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Enhancing Web-Based E-Government Models through Integrated Email-SMS Alert System: A Prototype Design, Development & Testing

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Abstract:
Most e-government models adopted in developed and developing countries are Web-based and depend on websites, web portals, blogs and emails systems to deliver services to consumers. Such models provide static information and are not interactive, making it difficult for users to receive feedback from the government agencies. With the proliferation of smart mobile devices, the SMS-based models are slowly becoming popular in the developed countries but sparingly popular in developing countries. The smart mobile devices enable users to access e-government services with ease and at any time. However, majority of consumers use the basic-feature phones that make it impossible for them to access the e-government services. This study focused to enhancing the web-based e-government models by use an Email-SMS alert system. This study used survey and prototyping methods. Questionnaires were used to collect descriptive data about consumers' experience of using e-government services through email systems and SMS-based systems in a government agency. The study found that email systems were ineffective, inefficient and unreliable technologies for availing e-government services. This is because consumers took too long to access their email accounts and did not have a notification method of knowing when new services were available. It was also found that, even though SMS was efficient in providing information, it was not effective and reliable in accessing e-government information and services since most consumers used basic-feature phones that limited the information they could receive into 160 characters. Based on the findings of the survey, a prototype of an Email-SMS alert system for notifying users about new e-government services on basic-feature phones was designed, developed and tested. It was found that such a system can always notify consumers whenever new e-government services were on the web-based systems irrespective of the type of a phone one has, hence prompting them to access the services from the nearest Internet access point. This improved the access time and feedback on services requested for.

Keywords*: Web-Based e-government model, SMS-based e-government model, integrated email-SMS alert system, prototype*

1. Introduction

E-government has been defined as the "information technologies that have the ability to transform relations with citizens, businesses, and other arms of government and can serve a variety of different ends: better delivery of government services to citizens, improved interactions with business and industry, citizen empowerment through access to information, or more efficient government management with benefits such as less corruption, increased transparency, greater convenience, revenue growth, and/or cost reductions" (World Bank Website , 2005). Several models of e-government service delivery have been proposed. The web-based and SMS-based e-Government models are the commonly used in the developed and developing countries. Websites, web portals, blogs and email systems are the main technologies that have been used to implement the web-based e-government service delivery models. However, issues of concern have been raised over time about the web-based e-government service delivery systems. Layne & Lee (2001) opine that such issues of concern include accessibility, effectiveness, efficiency and reliability of these models. As new ICT frontiers emerge, other e-government models that are deemed to be more robust than the Web-based models have emerged. One such model is the SMS-based e-government model.

Susanto, Goodwin and Paul (2006) opine that the SMS-based e-government models are more likely to increase e-government usage than the web-based e-government models. Alluding to this, Nonyongo, Mabusela and Monene (2007) hold the view that SMS-based models are quick, efficient, cheap, convenient and reliable in delivering e-government services. However, the SMS-based models have been found to have limitations like the maximum character limit of 160 characters and the inability to allow attachment of additional documents in a single message unlike in most of the systems used to implement the web-based models (Macias, 2009).

This indicates that none of the two common e-government models can independently offer reliable services and therefore, alternative technologies should be adopted to ensure e-government service delivery systems are not discriminative. Supporting this position, Lee and Hong (2002) contend that e-government services are for every citizen and so a leading-edge technology should not be adopted to deliver e-government services unless all citizens are able to use

it (Lee and Hong, 2002). Similarly, Dalziel (2004) opine that governments should provide the channels of e-government service delivery which people have the technology and skills to utilize. It is in view of this that, this study focused to enhancing the web-based e-government models by use an Email-SMS alert system which would enable user of basic-feature mobile devices to get notifications on their devices whenever new e-government information or service was posted on a government website, web portal, email or blog.

2. Problem Statement

Most developed and developing countries use the web-based e-government models to offer government to citizen (G2C), government to business (G2B) and government to government (G2G) services online. In these models, government services are offered through use of websites, blogs, portals and email systems. The models depend on the Internet technology to avail information and services to the users. These models offer static information and are non-interactive, implying that users take long to notice when new information or online service is available. Additionally, users do not receive feedback immediately. These e-government models have been found to be ineffective, inefficient and unreliable (Backus, 2001; Heeks, 2003). On the other hand, in instances where SMS-based models are used, not all users are able to access the e-government information and online services. This is because the SMS-based e-government models depend on smart devices that can connect to the Internet and are capable of running most the applications required to access online information and services. However, majority of consumers of e-government services use the basic-feature phones with limited functionalities. Such consumers are denied their rights to access e-government information and online services. The mentioned limitations of web-based and SMS-based models motivated the design and development of an integrated model that uses Email-SMS alert system to enhance the existing web-based e-government models.

