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The Changing MOOC Technology and How It Can Play a Role in the African Educational and Development Objectives

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1. INTRODUCTION

In the last issue, I talked about the rapidly developing Massive Open Online Course (MOOC) technology and I explained how that technology can help Africa in its development objectives by bringing massive education at all levels to a lot more of the population than the current educational technologies and practices put together. In this follow up article, I want to stay with the MOOCs theme and African development, but I intend to discuss the changes that are taking place within the MOOCs technology and how these changes are much better positioned to help improve the African landscape if they are fully embraced.

As I pointed out in my last article, today’s African higher institutions and educational landscape are facing problems that are hindering not only high quality research, but also the delivery of education to the masses that need it. The causes are many including (Kizza, IJCIR, Special Issue Vol. 5, No. 2, pp. 6-10):

- Heavy teaching responsibilities leading to - little time for research
- Reluctance of the state to finance broader education and research
- Low pay of teaching staff leading to a list of problems from ineffective teaching to preference of consultancies to improve salaries
- Low and decreasing numbers of senior professors
- Deterioration in the general education standards
- Mushroooming low quality universities
- Low numbers of students with access to higher education

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With these problem growing every passing day, Africa needs to look for new ways of delivering quality education to high numbers of students. The time is just about right. With African economies growing across the continent, together with developing mobile technology, the basic landscape for new models of quality education delivery is at hand.

2. CURRENT PROBLEMS WITHIN MOOC TECHNOLOGY

Although I have advocated for Africa to embrace MOOC technology, I want to correct the impression I might have left in my last article about the wonders of MOOC technology. The reader should have no illusions that MOOCs will solve African educational and development problems, however I want to stress that inspite its current problems, as we discuss below, MOOC technology is still extremely good for the African landscape.

In the last three to four years, main MOOC industry big players like Coursera, Udacity, Edx and others have been experiencing problems that go beyong surging interests and large numbers. In “The Dark Side of the MOOCs: Big Problems with Massively Open Online Courses”, Jamie Littlefield (Littlefield, http://distancelearn.about.com/od/isitforyou/a/The-Dark-Side-Of-The-Moocs-Big-Problems-With-Massively-Open-Online-Courses.htm) outlines some of these problems to include:

- Impersonal nature – as thousands of students enroll in sections with probably one instructor, the instructor becomes a mere "facilitator" and sometimes absent when there is automated grading. Standard assignments that enhance student interests like interactive group discussions are always washed out of MOOCs instruction delivery.

- Luck of student feedback – with large numbers of students in courses, it is inconsivable to expect, let alone have instructor feedback, a basic ingredient in knowledge delivery.

- Few students make it to the final line – with limited instructor feedback and the absence of peer interaction, the two basic and essential glue of knowledge delivery, large numbers of students tend not to finish the courses they started.

- Missing meaningful target – most MOOCs courses are offered without a final gainful artifact for students like a meaningful certificate beyong a certificate of completion.

As I advocate MOOCs for the African landscape, I am very mindful of these problems that is why, in this follow up article, I want to discuss what is being done and what will be of more value for African instructors intending to start MOOCs courses and African students interested in embarking on MOOCs courses.

3. EVOLVING MOOC TECHNOLOGY

The problems outlined above are forcing the MOOCs providers to find better ways of delivery. The evolving MOOCs model must move away from the original self-formative model of a MOOC course that has to be online, free -open-, massive and involve enrollment of thousands of students (MOOCs: The evolution of open knowledge, http://desarrolloweb.dlsi.ua.es/moocs/evolution-open-knowledge).

Among the changes taking place to add value and credibility to the current MOOC model are:

- MOOC evolving into a MOOR (Massive Open Online Research)- In September, 2013, the University of San Diego’s Jacob’s School of Engineering announced it was launching what it believed was the first major online course that featured a great deal of massive open online research (MOOR), in addition to the usual coursework. According to the announcement, the course, called Bioinformatics Algorithms — Part 1, was to be offered through Coursera and was to give students a chance to work on targeted research projects
under the guidance of “prominent bioinformatics scientists” from all across the globe (Hosler, Aimee, http://www.emergingedtech.com/2014/01/massive-open-online-research-the-mooc-evolves-into-the-moor/, January 8, 2014). There are thousands of students around the globe looking for quality research that they would not otherwise get at their home institutions. Courses like these have already a built-in final target for the global graduate student looking for a research project and a credible supervisor. This would be a great service and will create value for the global community interested in MOOCs courses.

- Test-Based Online Credentials – Certificates of attendance and completion. We all know that when something is free, it rarely holds much value. Since its debut, the MOOCs model of knowledge delivery has been free - free content, courses and textbooks. Because it is free, there are limited incentives for providers to offer students something tangible to validate their knowledge and prove their skills. This lack of credentials of accomplishments has led to massive student attrition in most MOOCs courses. One way to address this problem has been for the providers to start offering some form of tangible credentials to students who diligently work hard and complete the courses. Among the forms of credentials, according to Brad Zomick, (Brad Zomick, http://www.skilledup.com/blog/prove-your-skills-test-based-online-credentials/) are:

  - **Test-based credentials**: These credentials are earned by a student taking multiple-choice or project-based tests in various skill areas. This type of credentialing is not new. It has been used in the online freelance market and in programming.

  - **Online Badges**: Badges allow individuals to demonstrate job skills, educational accomplishments, online course completion or just about anything else that a badge creator decides. And they are still very nascent and in the very early stages of their growth.

  - **Completion Certificates**: lynda.com, TeamTreehouse and Grovo, among others, offer certificates upon completion of courses. Sometimes, short quizzes or challenges are used to ensure that the student is able to demonstrate real knowledge, although this is rarely (if ever) as robust as test-based credentials.

  - **Online Certificates**: Among alternative credentials, online certificates currently command the highest value and are nearly comparable to a traditional degree. Big and prestigious universities offering MOOCs have started offering these online certificates bearing the institutional symbols. Earning an online certificate from an online college, a company or an industry-specific organization is typically much more involved than the other credentials, and are often connected to specific job functions. Many of these certificates have been created by companies such as Cisco, IBM or Microsoft from their own needs or the needs of their customers.

This is a small glimpse into a changing MOOCs technology landscape to make it more appealing and rewarding to those taking courses in MOOCs or those interested in talking courses. With these and other coming changes, the MOOCs model of knowledge delivery is getting better and more fitting for the African educational landscape.

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LITTLEFIELD, JAMIE. “The Dark Side of the MOOCs: Big Problems with Massively Open Online Courses”, (http://distancelearn.about.com/od/isitforyou/a/The-Dark-Side-Of-The-Moocs-Big-Problems-With-Massively-Open-Online-Courses.htm)
A Framework for Enhancing e-Health Data Integration and Sharing in Distributed Environments

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ABSTRACT

This paper describes a proposed conceptual framework for integrating e-Health records for health research institutions. The framework is based on a cross-sectional study at Ifakara Health Institute in Tanzania. It is developed by identifying both social and technical aspects associated with intra-organization data integration and sharing. The two major questions answered in this research are: i) what are the principal socio-technical factors in a value chain of intra-organization data integration? and ii) what is the intensity and strength of these factors in influencing the effectiveness of health data integration and sharing between and across a network of collaborators? The specific objective of the study focuses on the impact of socio-technical factors on intra-organization data integration and sharing. Technical and social factors were analyzed as service requirements to enhance data integration in health research institutions. The significance of each domain in respect to data integration was identified. Finally, a conceptual framework was proposed to address the gap in the process of intra-organization data integration.

Keywords: Integration, health information framework, socio-technical domain, e-Health, data sharing

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1. INTRODUCTION

The world has progressively become interconnected and complex, and therefore, human health is increasingly perceived as the integrated outcome of many factors including institutional determinants (Huynen, Martens, and Hilderink, 2005). Electronic data collection, integration and sharing contribute significantly in improving collaborative research in human health. Collaborative research is perceived as the way to achieve world health for life. It is a strategy for choice when needs are many, resources are scarce, and individual effort has proved unsuccessful in addressing serious health issues (Haithcox-Dennis, DeWeese, and Goodman, 2014). Through collaboration, health for life is an expected outcome of e-Health records integration and sharing. Collaboration in health research like in any other form of collaboration is not always easy to achieve. This is due to the fact that its success depends much on adhering to some core principles such as: stakeholders with a vested interest in the issue, trust among and between the partners, a shared vision and common goals, expertise among partners to solve community problems, teamwork strategies, open communication, motivated partners, sufficient means to implement and sustain the collaborative effort, and an action plan (Rinehart, 2001). As collaboration develops and matures, partners should continually revisit each component to assess the status of the collaboration and determine what actions are needed to enhance collaboration. All these are linked to social aspects and stakeholders’ relationships. It is pointed out in (Blobel, 2002) that the basic conditions of health and welfare in both developed and underdeveloped countries are changing and caused by social, economic, technological, political and environment drivers. Under such challenges, the society are modifying their health management systems structure to decentralized and specialization, share caring concept, extending communication and co-operation as well as increasing means of data sharing between and among the collaborators. A loosely couple framework is therefore important to health research institutions to provide a road map to competitiveness in the global environment.

Even though many frameworks for health systems exist, there is no one addressing the issues of social aspects in information integration and sharing. The WHO conceptual framework for health systems focuses on improving efficiency and responsiveness (Siddigi, 2008; WHO, 2014). Globalization conceptual framework for health also focuses on contextual and disaster determinants whereas conceptual framework for health analysis and action focuses on economic of health (Huynen, et al., 2005). Furthermore, the conceptual framework introduced in the previous study (Podolak, Harrison, and Vetter, 2012) focuses on data access and protection of an individual privacy as well as health data inequalities. The information framework suggested in the literature (Pardo, Cresswell, Dawes, and Burke, 2004) lacks the justification of significance of items with respect to data integration. Also, the conceptual framework discussed in (Smith, Madon, Anifalaje, Lazarro-Malecela, and Michael, 2007) spotlight on health policymakers. We argued that socio-technical domain is the determinant in the intra-organization data integration and sharing. The coefficient contribution of each domain in the framework is interrelated in such a way that holistic approach is required to harmonize the process of intra-organization data integration. It is argued in the work (Irene, 2010) that health data has critical roles to play in improving the quality, accessibility and efficiency of health service. In addition, health data has important role in ensuring that health systems can continue to improve affordability. In addition to technical and standardization challenges in data integration, one must also take into consideration leadership, political, organizational legal, psychosocial and commercial issues as well as emerging technologies.

This paper describes a proposed conceptual framework for integrating e-Health records for health research institutions. The framework is based on a cross-section, multicenter study, and one time data collection occurred at several branches of Ifakara Health Institute (IHI) in Tanzania. The framework is developed by identifying both social and technical aspects associated with intra-organization data integration and sharing. The two major questions answered in this paper are: i) what are the principal socio-technical factors in a value chain of intra-organization data integration? ii) What is the intensity and strength of these factors in influencing the effectiveness of health data integration and sharing between and across a network of collaborators? It is therefore, significant that a statistical
analysis be performed to seek evidence on how socio-technical factors associate with intra-organization data integration. Technical and social factors are analyzed as service requirements to enhance data integration in health research institutions and point out the significance of each domain in respect to data integration. Finally, a conceptual framework is proposed to address the gap in the process of data integration.

Organization: This paper is organized as follows: - Section 2 explains the methodology adopted in this study. It describes the ethical clearance and data analysis method. Section 3 presents the finding where the main contribution is on Technical and Social factors as well as a proposed framework for data integrating and sharing health data. Critical discussion is presented in section 4. Finally, section 5 gives the conclusion.

