Implementation of a web-based E-government proxy for a marginalized rural population.

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Abstract: **Electronic transactions over the Internet to remote rural areas may be costly and inefficient owing to poor connectivity. The system described in this paper aims to bring a collection of government services electronically to the rural public, making these services more available and efficient. Four software modules, based on open source standards, have been developed and integrated to form a single, dynamic web component. The e-government functionality formulates a communication channel for the government to reach out to the most remote parts of South Africa.**

Index Terms: **software modules, RAD, e-government functionality, web component, communication channel, rural ICT, proxy.**

I. INTRODUCTION

The growth of computers and telecommunications technologies value and the proliferation of the Internet and web can not be underestimated. As a result we see that citizens, policymakers, and others have raised their expectations about the delivery of government services digitally. The paper carries a description on the development and implementation of an e-government web-based system. The system integrates three back-end interfaces which are system administration, Home Affairs and Municipality together with one front-end interface, DwesaCitizen. The whole system allows a remote user to download important Home Affairs forms and fill them before uploading them through to Home Affairs a proxy. It allows the users to send reports to Municipality. The Home Affairs and municipality will use back-end interfaces to process user applications and reports [1][8].

The objective of the paper is to present the Dwesa e-government (Dwesa-Gov) system which is a software application type of product that uses information technology to bring a group of government services to the benefit of citizens, business partners and employees without them physically contacting the government departments. Part of the system name, Dwesa-Gov, refers to the rural area in Eastern Cape Province called Dwesa, where the e-government application will be deployed. With e-government, information about the services offered by the government through the different ministries can be circulated quickly down to the grass root levels [10][11][13].

This paper proceeds as follows. Section 2 briefly describes some background literature relevant to the project. Section 3 discusses the problem domain this project tackles. The development and implementation are explained in Section 4. The conclusion and some possible future works will be highlighted in the last section, Section 5.

II. BACKGROUND LITERATURE

Any e-government system can be seen in terms of the processes implemented. Further a working e-government prototype can be created by phased development of various modules which implement increasingly complex functionality. The figure below shows how e-government systems can be categorized according to the completeness of the functionality they offer citizens versus the complexity required of the systems and the organizational structures of government itself. The figure also shows that this development of e-government system progresses in stages [1][11][12].

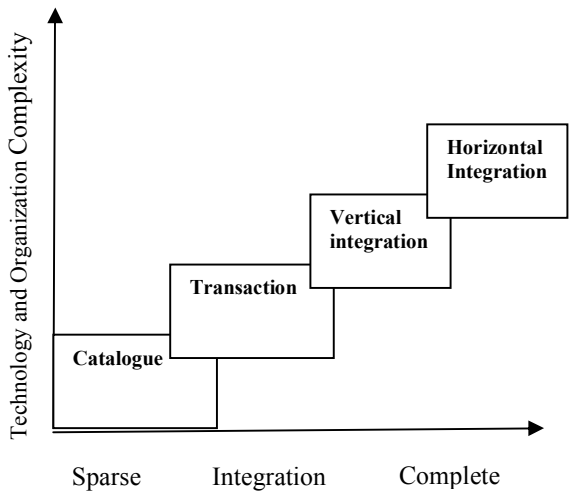

Figure 1. Stages of E-government Systems

There are four stages suggested by the graph above.

- **Catalogue**: Here the system supports online presentation and access to downloadable forms. The

technology and organization of the system at this stage is less complex because of sparse content.

- **Transaction:** Here services can be accessed interactively online. Databases support online transactions at this stage. The research presented in this paper aims to produce a system prototype that falls on this level.
- **Vertical Integration:** supports local systems linked to higher level systems within similar functionalities. It focuses on integrating government function at different levels, such as those of local government and state government [12].
- **Horizontal Integration:** Here system integration proceeds across different functions. It integrates separate systems from different departments. This may be referred to as real one stop shopping for citizens. A system at this stage will require advanced technology and complex organization [1][12].

