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# Evaluation of Existing Architecture for M-Mining Market Access Information Among Sugarcane Farmers in Migori County, Kenya

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***Abstract*– The application of mobile technology in agriculture is expanding rapidly, with new devices and applications being available for everyday use. However, the absence of seamless architecture required to integrate mobile devices with server has limited its use. Ideally this kind of architecture would enhance mining and dissemination of expert information to reach farmers on time. Consequently, farmers can hardly set prices and market their sugarcane products on time hence low income characterized by widespread poverty and low living standards. Although mobile data mining has been applied in other sectors of the economy such as transport and stock market, its application in agriculture is still wanting. There is therefore a need to upscale service oriented mobile data mining techniques to improve discovery and dissemination of agricultural market access knowledge. The objectives of this study were to: (i) examine existing architectures for m-mining agricultural resources; and (ii) evaluate their challenges using scenario and experienced based methods. Results showed the existence of predominantly manual system which was limited by various socio-economic and technological challenges including, inconsistency, error prone, poor internet connectivity. The results also showed that the choice of market for sugarcane greatly depended on the price and mode of payment. The study adopted service oriented architecture as the guiding model. The study recommended integration of mobile phones (SMS technology) as suitable architecture for m-mining and dissemination of market access information.**

***Index Terms*– Architecture, M-mining, Sugarcane Marketing and Seamless Technology**

## I. INTRODUCTION

STUDIES in data mining are creating new and more automated methods for discovering knowledge to meet the needs of the 21st century economies. The methods are driven by the business trends of one-to-one marketing, Customer Relationship Management, Enterprise Resource Planning, risk management, intrusion detection and web personalization. The business trends require customer-information analysis and customer-preferences prediction anchored on workable architecture that promotes remote interoperability among various devices. Similarly, sugarcane farming which is the backbone of the economy of Migori County, require seamless technology for timely access and dissemination of market information. However, farmers in Migori County are challenged with slow flow and poor access of sugarcane market access information leading to poor marketing strategies, low income evidenced by poor living standards and widespread poverty.

As a result of technological advancement, mobile phones are important communication channel today both at personal or business level. Dependency on mobile phone has become an absolute necessity [1]. Mobile phones subscription growth has led to a significant development trend witnessed in recent years in many developing countries. Therefore, among many rural agricultural producers, the mobile phone is enhancing communication, information exchange, and innovation in service delivery [2]. The mobile industry continues to scale rapidly, with a total of 4.8 billion unique mobile subscribers globally by 2016 and predicted 5.7 billion subscribers by 2020 [3]. Half of the world's population now has a mobile subscription—up from just one in five, 10 years ago. According to Communications Authority of Kenya (July – September 2016) [4], Kenya had 38.5 million mobile subscribers and penetration rate of 87.3%. In terms of subscriber market share, Safaricom market share is 65.6%, Airtel stand at 17.5%, Orange market share is 12.5% and Equitel share is 4.4% [4]. In the period July September 2016, the number of Short Messages Service (SMS) sent rose to 12.2 billion up from 6.6 billion in April – June 2015 [4]. This massive increase can well explain the significant value and trend in the use of SMS in day to day communication among mobile phone users in Kenya.

Analysis of data used in mobile application is a complex process that often involves remote resources and people [5]. Data mining in mobile environments improves interoperability between clients and server applications independently from the different platforms they execute on. Mobile user wants useful information in short time [6]. Therefore, it is better to mine information so that users are able to extract relevant data. Mobile based database systems, as basic concept of mobile computing, have enabled mobile devices to efficiently access large number of shared databases on stationary or mobile data services.

Data mining techniques include: (a) the Create, Select, Update and Alter (CSUA) based data mining approach for mobile computing environments developed by Ashutosh K. Dubey, Ganesh Raj Kushwaha and Jay Prakash [7] (b) pervasive data mining of databases from mobile devices through the use of Web Services developed by Domenico Taliay and Paolo Trunfioz [8] (c) K. Meena and M. Durairaj introduced a N algorithm for data mining [9], and (d) architecture of PDM framework developed by Frederic Stahl, Mohamed Medhat Gaber ,Max Bramer and Philip S. Yu [10].