2. METHODOLOGY

A cross-sectional study was deployed in seven branches of the IHI and one branch of the National Institute Medical Research (NIMR). Primary data was collected in order to identify factors associated with electronic data collection (EDC) and Intra-organization data integration (IDI) and sharing. Guided questionnaires were used to measure intensity and strength of the factors associated with IDI. The questionnaires were divided into two groups: the first targeted research scientists and principal investigators. This group is responsible for research coordination and management. The second targeted software developers, data managers and system administrators. This group is responsible for innovation on the design of research tools. Descriptive analysis and bivariate correlation were conducted using STATA to determine association between outcome variables and independent variables. Fisher’s exact test was used as a statistical proof to determine the significance between the variables whereas Spearman’s test was used to determine correlation coefficient of each of the factors. The significance was tested at confidence interval (CI) of 95% that is using a p-value of \( p \leq 0.05 \).

2.1. Ethical Considerations

The protocol of this study was approved by the scientific board of the Nelson Mandela African Institute of Science and Technology (NM-AIST) and granted an institutional ethical clearance number IHI/IRB/NO.03-2014 by the Institutional Review Board of IHI. All participants in the study were asked for their written informed consent before collecting data and they had complete right to withdraw from the study at any time without any disadvantage.

2.2. Data Analysis

Descriptive results are presented for devices used for electronic data collection and means of data sharing as well as the procedure used to process data. Probabilistic value (\( \rho \)) and correlation coefficient (\( r \)) for the domain score are determined to describe variation in different factors in relation to IDI. The IDI score was used as the dependent variable in the regression analyses. Several items were grouped to form a single domain. A mean score of each domain was obtained by taking the average of responses of the items that form a domain.

3. RESEARCH FINDINGS

3.1 Demographical Characteristics

A total of 121 respondents were administered through questionnaires. Among them, 96 were males, and 25 were females. Responses by job grade indicate that 13.2% were principal research investigators, 62.8% were research scientists, whereas 24% were system administrators and software developers. The respondents’ working experience was that 2.5% had less than one year, 43.0% had 1-3 years and 54.5% had more than 3 years working experience.

3.2 Outcome Variable

The outcome variable “Intra-Organization Data Integration and Sharing” was defined from three groups of information as shown in Table 1. The first was the measure of devices used to collect electronic data. The second
information was about the measure of data sharing among the research groups and the last was the measure of the procedure for collecting and processing data.

### Table 1. Devices used for electronic data collection, sharing and means of data collection (N=121)

<table>
<thead>
<tr>
<th>Item</th>
<th>Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Devices</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personal Digital Assistance</td>
<td>48</td>
<td>40.0</td>
</tr>
<tr>
<td>Tablet PCs</td>
<td>36</td>
<td>30.0</td>
</tr>
<tr>
<td>Notebook (Laptop)</td>
<td>67</td>
<td>55.0</td>
</tr>
<tr>
<td>iPad</td>
<td>5</td>
<td>4.1</td>
</tr>
<tr>
<td>Phone (iPhone / Mobile)</td>
<td>34</td>
<td>28.1</td>
</tr>
<tr>
<td>Sound File / Voice Recorder</td>
<td>26</td>
<td>21.5</td>
</tr>
<tr>
<td>Manually (by Paper)</td>
<td>23</td>
<td>19.0</td>
</tr>
<tr>
<td><strong>Used Electronic Devices (either of Electronic Devices)</strong></td>
<td>107</td>
<td>88.4</td>
</tr>
<tr>
<td><strong>Means of Data Sharing</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CD / DVD / Flash</td>
<td>68</td>
<td>56.2</td>
</tr>
<tr>
<td>Centralized Database</td>
<td>52</td>
<td>43.0</td>
</tr>
<tr>
<td>Website (Network)</td>
<td>46</td>
<td>38.0</td>
</tr>
<tr>
<td>Email</td>
<td>93</td>
<td>76.9</td>
</tr>
<tr>
<td>Tape</td>
<td>3</td>
<td>2.5</td>
</tr>
<tr>
<td><strong>Data Sharing</strong></td>
<td>75</td>
<td>62.0</td>
</tr>
<tr>
<td><strong>Procedure for Data Collection</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data collected annually and entered in database for processing</td>
<td>83</td>
<td>68.6</td>
</tr>
<tr>
<td>Data collected online using web application</td>
<td>7</td>
<td>5.8</td>
</tr>
<tr>
<td>Data collected manually then processed electronically</td>
<td>71</td>
<td>58.7</td>
</tr>
<tr>
<td>Data collected electronically using both mobile and computer</td>
<td>57</td>
<td>47.1</td>
</tr>
<tr>
<td><strong>Either of the Above</strong></td>
<td>119</td>
<td>98.4</td>
</tr>
<tr>
<td><strong>Outcome Variable (Use of Electronic Device + Data Sharing + Recommended Procedures for Data Collection)</strong></td>
<td>67</td>
<td>55.4</td>
</tr>
</tbody>
</table>

### Associated Technical Factors

The determinants for IDI are grouped into two major categories. The first category is those which are brought about by technical and technology setting and the second are those which arise from social settings. The first category includes technical, security, technology, and human domain. The technical factors associated with IDI are presented in Table 2 below. The findings indicate that the security ($\rho =0.024$) and technology domain ($\rho =0.043$) were significantly associated with IDI while technical and human domain were not significantly associated with IDI.
 Table 2. Technical Factors associated with data sharing (N=121)

<table>
<thead>
<tr>
<th>Factor</th>
<th>Number of Respondents</th>
<th>Yes (%)</th>
<th>No (%)</th>
<th>Fishers Exact P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Security Domain</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agree</td>
<td>89 (73.5)</td>
<td>59 (66.3)</td>
<td>30 (33.7)</td>
<td></td>
</tr>
<tr>
<td>Moderate</td>
<td>25 (20.7)</td>
<td>10 (40.0)</td>
<td>15 (60.0)</td>
<td>0.024</td>
</tr>
<tr>
<td>Disagree</td>
<td>7 (5.8)</td>
<td>6 (85.7)</td>
<td>1 (14.3)</td>
<td></td>
</tr>
<tr>
<td><strong>Technology Domain</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agree</td>
<td>97 (80.2)</td>
<td>55 (56.7)</td>
<td>42 (43.3)</td>
<td></td>
</tr>
<tr>
<td>Moderate</td>
<td>20 (16.5)</td>
<td>17 (85.0)</td>
<td>3 (15)</td>
<td>0.043</td>
</tr>
<tr>
<td>Disagree</td>
<td>4 (3.3)</td>
<td>3 (75.0)</td>
<td>1 (25.0)</td>
<td></td>
</tr>
<tr>
<td><strong>Technical Domain</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agree</td>
<td>94 (77.7)</td>
<td>56 (59.6)</td>
<td>38 (40.4)</td>
<td>0.258</td>
</tr>
<tr>
<td>Moderate</td>
<td>22 (18.2)</td>
<td>14 (63.6)</td>
<td>8 (36.4)</td>
<td></td>
</tr>
<tr>
<td>Disagree</td>
<td>5 (4.1)</td>
<td>5 (100)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>Human Domain</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agree</td>
<td>96 (79.3)</td>
<td>62 (64.5)</td>
<td>34 (35.4)</td>
<td>0.379</td>
</tr>
<tr>
<td>Moderate</td>
<td>19 (15.7)</td>
<td>9 (47.2)</td>
<td>10 (52.6)</td>
<td></td>
</tr>
<tr>
<td>Disagree</td>
<td>6 (5)</td>
<td>4 (66.7)</td>
<td>2 (33.3)</td>
<td></td>
</tr>
</tbody>
</table>

3.3.1 Technical Domain

The findings indicate that the technical domain has strength in contribution to the process of IDI. The responses show that 77.7% agree that the technical domain is important for supporting data integration, 4.1% disagree whereas 18.2% find it moderate. Out of those who agree, 59.6% collect data electronically while 40.4% do not. Despite the fact that technical domain is important factor in IDI, Fisher’s exact test shows that there is no significance difference between the technical domain and data sharing (p = 0.258). Intuitively, Spearman correlation shows positive association between technical domain and data sharing. The coefficient is found to be r = 0.105.

3.3.2 Security Domain

There is a higher strength and intensity of security domain on data integration and sharing (Ndume, Nkansah-Gyekye, and Ko, 2014). From table 3, at the responses indicate that 73.5% agree that security impedes electronic data sharing, 5.8% disagree while 20.7% find it moderate. Out of those who agreed, 66.3% have the possibility of data sharing and 33.3% have no data sharing. The result of Fisher’s exact test shows that security domain and data sharing is significant (p = 0.024). There is negative correlation between IDI and security domain and the coefficient r = −0.121. The negative correlation can be explained that the three important aspects of security i.e. confidentiality, integrity and availability should be balanced in the cause of data sharing.

3.3.3 Technology Domain

The technology spillover on electronic data collection increases the chance of data integration. Nonetheless, implementation and practice require technical knowhow and sometimes expensive resources. Responses in Table 2
show that 80.2% agree that technology has a positive effect on data sharing, 3.3% disagree while 16.5% find it moderate. Of those who agree; 56.7% are in a position of engaging in data sharing while 43.3% are not. Fisher’s exact test found that there is significant difference between technology domain and data sharing \((p = 0.043)\). The correlation between data sharing and technology is positive and the coefficient is \(r = 0.215\).

### 3.3.4 Human Domain

It is observed in Table 2 that 79.3% of respondents agree that the human factors hamper electronic data collection, integration and sharing, 4.9% disagree and 41.1% find it moderate. Of those who agree, 64.6% collect data electronically, whereas 35.4% do not. Even though responses indicate that the human domain is an important aspect in data sharing but Fisher’s exact test indicate that there is no significant difference between the human domain and data sharing \((p = 0.379)\). The Spearman correlation between data sharing and human domain is negative and the coefficient is \(r = -0.096\).

### 3.4 Associated Social Factors

The social determinant of Intra-organization data integration and sharing include organization setting, finance, skill sharpening, innovation as well as Information Technology (IT) policy and procedure. The description of these determinants and their association and significance with data integration are given in Table 3.

<table>
<thead>
<tr>
<th>Table 3. Social factors associated with data integration and sharing (N=121)</th>
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<tbody>
<tr>
<td><strong>Factor</strong></td>
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<tr>
<td><strong>Organization Setting</strong></td>
</tr>
<tr>
<td>Agree</td>
</tr>
<tr>
<td>Undecided</td>
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<tr>
<td>Disagree</td>
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<tr>
<td><strong>Innovation</strong></td>
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<tr>
<td>Agree</td>
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<tr>
<td>Undecided</td>
</tr>
<tr>
<td>Disagree</td>
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<tr>
<td><strong>IT Policy and Procedure</strong></td>
</tr>
<tr>
<td>Agree</td>
</tr>
<tr>
<td>Undecided</td>
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<tr>
<td>Disagree</td>
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<tr>
<td><strong>Finance for IT</strong></td>
</tr>
<tr>
<td>Agree</td>
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<tr>
<td>Undecided</td>
</tr>
<tr>
<td>Disagree</td>
</tr>
</tbody>
</table>
3.4.1 Organization Setting

The results in table 3 show that 86.0% agree that the organization setting is very important for the success of IDI, 13.2% were undecided, whereas 0.8% disagree. Of those who agree, 62.5% collect and process data electronically while 37.5% do not. Although respondents found organization setting a critical factor, statistical tests find negative correlation with data integration and Fisher’s test found a p-value of $\rho = 0.633$ indicating that it is not significant. The negative correlation can be explained that implementing IDI in a tightly coupled organization may be difficult.

3.4.2 Research Innovation

The research findings indicate that research innovation is significant in the process of IDI. The p-value is found to be $\rho = 0.003$ and the correlation coefficient is $r = -0.174$. Responses confirm that 77.7% accept an innovation as an important aspect in data integration, 9.9% were undecided and 12.4% disagree. Out of those who agree, 63.8% collect and process data electronically, whereas 36.2% do not.