3. Objectives of the Study

The objectives of this survey were to;

- Establish the e-government services consumer experience on use of web-based and SMS-based models.
- Design, develop and test a prototype of an email-SMS alert system for enhancing the web-based e-government models.

4. Methodology

The study adapted descriptive research through a survey and prototyping designs. Descriptive research design was used since it describes the state of affairs as it is. According to Orodho and Kombo (2005) descriptive design is used when collecting information about people's attitudes, opinions, habits and other possible behavior. The prototyping design is used in systems design to test a concept before the real system is developed Trevor & Hilbert (2004).Questionnaires were used to collect the views on the experience of consumers of e-government a service in a government agency i.e. University of Nairobi. Data collected was analysed using Statistical Package for Social Science (SPSS). Based on the results obtained after data analysis, a prototype of an email-SMS alert system was designed, developed and tested to enhance the web-based e-government service delivery model.

5. Findings and Discussion

5.1. Information on Email Account Ownership

The study sought to establish whether consumers of e-government services at the University of Nairobi owned email accounts. The results shown that m of the respondents (89.3%) admitted to own email accountsas in Table1 below;

Do You Own an Email?	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	75	89.3	89.3	89.3
No	9	10.7	10.7	100.0
Total	84	100.0	100.0	

Table 1: Information on ownership of email accounts

This was an indication that email systems were the popular web-based technologies used to offer e-government services in the government agencies.

5.2. Information on Frequency of Access of Email Account

The survey also sought to established how often the email accounts were accessed by owners. The results showed that a majority of the respondents (54.8%) checked their emails only once per week as shown in Table 2 below;

Weekly Email Access	Frequency	Percent	Valid Percent	Cumulative Percent
Once	46	54.8	54.8	54.8
Twice	16	19.0	19.0	73.8
More than twice	18	21.4	21.4	95.2
Not at all	4	4.8	4.8	100.0
Total	84	100.0	100.0	

Table 2: Frequency of Checking Email Accounts per Week

This indicated that even though email systems were the main technologies employed to deliver e-government services, majority of the consumers of the services rarely checked their email accounts and therefore delayed or missed some information and services or whenever posted. This was attributed to the fact that the email systems did not have a mechanism of notifying the consumers whenever new information or service was available and users take long to get feedback Backus (2001).

5.3. Information on Whether Failure Get or Give Feedback Affect Decision Making

The survey sought to establish the opinion on how failure to get feedback or give back through delayed access to emails affected decision making. Majority of the respondents as shown in Table 3 below, i.e. 36.9% strongly agreed and 38.1% agreed that failure to get or give feedback through email affected decision making in the government agency.

Level of Agreement	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly agree	31	36.9	37.8	37.8
Agree	32	38.1	39.0	76.8
Not sure	11	13.1	13.4	90.2
Disagree	7	8.3	8.5	98.8
Strongly disagree	1	1.2	1.2	100.0
Total	82	97.6	100.0	

Table 3: Response on How Failure to Get or Give Feedback Affects Decision Making

The study established that failure to respond to urgent email messages notably affects the interaction and transaction phases of the web-based e-government model proposed by Baum & Di Maio (2001) and in UN's Five-stage model and Siau and Long (2005). This affected decision making in government agencies which in turn affected service delivery. The survey established that the web-based e-government models can be slow mode of service delivery, especially at the interaction and transaction phases if information turn-around time is not put into consideration during the design and implementation of these models

5.4. Mobile Phones Ownership, SMS Charges and Popularity

This survey sought to establish the popularity of mobiles phones and SMS use among the respondents. From the respondents, 98.6% own a mobile phone as shown in Table 4 below.