E-government can involve electronic relationships between government and different levels of constituents [4]. The theme behind this theory was applied when the Dwesa-Gov system was developed. The table below shows only two stages of e-government system development against three types of government relationships.

Table 1. Stages of e-government growth and type of government relationship [4].

Types of Government relationship	Stage 1: Cataloguing	Stage 2: Transaction
G2C (Government-to-Citizen)	Online presentation of information about government and its activities for the citizens.	Services and forms online to support online transaction for citizens.
G2G (Government-to-Government)	Online Presentation of information for other levels of government and employees	Services and forms online to support other level and government
G2B (Government-to Business)	Online presentation of the information for business about government. E.g. online product review of office.	Support business transaction with government e.g. make purchase of office supplies online.

It is very important to identify the phase which the e-government system will be in relation to the type of government relationship [4]. As the table above suggests, the Dwesa-Gov system lies between the two stages however, with a more concentrated effort towards Government-to-Citizen relationship.

III. PROBLEM DOMAIN

The Dwesa-Gov system was developed for Dwesa rural area in the Eastern Cape province of South Africa. The system is a part of an on-going major distributed multi-purpose ICT (DMPICT) project that has been partly deployed in the area. The DMPICT project offers various online services to the rural dwellers. An e-commerce system was developed and deployed on the platform to cater for the selling of the arts and crafts created by the dwellers. The literacy rate is drastically low as compared to urban centers [5][16]. The area suffers an acute shortage of basic utilities services. These utilities lacking in Dwesa include electricity, telecommunication facilities and tarred roads [5] and lack proper infrastructures. Poor state of the gravel road reduces the attractiveness of the area to transport operators to ply their trade in the area. The villagers face difficulties to get transport when they want to visit government departments. Villagers spend time, walking long distances to get to the government departments. The three government departments are;

(A) Home Affairs Department.

The closest Home Affairs office at Willowvale Business center is approximately 40km from Ngwane rural school. According to verbal reports, most of the villagers queue to get application forms for important documents like identity documents, birth and death certificates, and various types of government grants.

(B) Government Municipality.

The municipality department located in Idutywa is about 45 km away from Dwesa area. The municipality offices receive numerous queries from the villagers some of which are: allocation of stands, change of address; environmental problems; infrastructure degradation; problems arising in the society; land change of ownership; housing maintenance; and road damages

(C) Police Crime Unit Department

Dwesa villagers use cell phones to report life-threatening problems to the nearest police station. However, mobile tariffs are beyond the reach of already impoverished rural dwellers and the telecommunication infrastructure in the area face serious problems during bad weather leading to virtually unavailable communication. The reports that the villagers pass to the crime unit department fall into the following categories: illegal employer, crime offenders in the society, and environmental threats, e.g. illegal dumping of waste, damaging road signs, etc.

The officials from the crime unit will only be able to help once the case has been put forward by the villagers.

(D) Dwesa rural community

In urban areas, information and news spread quickly than it does in rural area. In African culture, each village is headed by a leader who, at anytime, can call for public meetings and gatherings. However, to converge a group of people require telecommunications services. In Dwesa, they use messengers to send word around if there is an announcement to make. The Dwesa-Gov system presents a portal to make announcement that can be read at various designated areas such as, for now, at the four schools that have the computers connected to the local WIMAX local roof. The portal gives the following services; announcements, public messages, discussion forum, weather alerts to the public.

The moderator will do the management and verification of announcements and the alerts.

IV. SYSTEM DEVELOPMENT

The RAD (rapid application development) software development method was chosen for various reasons. The use of this method requires that one gather necessary software engineering tools and language development environments. The RAD method is ideal because the system uses object-oriented programming methodology and allows the release of working prototypes at frequent intervals. This will allow the re-use of the software components and facilitates software version control. Furthermore, the Dwesa-Gov should be split into a number of components since it interacts which various types of users. Developing the Dwesa-Gov system using the RAD method, the system can be split into several independent modules that can be revisited and modified individually with no major changes required for modules links[1][2].