The goal of mobile data mining is to provide advanced techniques for the analysis and monitoring of critical data in mobile devices. Mobile data mining has to take into account the typical issues of a distributed data mining environment, with additional technological constraints such as low bandwidth networks, reduced storage space, limited battery power, slower processors, and small screens to visualize the results. The mobile data mining field may include several application scenarios in which a mobile device can play the role of data producer, data analyzer, client of remote data miners, or a combination of the roles.

Mobile phones are used in m-agriculture to inform farmers when to sow crops and what fertilizers to use among other agronomic practices. Agricultural resources especially information on market access is an important factor in agricultural value chain. ICTs are improving market access through market information system, network for transaction security and traceability of agricultural produce [11]. Recent development projects have used ICTs to reduce the asymmetry in information access among the market players and to create linkages between the actors in the chain that ultimately benefit farmers [12]. In Migori County, middlemen have monopolized the sugarcane market and hindered free flow of information to famers on market access [13]. This has resulted in low cane prices per tonnage, postharvest loses. Consequently, sugarcane production has reduced with a negative ripple effect on the livelihoods of the farming community and the economy of local and national governments.

Currently, there are various mobile applications such as iCow, AgroSim, Rural eMarket, M-Shamba, Mobile Agribiz, Farmer-Connect, Esoko, mFisheries among others [14] that are used in agriculture in Kenya. However, these applications do not support data mining technology to analyze and disseminate specific content and area-aware information to farmers, especially the sugarcane farmers in Migori County. Similarly, mobile data mining architectures such as MobiMine [15], VEhicle DAta Stream (VEDAS) [16] and Service Oriented Mobile Data Mining model (SO-M-Miner) [17] have been used in other sectors of the economy other than agriculture.

Therefore, a seamless, location-based architecture that can foster the integration of mobile devices and servers to enhance data mining can possibly enhance information sharing on market access among sugarcane farmers in Migori County and consequently help realize an improved agricultural production leading to enhanced livelihoods of the farmers. The objectives of the study were to: (i) examine existing architectures for m-mining agricultural resources; and (ii) evaluate their challenges using scenario and experienced based methods.

This study identified and evaluated the challenges facing the existing architecture for m-mining agricultural resources and thereafter recommended a suitable architecture.

## II. METHODOLOGY

Descriptive survey was conducted using 395 respondents in Awendo and Uriri Sub-Counties of Migori County, on m-mining of market access information. They included 389 sugarcane farmers and County Agricultural Extension Officers (CAEOs) and 6 Sony Sugar Company/Jaggery Processing Firm–Extension/Marketing Officers (SSC/JPF - E/MO). Data was collected using structured questionnaire and interview schedules.

## III. DATA ANALYSIS

Data was classified based on research objectives and entered into an Excel workbook and *Wordle*. Quantitative data was then analyzed using descriptive statistics with the aid of Microsoft Office Excel spreadsheet to show frequency of distribution. Qualitative data was analyzed using text analytics techniques with the aid of *Wordle.* Results were showed in frequencies, percentages, mean and explanatory notes and presented in form of tables and graphs.

## IV. RESULTS AND DISCUSSION

### *A) Existing Architecture and Architecture Ergonomics that Determining Marketing of Sugarcane*

The results showed that the choice of the market for sugarcane was greatly influenced by price (76%) paid by Sony Sugar Company and promptness of payment (10%) by Jaggery Processing Firms (Table I). Therefore, access to the right information on price and duration of processing payment determined the choice of a market by a farmer. Ultimately, the architecture should ensure that sugarcane farmers are able to access prevailing market prices and payment period.