3.4.3 IT Policy and Procedures

The IT Policy and procedures provide users with systematic protocol on how to use health records. The findings indicate a positive correlation between IT policy and data integration. The descriptive analysis show that 68.6% agree that IT Policy and procedure are important in data integration and sharing, 18.6% were undecided while 13.2% disagree. Of those who agree, 61.5% are in the process of data integration, where 38.5% do not. Despite the higher acceptance of IT policy in data sharing, statistical tests found a p-value of $\rho = 0.503$ indicating that it is not significant. Nevertheless, there is positive correlation and coefficient is $r = 0.036$.

3.4.4 Finance for IT

Research findings indicate that there is a positive correlation between the financing for IT and data integration. The correlation coefficient is found to be $r = 0.287$ and p-value is $\rho = 0.040$ indicating that it is significant. Descriptive analysis indicates that 68.6% agree that finance for IT is a requisite for data integration; 13.2% are undecided and 18.2% disagree. Out of those who agree 68.7% collect and process data electronically whereas 31.3% do not.

3.4.5 Skillful Level

The findings show that skillful human resource is an important aspect in the process of data integration. Descriptive analysis indicates clearly that 70.3% agree that skillful human resource is remarkable in the process of data integration, 16.5% were undecided while 13.2% disagree. The statistical test found significant difference between skillful human resource and data integration and sharing. However, there is a negative correlation and the correlation coefficient is $r = -0.220$. The negative correlation demonstrates that unskilled human resource may degrade the process of data integration.
3.5 Proposed Framework

As depicted in Figure 1, a conceptual framework for enhancing e-Health data integration was developed by including both social and technical factors that associate with IDI. The principal socio-technical factors in a value chain of IDI are presented on the framework. The framework is built on the theoretical proposition of data integration and empirical research on e-Health records management and sharing among collaborators. Modeling of the framework for data integration is taken holistically. The framework includes multiple factors representation encompassing the business process of the organization such as technology, security, IT policy and procedure and technical know-how on IT problems which arise spontaneously in the organization. An assessment must use a simple tool like a survey in order to understand organization strength. The analyses include determination of the strength and intensity of social aspect of the organization such as finance, innovation strategy, skillful human resource, policy and procedure as well as leadership aspect of an organization setting. The benefit of IDI can be realized by the health community only if there is coherence between both social and technical aspects of the organization. Responses concerning the importance of data integration and sharing indicate that 90.9% agree that data sharing is important for information and knowledge sharing which can result into innovation. 93.4% indicate that data sharing is important for collaboration in work process for better results and decision making. Furthermore, responses show that 81.8% found data sharing is important in building trust among researchers, nevertheless 85.1% found data sharing important for enhancing decision making.

![Figure 1: Proposed conceptual framework for data integration and sharing in e-Health](image)

4 DISCUSSION

4.3 Technical Implications

The security domain is an important factor which scientists face when implementing data integration and sharing of research results. There is little willingness of research scientists to share data especially when they are not certain about the security of their data and the backup procedure of the centralized data set. Dealing with personal medical information that is highly sensitive in a shared care information system require appropriate services and mechanism for guaranteeing security and privacy by legal, organization and technological means according to the policy agreed. It is important to note that security and privacy contain political, legal, social organizational and technical and
technological issues. Therefore many organizations and institution deal with different orientation, competence, efficiency and efficacy with this security challenges.

If there is no guarantee of the security, scientists will not attempt to upload data to a centralized health repository for sharing. They are worried of research data to be used or published without prior approval of the owner. Another key issue within the context of security on data sharing is the type of collaboration kit used. Despite the availability of a number of collaboration kits such as Ning (aimed for network expansion), public library of science (knowledge expansion), Epic surveyors (remote functionality), Scribed (research promotion) as well as Skype, Wiser, Twitter and Facebook, some of the kits don’t give researchers peace of mind with respect to security, intact and credibility of their work. Considering the legal framework, it is necessary to have a number of laws concerning data protection and data security whether directly or indirectly. Technically and mechanically, authentication, integrity, confidentiality, accountability, authorization, and security infrastructure services must be considered to support shared care paradigm. However, the security framework highly depends on the concrete application scenario. For that reason, often the consideration and interpretation are referred to the specific situation of distributed e-Health system.

On technology domain, internet connectivity enables research scientists to have data in hand. With physical network real time data collection is possible through web-based application. The system architecture and interoperability of hardware and software impose challenge in electronic data collection and integration. On the other hand, ontology, data definition tool, semantic, as well as the tools for accessing integrated database is among the factors that contribute to difficulties of sharing integrated data. The complexity of technology domain therefore arises due to interaction of large numbers of systems such as clinical trials, laboratory systems, use of various district health information systems, pharmacy systems as well as business management systems (Bertolini, Schäf, and Stolz, 2012). The information application used by the provider to support their e-Health process information–related, have to support also their communication and co-operation. For that reasons, application system must be capable of supplying each other with information and function, i.e. of sending and receiving requests as well as providing and using services.

In the technical domain, it is noted that the dynamism of technology affects some longitudinal research which has to be carried for a long period. Investigators may be required to change the means of data collection from time to time in order to meet technology needs. Re-engineering of the process also obstruct data sharing. In addition, the lack of standardized tools to collect electronic data and data integrity adds complexity in data integration. The implementation of advanced technology requires skill sharpening to meet the demand of new technology. Likewise, querying multiple data sets with different format requires mediated schema. For example, some research data might be stored in MYSQL while others are stored in excel or SQL server. Matching data from different schema requires scientists to have knowledge on query syntax. In that context, building a complex e-Health system for research scientists require technical investigation by look for definition of terms. Also, it is important to use class diagram to define database schemas, and providing use-case for specification as well as modeling of the interaction of the system using sequence diagram.

The human domain implies that manually collected data result into double work when it comes to electronic data sharing. For instance, manually collected data needs to be scanned so that they are accessible electronically or they may require creation of new metadata. Old data may be incompatible with technology if stored for a long period. Moreover, the harmonization and operation plan to share manually processed data is difficult. It is argued that each work item needs a certain amount of resources including staff or facilities (Bertolini, et al., 2012). Even though, the harmonization of the work flow management becomes increasingly complex, but it is crucial to the health research institutions with geographically distributed offices. In addition, it is noted that, poor programmed software may induce errors hence affect the whole project. Similarly, the delays of procurement of devices for data collection do affect the time schedule of the project.
4.4 Social Implications

In theory, data integration is perceived as a simple technique that needs only technical knowhow. However, in practice it is a complex process that combines various factors including organization setting. In fact, the success of data integration process can be achieved by combining efforts from both technical knowhow and social issues. Organization setting that support collaboration always has mutual benefits in improving population-level health outcome by creating an environment change in the different community sectors where health-related behavior occurs (Roussos and Fawcett, 2000). In this research, it is observed that collaborative health research yields coherent global strategy. This argument is supported in (Duff et al., 2009) that collaborative project is useful for achieving health outcomes than an integrative project where participants merely join their separate contribution. Diversity of team members in health projects ensures that the team can draw on different perspectives and bases of expertise. It is argued that the rapid changes in technology have special impact in data management of the organization (Halevy et al., 2005), for this reason, modern management pattern is required to deal with technology management and innovation (Karimi, Somers, and Gupta, 2001; Magdalena and Munteanu, 2009). Integrating information of different collaborators may require change of the organization structure, philosophy and procedures. From the result of this research it is argued that managers needs to know how to organize team spirit and leadership and realize the ambition of group leaders, in order to align with political willingness and create structures that support collaboration and innovation. The framework for building Africa’s health workforce observatory concurs with this view that workforce leadership and governance capacity need to be strengthened in order to get quality service in health systems (WHO, 2012a).

The strategy for organizing human resource should include human resource planning, education strategy, workforce management and utilization, as well as the use of partnership among key stakeholders (Mtasiwa, 2008). Integrating data from different branches of the organization requires not only the control over traditional human resource but also the need to have skillful human resources. Data integration goes beyond financing; it also requires end user perception and view (WHO, 2012b). This is due to the fact that utilizing the data integration system may be accompanies by the pain of system failure or delight of system success. If this happen it affects the whole organization. Concern in human resource includes the need to address the issues of work force planning, education, recruitment, retention and performance as well as defining regulatory options to improve quality. For IT services, it is not enough to recruit people but to recruit skillful persons who are self confident on decision making and who can do IT troubleshooting with confidence. It is noted in this research that software developers normally invest more time during developing the research tool and therefore, become annoyed with administrative regulation of signing in and out while their work requires more than eight hours a day. This deters their self planning which can increase chances for innovation.

In some instances, contract enforcement and employment rules are violated. Software developers might be tasked to develop software for a new project without legal agreement and justification on how the person will benefit the project financially or through publication. In addition, employment contract build confidence, trust and willingness of the staff in the process of IDI. A transparent training schedule and continuous skill sharpening should catch the attention of people working in software developments. Furthermore, better resource allocation and utilization increase people perception and attitude towards organization.

Finance is an aspect that makes many projects fail or succeed. Constraints with schedule and costs are always inherent in application development. Staying within budget is an obvious concern because over expenditure always deters project completion. In this research, it is argued that the amount invested in IT facilities reflect the extent to which IT services is delivered. The finance aspect must address the issues of resource committed to innovation-related activities, training, rewards as well as revenues. This argument is in support of the WHO health system conceptual framework (Siddigi, 2008). Even though research findings indicate that there is a positive correlation between the finance for IT and the process of data integration but the observed relation does not necessarily imply a causal relationship. The question of whether IT department relatively needs more finance depends on the
organizational mission in improving the quality of IT service aiming at efficiency and productivity. Further findings reveal that poor services in IT are associated with existing IT Infrastructure and organizational commitment on IT. Many branches have IT infrastructure which has non-uniformity of devices with connectivity like D-Links, Cisco or ZyXEL, such connection may reduce data speed in the network and results into poor IT services to users.

Since collaboration across organizations on data sharing implies joint responsibility and shared procedures, it follows that any legitimacy damage and los of integrity on data should adhere to policy frameworks. Any dispute arising cannot be cordially settled between parties in the collaboration without an arbitrator. The absence of a clear policy in the framework may lead to loss of rights for one party as far as information integration and sharing is concerned. It is therefore, argued in this research that IT policy, or e-Government policies is the determinant of the smooth running of data integration and sharing. If there are no guidelines in data sharing, access and retrieval of scientific findings may lead to misunderstanding among the parties and cause legal action for the side against proper use of the data.

The goal of innovation is to improve technology and achieve the business requirement of the organization. Innovation can be of many forms including product, process, organizational method, research or workplace organization, stakeholder’s relations, communication, dissemination process, and others. Cultivating innovation creates more opportunities for an organization to excel. Innovation is an excellent way to create innovation mindset. Materials for innovation provide a variety of experience and unconventional skills not only for expanding the hemispheres of the brain, but also stimulating the mind and spirit of scientists to think globally. However, a successful innovation methodology must incorporate inspiration of both leadership and employees to generate an outcome of higher value. Innovation in design, engineering and research methodology results into outcomes that attract more funding for further research. Likewise, any success in innovation should takes into consideration established standards for fairer practice and protection of the rights of the innovators. Training is required on mentoring research scientists in order to impact innovation, skill and knowledge to young scientists. It is noted in (Gupta, 2009) that in an early stage people may think on the innovative idea as good, crazy, stupid or funny idea, it takes longer but then ideas becomes more innovative. It is advised in (Halevy, et al., 2005) that any idea is worth a try. The evidence suggests that adoption and diffusion of innovation in health systems is influenced by the nature of complexity of the innovation (Atun, de Jongh, Secci, Ohiri, and Adeyi, 2010). Therefore, an organization attempting to institutionalize innovation must determine its methodology of choice.