Figure 2 suggests that when the RAD system development method is used, the system prototypes can be iterated to launch working versions of the system, thereby saving the resources for system development [2].

The steps taken to develop the Dwesa-Gov system are briefly described below.

- Gathering requirements using workshops or focus groups during Dwesa trips. The e-government functionalities were learnt through consultations with Dwesa citizens.
- Prototyping and early, iterative user testing of designs.
- The re-use of software components
- A rigidly paced schedule that defers design improvements to the next product version
- Less formality in reviews and other team communication

The Dwesa-Gov system was developed using open standards software to meet the requirements needed to best fit the already in-house, MPICT system. The development

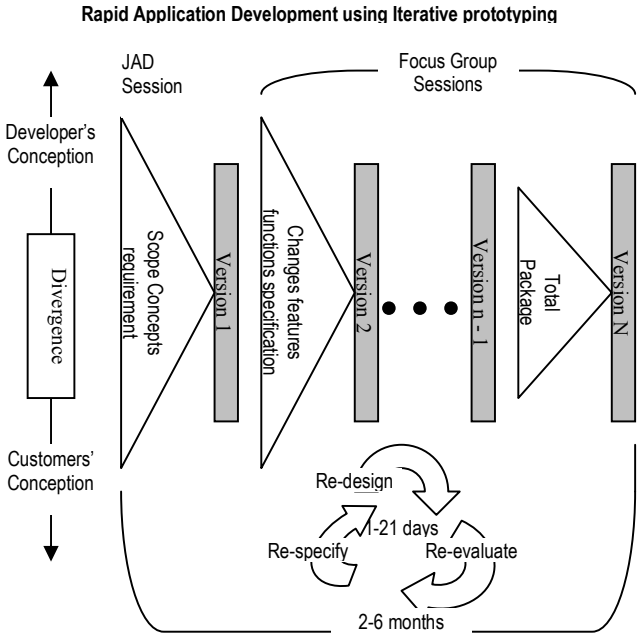

Figure 2. RAD system development method, adapted from [2].

of the system is expected to enter four phases [1]. The development of the system depended on various factors. Such factors include the type of users the system is targeting, the size and type of content. These and other factors were compiled and analyzed before the selection of appropriate software tools to use [3]. The system runs using open source software. The Linux operating system provides the ideal platform for the system. The following software was used to develop the system:

Zoop MVC framework 1.2, an object oriented PHP web application framework based on a front controller. It is designed to be very efficient for a PHP programmer to work with. It is easily extendable and you only include the functionality you use. It features GuiControls; fill AJAX support and integration; automatic form validation and creation [14].

Apache Web Server 2.2.6, where the web application files and its framework are stored and accessed by user. The users will need web browser client software on their machine to run the web application files [5].

MySQL 5.0.48 database Server an open source relational database management system that uses Structured Query Language (SQL) for the management of user and administrative data stored in the database tables. It is a reliable and flexible database server to use [5][15].

PHP Version 5.2.4 scripting Language to create dynamic web systems and we realized that it handles user input efficiently [5].

V. THE FUNCTIONALITIES OF DWESA-GOV SYSTEM.

The system presents different portals to different type of users. The Dwesa-Gov system was built in to support four types of users. The administration center, citizen, municipality and Home Affairs agencies. The functionalities, as described below, vary between these types of the users.

(A) Administration Center.

The Dwesa-Gov system comprises a portal that allows the management of the system. Special secured passwords were implemented, using MD5 encryption and One Time Password, specifically for the administrators, to give a maximum security to the whole system. Administrators have the following tasks

- User accounts management.
- Uploading important application forms.
- Activating user services as plug-ins.
- Acts as an intermediary between the citizens and the third parties.

The Dwesa-Gov system provides communication channels between the four users, managed and monitored by the administrator.

