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A MOBILE APPLICATION TOOL TO MITIGATE COMMUNICATION CHALLENGES IN WATER RESOURCE MANAGEMENT OF LAKE VICTORIA BASIN

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Abstract

Lake Victoria Basin is a very important resource for the five riparian countries: Uganda, Kenya, Tanzania, Rwanda and Burundi. The Lake Victoria Basin provides resources for fishing, agriculture, medicine, forestry, water transport and other economic activities. However, its surrounding is affected by population growth, urbanization, industrialization, increasing commercial activities and inadequate provision of sanitation services among others. These grossly affect the landscape and water resources around the lake. In this paper, a web based mobile application tools (MAT) prototype is presented. The system consists of web access, mobile access, web service handler, mobile service handler and a database. It can be used to mitigate communication challenges by enhancing stakeholder's participation, information sharing and enforcement of laws by timely communication and coordination of activities of good governance. The test results confirm that the system is effective and can be used to operate in real world environment in the management of water resources by providing the key actors with relevant information to facilitate decision making.
Keywords: Communication, Information Sharing, Lake Victoria Basin, Water Resource Management, Mobile Application Tool.

1. INTRODUCTION

Wang et al. (2015) observed that water resources face many severe challenges which include contamination, aging infrastructure, lack of data for informed decision making, weak public awareness of water challenges, and inefficient water management strategies. A lot of these challenges, according to Gebrechorkos and Fathy (2016), and Anzaldi (2014) are due to global change issues, such as population growth, economic development and climate change.

Choil, Chong, Kim and Tae (2016), noted that "water related hazards account for 90% of all natural hazards, and their frequency and intensity are generally increasing". They projected that in the next 20 years, the gap between water demand and availability is will grow significantly and is expected to reach 40% by 2030. The authors above also noted that climate change is causing increased water shortages and more frequent, more severe droughts, especially in Europe and Mediterranean countries (Anzaldi, 2014).

Ospina and Heeks, (2012) noted that appropriate climate change information that is reliable, context-specific, targeted to local audiences, delivered in non-technical language and in user-friendly format, is lacking.

In Uganda, Lake Victoria Basin (LVB) is the major stimulus of population growth, industrial and agricultural activities which represents social, economic and political dimensions of water resource characteristics. According to Okurut (2010), it is estimated that 200 tons of untreated effluents are discharged into the Lake Victoria every day .He added that the greatest work to be done to save water resources in Lake Victoria is to fully enforce by laws and regulations**.** Surprisingly, according to the research findings of Linuma and Tenge (2017), people living around the Lake Victoria Basin were not aware of the formal institutions that are involved in water resources management in LVB

According to East African Community Development Strategy assessment (EAC, 2006-2010), it was revealed that communication and knowledge sharing are vital for resources management in Lake Victoria Basin. At the moment, there are inadequate stakeholders' participation, inadequate communication and information sharing strategies; water quality monitoring and evaluation process is entirely manual. Hence, there is a need to develop an ICT tool which can help to timely communicate and coordinate activities of governance of LVB

Ospina and Heeks (2012), pointed out that issues such as geographical remoteness, difficulties in transportation and social marginalization, low literacy levels, lack of relevant and appropriate information normally constrain awareness for the local audiences. They also argued that lack of adequate skills and technologies to record and analyze data, are some of the mitigation actions that water resources management faces (Wang et al., 2015).

1.1 Governance Challenges

In order to govern natural resources for example ecosystems, forests, lakes, rivers, natural resources and agricultures successfully, Ssozi, Blake and Rivett (2015) recommend that "there is need to face the increase diversity of connections between different environmental characteristics and decisions of local, regional, national, and supranational relevance, with high coordination and exchange between administrative entities and actors across the public/private and the expert/stakeholder divide", see also (Zacharoula, 2012). It is also noted that consumers in the water sector provide a weak influence in decision (Vermesan and Friess, 2013).

Anzaldi (2014), argued that "traditional approaches to water resources management have typically been handled by technical people and developed for very specific purposes and do not include interactions with the end users or stakeholders and that, they don't include important factors that are transparent to the public".

To achieve sustainability, Philippe (2011) noted that all countries are required to apply an integrated and participatory water resource management approach. This again implies that technological changes can help improve services to people and help reduce the stress on water systems around the world. Without adequate intervention in the management of water resources, it is clear that the poor will suffer even more. Managing scarce water resources requires the application of appropriate technology, some of it embedded in traditional knowledge and some inspired by fresh science research work and new insight (Mongi, Majule, & Lyimo, 2010).

