead of face to face interview for civil registration officers.

4. Data Analysis

4.1 Analysis of Responses from Community Agents

The local chiefs are officers charged with legally reporting the events that take place within their jurisdiction that occur outside hospital facilities. The tasks in analysis of their work involved to find their experiences, challenges, views in the process of improving their work and general views to matters on this study. The first question was trying to find out the experience chiefs have in finding birth events that have taken place in their community.

Table 1: The chief experiences in finding birth events

| Choice | Frequency | Percentage | Cumulative Percentage |
|----------------|-----------|------------|-----------------------|
| Easy | 9 | 31.03 | 31.03 |
| Very Easy | 2 | 6.90 | 37.93 |
| Difficult | 15 | 51.72 | 89.65 |
| Very Difficult | 3 | 10.34 | 99.99 |
| Total | 29 | 99 | 100 |

Out of 29 respondents, 31.35% of them said that finding out birth events that have occurred was easy. 6.97% said that it was very easy. Another 52.25% said that it was difficult and the last 10.45% said that it was very

difficult. From this study we can see that the majority of respondents (sum of difficult and very difficult responses, 62.7% found it difficult to learn about the birth events in their communities.

We also tried to find out whether if they received a pre-notification message of a birth occurrence from CRO, how fast they thought it would take them to carry out the actual physical confirmation in their communities.

Table 2: How long it would take chiefs to do actual confirmation after an alert

| Choice | Frequency | Percentage | Cumulative Percentage |
|---------|-----------|------------|-----------------------|
| A day | 10 | 32.26 | 32.26 |
| Week | 12 | 38.71 | 70.97 |
| A month | 9 | 29.03 | 100.00 |
| Other | 0 | 0.00 | 100.00 |
| Total | 31 | 100.00 | 100 |

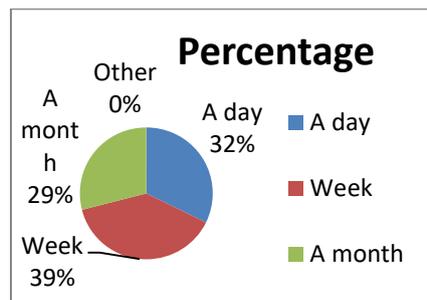


Figure 4

From the 31, respondents, 32.2% of them said that it would take them a day. 38.71% of them said that it would take them a week. 29.03% of them said that it would take them a month. This means that 71% of the chiefs said it would take them a week to issue an actual confirmation of birth after pre-notification message or alert.

We tried to know if such a system would increase the level of birth notification in their community. The responses were as follows:

Table 3: The views on system intervention to increase registration level

| Choice | Frequency | Percentage | Cumulative Percentage |
|--------|-----------|------------|-----------------------|
| Yes | 19 | 63.33 | 63.33 |
| No | 4 | 13.33 | 76.66 |
| Maybe | 7 | 23.33 | 99.99 |
| Total | 30 | 99.99 | 99.99 |

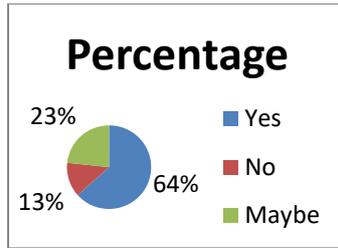


Figure 5

Out of the 30 responses we got, 63.33% responded yes to this issue. 13.33% responded no and another 23.34% were not sure. From this data, we can conclude that most of them thought that a prior message would increase the level of birth notifications in their area and thus this system is a noble course.

4.2 Analysis of Responses from parents

We tried to find out how the respondents rated the birth notification process from their experiences.

Table 4: Parents perception on the current notification process

| Choice | Frequency | Percentage | Cumulative Percentage |
|----------------|-----------|------------|-----------------------|
| Easy | 44 | 40.37 | 40.37 |
| Not quite easy | 20 | 18.35 | 58.72 |
| Difficult | 21 | 19.27 | 77.99 |
| Very difficult | 24 | 22.02 | 100.00 |
| Total | 109 | 100.00 | 100 |

Among the 109 respondents, 40.37% said that the process was easy. 18.35% said that the process was not quite easy. Another 19.27% said that the process was difficult while the remaining 22.12% said that the process is very complicated. We found that most of the respondents found the birth notification process to be easy but the majority in the sample (59.63 %) had a problem with the current notification process.

