An M&E mobile based Application for Pico PV Lighting Solutions for the "Kerosene Free Kenya" Project

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Abstract

This paper describes the use of a mobile based application used as a Monitoring and Evaluation (M&E) tool to a pilot project supported by the National Council for Science and Technology of Kenya (NCST) which seeks to research best practices and lessons learned in the dissemination of Pico PV systems to rural households in Kenya. In order to overcome the affordability barrier a microfinance institution (MFI) was brought into the system, to properly handle the challenge of access to finance while Lighting Africa will provide standards for the products to be distributed. Many of such pilot system have been used in practically all countries of East Africa. The novelty of the present one is the use of an Unstructured Supplementary Service Data (USSD) mobile based tool to collect and transmit data. This will make the analysis of the product quality, user experience and faults much simpler and given the two ways relationship between the researchers and the users, consumer satisfaction and product improvement is envisaged to happen in a to date unprecedented manner. As the clients are distributed in a known geographical region, the researchers have provided for the training of technicians to handle repairs and battery replacement locally. As the duration of the project is 2 years, it is expected that the follow up of product performance and life span will be measured way beyond its payback period.

1 Introduction

Kenya has about six million households which are not yet connected to the national grid. This is a rather expected situation as the country counts with just above 16% of its population having access to electricity [1]. Most of these customers are city dwellers and rural electrification is almost negligible. When night falls, the only option for lighting is the use of kerosene powered lamps called locally "koroboi".

It is estimated that each household spend on average about 25 US cents of a dollar per night for lighting in kerosene. If we multiply this figure by the above mentioned number of households we find that Kenya spends each day 1.5 million USD in kerosene for lighting purpose only. For a country as poor as Kenya and with no local production of products derived from petroleum this is short of a national disaster as the nation spends more than half a billion dollar per year in lighting.

The situation is paradoxical and further difficult to understand when one realizes that the level of insolation in the country is very high throughout the year. A number of private sector companies are currently engaged in the business of disseminating solar lanterns which apart from providing clean lighting can also charge the ubiquitous mobile phones which are widespread throughout the Kenyan geography making the charging of these gadgets yet another challenge to the rural people in areas where electricity is not available.

The Government of Kenya announced an ambitious plan to phase out the use of kerosene for lighting and cooking, and replace it with clean energy products such as solar lighting kits, at the recently concluded Rio+20 conference.

Kenya and Norway signed an energy and climate agreement which will develop a framework policy for renewable energy and energy efficiency that will enable more widespread adoption of solar lighting products and improved cook stoves, displacing kerosene. [2]

The Mobile and Web-based Sales Tracking, Monitoring and Evaluation System that will be used by researchers to monitor and evaluate the sale and use of 500 Pico PV systems is described in detail.

2 Summary of the project

The project has basically four categories of partners, namely: researchers (Strathmore University, UNIDO, and Lighting Africa), Mobile Application developers (@iLabAfrica), Micro Finance Institution (MicroAfrica) and the Technology providers (ten of the many companies disseminating Pico systems in Kenya). These ten companies were selected based on a thoroughly done survey by Lighting Africa which has set standards for these types of product. Such standards have been accepted by the ICE.

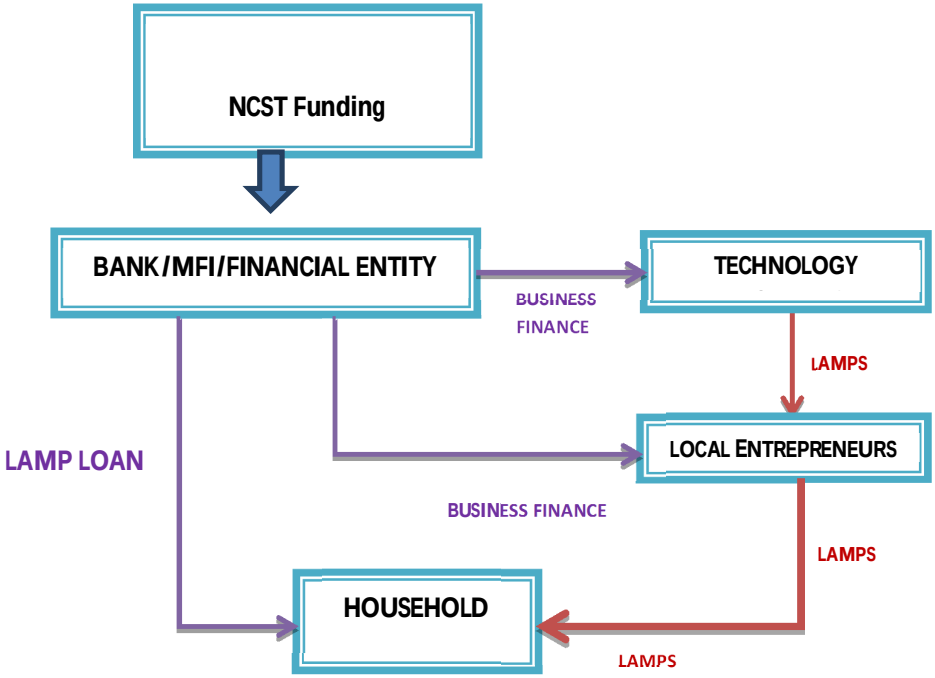

Figure 1 – Methodology [4]