2. PROPOSED MAT PROTOTYPE

2.1 System Design

The prototype was designed using the usual phases of system design and development: conceptual, logical and physical design. The system architecture from the logical design describes the flow of information and how, requests and responses are processed. The physical part presents the user interface design, database design as well as hardware and software requirements. The iterative spiral model facilitated the use of a core subset of diagrams and a framework that enabled switching from use cases to code. This gave the researchers a more structured and manageable coding cycle.

The Mobile application was developed using Java 2 Mobile Edition (J2ME), web services were developed using HTML, CSS for display and php scripting for accompanying dynamic events. Elements developed are presented below;

Online server: This is the online web service that receives every request from either a web browser or mobile app and routes to the corresponding services source.

Web interface server: Offers web service that handles all web browser requests.

Mobile app server: All requests from mobile app are handled by web service.

Svc: These are the actual web responses that both browser and mobile app request for.

2.2 Database Management System

My SQL was used to create the database for storing data relevant to water resource management around Lake Victoria Basin. SQL was used to create and connect relational tables. The design includes users' authentication. Figure 1 shows the connection between the different elements of the MAT prototype.

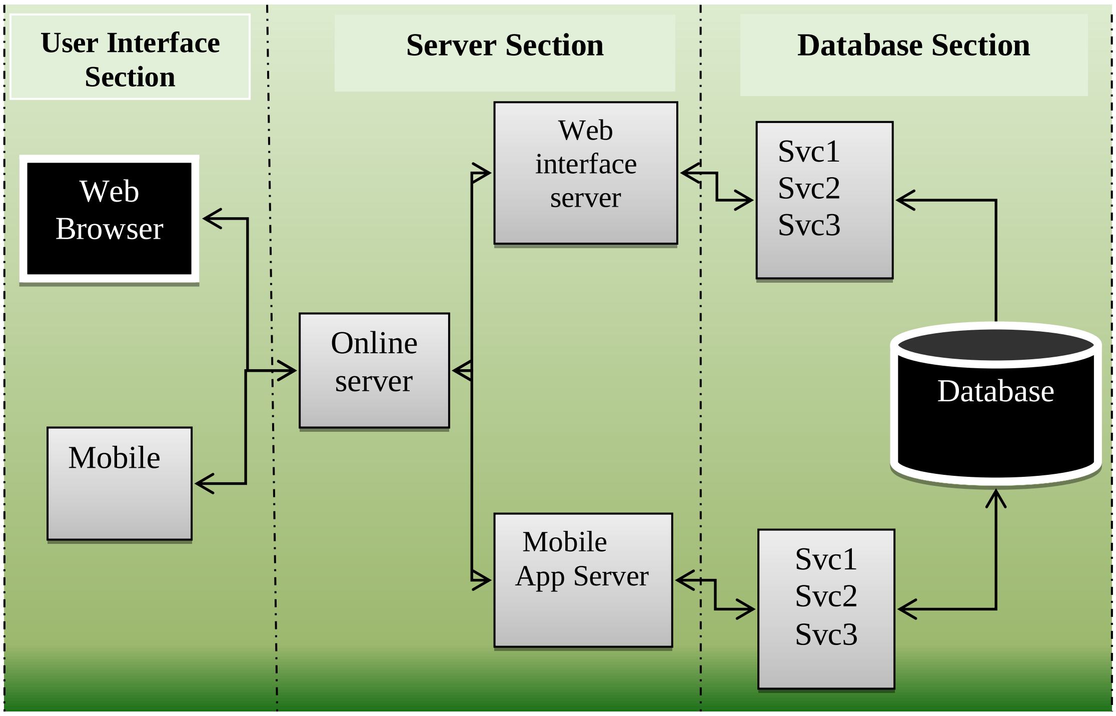

Figure 1: Physical / Overall System Architecture

2.3 Mobile App Implementation Design

Figure 2 shows mobile application implementation design. It shows a physical design which describes the hardware and software that were required in the logical design and the interfaces of the implemented system. It is the actual technical implementation running design. Graphical design was by NetBeans IDE (version 8.2). The mobile app is developed using J2ME (Java) as the programming language.

Design elements includes: *Mobile devices:* Activity that launches the mobile app, *splashScreen*: An alert screen introducing the app by a short text, *loginScreen:* A prompt that demands user to enter their login credentials, *event:* to select between sending and retrieval of info online, *viewinfo:* This comes after user has selected view info, *currentnotices:* This is the text holder which displays the text content retrieved from online, *Sendmessage:* Under this, one is prompted to further clarify whether information to send is a communication SMS or an observational update, *field_of_update:* is where one intends to send an observational update that belongs i.e. forestry, fishing and water., *text_prompt:* one enters the text content meant to be uploaded to the online database, *closure_screen:* *Recipients:*It contains the various categories describing registered users like office titles, residence, and operation station, *known_lists:* These are the registered occurrences of each item that could be selected from the previous prompt. For example if one had selected operation station form the previous prompt, this prompt list would contain all existing operation/duty stations registered in the online system. *sms_prompt:* prompts to enter the text message that will be pushed to recipients, *last_screen:* message status report display.