Mobile ownership	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	79	94.0	94.0	94.0
No	5	6.0	6.0	100.0
Total	84	100.0	100.0	

Table 4: Information on Ownership of Mobile Phones

This was an indication that consumers of e-government services owned mobile phones, however, from the study; most of the mobiles owned were basic-feature phones since majority of the respondents (72.6%) could not access Internet and emails on their phones as shown in Table 5 below:

Access of Internet and Email Through Phone	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	23	27.4	27.4	27.4
No	61	72.6	72.6	100.0
Total	84	100.0	100.0	

Table 5: Access of Internet and Email through the Phone

On SMS charges and popularity, most of the respondents, 42.9% strongly agree and 48.8% agree that the current downward trend of SMS charges has made SMS become an affordable tool of communication among mobile users. This has made SMS a popular tool of communication compared to email as according to 47.6% who strongly agree and 42.9% who agree of the respondents as shown in Table 6 below;

SMS Charges & Popularity	Strongly Agree		Agree		Not sure		Disagree		Strongly disagree		Total	
According to the current trend in mobile phone service charges, SMS charges have become affordable	36	42.9%	41	48.8%	1	1.2%	3	3.6%	3	3.6%	84	100.0%
SMS has become a popular tool of communication owing to its affordable charges	40	47.6%	36	42.9%	4	4.8%	4	4.8%	0	.0%	84	100.0%

Table 6: SMS Charges and Popularity

This indicated that the use of mobiles and SMS to deliver e-government service was gaining root in most of the government agencies and most of the consumers owned mobile phones and as market forces made mobile service charges to drop (Emeka, 2010). According to Susanto and Goodwin (2006), people in developing countries are more familiar with SMS than Internet, the number of SMS users is much higher, the SMS infrastructure is more extensive, and the SMS cost as well as mobile phone prices are much lower and affordable compared to the Internet and PCs, indicating that SMS-based e-government could be the most appropriate channel to deliver e-government services in developing countries.

5.5. SMS Reliability and How It Can Improve Email Reliability

The survey sought to establish the reliability of SMS as compared to that of email tool and whether SMS can be used to improve reliability of email. Most of the respondents, whom 41.7% strongly agree and 42.9% agree, admitted that SMS is a faster and reliable tool of communication compared to email as shown in Table 7 below:

SMS Reliability Compared to Email	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly Agree	35	41.7	41.7	41.7
Agree	36	42.9	42.9	84.5
Not sure	6	7.1	7.1	91.7
Disagree	7	8.3	8.3	100.0
Total	84	100.0	100.0	

Table 7: SMS Reliability as Compared to Email Tool

This indicated that majority of the consumers used SMS for communication more often than the email due to its unreliability. However, the unreliability of email in this case could be attributed to the fact that the consumers did not have smart mobile devices and had difficulties in accessing their email account because of lack of Internet due to poor infrastructure in the country and impeding high cost of accessing Internet. This was an indication that as much as web-based e-government models were being used, the technologies used to implement the models were not reliable despite the fact that more information and online services could be shared and retrieved using such technologies.

The finding from this survey indicated that there was need to enhance the web-based models by integrating its implementation tools with the SMS systems (SMS-Based models) so as to improve on its effectiveness, efficiency and reliability. The results necessitated the design, development and testing of an Email-SMS alert system.

6. Email-SMS Alert System Prototype Design, Development and Testing

The proposed solution was to enhance the Web-based e-Government model by improving the functionality, reliability, effectiveness and efficiency of email communication tool commonly used in this model. The solution sought to synchronize communication between government SMS gateways and mail servers. This was to integrate both the web-based models (with focus on the email tool) and the SMS models. The goal was to have a communication model that eases the access of information and facilitate almost instantaneous response to information and services send through E-mails by sending instant alerts messages to the recipient's mobile phones when new emails are registered in their inbox. This aimed at eliminating the major limitation of e-mails where one cannot notice when a new email is send to him/her especially when offline.

7. System Design

7.1. Email-SMS Alert System Architecture

The system sought to interface an email server and a SMS gateway to ensure that when new messages are received in an email server, an SMS showing the Sender's address, Subject, Date, Time and the Email Flag is send to the recipient's mobile phone as per the proposed email-SMS alert system architecture shown below;