We inquired if the respondents could consider the use of a mobile phone or web application to notify the birth of their child. The response was as follows

Table 5: How the respondents would consider using mobile phone in notification

| Choice | Frequency | Percentage | Cumulative Percentage |
|--------|-----------|------------|-----------------------|
| Yes | 109 | 100.00 | 100.00 |
| No | 0 | 0.00 | 100.00 |
| Total | 109 | 100.00 | 100 |

All the respondents said that they would consider the use of a mobile phone. We inquired for the method they are likely to use in a mobile phone and the responses were as follows.

Table 6: Response on use of mobile technology

| Choice | Frequency | Percentage | Cumulative Percentage |
|------------------------|-----------|------------|-----------------------|
| SMS | 53 | 48.6 | 48.6 |
| Mobile Application | 4 | 3.7 | 52.3 |
| Web Application | 8 | 7.3 | 59.6 |
| Call | 26 | 23.9 | 83.5 |
| Combination of choices | 18 | 16.5 | 100.0 |
| Total | 109 | 100 | 100 |

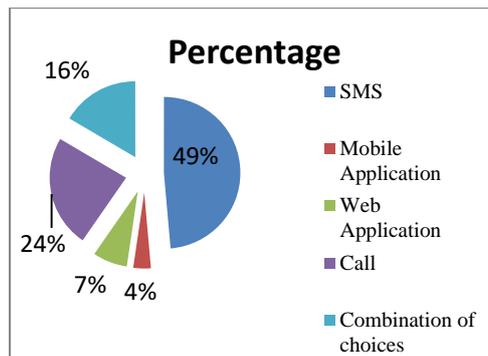


Figure 6

Out of the 109 respondents, 48.3% of them preferred the use of SMS. Another 3.7% preferred the use of a mobile application. 7.3 % preferred the use of a web application, 23.9 would want to use of a voice call, while the remaining 16.5 % preferred combination of choices. From this, we can see that SMS was their preferred mode. The least was a mobile application, and probably the reason being this community is not conversant with the use of mobile applications. We asked if they thought that mobile notification systems in birth registration can help in registering their child more easily. Below are the responses we received.

Table 7: Responses on views if mobile can help register children easily.

| Choice | Frequency | Percentage | Cumulative Percentage |
|--------------|-----------|------------|-----------------------|
| Yes | 92 | 84.40 | 84.40 |
| No | 0 | 0.00 | 84.40 |
| Not Sure | 17 | 15.60 | 100.00 |
| Total | 109 | 100.00 | 100 |

Out of the 109 respondents, 84.40% agreed while 15.60% were not sure. Most of the respondents thought that this could help in registering their children more easily.

We asked the respondents if they felt mobile interactions prior to visiting the chief would ease notification and registration process. The responses were as follows:

Table 8: Respondents' views on alerts to chief on easing overall notification and registration

| Choice | Frequency | Percentage | Cumulative Percentage |
|-------------|-----------|------------|-----------------------|
| Yes | 75 | 68.81 | 68.81 |
| No | 0 | 0.00 | 68.81 |
| Maybe | 25 | 22.94 | 109.75 |
| Am not sure | 9 | 8.26 | 100.00 |
| Total | 109 | 100.00 | 100 |

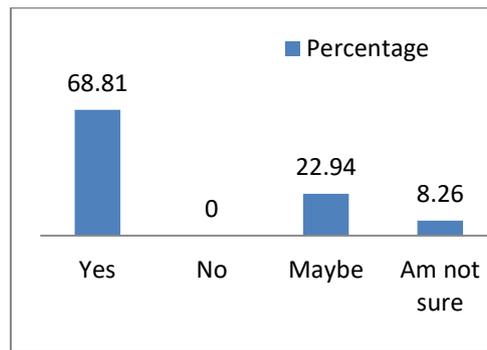


Figure 7

We had 109 responses in this issue. 68.81% of the respondents felt that the mobile interactions would ease notifications hence. None of the respondents said no. 22.94% of the respondents said maybe and the remaining 8.26% were not sure. So we can see that if mobile interactions were used, most of them thought that it would ease the registration and notification process.