2.4 Demonstration and Functionality Testing

Prototype was accessible for demonstration and testing. The test results were fed back for fixing bugs. The process was repeated till an acceptable working state was achieved

System Hosting/Demonstration

Ngrok (2018) software was used for hosting the system. It is a free online platform that gives local server presence on the web. In this case it directs all packets going to the specific subdomain down to the local machine's server. When the client program is downloaded and installed, it runs giving the particular a temporary subdomain which should be used on the web. All requests made to this subdomain are routed down through the client and unto the actual server on the local machine. For a specific customized sub domain name, one has to sign up to register this sub domain name. If you want to make your local host accessible from the internet, such that someone types a specific url and then get the services on your local machine, follow the procedure below. Download ngrok client, simply run it via command line specifying which port your server is running at as below.

C:>C/<*path to your ngrok file*>/ngrok 8080, In this case, the server is running at port 8080, Ngrok will then connect to the online platform and return the sub domain created for you. At this point your local server is online by virtue of that sub domain. When there is a connection to your local server, Ngrok will list it at the command line interface.

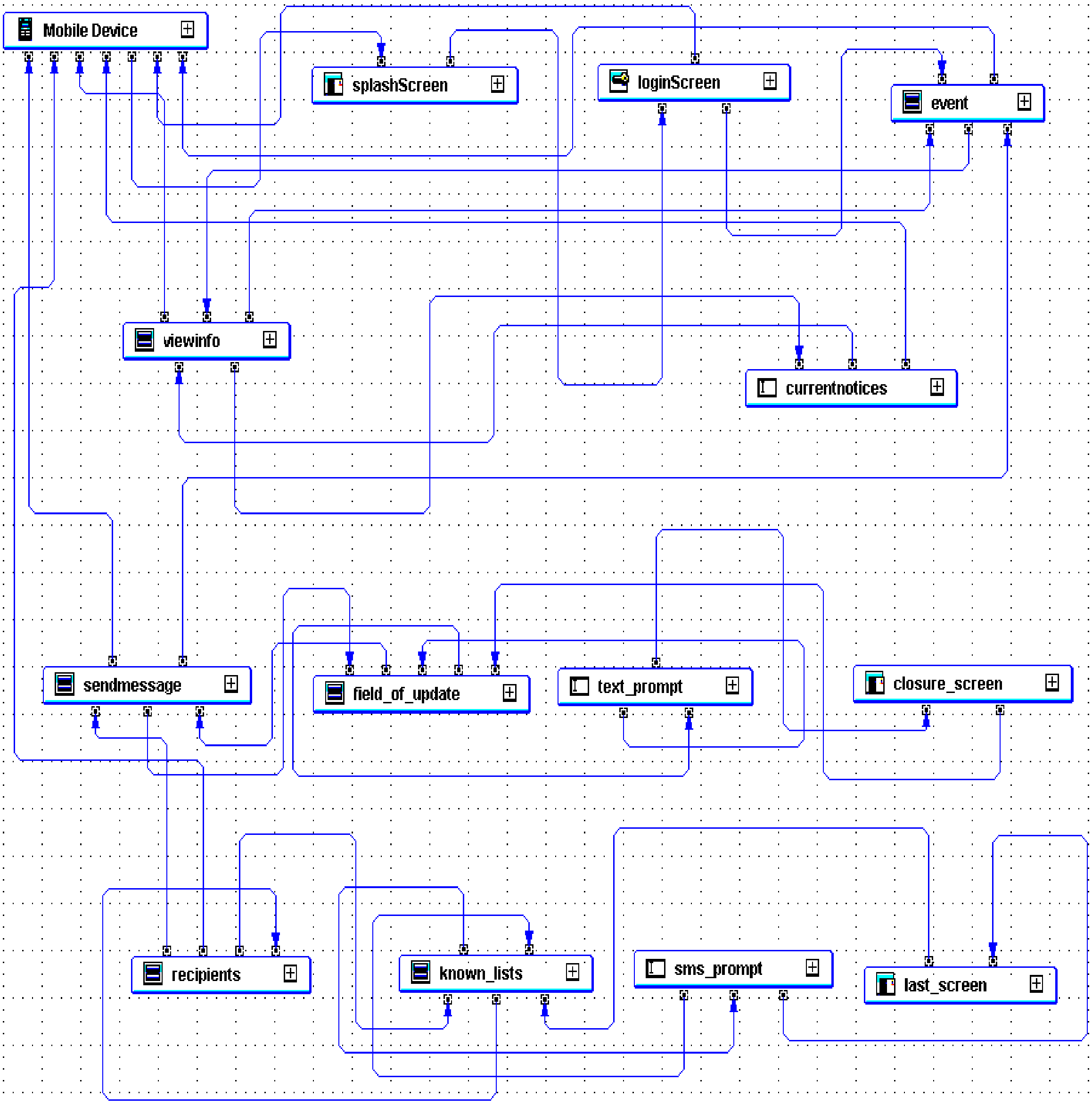

Figure 2: Mobile Application Implementation Design

2.5 Testing

The integration of the various components was achieved by data input in to the system and obtaining the output information. In cases of errors, correction measures were followed until the expected output was realized.