5 CONCLUSION

In this paper we have proposed a conceptual frame work for intra-organization data integration and sharing. The conceptual framework is intended to guide scientists in harmonizing and creating health data repository for centralized information access and sharing. The model comprises of two major components. Each component is set of domain associated with intra organization data integration and sharing. The framework can be used as a cornerstone in developing regression model for intra-organization data integration and sharing.

Statistically, the security domain and technology domain were significant with data integration and sharing. Furthermore, the results provide support to the view that innovation, finance for IT, and skillful human resources were significant to the IDI and sharing. Nevertheless, descriptive analyzes demonstrate that all nine factors have strength and strong intensity of association with the process of data integration. These observations highlight the danger of using statistical inference on the determination of intra-organization data integration and sharing.

Also, it is observed that the health research data stored in a distributed health information system and which deal with sensitive personal information requires sensitive services guaranteeing both communication and application security in order to support intra-organization data integration and sharing paradigm. However, due to the enhancement of people mobility, mobile computing and technology such as high internet access, distributed collaboration still remain as an enabler of sharing research results among research scientists. The way forward is to
address the issues of technology by developing techniques of exchanging data in a low bandwidth distributed environment using web services.

6 REFERENCES


An Intelligent Offsite Object Identification and Recognition Video Surveillance System

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ABSTRACT

The need for an automated surveillance system in some aspects of our daily life cannot be overemphasized. Existing monitoring video cameras are very cheap, but the human resource to manage them is very expensive and prone to errors. Most surveillance cameras are currently used after an incidence, to run through a set of recorded data to identify a culprit. The need for a continuous monitoring system that can alert users or security officers of an incident in progress is therefore important in today’s risky environment. The methodology uses a combination of temporal differencing and background subtraction method for object detection. It is then followed by a template-matching classification algorithm which uses the object silhouette followed by the contour tracing algorithm. After object detection and classification, we use PCA and feature based technique to identify the human detected. We also carried out performance analysis based on run time, time performance and detection quality of algorithms. The results show that our algorithms give a better performance than existing ones. The system works under existing infrastructures and ISPs without any modification, so that no new popular application on a mobile phone is created.

Keywords: Video Surveillance, Face Recognition, Silhouette, Feature Extraction, Principal Component Analysis

1. INTRODUCTION

The increase in the number of cameras in ordinary surveillance systems overloaded both the human operators and the storage devices with high volumes of data making it infeasible to ensure proper monitoring of sensitive areas for long periods of time. In order to filter out redundant information generated by an array of cameras, and increase the response time to forensic events, assisting the human operators with identification of important events in video by the use of “intelligent” video surveillance systems has become a critical requirement. The making of video surveillance systems “intelligent” requires fast, reliable and robust algorithms for moving object detection, classification, tracking and Object recognition (Dedeoglu 2004).

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The aim of this research is to develop an automated robust surveillance system with authentication features. The real-time video surveillance will be designed with robustness as the major design goal. The system aims at increasing the efficiency of security guards performing surveillance.

This paper presents a system which distinguishes transitory and stopped foreground objects from static background objects in dynamic scenes; detect and distinguish left and removed objects; classify detected objects into different groups such as human, human group and non-human; detect faces in human video imagery; authenticate the object identified and sends an MMS to the system user.

The system alerts the user of exempted object and is flexible enough to incorporate other functionality with relative ease. It logs the activities for future references and operates in real-time. The final decision, whether the object is a threat or not is still up to the user.

2. RELATED WORKS
Moving object detection is the basic step for further analysis of videos. It handles segmentation of moving objects from stationary background objects. This not only creates a focus of attention for higher level processing but also decreases computation time considerably. Commonly used techniques for object detection are background subtraction, statistical models, temporal differencing and optical flow. Due to dynamic environmental conditions such as illumination changes, shadows and waving tree branches in the wind object segmentation is a difficult and significant problem that needs to be handled well for a robust visual surveillance system.

![Fig.1: Generic object detection system](image)

2.1 Phases of the Generic Object Detection System
1. Pre-processing consists of a collection of simple image processing tasks that change the raw input video into a format that can be processed by subsequent steps.
2. Background modelling uses the new video frame to calculate and update a background model. This background model provides a statistical description of the entire background scene.
3. Foreground detection then identifies pixels in the video frame that cannot be adequately explained by the background model and outputs them as a binary candidate foreground mask.
4. Finally, data validation examines the candidate mask, eliminates those pixels that do not correspond to actual moving objects, and outputs the final foreground mask. Domain knowledge and computationally-intensive vision algorithms are often used in data validation.

2.2 Object Classification
Object classification categorizes detected objects into predefined classes such as human, vehicle, animal, clutter, etc. It is necessary to distinguish objects from each other in order to track and analyze their actions reliably. Currently, there are two major approaches towards moving object classification, which are shape-based and motion-based methods (Wang et al. 2003). Shape-based methods make use of the objects’ 2D spatial information whereas motion-based methods use temporal tracked features of objects for the classification solution. Detecting natural phenomenon such as fire and smoke may be incorporated into object classification components of the visual surveillance systems.

2.3 Human Identification
The next important step is to understand the identity of persons entering the scene. Latest studies on person identification demonstrate the popularity of architectures based on biometrics (distinctive personal features). Face and gait are the main biometric features that can be observed within passive surveillance context (Hu et al. 2004). Research on face recognition has a longer history and there are several studies on face detection, face tracking, extraction of facial features and face recognition (Rowley et al. 1998; Turk and Pentland 1991; Hjelmas and Low 2001).

Gait-based recognition has gained more attention in recent years. These studies can be classified into three main categories: model-based methods, statistical methods and physical feature-based methods. Model based methods use anatomical models to analyze gait of a person. Parameters like joint trajectories or angular speeds are used to build the models (Yam et al. 2001; Tanawongsuwan and Bobick 2001). In statistical methods, moment features of object regions are utilized for identifying individuals (Shutler et al. 2000; Lee 2001). Finally, physical feature based models make use of the geometric structural properties of human body to identify the motion pattern of an individual. Among these properties are the height, stride length and cadence (Abdelkader et al. 2002). A more detailed discussion on gait-based recognition studies can be found in (Hu et al. 2004).

3. METHODOLOGY
The objective of this work was to develop a surveillance system which detects motion in a live video feed and if motion is detected, then to verify the captured object, if is a strange object or a known one and to store the video feed for future reference and processing purposes. The activation of an MMS alert would help in nullifying a threat of security and storing of video provides a proof of such malicious activity. Keeping the work objective in mind, a basic system architecture as shown below in the Figure 2 was developed.
The system architecture describes how the system component interact and work together to achieve the overall system goals. It describes the system operation, how each component functions, and what information is exchanged. The architecture provides an idea of how the actual system works and operates.

The system architecture can be sub-divided into sub-sections which interact to achieve the overall objective. The successive sections discuss the various techniques used to achieve the objective. The sub-sections include:

1. Camera Capturing Control
2. Object Detection
3. Object Classification
4. Object Recognition
5. Video recording
6. User Notification
7. Activity History

3.1 Camera Capturing Control
To detect motion, the webcam captures the live video frames of the area to be monitored and kept under surveillance in real time. This is done by using a webcam which continuously provides a sequence of video frames in a particular speed of FPS (frames per second).
This control integrates all the functions needed to connect to multiple cameras together. It allows the user to add or delete cameras as well as edit all the camera settings. At the Surveillance Station, users can choose to add a camera by following the on-screen instructions to complete the camera setup and select video format. To remove cameras from list, users can simply click “Delete” to detach its camera service from the control panel.

### 3.2 Proposed Object Detection System

In this research, we employ temporal differencing and Background subtraction for the development of our algorithm.

1. **Temporal differencing**: Temporal differencing makes use of the pixel-wise difference between two or three consecutive frames in video imagery to extract moving regions. It is a highly adaptive approach to dynamic scene changes; however, it fails in extracting all relevant pixels of a foreground object especially when the object has uniform texture or moves slowly. When a foreground object stops moving, temporal differencing method fails in detecting a change between consecutive frames and loses the object. Special supportive algorithms are required to detect stopped objects.

2. **Background subtraction**: Background subtraction provides the most complete feature data, but is extremely sensitive to dynamic scene changes due to lighting and extraneous events. The aim is to get the advantage of the two techniques and thus a more efficient system. It is also very important to employ an algorithm whose run time is minimal since the system is expected to work in real time.
3.3 Object Classification

The classification metric used in our method measures objects similarity based on the comparison of silhouettes of the detected object regions extracted from the foreground pixel map with manually classified template object silhouettes stored in a database. The whole process of object classification method consists of two steps:

1. **Offline step**: Creating a template database of sample object silhouettes by manually labeling object types.
2. **Online step**: Extracting the silhouette of each detected object in each frame and recognizing its type by comparing its silhouette based feature with the ones in the template.
3.4 Face Recognition
The problem of face recognition in a real world situation can be said to be in three categories:
1. Face detection
2. Face segmentation, feature extraction and normalization
3. Face recognition

3.4.1 Face detection. This is the entry point of the face recognition process. The face detection system architecture is based on three main modules using a client-server approach as solution for the distribution. The three modules are sensor control, data fusion and image processing. The sensor control module is a dedicated unit to control directly the two cameras and the information that flows between them.

The data fusion module controls the position of the remote control camera depending on the inputs received from the image processing and sensor control module. The information obtained from the static camera (the position of the recognised object) is used to feed the other camera. Therefore, the remote control camera can zoom to the recognised human to detect the face.

![Proposed image processing steps](image)

3.4.2 Face segmentation, feature extraction and normalization. Here, face images are normalized or enhanced to improve the recognition performance of the system. If we avoid pre-processing, there is a chance of getting a low performance by the system, thus the need to apply histogram equalization, automatic rescaling and manual face cropping. After this has been done, the chosen features are extracted and appropriately ranked.

3.4.3 The Proposed Face Recognition System. This work extends the existing systems by combining the PCA with a feature based technique thus giving us the advantage of the two techniques and a more efficient system which is robust to light variation and also robust to scale and rotation.
The proposed system though primarily based on the PCA technique, is enhanced by being combined with a feature based technique. This is aimed at attaining the advantage of the two techniques and thus a more efficient system. The system passes through different stages after acquisition and before recognition, the first being the extractions of some facial features which are very important.

Some features are selected and used as distinct fingerprints for each individual image in the database. The weight for each fingerprint and total the aggregate weight for each image in the database is computed, and the score is labelled for each image. After extraction of the needed features, the PCA is applied to the same image set in the database, this gives some weight descriptors for each image after the eigenface has been computed and thus giving the possibility of adding the total score for each image from their fingerprints to the new score computed based on their weight from the eigenface.

Any probe image being recognized is also analysed according to the above steps, such that the important features are also extracted and scored and the eigenface computed. The two weight scores are added i.e. from the eigenface computation and the features extracted and then compare the score with the aggregate scores in the database, if it matches the score of any image in the database, it is recognized as known.

3.5 Proposed User Notification System
The final step of the intelligent video surveillance systems is to alert the user of exempted objects. It will be achieved by an image processing module which converts raw image to its JPEG format for the MMS image. The software then sends an MMS to the concerned person.

Once the face image of the exempted object is identified, the user notification modules calls the method getSnapshot() and returns an array of bytes, which is the image data in the format you requested. The default image format is JPEG (Joint Picture Emission Group). The proposed model of the notification system is shown in fig 8.
3.5.1 **Creating a Message Connection.** To create a client Message Connection, simply call a method passing a URL that specifies a valid WMA messaging protocol.

3.5.2 **Creating and Sending a Multimedia Message.** The connection is a client, the destination address will already be set by the implementation (the address is taken from the URL that was passed when the client connection was created). Before sending the MMS message, the method populates the outgoing message by calling. It is imperative that an MMS functionality enabled SIM card is integrated in the system and the destination MMS ID supplied by the administrator must work correctly.