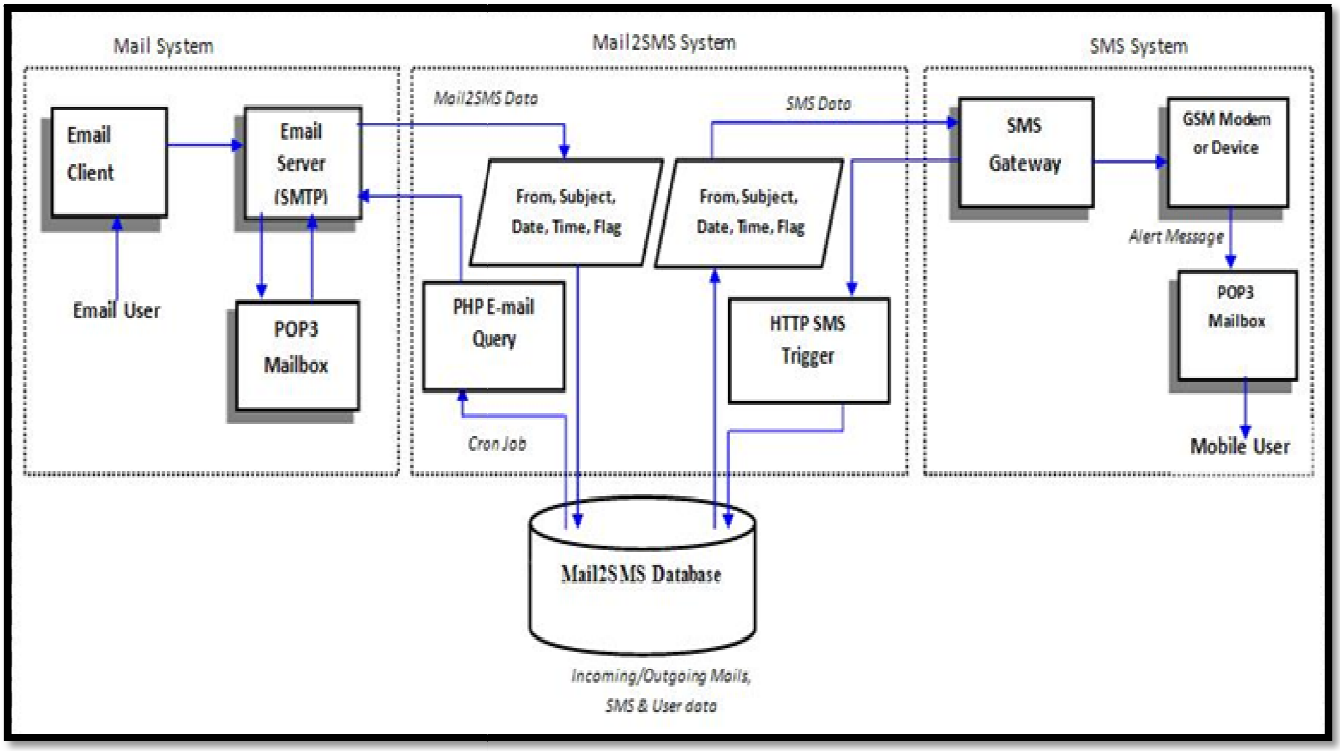

Figure 1: Proposed Email-SMS Alert System Architecture

7.2. Functioning of the Proposed Email-SMS Alert System

A PHP script was written to constantly query the email server for new emails received. The query will return the email address of the sender, subject, date, time and flag information in the email that will indicate whether the mail is urgent or not. This information will be written to a database. The SMS gateway through the http trigger listens through port 5050 to the database for the new data added which in send as a notification SMS through the SMS gateway to the recipient's mobile number that is stored in the database. A cron job was set up through the Windows Scheduler to execute the PHP script at regular intervals, for example, after one (1) minute, see excerpt below;

Cron Job Configurations
Start in:
C:\wamp\www\kyalo
Run:
C:\wamp\bin\php\php5.3.0\php-win.exe -f C:\wamp\www\kyalo/sms_sender.php

On receiving the notification SMS, the recipient can then log in to the inbox read the email on his or her computer, in the nearest Internet Access Centre for example in a Digital Centre, Cyber Café or a WAP enabled phone. This will ensure that an owner of an email account can be updated on every new email message sent to him or her and respond to it in time. This is expected to reduce the information turn-around time in organizations.

7.3. Database Design

A database for storing the various system entities was designed. The database will hold staff details, sent and received Email and SMS data. An Entity Relationship Diagram (ERD) was developed as shown in the **Figure 2 below**.