The Project aims to distribute Pico PV lighting and with the objective of collecting data from customers remotely without necessarily having to visit them or even know where they are located. The users are meant to pay in installments through direct sales or mobile money transfer such as Safaricom's M-PESA. The data collected from customers will be used to create reports that will assist researchers to evaluate the usage and performance of the systems and general customer satisfaction.

The figure below shows the System Architecture which has been developed by the centre of excellence in mobile applications of Strathmore University @iLabAfrica.

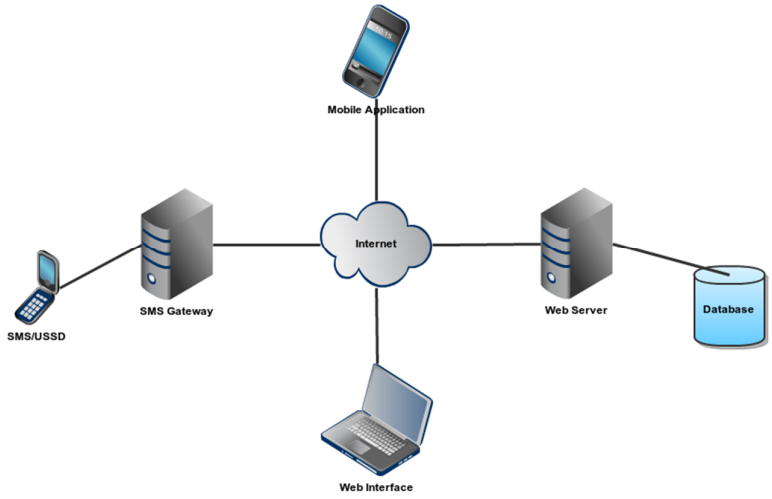

Figure 2 – System Architecture [3]

3 Functional Requirements

Database

The system shall include a database that will collect and host all the sales, monitoring and evaluation data. This data will include customer's details, sales information user profiles, locations and survey information. The system shall then generate the appropriate reports with information from users' location, personal data, phone number, possibility of communication to/from.

Web Interface

The web interface will be accessible through the internet. It will provide a register of beneficiaries, technicians, MFI field officers, team members that can access the database; managed by researchers. It will also provide access to the general public interested in graphs, mapping (Google map GPS taken via photos), reports, etc. This site will have a responsive web interface (responsive means the web interface will automatically customize to the screen size of the device without loss of information and quality) because it is supported by most phones with a GPRS connection.

The mobile web will also support offline data storage and only update the database when a connection is available. This feature takes into consideration the uneven mobile network coverage in Kenya. Compared to an operating system specific app, mobile web shall be easier to manipulate in case of any new requirements besides being device independent.

SMS/USSD Application

The system will consist of USSD application to send message, selectively by filter, in different languages to people. (Unstructured Supplementary Service Data is a protocol used by GSM (Global System for Mobile) cellular telephones to communicate with the service provider's computers). USSD can be used for (Wireless Application Protocol) WAP browsing, prepaid callback service, mobile-money services, location-based content services, menu-based

information services, and as part of configuring the phone on the network). USSD messages are up to 182 alphanumeric characters in length. Unlike Short Message Service (SMS) messages, USSD messages create a real-time connection during a USSD session. The connection remains open, allowing a two-way exchange of a sequence of data. This makes USSD more responsive than services that use SMS.[6] It will allow feedback from users and information gathering based on the products that have been sold to the customers.

SMS and USSD shall come in handy when the researchers wish to carry out short surveys about the lanterns or PV systems, such as how they are performing. As well, meetings can be called and reminders can be issued using the two ways availed by the application. It can also generate tips to users on how to handle the gadgets. Safaricom offers these services but through third parties and researchers plan to get some short code from the mobile service providers in order to implement the above features.

Payment Integration

The systems shall be given to the households on cash-on-delivery basis (what about credit terms?); a receipt will be issued by the MFI record purpose. The Pico systems will be given to the MFI at bulk purchase costs and the MFI will add a reasonable margin to cover their loan operation. The NCST has availed funds for the researchers to purchase the lamps upfront and upon re-payment by users, set-up a revolving fund so as to increase the number of beneficiaries as the project progresses. The MFI has robust experience in receiving payment through mobile money provider such as M-PESA.

Reporting

The system will generate reports on an ad-hoc basis. The researchers will be able to access different reports based on a selected period and selected parameters. Reports will include information such as customers' registrations, number of sales, total payments collected, survey feedback, user satisfaction, number of failures and technical intervention.