![Diagram of user notification system](image)

**Fig. 8: Proposed user notification system**

The users decides whether the threat is worth investigating or not. The system then logs that alert to the system.

3.6 **Video Recording and Activity History**

Video surveillance systems require recording facilities which helps the user to feel more secured. He/She would also feel more secure if the user can be guaranteed that the surveillance system will not only help in stopping the crime been committed but also provide evidence against the perpetrators.

The system commences recording as soon as an exempted object is detected with the aid of an integrated video recorder. The user still has the privilege of terminating the recording if the object is not considered as a threat to security. Fig 9 below illustrates the integrated video recording module.
Fig 9: Video recording and activity history
4. RESULTS AND EVALUATION

This section presents the test environment and the experimental results of our algorithms. It also presents the various experiments conducted to verify the claims on the proposed system. The model comparison is also highlighted.

4.1 Results for Object Detection Algorithm

The computational performance of the three different object detection algorithms approach - adaptive background subtraction, temporal differencing and adaptive background mixture models was tested. The runtime analysis of the algorithms is shown in Table II while the time performance analysis, which is the per-frame processing time of these algorithms for an image size of is shown in Table III

The time performance analysis was carried out by first executing each of the algorithms using a limited number of video frames. For example; this was achieved by applying the conditional statement below for the temporal differencing algorithm.

While (vid.FramesAcquired<=50) % Stop after 50 frames
    data = getdata(vid,2);
    diff_im = imabsdiff(data(:,3,:),data(:,1,:));
    imshow(diff_im);
end

Our method enabled us to measure the time taken to process a specified number of frames.

The Fig 10 above shows the comparison of the time performance for the various algorithms modelled in our work. The average time to process a frame is given below in Table I.
Table I: Time Performance Analysis of Object Detection Algorithm

<table>
<thead>
<tr>
<th>OBJECT DETECTION ALGORITHM</th>
<th>AVERAGE TIME TO PROCESS A FRAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temporal Difference</td>
<td>11.25033333</td>
</tr>
<tr>
<td>Background Subtraction</td>
<td>11.19818333</td>
</tr>
<tr>
<td>Mixture Model</td>
<td>16.87103333</td>
</tr>
<tr>
<td>Hybrid Model</td>
<td>14.06873333</td>
</tr>
</tbody>
</table>

The result shows that our hybrid model gives a better time performance than the Gaussian mixture model. It was observed that our hybrid model proves to be better algorithm than each of the other models – temporal difference and background subtraction model since it combined both of their advantages.

4.2 Result of Performance Evaluation of Object Classification Algorithm

In order to test the object classification algorithm we first created a sample object template database by using an application to extract and label object silhouettes. We used four sample video clips that contain humans and non-humans such as vehicle, animals etc. The number of objects of different types extracted from each movie clip is shown in Table V. The sample object database was used to classify object in several movie clips containing human and non-human. The resultant performance of our object classification algorithm is shown in Table V.

Table II: Number of Objects in sample object template database

<table>
<thead>
<tr>
<th>VIDEO CLIP</th>
<th>HUMAN</th>
<th>NON HUMAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Movie Clip 1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Movie Clip 1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Movie Clip 1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Movie Clip 1</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>TOTAL</td>
<td>8</td>
<td>6</td>
</tr>
</tbody>
</table>

Table III: Result of Object Classification Algorithm

<table>
<thead>
<tr>
<th>VIDEO CLIP</th>
<th>HUMAN</th>
<th>NON HUMAN</th>
<th>CORRECT (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Movie Clip 1</td>
<td>0</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Movie Clip 1</td>
<td>1</td>
<td>1</td>
<td>100</td>
</tr>
<tr>
<td>Movie Clip 1</td>
<td>2</td>
<td>2</td>
<td>80</td>
</tr>
<tr>
<td>Movie Clip 1</td>
<td>4</td>
<td>3</td>
<td>100</td>
</tr>
</tbody>
</table>

4.3 Result of Face Recognition Algorithm

This section shows the experimental results that were obtained from the conducted experiments on the proposed face recognition system. In testing the viability and efficiency of our approach, a sample set of face images (Colface database) were obtained under different variations of lighting, scale and orientation of ten subjects with seven images each per subject. Based on the different experiments conducted, some of the images are used as training images while others used as testing / probe images. Also, the ORL face database was used.
A normal experiment was conducted on all the subjects using five images each as training images and the remaining image as the testing image (for Colface face database) while for ORL, seven images is used as training and three used as probes. This experiment tests the algorithm on the two face database used with and without the application of histogram equalization. The result obtained is shown in the tables below.

### Table IV: Face Recognition Algorithm without Histogram Equalization

<table>
<thead>
<tr>
<th>Face Database</th>
<th>Total No of Images</th>
<th>Total No of Subject</th>
<th>No of Training Images per subject</th>
<th>No of Probe images per subject</th>
<th>Recognition accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colface</td>
<td>70</td>
<td>10</td>
<td>5</td>
<td>2</td>
<td>76.2%</td>
</tr>
<tr>
<td>ORL</td>
<td>400</td>
<td>40</td>
<td>7</td>
<td>3</td>
<td>81.9%</td>
</tr>
</tbody>
</table>

### Table V: Face Recognition Algorithm with Histogram Equalization

<table>
<thead>
<tr>
<th>Face Database</th>
<th>Total No of Images</th>
<th>Total No of Subject</th>
<th>No of Training Images per subject</th>
<th>No of Probe images per subject</th>
<th>Recognition accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colface</td>
<td>70</td>
<td>10</td>
<td>5</td>
<td>2</td>
<td>79.2%</td>
</tr>
<tr>
<td>ORL</td>
<td>400</td>
<td>40</td>
<td>7</td>
<td>3</td>
<td>86.9%</td>
</tr>
</tbody>
</table>

Fig.11: A chart showing the recognition rate for the two face databases

The results from proposed adaptive background subtraction and the temporal differencing models clearly present the fact that the recognition accuracy of the algorithm did not really deteriorate when working with compressed images. However, a slight difference can be noted from the recognition rate achieved when both the probe images and the training images are uncompressed compared with the recognition rate achieved in the experiments just conducted. This is however little compared to what one would have expected because of some information lost during compression. It is also acceptable bearing in mind the percentage of data discarded during compression. A critical look also shows that the algorithm performance was worst when both the probe and the training images were compressed but this is also acceptable.
Based on these results, it can favourably be concluded that compression, though affects performance, the effect is not that significant, in fact the effect cannot be compared to the effect that issues like pose (in varying degrees), background noise and illumination have on face recognition accuracies.

5. CONCLUSION

In this work, we implemented three different object detection techniques and compared their time-performance with the developed Hybrid model. The Fuzzy analysis helped to measure the degree of each technique’s capabilities. Our Hybrid model’s temporal differencing gives better runtime result for dynamic scene changes and detecting motion while the adaptive background subtraction scheme gives the most promising results in terms of detection quality and computational complexity to be used in a real-time surveillance system.

The feature based approach makes use of the individual properties of the organs that are found on a face such as eyes, mouth and nose as well as their relationships with each other. Principal component analysis on the hand is based on information theory concepts. The most relevant information that is contained in a face image is extracted. Eigenfaces method is a principal component analysis approach, where the eigenvectors of the covariance matrix of a small set of characteristic pictures are sought. These eigenvectors are called eigenfaces due to their resemblance of face images. Recognition is performed by assigning weight vectors to face images, according to their contributions to the face space spanned by the eigenfaces and then combining those weights with the weights computed from the extracted weights. Ultimately, our approach excels in its speed, simplicity and learning capability as applicable to real time surveillance systems.

Communication of the system with the user was based on the latest technology of sending MMS and remote controlling using Internet network cloud. The proposed system will work under existing telecom infrastructures and ISPs without any modification, so that no new popular application on a mobile phone is created.

The system developed does not carry out event and activity analysis which will likely be the future step of our research. Finding moving direction is not the target objective of this project and object tracking from one consecutive frame to the other can be a direction for future extension.

False alarm detection is not done and left for future work. A further step of research is to implement a tracking algorithm that can monitor transient objects from one frame of the video stream to another.

Future research may also extend the face recognition algorithm by implementing an automatic background removal algorithm. This will help minimize the effects of face background and head orientation on the recognition performance i.e. background of face images should be removed and heads should be normalized in some certain degrees based on the orientation.

REFERENCES


Evolutionary Collaborative Partnership Model (ECPM): the East African E-learning Provider’s Project-Based Legitimization Strategy

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ABSTRACT
The paper examines the lack of legitimacy of e-learning projects including academic certificates through online distance programs. The paper analyses whether the lack of legitimacy that exist among e-learning projects can be eradicated through a sound proposed strategy. The rationale of this study is based on the fact that most scholars claim that various e-learning projects and programs lack legitimization, and the literature related to legitimization issues is limited. From the perspective of e-learning providers working in East Africa, this paper used Classic Grounded Theory. The study developed an Evolutionary Collaborative Partnership Model (ECPM). For legitimization to be achieved, the study revealed that three processes needed to be followed: the identifying and acquiring of collaborating partners, referral networking and strategic alliances. The study identified two types of collaborating partnerships: asymmetrical and reciprocal collaborating. The study discovered five stages in an incremental sequential process in the evolutionary e-learning collaborative partnership model including identification of key drivers, problem setting, direction setting, structuring and outcomes.

Categories and Subject Descriptors: K.3.1. [Computer Uses in Education]

General Terms: Collaborative Learning, Distance Learning

Keywords: e-learning partnership, collaborating partnership, legitimization, classic grounded theory, e-learning provider, Evolutionary Collaborating Partnership Model

IJCIR Reference Format:

1. INTRODUCTION
E-learning is the use of Information and Communication Technologies (ICTs) in teaching and learning (Fisser 2001; Khan 2005, 2007; Ndue et al. 2008; Omwenga et al. 2004; Pelliccione 2001; Sife et al. 2007). The implementation of e-learning is advancing and likely to impact all level of education. Clarke (2003) insists that the importance of e-learning will increase across the education spectrum from primary schools to Higher Learning Institutions (HLIs) in East Africa. E-learning providers are in process of implement e-learning (Sife et al. 2007). While some blend it with

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traditional teaching and learning practices, others are substituting it for traditional teaching and learning (Kathawala & Wilgen 2004). The implementation of e-learning is spurred by both pedagogical and socioeconomic factors (Govindasamy, 2002). The need for pedagogical improvement in line with teaching and learning drivers the implementation of e-learning (Lee, 2006). The socioeconomic factors include the scarcity of teaching materials, rapid population growth, lack of qualified human resources (experts), lack of physical infrastructure (buildings, etc.), cost effectiveness (Ndume et al. 2008; Pelliccione 2001; Sife et al. 2007). Generally, the adoption of e-learning mainly promoted by the failure of traditional education delivery in many countries. E-learning is considered to be of the utmost importance in combating both pedagogical and socioeconomic factors (Sife et al. 2007). It also gives learners and trainers flexibility in terms of time and space. Regardless of perceived e-learning benefits, and efforts invested in implementing it, still there is low growth rate and even those implemented projects and programs fail (see Table 1) to survive (Gunga & Ricketts 2007; Juhary 2005; Puteh 2008; Selim 2007). Africa Association of Universities (2001) argues that African universities are both unable and ill-prepared to participate in the evolution of ICT for teaching and learning due to lack of legitimacy of its online distance learning certificates. These degrees lack acceptance among employers due to negative perceptions. E-learning lack legitimate among various stakeholders (parents, teachers, sponsors, etc.). The academic gained through online distance education (e-learning) lacks legitimacy (Sife et al. 2007). As Ndume et al. (2008) argue that there exist doubts on the part of stakeholders about the quality and currency of certificates obtained from online courses. Little empirical research has been done to investigate ways in which e-learning legitimization can be achieved.