Further, the study found out that the existing architecture is predominantly manual (78%) with most farmers and CAEOs relying on information provided by SSC/JPF - E/MO (Table II). This was unlike the automated system such as MobiMine [15], VEDAS [16] and SO-M-Miner [17]. The manual system is prone to exploitation by the middlemen hence farmers are not able to get the best market for their canes. This may be the cause for the widespread poor livelihoods and poverty that has dominated the lives of many sugarcane farmers around this region despite many years of farming this crop. Enhancing the use of mobile devices in this region would greatly increase access to agricultural information among sugarcane farmers in Migori County. This ideology can be supported by the high penetration rate of mobile phones (87.3%) [4] and the significant usage of SMS (12.2 billion) [4] in Kenya hence its integration in sugarcane farming will be highly accepted by farmers. Similarly, mobile phone device is personal, pervasive, and provides the opportunity for proximity. The farmers, thus, will get timely information to leverage on the sale of their sugarcane.

Table I: Existing architectural issues that determine the choice of market for sugarcane

| | Sony Sugar Company - No. of farmers and CAEOs | % | Jaggery Processing Firm No. of farmers and CAEOs | % |
|---|---|---|---|---|
| Accessibility | 1 | 0% | 21 | 5% |
| Others | 0 | 0% | 0 | 0% |
| Prompt payment | 2 | 1% | 38 | 10% |
| Few procedural requirements | 14 | 4% | 11 | 3% |
| Pay a good price | 297 | 76% | 5 | 1% |
| Total | 314 | 81% | 75 | 19% |

Table II: Existing tools for accessing agricultural information

| Tool | No. of farmers and CAEOs | % |
|---|---|---|
| Desktop and Laptops | 9 | 2% |
| Others (TV, Radio and newspaper) | 16 | 4% |
| Mobile phones | 62 | 16% |
| Extension/Marketing Officers | 302 | 78% |
| | 389 | 100% |

*B) Data Flow of the existing manual architecture*

From Fig. 1 it is shown that a farmer manually requests for agricultural market access information from the SSC/JPF - E/MO. If the requested information is available, the SSC/JPF - E/MO delivers it to the farmer for decision making. A farmer who decides to sell his/her sugarcane to Jaggery Processing Firms receives instant payment for canes delivered while those who sell to Sony Sugar Company fills a contract form initiating an agreement between the company and the farmer. The contract form captures the farmer's data including: names, geographical location, plot number, contact details and size of the land. The content of the form is then fed into Agricultural Management System (AMS) database for to facilitate tracking of payment. Fig. 2 shows the architecture for the AMS.

A farmer logs in to the *famers' portal* to view his/her details and track payment. However, the use of AMS was limited by lack of internet access by most of the stakeholders due to low literacy levels, poor internet connectivity in Migori County and the widespread ownership of basic mobile phones by farmer. SMS technology do not rely on internet to send and receive messages in mobile phones, hence its choice as the mode of information delivery in the architecture to be proposed. Also, access to the farmer's portal is read only.

*C) Mode of Information Sharing and Delivery to Farmers*

Fig. 3 shows that mobile phones – phone calls (18%) ranked a distant second to face to face - (66%) in accessing market information. This implies the potentiality of mobile phone application in m-mining market access information by sugarcane farmers even though it had not been fully utilized.