5. System Analysis and Design

System analysis and design is the process of collecting the actual data, reviewing and studying the processes involved. It involves identifying the problems and recommending appropriate solutions that can be undertaken and detailing steps in the construction of proposed solution to the system [14]. This also involved the study of real business processes, operation procedures and the information flow so as to design solution aligned to core organization goals. It involved subdivision of complex tasks or processes into manageable smaller units that enable easy data identification and management of processes. The views and inputs were collected from parents,

community health workers, CRO, chiefs, and the officials in civil registration, hospital as the key participants in notification and registration process, as well as NHIF as a data consumer.

5.1 Services Design and Development

In the service design and development, it advocates for the identification of the right services, organize them into convenient order of composite services, choreographing them together to support business processes [12]. The business services or processes can be made up of smaller or finer services that have to be sustained by infrastructural services and management services such as provision technical utilities. These include services such as logging into a given system to use it, security attributes or features, authentication of processes, and other system modules that control the resources.

According to Papazoglou [13] service-oriented design and development is based on an iterative and incremental process that comprises one preparatory and eight distinct main phases that concentrate on business processes. These are planning, analysis and design (A&D), construction and testing, provisioning, deployment, execution and monitoring. These phases may be traversed iteratively

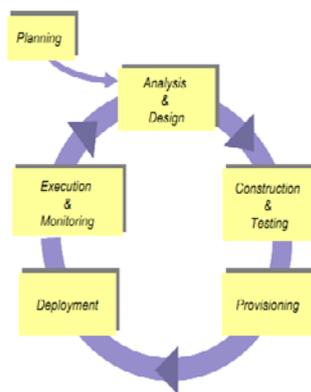


Figure 2a: Phases of the service-oriented design and development methodology [13]

These are phases that were followed in development of the study prototype.

5.2 The system services architecture model

The clients will interact with system through a three-tier model consisting of a mobile app, a web application and an SMS gateway. Parents and guardians are able to pre-notify birth events through a mobile application, mobile SMS or a web application. The parent gets feedback on reported births via the same mode. Upon pre-notification by parents the local agent/administrator registered in the system are notified via SMS alert and email. The nearest hospital facility to the parents' location is also notified about the birth event through email. The local agents (chiefs) or hospital agents (community health workers) will physically confirm the birth event, then using cross platform mobile application or web portal approve or reject the events. The chiefs will also receive SMS notifications of birth occurrences in their area that need their attention. They can also access the data via the mobile app that is installed in their mobile phones. The chiefs are able to report birth occurrences

that they learn of via a mobile app or a web portal. The system administrator who is in the office of civil registration department is able to register chiefs, hospitals and data consumers as well as define locations in the system. This is done through a web application that is accessible through administration portal via web browser. Registered data consumers are capable of accessing data or reports via a web portal in designated Jason format which they can export to their applications for various uses.