<table>
<thead>
<tr>
<th>Institution</th>
<th>Country</th>
<th>Years in Operations</th>
<th>No. of Years in Operation</th>
<th>Total Amount Spent</th>
<th>Types of Initiative</th>
<th>Education Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>UK e-University</td>
<td>UK</td>
<td>2000-2004</td>
<td>4</td>
<td>£50M</td>
<td>Political</td>
<td>University</td>
</tr>
<tr>
<td>US Open University</td>
<td>USA</td>
<td>1998-2002</td>
<td>4</td>
<td>$27M</td>
<td>Institutional</td>
<td>University</td>
</tr>
<tr>
<td>Alliance for Lifelong Learning</td>
<td>USA &amp; UK</td>
<td>2000-2006</td>
<td>6</td>
<td>$12M</td>
<td>Consortium</td>
<td>Further Education</td>
</tr>
<tr>
<td>IT Forneb</td>
<td>Norway</td>
<td>1998-2001</td>
<td>3</td>
<td>€9M</td>
<td>Political</td>
<td>Further Education</td>
</tr>
<tr>
<td>The Scottish Interactive University</td>
<td>UK</td>
<td>2002-2007</td>
<td>5</td>
<td>£2.3M</td>
<td>University</td>
<td>University</td>
</tr>
</tbody>
</table>

Table 1: List of Failed Institutions Sorted by Money Spent
(Source: Keegan et al. (2007))

In order to attempt to solve the lack of legitimization, this paper first shades light on e-learning and its status in East Africa and its economic importance to the region. The paper proposes a model to activate and improve the legitimization of e-learning in East Africa, the Evolutionary Collaborative Partnership Model (ECPM).

2. E-LEARNING

E-learning is defined as the use of modern networks, electronic devices, channels (wireless, satellite, etc.), Internet and web technologies in teaching and learning processes, offering the opportunity to learn or teach anywhere, anytime and to include any content. It includes the design, creation, delivery, storage, management and evaluation of educational content, as well as the development of learners and trainers (Tossy, 2012). The use of e-learning can be via CD-ROM, a communication network, or the Internet (Yieke, 2005). E-learning captures a wide range of terms referred to as labels (Albert & Mori, 2001) as shown in table 2 below.

<table>
<thead>
<tr>
<th>E-learning Label</th>
<th>Acronym</th>
</tr>
</thead>
<tbody>
<tr>
<td>Web Based Learning</td>
<td>WBL</td>
</tr>
<tr>
<td>Web Based Instruction</td>
<td>WBI</td>
</tr>
<tr>
<td>Web Based Training</td>
<td>WBT</td>
</tr>
<tr>
<td>Internet Based Training</td>
<td>IBT</td>
</tr>
</tbody>
</table>
Online Resource Based Learning | ORBL
---|---
Advanced Distributed Learning | ADL
Tele-Learning | T-L
Computer-Supported Collaborative Learning | CSCL
Mobile Learning | ML or M-learning
Nomadic Learning | NL

Table 2: List of E-learning Labels
(Source: Tossy, 2012)

E-learning has the potential to facilitate learner engagement (Uys, 2004). Chacha (2009) outlines the need to tap the potential of ICTs to enhance data collection and analysis, and to strengthen management systems in educational institutions; to improve access to education by remote and disadvantaged communities; to support initial and continuing professional development of teachers; and to provide opportunities to communicate across classrooms and cultures. Clarke (2003) in his report to the Department of Education and Skills (DfES) in the United Kingdom (UK) argued that the 21st century education system should: offer flexible provision to a diverse range of learners; support and enable the development of a professional workforce, creating skilled graduates capable of problem solving and creative thinking; empower learners to make choices about how, when and where they learn and with what and whom; give better value for students in supporting their learning in ways best suited to their particular needs and goals, and in timely and cost-effective ways, and support creativity and innovation not only in mainstream research activities, but also in approaches to teaching and the support of learning. Chacha (2009) argues that lack of legitimacy of online degrees, low investment in ICT infrastructure, coupled with the high cost of connectivity and bandwidth, are major problems hindering the effective use of the resources available on the Internet. Most e-learning providers in East Africa are facing these problems, making the integration of ICTS into teaching and learning difficult.

3. CONTRIBUTION OF E-LEARNING IN THE EAST AFRICA ECONOMY

The key to the development, both economy and productivity of East African countries is education (WB, 2002). It is the only way of making Africans access the critical knowledge on economic activities. The use of ICTs in education, will enhance access to knowledge. Therefore, e-learning has benefits to learners, teachers, and organizations. Besides many challenges in its implementation, e-learning still has many benefits (Flinn& Lawrence, 2003). There many drivers of adopting e-learning. These drivers are also termed as benefits:
- Saves money invested in infrastructure development (such as classrooms, etc.)
- Reduces cost for the development of the workforce, costs of course delivery.
- Enables teachers to acquire necessary skills affordably and fast.
- Enables the learners collaborate and share the limited resources.
- Widens participation and suits all people - the disabled, working and non force.
- Allows individuals to learn from anywhere, anytime and anyplace
- Increase access to and improves quality of education in a relative cost-effective way.
- Creates fair playing field for the high population and the few higher learning institutions.
- Creates flexibility in design and delivery of curriculum content.

In addition, e-learning offers convenience and portability, cost and selection, budget and flexibility, great collaboration, global opportunities and higher retention.
4. CLASSIC GROUNDED THEORY METHODOLOGY

This paper uses Classic Grounded theory methodology (CGTM) by (Glaser & Strauss 1967). It has been further elaborated and refined by (Glaser 1978; Glaser 1992; Glaser 1996; Glaser 1998; Glaser 2001; Glaser 2003; Glaser 2005; Glaser 2006; Glaser 2008; Glaser 2009; Glaser 2011). This theory was chosen for three reasons. Firstly, CGTM claims to deliver the main concerns of e-learning providers in East Africa. Secondly, CGTM fits the nature of the phenomenon being researched (e-learning providers), as it follows (Lowe 1996) description of CGT as being designed to “develop and integrate a set of ideas and hypotheses in an integrated theory that accounts for behaviour in any substantive area”. Thirdly, CGTM provides a flexible set of inductive strategies for collecting and analysing data. Glaser (1992) and Glaser & Strauss (1967) outline the key distinguishing characteristics of the CGTM research methodology as (a) Simultaneous involvement in the data collection and analysis phases of research; (b) Developing analytic codes and categories from data, not from preconceived hypotheses; (c) Constructing middle-range theories to understand and explain behaviour and processes; (d) Memo-writing, that is, analytic notes to explicate and fill out categories; (e) Making comparisons between sets of data, data and concept, and between different concepts; (f) Theoretical sampling, that is sampling for theory construction to check and refine conceptual categories, not for representativeness of a given population; and (g) Delaying the literature review until after the emergence of a core variable.

CGTM is a general inductive research methodology designed to reveal deep seated latent patterns of human behavior and how the main concerns are being continually being resolved (Glaser, 1978). It can be applied to all types of data, both quantitative and qualitative, or the combination thereof as has been outlined by Glaser (1978). CGTM provides researchers with a means to build theory relevant to the particular discipline within which they are conducting their research.

Christiansen (2005:81-84) argues that CGT is an "ontology free and epistemology free methodology". The ontological assumptions have no place in the use of CGT since it is grounded in data. Glaser (1978:45) explains further that in the CGTM methodology all ontological and epistemological suppositions are irrelevant and are not useful: “... logical conjectures or preconceptions that pre-frame the research, and pre-framing has to be avoided in any CGTM work, in order to keep close to what the data has to say, and to discover and name emergent latent patterns in the data.” The CGT minimizes the influence and potential distorting effect of preconceptions, logical deductions and elaborations and ungrounded assumptions (Glaser, 1978). As a result, a researcher using CGTM is free from both ontological & epistemological assumptions. Glaser (1978:76) argues that “It is only a question of applying a rigorous and systematic method for discovering and explaining these patterns. Thus, just do it.” In summary, Glaser (2005:5-6) argues that “the quest for an ontology and epistemology for justifying CGT is not necessary.

According to Glaser (1978), CGTM is a multivariate process which happens sequentially, subsequently, simultaneously, serendipitously and in a scheduled manner. It is the systematic generation of theory from data acquired by a rigorous research method (Glaser, 1978; Glaser, 1992; Glaser, 1996; Glaser, 1998; Glaser, 2006; Glaser 2008; Glaser, 2009; Glaser 2011). In essence grounded theory is an integrated set of conceptual hypothesis, i.e. probability statements about the relationship between concepts. The hypothesis is generated through constant coding and analysing of data. CGTM is a general research method which is not evidence based (Glaser, 1978, 1998). This is because the use of evidentiary data presupposes that a deductive hypothesis based research method is being employed. Thus CGTM is a general research method which is mainly inductive. Glaser explains why it is inappropriate and unproductive to treat CGTM as though it were evidence based on “the credibility of the theory should be won by its integration, relevance and workability, not by illustrations as if it were proof. The theory is an integrated set of hypotheses, not of findings. Proofs are not the point.” (Glaser, 1978)

Stages for Doing Classic GT

Throughout the process of CGTM research, a researcher needs to maintain transparency, through following all CGTM stages and procedures outlined by Glaser (1978), including (1) Generating Theoretical Sensitivity; (2) Theoretical Sampling; (3) Theoretical Memos; (4) Substantive Coding; (5) Theoretical Coding; (6) The Constant Comparison Method; (7) Sorting; and (8) The Emergence of the Core Variable. As detailed in Figure 1, although there are very specific stages through which the CGTM researcher must go, the order of doing them will change according to what emerges from the data. This kind of flexibility in terms of sequence and process is necessary in order to reveal certain deep seated patterns of human behaviour.
Evaluating Classic Grounded Theory Study

Glaser (1978, 1992, and 1998) outline the four main criteria with which to evaluate classic grounded theory study. Firstly, CGT should be ‘fit’ - that the concept adequately reflects the data that it purports to express. The categories of the emerged core variable must fit the data used to create the theory (Glaser 1978). Secondly, is ‘workability’ - how the core variable accounts for the respondents’ continual resolution of their main concern is a key issue. The emergent GT must clearly explain what is happening, and the process of its happening and by so doing should be able to predict future behaviour (Glaser, 1978, 1998, 2001). Thirdly, the CGT study should be ‘relevance’ - how the emerged core variable has been received by the members of the constituency from which the data was drawn is also pertinent (Glaser, 1998). Fourth, is ‘modifiability’, the CGT is considered to be modifiable if it is easy for subsequent CGTM researchers to be aware of what research has been done so far in the area, and to proceed to modify or refine the theory as they collect and code new data (e.g. code new data for emergent fit), without invalidating the theory.

5. RESEARCH DESIGN AND APPROACH

5.1 Research Population

The data for this study was drawn from e-learning providers working in East Africa. These included higher education institutions (HEIs) staff members, programmers, consultants, and management personnel. Following the Classic Grounded Theory Methodology, the number, scope and range of those being interviewed were determined in an ongoing process based on the emergent data

5.2 Data Collection

A total of 24 e-learning provider respondents from Tanzania, Kenya and Uganda were interviewed on several occasions. This meant a total of 101 respondent encounters. Three types of data collection techniques were used. First data was collected through interviews, oral conversations, defined by Payne and Payne (2004) as “data collection in face-to-face settings”. The most important aspect of these interviews was that they were of short duration, conducted without tape recordings, and were followed immediately by detailed memo writing (Glaser & Strauss, 1967; Glaser, 1978). Second; data was collected through unstructured observation, e-learning providers engaged in e-learning activities were observed during their daily activities, and were systematically documented in the course of writing theoretical memos. Thirdly, a review of existing documents related to the e-learning providers such as those dealing with e-learning contexts and trends, performance ratings, program logs, tally sheets, and other existing indicators. Much of this data was sourced from the Ministry of Higher Education, universities and other governmental and non-governmental sources.