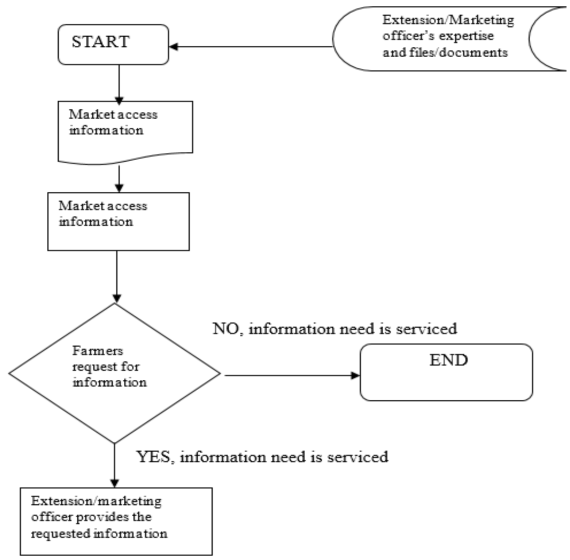


Fig. 1: Data Flow of the existing manual architecture

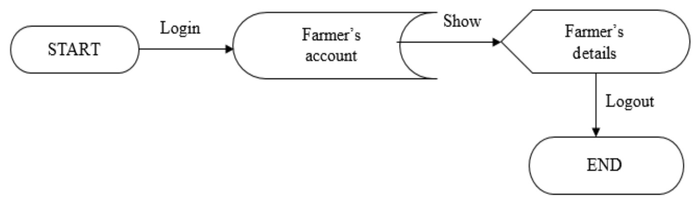


Fig. 2: Data flow of the farmers' portal (Source: Field data (2016))

Thus, it is important to explore the SMS technology to mine, store and share agricultural market access information. It is expected that this architecture would receive great acceptance since majority of the stakeholders were already aware of the capability of mobile phones to remotely access information especially the KCSE/KCPE results.

Sharing information is critical in promoting the growth of knowledge society. Information is the power that drives the current economies, therefore improved access and sharing of information among famers would lead to better marketing strategies being adopted by the farmers. Results indicated that there was little attempt (29%) (Fig. 4) by farmers to share information in Migori County. Random dissemination of messages on current market trends will timely reach many farmers and thus competitively set best cane prices. This functionality was also used to share information to farmers on the best agronomic practices for improved productivity.

*D) Awareness Levels of Remote Access and Availability of Central Database to Access Information on Marketing Sugarcane*

The study found out that farmers used mobile phones to remotely access national examination (KCSE/KCPE) results (91%) (Table III). This signifies the potential applicability and acceptance of the use of mobile phones to remotely access market information. This present ideal baseline for rolling out suitable architecture among farmers since some of the farmer had used the similar form of data mining in other sectors.

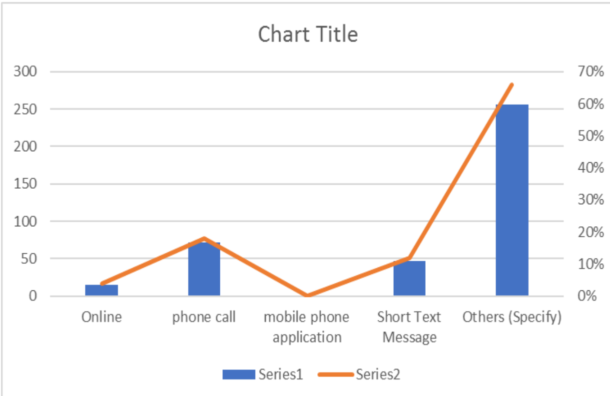


Fig. 3: Mode of Information Delivery to farmers in Migori County

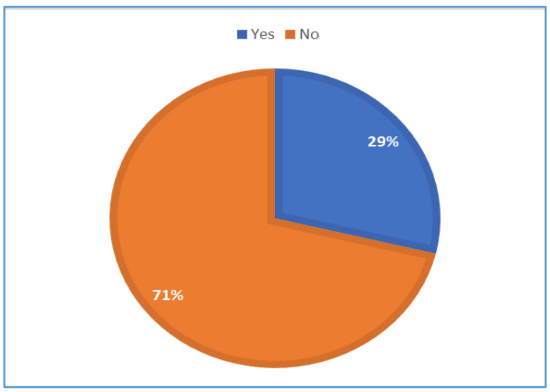


Fig. 4: Sharing of information among farmers

The results in Table IV showed lack of awareness among farmers and CAEOs (0%) on the existence of a central database was attributable to lack of appropriate tools/systems by farmers and CAEOs to access the database. The database required access to internet which most farmers and CAEOs could not afford either as a result of technological challenges, low literacy levels or inability to buy smartphones which were expensive compared to basic phones.