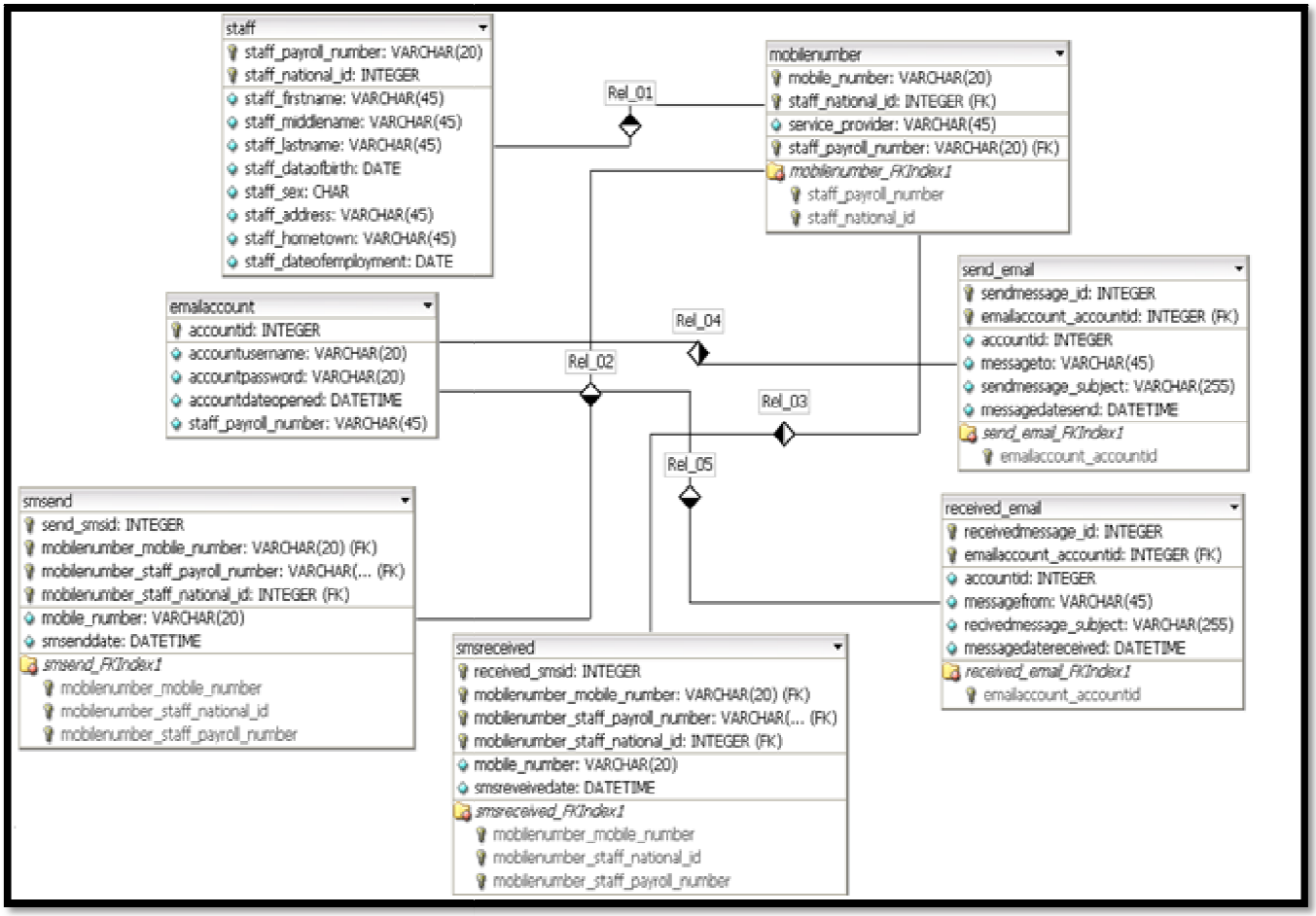

Figure 2: System Entity Relationship Diagram (ERD)

7.4. Software Requirements and Configuration

Open source software was used in this system. The Web server, Email Server, SMS Gateway, PHP code editor and the Email Client software were installed on the same computer. The software used included;

7.4.1. WAMP Server

WAMP Server is a Windows Machine/Software that has Apache, MySQL, and PHP on it. This is a webserver and was installed for local web administration using MySQL database and Apache. The version of WAMP used for this project is WAMP 2.0. A database named EMAIL2SMS was created.

7.4.2. HMAILSEVER Mail Server Software

This is an open source mail server that can run on both Linux and Windows platform. This was used in order to administer mail services. It can run on an external data base like MySQL and helped to create an email domain. The version used was HMAILSERVER 5.3.1.