5.3 Data Analysis

The CGTM is a general research method which treats everything as data, whether quantitative or qualitative (Glaser, 1992). The following Glaser (1978) CGT Research process was followed; (1) Theoretical sampling and substantive coding; (2) Theoretical coding; (3) Theoretical memo writing; (4) Constant comparison between and within memos; (5) Sorting codes; (6) Data saturation; (7) Emergence of the core variable. Although the above is represented in a linear format, in practice the exact sequence varied according to what patterns seemed to be emerging from conversations with respondents (See Figure 1). The reason for this is that GT is a process, not a unit based, approach. The data was simultaneously, subsequently, and sequentially collected, analysed and synthesised.
Determine Population

The E-learning Providers Working in East Africa from:
- Researcher’s Networks
- IT professionals’ Networks

Data Collection
Memoing
Note-Taking
Emerging Issue Fractured
CONSTANT COMPARISON & SORTING

Any pending issues
Saturated?
Emerged Core Variables
Is more than one?
End

Data Set n
Initial Interview
6 respondents

Data Set n + n
Subsequent Interview
18 respondents

Memoing
Data Collection
Coding
Note-Taking

- Return to data laboriously and constantly compare across all the memos to prove which is more robust and prominent than the other
- Re-enter the field to collect data (4 respondents for the original cohort)

- Return to data laboriously and constantly compare across all the memos to prove which is more robust and prominent than the other
- Re-enter the field to collect data (4 respondents for the original cohort)

Asymmetrical Collaboration
Cultivating Recognition

Figure 1: Classic Grounded Theory Data Analysis Framework
6. RESULTS AND DISCUSSION

6.1 E-learning providers Legitimizing Strategy

As Figure 2 shows, legitimizing was identified to the sub-core variables amongst e-learning providers based in East Africa and who participated in this study (Tossy, 2012). The e-learning providers have continually used legitimizing so that e-learning projects can be successfully implemented. Legitimizing is defined in this context by e-learning providers as the process of ensuring the project is valid, delivered and sustainable. This is achieved by the accumulation of social credit bestowed on the e-learning providers by their peers and clients. This study defines Legitimizing as the process of ensuring the e-learning activities, including planning, designing, delivery, and evaluation take place and that each e-learning as product or deliverable is both valid and sustainable. Thus the validity, in terms of quality and appropriateness for purpose, and the sustainability of the project is ensured and maintained by means of the "Legitimizing" process (see Figure 1), which is an on-going and perpetual process. Thus for e-learning projects to be continuously sought after, e-learning providers need to ensure a project is legitimized by all stakeholders (i.e. client, funder, etc.) and is accorded respect throughout the process. The main symptom of, and reason for, a lack of legitimization is the lack of respect and trust shown to e-learning providers by some of the stakeholders, including funders and clients. A Legitimizing process is undertaken by e-learning providers in order for them to gain the necessary respect from their clients.

The process of Legitimizing involves three main activities or processes: Collaborating partnership, Referral Networking and Strategic Alliancing. The process begins with the seeking out and setting up of collaborating partnerships. This is a process in which e-learning providers collaborate with other experienced e-learning partners prior to a formal funding submission for their e-learning projects. This collaboration can be either with a partner who has a considerable degree of influence and power (asymmetric collaboration) or with a partner with a similar or equal level of power and influence (reciprocal collaboration). Secondly, the collaborating partners make full use of their existing referral networks so that the potential client or funder is more likely to have confidence in the proposal. Finally, e-learning providers are more successful if they have already entered into formal strategic alliances with other respected partners and these inform, and are integrated into, the proposal document. Successful e-learning providers are able gain more traction in their projects when they are able to simultaneously synchronise several different projects. This is because of the potential for sustainability from one project to another that synchronicity is able deliver. The details of each sub secondary core variable of Legitimizing (see Figure 2) are discussed in the following paragraphs.
While Gray (1995) defined collaborating partnership "as a voluntary pooling of resources (labour, money, information, etc.) by two or more parties to accomplish collaborative goals", this study adds a further advantageous characteristic to this definition of a Collaborating partnership as a partnership which involves the process of creating business opportunities through the advantages of partnerships. Collaborating partnerships are arrangements devoted to maximising the success of some aspects of e-learning implementation which are, as goals, are held in common among otherwise independent organizations or units. E-learning collaborating partnerships include cooperative marketing initiatives, public-private partnerships and inter-sector partnerships (Gunga & Ricketts 2007; Ndume et al. 2008; Puteh 2008; Selim 2007; Sife et al. 2007; Singh 2003; Uys 2003, 2004). Recent economic, political and social forces have combined to make collaborating partnerships an explicit priority of higher learning institutions in the implementation of e-learning. It has become popular in e-learning implementation to emphasize the importance of forging partnerships...
to accomplish collective and organizational goals. As has been mentioned, Collaborating partners are of two types: (1) Asymmetrical Collaborating partners; and (2) Reciprocally Collaborating partners.

Asymmetrical collaborating partnership is a concept which explains how the weaker party in the collaboration is able to obtain the benefits that collaboration brings (e.g. funding opportunities, scholarships) whilst skillfully avoiding being dominated by the more powerful partner. Reciprocal Collaborating partnership is the process of generating mutual benefit for the parties in the partnership through the sharing of power and status. The power comes from funding opportunities and decision making. The collaborating parties in reciprocal collaboration tend to share power and benefits equally regarding the implementation of the e-learning project. As Figure 2 shows, collaborating partnerships range from situations where e-learning providers (internally - within the organization) or organizations (externally - outside the organization) interact briefly around a common problem to those situations where multiple organizations (externally) are represented in an on-going venture. The partnership may shift from an asymmetrical partnership to a reciprocal partnership and back again over time. It may also shift from internal to external partners or both at the same time. The collaborating partnership may be highly structured, characterized by legally binding agreements between participating organizations. An example of such e-learning partnerships and initiatives could be interactions between academic departments and technology support groups which voluntarily provide services for planning, designing and delivering online learning. Such partnerships aim to increase the quality and access of what they offer (Selin & Chaves 1995; Sife et al. 2007; Sifuna 2007). It has been found that most collaboration between national, regional and international interests are aimed at funding e-learning initiatives. Developed countries are now forging collaborative links with and between international interests for the purpose of expanding e-learning operations beyond their borders.

Several assumptions contribute to and underpin a conceptual framework for understanding the dynamic nature of e-learning collaborating partnerships (Selin & Chaves 1995). First, it is assumed that e-learning implementation operates in a turbulent and constantly changing environment: many economic, social, technological and political forces influence policy and management direction. For example, the rapid change of technology globally is having a profound impact on e-learning implementation and development. However it is also assumed that e-learning projects have the ability to influence and adapt to their environments through strategic planning.

Second, a domain level focus improves the examining of e-learning collaborating partnerships. Most e-learning managers still embrace an organisation set perspective, where their organization is thought to be the focal agency and other organizations and interests are considered to be external "publics". While this perspective may be appropriate for a more predictable environment, successfully navigating a turbulent environment requires that managers adopt a domain level focus which includes "the set of actors (individuals, groups, and/or organizations) that become joined by a common problem or interest". One example of a domain might be the set of actors interested in establishing multi-institutional operations, to position them for funding. Such collaborating partnerships involve many organizational and individual interests that transcend traditional organizational boundaries. Finally, a process-oriented, rather than a cross-sectional approach to the study of e-learning collaborating partnerships can be adopted. The next section on an evolutionary model of e-learning collaborating partnerships (see Figure 1) emphasises collaborating partnership dynamics and views them as dynamic systems of interactions, constantly changing in response to internal and external e-learning implementation forces.

"Referral Networking" and Strategic Alliancing are the other two activities or processes involved in Legitimising. Referral Networking involves stimulating existing contacts and creating new contacts. These connections and networks can be useful for endorsing e-learning projects, thereby increasing and strengthening their legitimacy. Referral Networking can be of value to e-learning providers in terms of capturing more opportunities for funding, collaboration, and for increasing the popularity of the online programs. Strategic Alliancing is a mutually beneficial process for e-learning providers to work together for the purpose of delivery of online courses or for securing funding. Strategic Alliancing is a medium to long term process of connecting with other parties in a particular field. This includes matching the strategic objectives of one institution to another or to others. The evolutionary model of e-learning providers is discussed in the next section.

6.1 An Evolutionary E-learning Partnership Model

As illustrated in Figure 2, the evolution of e-learning collaborating partnerships begins in a context of the existence of key e-learning drivers. There exists a wide range of these key drivers, or pressures to form partnerships, including scarce resources, common vision, incentives, existing networks, high population growth, lack of enough qualified human resources and lack of physical infrastructure (Gunga & Ricketts 2007; Meyen 2002; Ndume et al. 2008; Selin & Chaves 1995; Sife et al. 2007; Sifuna 2007; Tossy 2012). The collaborating institutions operate within societal environments. These societal environments exert competitive, technological, political, social and economic forces and pressures to increase and strengthen collaborating partnerships (Selin & Chaves 1995). Gunga and Ricketts (2007) argue...
that partnerships bring together innovative minds to help overcome the various e-learning challenges. They also avoid dual, or separate, problem solving within the same country and in the same context. From these key drivers, partnerships evolve sequentially through a problem setting, direction-setting and structuring phase. Partnership outcomes and feedback arrows (in Figure 2) emphasise the dynamic and cyclical nature of the evolutionary process of collaborating partnerships.

At the Problem-setting stage of the collaborating partnerships, the institutions in such partnerships appreciate the interdependencies existing among them. This is because they realize that the action to take in solving a particular problem, or problems, needs collective efforts among them. It is during this stage that consensus is reached on partnership operations. This will include actions like agreement signing. At this stage, the partners and stakeholders begin to mutually acknowledge the issue, or issues, which bring them together. Positive perception in terms of the unforeseen benefits will increase the strength of the partnership.

At the Direction Setting stage the partners tend to establish goals to achieve the common vision recognized in the problem setting stage. The established goals tend at this stage to be measureable and responsive to the perceived benefits stipulated at the problem setting stage. The partners set ground rules for the operation of the partnership including join information searches, exploring options and organising sub groups of operations. The direction setting stage is also the stage where partners begin to identify and appreciate a sense of common purpose. The joint information search helps strengthen the future of the partnership.

The Structuring stage involves formalising and institutionalising the collaborating partnership and devising a regulatory framework to guide future collective action (Gray 1989, 1995). For the partnership to survive stakeholders’ interactions need to be managed in a systematic manner. At this stage, the legal formalisation of the collaborating partnership is developed and put in place. This involves signing various agreements, assigning roles, and finally reaching formal agreements to monitor and assure collective compliance to the goals of the group (Selin & Chaves 1995). At the end of this stage all formal relationships, roles, tasks and monitoring and control systems are in place. Some of the roles are assigned to special committees, such as a procurement committee, online content committee, etc.

It is at the last stage in the process of the collaborating partnership establishing and increasing legitimization, the Outcome stage, that the outcomes of the processes are realized. These outcomes may be visible and tangible products of the partnership and may include program modules, offices, and numbers of students registered for the program modules courses materials (Selin & Chaves 1995). For the collaborating partnership to flourish there needs to be communication throughout the collaborating process (illustrated by feedback arrows in Figure 2). As the various forms of feedback continue, the collaborating partnership process becomes cyclical to the benefit of the partners and of the partnership. This means that a continuous process of evaluation and re-evaluation becomes one of the main purposes and characteristics of the partnership, thus constantly improving the quality of deliverables, broadening the scope of the partnership, and admitting more partners into the collaborating partnerships.