(B) Dwesa rural Citizen Portal

The whole project was developed to serve mainly the rural people situated in Dwesa. The Dwesa-Gov system provides the citizens with a user-friendly portal that has links to the three special services developed as shown in Figure 3 [13]. The citizens require registering in order to access any of the following services

- Online Reporting Center (ORC).
- Online Application Center (OAC).
- Dwesa Forum Corner. (DFC)

The ORC portal allows citizens to launch reports and complains to the Municipality. The categories of reports are well-handled to make the system efficiently. The reports are loaded in a database table accessible by Municipality agents only.

The OAC portal presents a government-to-citizen type of government relationship. The OAC system would be a proxy that allows villagers to retrieve from Dwesa Server and the OAC portal will uses the proxy to automatically download and upload to the Home Affairs server during the low traffic time. The portal is in its infant stage where downloadable applications forms have been made available to the citizen. The application forms are always up-to-date as methods of web scraping were applied to exchange bits of information between the OAC portal and the home affairs. The OAC module has been enhanced to give the citizens a capability to upload the

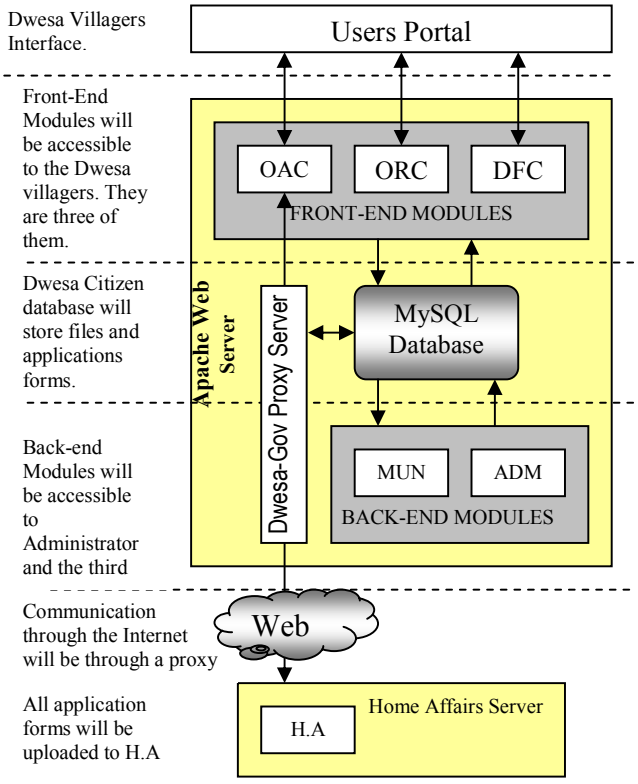

Figure 3. Dwesa-Gov System Architecture [13].

forms to the Home Affairs server proxy. Technically, users upload forms to the database table and the OAC system will use proxy to upload the files to the Home Affairs server. Security measures are being put on place to prevent misuse of the service. Such measures include the use of encryption in transmission methods. The system only accepts a number of applications forms already defined in the system. The file sizes, structure and type has played a central role to monitor the abuse of the Dwesa-Gov system's OAC portal.

The DFC portal provides a communication platform for Citizen-to-Citizen type of government relationship. The forum portal has been deliberately reduced to a small but sophisticated system. The forum lacks some real features of content management system. This was done to simplify the portal to targeted citizens who are computer illiterate. The aim of the forum is to give the rural villagers a functionality to send announcements and to offer public notices to the villagers. Announcements are verified from the administration center before they are published on the site. Furthermore, the forum portal cater for public discussions, however there is a

limit for the messages that a citizen can send. A system feature was implemented to enable citizens' manage their own system accounts.