7.4.3. Dreamweaver

This was used for coding and testing PHP script for sending SMS. Version 8.0 was used.

7.4.4. Mozilla Thunderbird

This is email client software that was used for testing the sending and receiving of emails. The version used was Thunderbird 3.1.6. In this SMTP, POP3 and local host configurations were done and enable push and pull of mail into the database and retrieving the mails from the database in the local host.

7.4.5. Frontline SMS Gateway

This is the SMS gateway software that was used in this project. It was used to facilitate the sending and receiving of SMS through a GSM device or modem. The Version used in this project was FrontlineSMS Version 1.6.16.3.

7.4.6. PHP SMS Code

A PHP code for SMS sending was developed to ensure synchronization between the Email Server and SMS gateway. The code developed is shown in the Figure 3 below.

```
<?php
$con=mysql_connect("localhost:3306","root","");
if ($con)
{
mysql_select_db("mail2sms",$con);
}
else
{
die("Could not Connect");
}
$query="select max(messageid) as msgID from hm_messages where is_read='0'";
$result=mysql_query($query);
if (mysql_num_rows($result)>0)
{
$fetch=mysql_fetch_array($result);
$details=mysql_fetch_array(mysql_query("select
metadata_from,metadata_subject,messagecreatetime,metadata_accountid,messageaccountid,accountaddress,accountid,accountdomainid,accountpriority,accountmobile from hm_messages,hm_message_metadata,hm_accounts where messageid=metadata_messageid and
accountid=metadata_accountid and messageid='".$fetch['msgID']."'"));
$recipient=urlencode($details['accountmobile']);
if($details['messageaccountid']=$details['accountid'])
{
$smsender=urlencode($details['accountpriority']);
}
$message=urlencode("New Email from: ".$details['metadata_from']."\. Subject: ".$details['metadata_subject']."\. Received on
".$details['messagecreatetime']."\. Priority: ".$smsender);
$confirm=urlencode($details['accountdomainid']); //Confirms the domain to filter the emails at the domain level
if($confirm<2 and $details['accountmobile']) //Ensures that SMS is send only to the email accounts in DomainId 1 and only to the mobile
number fetched
{
//send sms alert
file("http://localhost:5050/send/sms/".$recipient."/".$message."/");
mysql_query("update hm_messages set is_read='1' where messageid='".$fetch['msgID']."'"); //Ensures an SMS is not send to same
number for same email message more than once
mysql_close($con);
}
else
{
die('');
}
}
?>
```

Figure 3: PHP SMS Sender Code

7.5. System Testing

Testing the functionality of the system was done to ascertain whether the system could send SMS notification to the mobile number of an email account when a new mail was received in the user's inbox. Sample output of the send SMS test data was as shown in Figure 4 below;