4 Non-Functional Requirements

Security

The System makes use of user-profiles to limit access to various functionalities of the system. Authentication will be required to log into the system and different system roles will be assigned to ensure there is security of customer confidentiality and survey data.

The system shall initially have the following user-roles:

i) Manager/Administrator: Will be allowed to view registration reports and survey reports. Will also be allowed to add new users and assign roles and permissions to these users.

ii) Field Agent: Will be allowed access to register customers and save survey data through a smart phone application. This same feature is given to technicians.

iii) Customer: Will be allowed access using SMS/USSD to give feedback of products and request services such as technical support.

iv) Guests and the public shall only be allowed to see details as defined by researchers.

There will also be an access log to store system accesses and a mapping of system access to limit un-authorized access. System sessions shall as well be implemented for effective control and some expiry period per session when inactive shall be available too.

Performance

The system shall be updated and maintained regularly as requested by the client. @iLabAfrica development team shall be available to handle any arising issues as far as the system is concerned. The system will be accessible to any desktop, laptop or mobile device that has access to internet. The web design will be such that the interface is able to adopt itself to various screen sizes. The system will be developed in to enable addition of modules and features by any developer who will work on the system. The source code will be versioned using subversion systems (Git/SVN) and changes recorded to ensure development is documented. The system is scalable such that based on its success a nationwide scope can be implemented.

Software design/UML

In the above use case diagram (which one?), households/end users are simply the users of the PV lighting, field officers are in charge of the households in terms of distribution of the PV lighting and doing follow ups which include surveys. Similarly, researchers represent those interested in the various reports and analyses and feedback.

Profile information here are the details about the household including personal data, geographical location, family situation, etc. Whereas survey information is the feedback field officers collect concerning the PV lighting from the various users, payment records basically are the records about the installments a user pays.

Locations here stand for the geographical information about a user, each identified by a unique ID. A household must belong to a given location. Each Pico system is identified by a serial number. If the household buys two systems it will be clear that those two systems share the same location. Figure 2 represent a report which is automatically generated by the data submitted to the application by customers, technicians, MFI officers and researchers:

Figure 3 – Sample report from the application

Many other types of report can be automatically generated by the ones accessing the application. Some examples are: units sold, complaints report, technician's intervention, summary of inquires by users, etc.

Survey

The survey conducted via a smart phone uses a questionnaire provided in different languages as per the user's choice. This procedure eliminates the use of paper, the need for field researchers to collect data for each information collected by the mobile application goes directly to a structured database and becomes available to the various possibilities in the site.

As for the cloud based component of the system, Safaricom's domain is preferable. Safaricom is not only Kenya's leading mobile network operator but also a leading Internet Service Provider (ISP). The web and mail hosting services are cost effective packages with high speed. The packages combine domain registration, web hosting and mail hosting solutions along with many additional features to enhance the web experience as well as ensure the website data is secure. The cost of these packages is so affordable when compared with that of a conventional M&E survey making it manifest how much technology can bridge the gap between client and technology providers or researchers. @iLabAfrica will carry out tests, critical incidents tests and everything else before pushing to the application into the live environment.

Backups shall be done only at the small hours of the night and this applies to other arising issues to be handled by the development team, bugs shall be handled, and code testing. This will make the application readily available at practical all the hours of the day. Code maintenance will be done using collaborative tools available such as github.

5 Conclusions

As this is the first project in Kenya to use the ubiquitous mobile as a tool for M&E, the researchers expect to get the two following essential findings for Kenya in a much more affordable manner [5]:

1. What are obstacles impeding the adoption of clean lighting technologies?
2. What factors continue to influence the continued use of kerosene lighting?
3. What are the challenges faced by people using these new lighting technologies and what possible solutions exist?

Findings will be compiled and serve to advise the rollout of a kerosene replacement program by the government of Kenya expected to start in January 2014.

6 References

[1] Rural Electrification Using Off-Grid Solar PV Powered Energy Kiosks - Izael Da Silva, Strathmore University - Centre for Research in Renewable Energy and Sustainable Development, Nairobi, Kenya, in Proceedings of "Small PV Applications Symposium 2011, Ulm, Germany.
[2] http://www.lightingafrica.org/kerosene-free-kenya-rio-20-agreement-to-increase-access-to-clean-energy.html
[3] @iLabAfrica software support proposal
[4] NCST – Grant Application Form – Replacement ff Kerosene Lighting in Rural Households with Solar Lighting in A Pilot Area in Kenya
[5] GIZ Solar Lamps Field Test Findings 2010. https://energypedia.info/images/7/72/GIZ_Solar_Lamps_field_Report_Uganda_Webversion.pdf.
[6] http://en.wikipedia.org/wiki/Unstructured_Supplementary_Service_Data. Information obtained on 28th April 2013.

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