(C) Home Affairs and Municipality Portals

The Dwesa-Gov system has back-end interfaces for the Municipality Offices. The citizens will send the applications and queries to Dwesa-Gov System's database during the day. The system can be set up to automatically upload, during the night, the applications forms to the Home Affairs server through a proxy to limit the access to the Dwesa villagers only. This is done to deliver of files efficiently to the Home Affairs during low traffic time. For processing and responding to the queries, the Municipality agencies are presented with a portal. Home Affairs back-end interface will act as an alternative way for the Home Affairs department to access the submitted application forms. Home Affairs portal will be only accessible by the department officials. Security features are being investigated are sufficiently strong to enforce the rule. These include special passwords given to municipalities. The government department officials (GDO) will get the filled application forms and process them and will respond to the citizen via the Home Affairs back-end portal and this mode is used only when automatic upload scheme of the Dwesa-Gov system is off. Automatic upload increases efficiency as GDO or Municipality officials may experience unacceptable delay when downloading filled forms during the day time. The same benefit stand for Dwesa Villagers when trying to download and/or upload directly to Home Affairs servers.

Municipality back-end portal will show all the sent messages and inquiries. The latest inquiries are shown on top and functionality was added for them to respond to the inquiries to the respective citizen. The Dwesa-Gov system has developed to simplify the link between the Government and its citizens, how ever, on reporting cases to the municipality, the system insists that it will, by no means, be used to communicate life threatening situations.

All the functionalities that the Dwesa-Gov system offers are modeled around the Dwesa villagers. The access of the Dwesa-Gov system will start at education institutions level. The system will be accessible from four schools in Dwesa where computers are available. Special training sessions will be given to the teachers and students on how to make use of the functionalities. Our hope remains that the villagers will be allowed to use these computer facilities at the four schools.

The Dwesa-Gov system is an addition to the ICT multipurpose platform's functionalities. Several other systems with different functionalities are in process of being developed.

VI. CONCLUSION AND EXTENSIONS.

We have reported on the development of the Dwesa-Gov system developed to bring government services closer and faster to Dwesa rural villagers. The development of the prototype system demonstrates the use of the RAD system development method, but the system required a determined approach to security features. The experience from this project provided an ideal proposal of an improved communication channel between the government and its citizens using the e-government proxy functionality. Some directions for future work include the following.

(A) Localization of Dwesa-Gov front-end portal.

The Dwesa-Gov system was developed using open software standards that are written in English language. However, necessary measures were taken to ensure that the front-end interfaces for the system can be modeled into system that conforms within the environment and the society that it serves. Localizing the system linguistically and culturally ensure the reliability, flexibility and high adoption rate of the e-government proxy system. The system was built in modular fashion, making it easy for modeling. The system development method and software used makes version controlling an easy task. More and more versions can be developed through iterating between the system components built around the current system [6][8].

(B) Vertical integration of Systems

Vertical integration of systems exists when there is support for local systems to link to the higher level systems within similar functionalities. The Dwesa-Gov system can bring together some functionality that can be available from higher level systems. Government departments in South Africa can also have some regional stand-alone systems that are familiar and can be linked to the Dwesa-Gov system and provide a vertical integration. Further studies can be done to initiate Government-to-Business (G2B) type of government relationship. The idea will to offer support for business transactions with government, for instant, making purchase of office supplies online [1][4].

(C) Automated Management

In the present version, besides offering automatic upload and download to and from Home Affairs and Municipality Servers, maintenance and updating of the content is done manually. Our system heavily relies on the system administrator's presence. In future, some automation will be required to be implemented to increase the level of reliability of the system. At further stage, public notice LCD screens for public announcements and weather alerts in public places will be provided and supported by the Dwesa-Gov system. Further studies will initiate the use of SMS notifications to speed up the delivery of public announcements to the villagers [6].

(D) Security Enhancement.

When developing the Dwesa-Gov system, we have seen that the system handles much input from the users. The most important security measure required in the Dwesa-Gov system was to secure file uploads. We used a system-generated file

names instead of names supplied by the users when storing file on the system. This would prevent local inclusion attacks and also make any kind of file name manipulation by the user impossible. Whilst we strived to ensure that the Dwesa-Gov system meets the security standards, we propose future work will have to look on how applications uploads and downloads can be digitally signed. This will prevent malicious use of the Dwesa-Gov system [8].

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