Despite the SSC/JPF – E/MO being aware of the existence and use of the database (100%) (Table IV) its low uptake was due to the system's limited functionality. The farmer's portal was a read only portal, the SMS module had not been activated, modification of the system codes were limited to the vendor and it depended on internet access for remote manipulation of the database. Agricultural market sector is characterized by large data sets which require robust database for knowledge discovery - the AMS database was not robust. Therefore, the architecture to be proposed will be manipulated remotely by farmers through issuance of instructions in terms of keywords from the mobile phones and feedback received in real time. The database will also be robust.

### *E) Evaluation of Challenges Affecting use of Existing M-Mining Architectures*

The findings further revealed that the several constraints affected the use of existing architectures which is highly

Table III: Use of mobile phones to remotely access market information

| | Aware of the use of mobile phones for remote access | | Consider using mobile phones for remote access | |
|---|---|---|---|---|
| | No. of farmers, CAEOs and SSC/JPF - E/MO | Percent ages | No. of farmers, CAEOs and SSC/JPF - E/MO | Parentag es |
| *Yes* | 54 | 14% | 358 | 91% |
| *No* | 341 | 86% | 37 | 9% |
| *Total* | 395 | 100% | 395 | 100% |

Table IV: Awareness on the availability of central database – farmers, CAEOs and SSC/JPF - E/MO

| | Farmers and CAEOs | | SSC/JPF - E/MO | |
|---|---|---|---|---|
| Availability of database | No. of farmers and CAEOs | % | No. of SSC/JPF - E/MO | % |
| Yes | 0 | 0% | 6 | 100% |
| No | 389 | 100% | 0 | 0% |
| | 389 | 100% | 6 | 100% |

manual. See Table V. Some of the major challenges include high cost of Manual system which is characterized by physical movement spanning long distance to the factory or jaggery firms to seek information. Also, Poor internet connectivity in Migori County hinder querying of online databases such as the AMS System used by Sony Sugar Company.

Further, the AMS was not fully implemented hence limiting the functionality of the system. The system could not be customized to adapt to the operating environment without the assistance of the vendor. This posed challenges to the system users in terms of delays in cases of system failures. Framers who did not have internet access were also disadvantaged, since they were unable to access the system. The study will thus propose an architecture that is location-based to carter for the needs of users while considering the existing technological constraints.

It is suggested that adoption and utilization of appropriate mobile data mining will resolve most of the challenges raised by the farmers and CAEOs. It will: improve decision making by farmers; diversify market channels leading to high cane prices; reduce postharvest losses; and reduce duration of payments because of transaction security and ability to track payment processes. Ultimately, it will facilitate economic and financial freedom of the society.

## V. CONCLUSION AND RECOMMENDATION

The study found out that the existing architecture used by sugarcane actors in Migori County was largely manual. Farmers depended on information delivered by the CAEOs and SCC/JPF- E/MO. This manual system was prone to technological and human challenges including inconsistency, error prone, non-reproducibility, cost, poor internet connectivity, lack of relevant data, low bandwidth reduced

Table V: Major constraints farmers and CAEOs face in accessing/sharing market information using the existing architecture

| Challenges | Don't agree (1) | Least agree (2) | Fairly Agree (3) | Strongly agree (4) | Very strongly agree (5) | Total Weight | Mean |
|---|---|---|---|---|---|---|---|
| *1. Marketing/Extension Officer* | | | | | | | |
| Slow | 42 | 86 | 141 | 252 | 305 | 826 | 3.2 |
| Not Reproducible | 57 | 90 | 117 | 240 | 275 | 779 | 3.0 |
| Costly | 34 | 86 | 147 | 248 | 340 | 855 | 3.3 |
| Inconsistent | 43 | 90 | 129 | 240 | 325 | 827 | 3.2 |
| Error-Prone | 45 | 90 | 150 | 224 | 300 | 809 | 3.2 |
| Insecure | 36 | 96 | 150 | 208 | 350 | 840 | 3.3 |
| | | | | | | Average Mean | 3.2 |
| *2. Mobile phone (call/SMS)* | | | | | | | |
| Battery power | 12 | 32 | 66 | 112 | 200 | 422 | 3.6 |
| Reduced storage space and small size of the screen | 6 | 10 | 24 | 196 | 250 | 486 | 4.1 |
| Slower processors and Low bandwidth | 2 | 4 | 123 | 140 | 190 | 459 | 3.9 |
| | | | | | | Average Mean | 3.9 |
| *3. Desktop/Laptop(Online)* | | | | | | | |
| Internet access | 0 | 2 | 9 | 20 | 30 | 61 | 4.1 |
| Relevance of information | 0 | 2 | 9 | 16 | 35 | 62 | 4.1 |
| | | | | | | Average Mean | 4.1 |