Received Sent From To

Status	Date	Sender	Recipient	Message
Pending	14/03/2011 10:57:00	352008035834610	+254750491041	New Email from: "kyalo@kyalo.ac.ke" <kyalo@kyalo.ac.ke>. Subject: Project Corrections. Received on 2011-03-14 10:56:08. Priority: High
Pending	09/03/2011 14:27:00	352008035834610	+254712422824	New Email from: "musyoka" <musyoka@kyalo.ac.ke>. Subject: flag 13. Received on 2011-03-09 14:26:30. Priority: Very High
Sent	09/03/2011 15:32:25	352008035834610	+254750491041	New Email from: peter@kyalo.ac.ke. Subject: yes It works good wow. Received on 2011-03-09 15:29:27. Priority: High
Sent	09/03/2011 15:34:00	352008035834610	+254750491041	New Email from: peter@kyalo.ac.ke. Subject: yes It works good wow. Received on 2011-03-09 15:32:52. Priority: High
Sent	09/03/2011 15:34:25	352008035834610	+254727379483	New Email from: musyoka@kyalo.ac.ke. Subject: Re: sasa. Received on 2011-03-09 15:32:47. Priority: Normal
Sent	09/03/2011 15:35:00	352008035834610	+254727379483	New Email from: musyoka@kyalo.ac.ke. Subject: Re: Flag 12. Received on 2011-03-09 15:27:21. Priority: Normal
Sent	09/03/2011 14:33:00	352008035834610	+254727379483	New Email from: "mburu" <mburu@kyalo.ac.ke>. Subject: flag 13. Received on 2011-03-09 14:31:51. Priority: Normal
Sent	09/03/2011 14:34:00	352008035834610	+254727379483	New Email from: "mburu" <mburu@kyalo.ac.ke>. Subject: flag 13. Received on 2011-03-09 14:31:51. Priority: Normal
Sent	09/03/2011 14:34:25	352008035834610	+254727379483	New Email from: "mburu" <mburu@kyalo.ac.ke>. Subject: flag 13. Received on 2011-03-09 14:31:50. Priority: Normal
Sent	09/03/2011 14:35:00	352008035834610	+254727379483	New Email from: "mburu" <mburu@kyalo.ac.ke>. Subject: flag 13. Received on 2011-03-09 14:31:50. Priority: Normal
Sent	09/03/2011 14:39:00	352008035834610	+254733805246	New Email from: "kyalo@kyalo.ac.ke" <kyalo@kyalo.ac.ke>. Subject: Re: fine tuning. Received on 2011-03-09 14:38:10. Priority: Very High
Sent	09/03/2011 14:40:00	352008035834610	+254733805246	New Email from: "kyalo@kyalo.ac.ke" <kyalo@kyalo.ac.ke>. Subject: Re: finetuning. Received on 2011-03-09 14:38:05. Priority: Very High
Sent	09/03/2011 14:40:25	352008035834610	+254727379483	New Email from: "kyalo@kyalo.ac.ke" <kyalo@kyalo.ac.ke>. Subject: Re: Flag 12. Received on 2011-03-09 14:37:55. Priority: Normal
Sent	09/03/2011 14:41:00	352008035834610	+254750491041	New Email from: "kyalo@kyalo.ac.ke" <kyalo@kyalo.ac.ke>. Subject: Re: Project. Received on 2011-03-09 14:37:46. Priority: High

Figure 4: Sample Test Data Output

7.6. Handling SMS for Unwanted Email Messages

During the system testing, it was found that users were not be willing to receive SMS notifications for all emails received in their inbox since some were junk mails. Domain based filtering techniques were used to filter unwanted emails from being received in the users email account. This means that if an email was blocked at the domain level, it would not be received in the user's account and therefore an SMS would not be send to the user. For the purpose of this study, Domain Name Server Blacklist was used to ensure that SMSs are not send for email accounts in the blacklisted domain/s. The PHP SMS sender code was also designed to send SMS only for emails from only one of the given domains as shown in the code excerpt below;

```
$confirm=urlencode($details['accountdomainid']); //Confirms the domain to filter the emails at the domain level
if($confirm<2) // checks whether the domainid is less 2 and if so sends SMS to only the email account in this domain
{
file("http://localhost:5050/send/sms/".$recipient."/".$message."/");
mysql_query("update hm_messages set is_read='1' where messageid='".$fetch['msgID']."'");
mysql_close($con);
}
else
{
die('');
}
```

8. Conclusion

In this study, it was established that Web-based and SMS-based e-government models were implemented by government Agencies in Kenya; however, website, web portals, blogs and email systems were widely used as the technologies for implementing the models. It was noted that the SMS being a fast tool of communication than email, it could be used for improving email tool through SMS alerts. This would improve e-governmentservice delivery done through email systems irrespective of the nature of phone a consumer has. This would enable consumers who do not have smart mobile devices to access web-based e-government services through anintegrated model and hence enable a seamless service delivery. The findings in this study concurred with Layne and Lee (2001) who in their web-based model, proposed two levels of integration, that is, vertical integration and horizontal integration. According to them, vertical integration should focus on integrating government functions at different levels, such as those of local governments and state governments while the horizontal integration should focus on integrating different functions from separate systems so as to provide users a unified and seamless service. The study further established that SMS and the Internet may complement each other in a government's digital service delivery, for example, a citizen may send a form or pay a public service electronically by Internet and get notification via SMS, or pay the services through SMS and get the receipt by email.

9. Recommendations

The study made the following recommendations;

- Governments should adopt enhanced e-government models that do not discriminate consumers of e-government services based on infrastructural challenges
- Web-based e-government systems should include SMS notification modules to notify consumers when a new information or service in available
- Manufacturers should consider developing low cost smart devices that are affordable to low income earners
- Governments should subsidize Internet and mobile charges for low income earners to access e-government services.

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