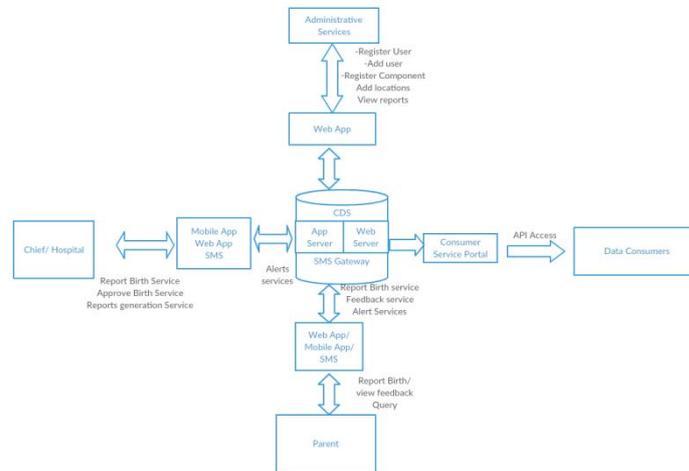


Figure 2b: The Services Architecture for the prototype

5.3 Prototype construction and implementation

The RESTful style [15] for implementing services was chosen because of less overhead while dealing with mobile applications. All the components of the system (mobile, web and SMS) communicates through interfaces, which have clearly defined methods and dynamic code. The components here are uniquely identified through a hypermedia link (URI) where resources can be found. We have client/server architecture where (App server, the mobile app and an SMS server) all interact seamlessly in a stateless transport network. In computing, a stateless protocol is a communications protocol that treats each request as an independent communication and that it is unrelated to the previous requests according to Fielding [15].

This means that the communication consists of independent pairs of request and responses. Therefore each unit or component of the system platform (mobile, web and SMS) was treated independently though the three modules were integrated. The RESTful SOA architecture is tiered, and data can be cached at any layer. The functional process logic, data access, computer data storage and user interface are developed and maintained as independent units on separate platforms.

5.4 prototype scope

Web server runs a web application by returning HTML, Soap messages or XML files over an HTTP connection to a given endpoint. In an integrated service a server responds to HTTP requests to deliver content and services, seamless interaction between various functional components is key requirement. This calls for a well mediated process so as to realize all capabilities of SOA. In this study it was made possible through integrating Ozeki

SMS server with the Apache web server so as to route the messages to mobile carriers. Data integration was possible through use HTML 5 and CSS standards which can be carried across different platforms and devices. Business to business integration was realized through use of Jason data formats to export data to external users who would use applications to acquire data from the system. According to Rosenberg [14] a service that obeys the principles of service-orientation is an autonomous, loosely coupled, and stateless unit of functionality that is made available by a formally defined interface. The functionality provided by a service is discoverable by applications' that uses the service. In other words, services expose their functionality via interfaces that other applications and services can read and learn how to use or interact with them.

5.5 Prototype interfaces

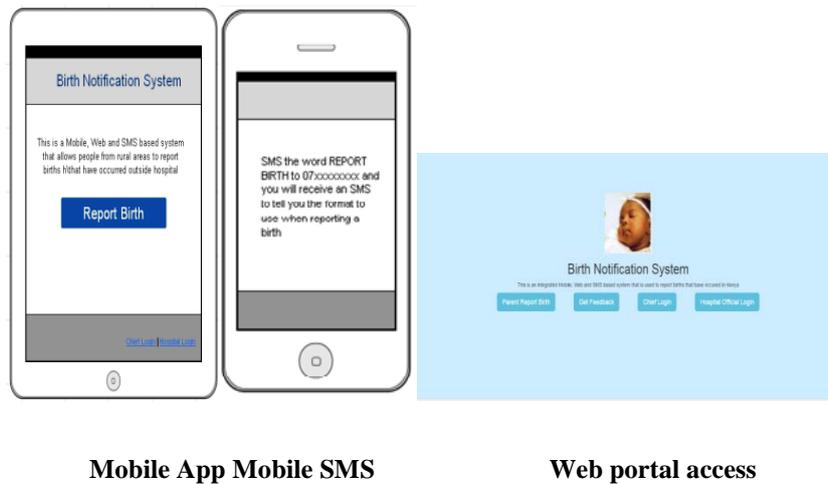


Figure 3: The interfaces for various services access

6. Prototype Testing and Evaluation

6.1 unit and integration testing

Each unit was tested individually starting from the web application, the mobile app then the SMS based system. This was to ensure that each module was working accurately as required as unit. Then integration tests were done by viewing the feedback and effect of one service action on another service through service request and response messages (or) actions.