2.6 In-house Testing

In-house testing was done to assess the system functionalities in a controlled environment and to provide researchers with the information on the quality of service. The system enables interaction of these stakeholders by the use of mobile phones, local radios, TVs and Internet.

i Users were able to send data to the central database which were visualized through the web-based portal. The web-based solutions had groups of all users and their priorities in the system. All the user groups were able to open the website, create post, view and comment on the available posts.

ii For mobile-based solution, users were able to send SMS to the system. However, the received SMS could only be viewed by authorized users for example Radio and TV presenters, System Administrators, water quality experts and managers. Upon receiving data on LVB, the system was able to notify classified users mainly those in authority and law enforcers by SMS and email.

3. RESULTS AND DISCUSSIONS

3.1 A Uniqueness of the MAT

MAT integrated the best features from internet, radio and mobile phone solutions. The integration allows for the system to benefit from strengths of individual technologies. The system integrates a web-based portal which allows stakeholders with access to the Internet to communicate, create and share knowledge, report and get feedback at anytime and anywhere.

Some of the existing solutions apart from missing the integration aspect did not fully solve the challenges of coordination, participation and sharing of data and information. Integration of web-based solutions with mobile technology enables community members with mobile phones to interact with the system through sending and receiving relevant multimedia information on LVB water resources.

The system empowers technicians at community level to capture and send data on LVB without a need to travel long distances with paper and pen. The current practice is not only costly but also prone to human error. The sent data can then be viewed by responsible LVB monitoring officers anywhere through the web-based application. The data and information can further be relayed through other components of the MAT to other stakeholders depending on need and sharing policy of the organization.

The graphical presentation can further simplify data visualization and interpretation for appropriate interventions or decision making. The information can be of great importance for enhancing law enforcement initiatives, checking on accountability, formulation of laws and regulations, awareness creations and even for improving health standards of community members.

Integration of the radio component allows for the interaction between the system and radio presenter has a bigger audience whereby important information for the purpose of creating awareness, educating, and sharing can be broadcasted to reach the entire community simultaneously.

3.2 Different Stakeholders levels supported by the System

The developed system supports five actors: Community with web access, Community with basic mobile phone access, Law enforcers, System Manager and Radio presenter. Each actor has different roles in the system as shown below in the table

Table 1: Showing Actors and their roles

S/N	ACTORS	ROLES
1.	Community with web access	1. Upload or view videos and/or photos, 2. Send or receive messages, 3. Communicate with social Networks
2	Community with mobile phones	1.Sends or receive sms
3	Law enforcers	1.Receives notifications through email, web and mobile phones
4	Managers(policy makers)	1. Communicate through text, audio, video in real times.
5	Radio presenters	View message through sms, or web browsers

3.3 Socio-Economic Benefits

MAT will contribute towards the economic empowerments by improving the livelihood of the communities around the basin by eliminating some of the poor practices that affect water resources in LVB, minimizing monitoring costs and improving accountability in the governance of Lake Victoria Basin. It will reduce costs incurred currently in manual recording, transfer and storage of data as well as risk of unreliable data due to human errors.

4. CONCLUSIONS

This paper examined the challenges faced in water resource governance and management in most of the selected water bodies in the world including LVB. It was discovered that participation of all the stakeholders in the governance of water resource is paramount. There is no way participation of all stakeholders can be achieved unless there is a reliable communication system in place. Since stakeholders are different and complex in nature, and given the fact that they use different platforms, there is a need for an integrated system developed to bring all stakeholders on board to enhance Water Resource Governance in LVB. MAT is an integration of web based, Mobile Apps, internet, social media, Television and Radios in one platform so as to cater for many stakeholders such as community leaders, Policy makers, Government Organization, Non-Government Organizations, Community Based Organizations and law enforcers in Lake Victoria Basin. *Limitation.* Despite the fact that the system can perform many functions, it does not guarantee at the moment, the secure transfer of information among members. However, as the prototype matures to a full-blown Mobile Application, data and information security will be improved upon, especially during system validation. It wasn't possible to visit all the countries of the East Africa Community due to logistical constraint.

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