storage space and small size of mobile screens to visualize. The research recommends the integration of mobile phones through the use of SMS technology into the existing data mining architectures to overcome the challenges currently facing marketing of sugarcane by farmers.

## REFERENCES


[1]. The International Telecommunication Union (2014). Retrieved from http://www.itu.int

[2]. Ling, R., & Donner, J. (2009). Mobile Communication. Cambridge, UK: Polity.

[3]. GSMA mobile economy report. (2015). Retrieved from http://www.gsma.com/mobileeconomy/

[4]. The Communications Authority of Kenya. (2016). Quarterly Sector Statistics Report. Retrieved from http://www.ca.go.ke/images/downloads/STATISTICS/

[5]. Mohammed, J. Z., & Wagner M. (2014). Data mining and analysis: Fundamental concepts and algorithms. Cambridge: Cambridge University Press

[6]. Devika, M., Shelke, S. B., Tina B. M., Pratik, N. G., Manowar, D.J., & Dubey, S.S. (2014). International Journal of Computer Science and Mobile Computing, 3 (4), 1227-1232.

[7]. Larsen, K.R.T., & Bloniarz, P.A. (2005). A cost and performance model for web service investment. Communications of the ACM, 43, 109-116.

[8]. Li, L., Yang, Y., & Wu, B. (2005). Ontology-based matchmaking in e-marketplace with Web services. In Proceedings of APWeb**,** (pp. 620-631).

[9]. Maedche, A. (2003). Ontology learning for the semantic web. Dordrecht, the Netherlands: Kluwer Academic.

[10]. Malek, M., & Haramantzis, F. (2004). Security management of web services. In Proceedings of the IFIP/IEEE International Symposium on Integrated Network Management (NOMS 2004).

[11]. BBC Trust. (2010). Mobile Apps: Market Overview and Strategic Implications for the BBC. Retrieved from http://www.bbc.co.uk/bbctrust/assets/files/pdf/our_work/mobile_apps/market_research.pdf .

[12]. Markets and Markets. (2010-2015). World Mobile Applications Market—Advanced Technologies, Global Forecast (2010-2015). Retrieved from http://www.marketsandmarkets.com/Market-Reports/mobile-applications-228.html.

[13]. Kenana Engineering and Technical Services. (2013). Baseline Study for Sugar Agribusiness in Kenya. KETS/TD/1610/Draft Report. Khartoum. Retrieved from http://www.kenyasugar.co.ke/downloads/KETS

[14]. Mawazo M. M., (November 2015). Linking Rural Farmers to Markets Using ICTs. CTA Working Paper 15/12

[15]. Kargupta, H., Park, B., Pitties, S., Liu, L., Kushraj, D., & Sarkar, K. (2002). Mobimine: monitoring the stock marked from a PDA. ACM SIGKDD Explorations, 3(2): 3746

[16]. Kargupta, H., Bhargava, R., Liu, K., Powers, M., Blair P., Bushra, S., & Dull, J. (2003). VEDAS: A mobile and distributed data stream mining system for real time vehicle monitoring. Proceeding of SIAM Data Mining Conference.

[17]. Derya (2011). New fundamental technologies in data mining book edited by Kimito Funatsu, ISBN 978-953-307-547-1, Published: January 21, 2011 under CC BY-NC-SA 3.0 license. © The Author(s).