6.2 Acceptance Testing

The system testing was done on a sample of users so as to analyze how user requirements were met directly in verifiable way. Its among other tests meant to measure user ability of the software in a real life condition. [17] Some of the users were disguised as parents, others as local administrators (chiefs) and others as hospital officials. The core objective was to test success in use of prototype in a user environment, identify problems which unit or integration tests might have missed, and then provide a complete overview on how “done” the system is.

Table 10: The integration of services tests

| Service requestor / action | Service response | Other service messages to parents | Other service actions |
|----------------------------|-------------------------|-----------------------------------|---------------------------------|
| Parent mobile app | Child notification done | Sms, email confirmation | Chief/ hospital alerted |
| Parent SMS | Child notification done | Sms, email confirmation | Chief/ hospital alerted |
| Parent Web App | Child notification done | Sms, email confirmation | Chief/ hospital alerted |
| Chief verification | Birth event verified | Sms, email confirmation | Pdf generated notification card |
| Chief notification | Event notified | Parent receives SMS / email alert | Pdf generated notification card |
| Hospital notify | Event notified | Parent receives SMS / email alert | Pdf card generated |
| Report services | View reports | - | Print / export reports |
| External data users | Generate reports | - | Export Jason format |

Table 11: The summary of parents' ability to perform actions in the integrated system

| | SMS use | Web portal | Mobile App | Feedback |
|-------------|---------|------------|------------|----------|
| Success | 4 | 4 | 4 | 12 |
| Failed test | 2 | 0 | 1 | 3 |
| | | | | |
| % Success | 66% | 100% | 80% | 80% |

The problem faced by some of the parents was remembering the mobile number to send the message to, thus typing the number wrongly in their phone. There was a case of also failing to format the message as described in section

Table 22: The summary of chiefs' ability to use the system

| | Web portal | Mobile App | Feedback |
|-------------|------------|------------|----------|
| Success | 5 | 4 | 5 |
| Failed test | 0 | 1 | 0 |
| | | | |
| % Success | 100% | 80% | 100% |

The problem encountered by the chief users was the use of the mobile application with little training.

6.3 System Evaluation

This was done to get the perspective and views of the users on various results of the system and how they rate the system. The key elements for this test were on interface designs, ease of use, and ease of navigation, connecting to the system and feedback from the system. A sample used in acceptance testing was given the chance to rate the system and other ten people who are developers were involved.

Table 13: System Evaluation results

| | Excellent | Good | Poor | Very poor |
|------------------|-----------|--------|-------|-----------|
| User Interface | 21 | 8 | 1 | 0 |
| Navigation | 12 | 16 | 2 | 0 |
| Feedback time | 8 | 19 | 2 | 1 |
| General Rating | 16 | 11 | 2 | 0 |
| Overall rating % | 47.50% | 45.00% | 5.83% | 0.83% |

From the sample, 47.5% of the users thought the system was excellent, 45% thought the system was good. Another 5.83% thought that the system was poor and 0.83% of the users thought that the system was very poor. Therefore the evaluation of the system revealed that 92.5% of the overall sample believed that system was good intervention.

6.4 Conclusion and Further work

The findings from the study showed that the current systems and processes are not sufficient to capture all rural or community events effectively. The researcher learnt that the introduction of ICT technologies at the earliest stage can improve birth registration that can open avenue for data sharing in planning and national development. The prototype testing revealed that the use of loosely coupled services in service oriented architecture that are integrated is a good model [18]. This is because other services can be added and scaled without affecting the existing birth registration services. The development of prototype also demonstrated there is shortened period in notification of birth event since it could happen in real time which under current system takes about a month to get the notification slip.

The introduction of distributed birth notification service for civil registration is a solution that would greatly improve data and information capturing, processing and sharing. This therefore implies research on appropriate ICT applications on integration of registration and health systems in developing countries should be on the fore.

Further study should focus on integration of captured birth information to other individual and family data held by the state departments and institutions. The future study can also explore methods that can be used to increase services on such systems, such as online generation of secure birth, death certificates from reported events or one time online “office” for governmental services. The reporting of death events in almost real time would help the country get a complete statistic of almost only the people who are alive in specified period of time.

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