7. CONCLUSION

The purpose of the study was to develop an evolutionary model for a partnership for e-learning providers. This is a dynamic and sustainable model, which will assist e-learning providers in overcoming the lost trust, legitimacy and value of the e-learning awards and degrees. It will also help the successful marketing of e-learning products. This paper discussed and developed an Evolutionary Collaborating Partnership model (ECPM). ECPM is envisaged to be the most effective and sustainable legitimisation strategy for e-learning providers. Any partnership to sustain and nurture itself, requires special facilitative skills at each stage of its establishment and consolidation. These skills range from the management of partners, communication, time, cost and others. In addition constant feedback from clients is necessary for the growth and sustaining of any collaborating partnership and thus extensive efforts and resources need to be invested in e-learning collaborating partnership planning and management. The collaborating partnership is viewed as a process which is influenced by a set of economic, social, political and technological forces. Some of the constraints to collective actions or collaborating partnerships have been listed and include competition, bureaucratic inertia, and geographic and organization fragmentation.

Thus the study recommends that in order to overcome these barriers and to increase the benefit of collaborating partnerships, human resources in the form of committed innovative creative people and those with special facilitative skills are needed. The study is intended as a model for institutions interested in embarking on collaborating partnership processes in e-learning. For purposes of speeding up the use of e-learning, the research recommends that researchers and educational institutions operationalise the proposed model and evaluate it.
8. REFERENCES


On the Development of the Mobile based Agricultural Extension System in Tanzania: A Technological Perspective

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ABSTRACT

Agriculture is the back bone of Tanzania’s Economy. For it to contribute significantly to the economy, farmers need access to agricultural information and knowledge in timely, complete and quality manner. The traditional practice for delivering agricultural information in Tanzania is mainly through farmer-to-farmer visits, farmers’ own experience and extension officers. The practice requires extension officers to visit farmers in order to give advisory services. Thus due to the few number of extension officers, the system is overstretched which necessitates the urgent need to find an alternative method to improve extension services. This paper presents a mobile based Farmers’ Advisory Information System (M-FAIS) aimed at improving the coverage of extension services in Tanzania. The philosophy behind this initiative is on capacitating the extension officers to serve many farmers anywhere anytime. The study contributes to the approach for testing complex system in agricultural informatics. The approach integrates the conventional system testing approaches (technology-centric approach) and extends it to include consideration of system usability (user-centric testing approach) prior to system release.


General Terms: Management

Additional Keywords and Phrases: Mobile phone, Farmers advisory information system, Agriculture, Agricultural extension services, Farmers, user and technology centric approaches

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1. INTRODUCTION

The agricultural sector in Tanzania constitutes a quarter of the national GDP and accounts for 75% of rural households’ income (WB, 2011). Agricultural productivity is low and total cereal yields are below the levels in neighboring countries such as Zambia, Malawi and Zambia (WB, 2014). The monitoring of poverty in Tanzania during the last decade, indicates a decrease in the proportion of the population below the national poverty line, but in rural areas, the decrease has been rather limited (Haug and Hella 2014). Poverty among male and female farmers is due to; poor agricultural information facilities and inadequate access of agricultural information and knowledge by farmers (Iraba and Venter, 2011). According to Sunden and Wicander (2003), the majority of the smallholder farmers live in...
information-deserted areas which are places where availability of agricultural information is limited. Due to limited agricultural information, most rural people in developing countries face difficulties in decision making regarding their economic activities such as crop production, livestock keeping and marketing information (Obayelu and Ogunlade, 2006). As a result, the proportion of poverty among rural people decreases despite the many efforts done to reduce it (Grindle, 2004). Several of the recent policies and strategies launched by the Government of Tanzania emphasize improving access to agricultural information, extension and training for small scale men and women farmers. In this respect, there are several initiatives and programmes such as Kilimo Kwanza, National Strategy for Growth and Reduction of Poverty II (NSGRP II) (or MKUKUTA II in Kiswahili acronym), Agricultural Sector Development Programme (ASDP), Tanzania Agriculture and Food Security Investment Plan (TAFSIP) under the Comprehensive Africa Agriculture Development Programme (CAADP), Feed the Future Programme, Southern Agriculture Growth Corridor of Tanzania (SAGCOT) (Haug and Hella, 2014). The level of awareness among most farmers on agricultural innovations emanating from these Government initiatives is very low due to limited information, leading to poor decisions on the effective utilization of scarce resources, farming technologies and existing market potential. Manda (2002) pointed out that the majority of farmers do not necessarily make critical agricultural decisions on the basis of scientific, technical and marketing information. It is for this reason that technological advancement and the emergence of new markets have no great impact on the lives of most rural farmers in developing countries. Farmers need to be empowered using the available mobile technology (Ginige and Richards, 2012). Thus, this is the area which has been proposed to be one of the researchable topics on the development of mobile based information systems in agriculture (Gichamba and Lukandu, 2012).

1.1 The role of ICTs in Agricultural Information dissemination and communication

Information and Communication Technologies (ICTs) have been thought as the best method for bridging the information gap for rural farmers with respect to information related to innovative practices, technologies, Government policies, credit facilities, and markets (Chilimo and Sanga, 2006). Several media and communication channels are used to communicate agricultural information in rural areas. Maru (2003) and Etta et al. (2001) mention radio, mobile phones, television, fax, Internet and digital technologies, print (products of the press) and computer based or computer mediated modes as common media used in information dissemination and communication.

The case for the mobile phones being more important especially in disseminating and communicating agricultural information in order to improve agricultural extension services in developing countries, has been argued by researchers and practitioners that are deploying ICT tool for development (Sanga et al., 2014a). For instance, in India mobile phones based system have been opted as a means of reaching rural farmers in which a small, but relevant amount of data is transferred to farmers via SMS (short message service) text messaging (Veeraraghavan et al., 2009).

1.2 Mobile phone usage in Tanzania

A mobile phone (also known as a cellular phone or cell phone or a hand phone) is a device that can make and receive telephone calls over a radio link while moving around a wide geographic area. It does so by connecting to a cellular network provided by a mobile phone operator, allowing access to the public telephone network. By contrast, a cordless telephone is used only within the short range of a single, private base station. In addition to telephony, modern mobile phones also support a wide variety of other services such as text messaging, multimedia messaging service (MMS), electronic mail (email), Internet access, short-range wireless communications (infrared, Bluetooth), business applications, gaming and photography. Mobile phones that offer these and more general computing capabilities are referred to as smart phones (Raento et al., 2009).

In Tanzania, mobile telephony is the fastest growing ICT sub-sector, with estimation that over 28 million Tanzanians own a mobile phone with a penetration rate of about 62 per cent (TCRA, 2012). Mpogole et al. (2008) argue that the increasing competition among network providers in Tanzania has resulted in a reduction of costs for mobile phone services and hence, increases significantly the number of mobile phone users. Studies by Forlin (2008); Rashid and Elder (2009) recommended that increased growth rates of mobile phones usage have been attributed by many factors including: the liberalization of telecommunication markets; user-friendliness of the phones; the need for basic literacy in using the phones; pre-payment modes; and usage of local languages in communication. On the other hand, the reasons for owning or using a mobile phone by rural farmers are to communicate with friends and family members, maintain relationships, emergency situations, help in job search, help in income generating activities and business networking (Samuel et al., 2005; Chakraborty, 2005; de Silva & Zainudeen, 2007).
1.3 The mobilephone and socio economic development

Access to telecommunication has been cited as a factor for socio-economic development especially in rural areas (Samuel et al. 2005). Mobile communication increases economic growth, alleviates poverty, and helps in overcoming the perceived digital divide (Chakraborty, 2005). De Silva and Zainudeen (2007) also argue that the use of mobile phones in the right way and for the right purpose can have a significant outcome in addressing specific social and economic developmental goals. Sife et al. (2010) say mobile phones can contribute significantly in improving rural livelihoods and reduce poverty in Tanzania.

1.4 Research Justification

In Tanzania, ICTs are among the best tools used for improvement of delivery of agricultural extension service particularly in communicating information related to agricultural production and marketing information (Mtega 2012). Some of ICT facilities employed are the use of telecenters, ward agricultural resource centres and community radios [James 2010]. These ICT facilities however face a number of problems in communicating agricultural information and knowledge for sustainable agricultural development in Tanzania. Some of the problems are: lack of funds, high operational costs, illiteracy, long distance to telecentres, language barrier, lack of electricity, frequent power cuts, fewer local agricultural information content and sustainability issues. Further, most of the managers of these facilities are not aware of the farmers’ information needs, which constrain them from meeting related farmers needs (Chilimo, 2008). Due to the aforementioned problems, there is an increased use of mobile technologies which has overshadowed some forms of public access to the mentioned ICTs facilities in rural areas [Lwoga 2010]. Some researchers have termed the revolution of mobile phones has brought a negative effect called possessive individualism (http://gurstein.wordpress.com/2012/07/21/the-mobile-revolution-and-the-rise-and-rise-of-possessive-individualism/).

According to Veeraraghavan et al (2009), mobile phone promises to unlock most of problems facing telecentre, ward agricultural resource centres and community radio. Kapange (2004) also reported that, the mobile phones mushrooming in Tanzania are increasingly becoming affordable and make communication easier even to the rural poor. Hence, they can be used to strengthen the agriculture extension services to smallholder farmers. Tanzania Communications Regulatory Authority’s statistics shows that more than 28 million (62%) Tanzanians own mobile phone (TCRA, 2012). Given the fact that mobile phones have penetrated even to rural areas, it is an opportunity to take advantage of mobile phones to address the problem of poor coverage of agricultural extension services (Mvuna 2010). Therefore, this study presents work towards developing a mobile based farmers’ advisory information system (M-FAIS). The ultimate goal is to use mobile phone as effective ICT tool to enhance delivery of agricultural extension services to different actors in maize value chain in Kilosa, Tanzania.

1.5 Related Work

Parikh et al. (2007) define value chains as the series activities that extend from farmers to consumers. Also, they state that in between there are intermediaries who add value to agricultural food products in various ways, including processing, packaging, certifying, transporting, distributing, whole selling and retailing to the end consumer (Parikh et al. 2007). In this paper, Parikh et al.’s definition was adopted. The analysis of different agricultural knowledge and information systems (AKIS) which have already been implemented to support agricultural value chains in Tanzania was done accordign to Parikhet al.(2007) who mentioned four types of information systems which need to be integrated to enhance the information flow in any agricultural value chain. According to Parikn et al. the systems are: (i) Marketing information systems (ii) Agricultural extension systems (iii) Procurement and traceability systems and (iv) Inspection and certification systems.

Among the four mentioned systems, in Tanzania there are marketing information system which is workable (Mapunda, 2011; Mwakalinga 2005). Also, there is an SMS based system to communicate market prices weekly. This system is under pilot at Kilosa Rural Services and Electronic Centre (KIRSEC). In addition, FrontlineSMS is used by Kilosa Community Radio to send and receive bulk text messages from listeners during radio presentation of different radio programmes. Furthermore, there is a web based livestock marketing Information System called “Livestock Information Network Knowledge System (LINKS)” which enables farmers through their mobile phones to access the prices of livestock and livestock products in various markets located in different regions of Tanzania. Furthermore, there are *TigoKilimo and Z-Kilimo which provide farmers with relevant and timely agricultural information from their mobile*

*http://www.itu.int/ITU-D/sis/newslog/2012/08/20/TigoLaunchesMobilePhoneFarmingProgrammeTanzania.aspx*
phones. They are SMS-based applications which enable the farmers get real-time information on weather forecast and agricultural tips. Their disadvantage is that it is meant for dissemination of agricultural advisory service. From our analysis, we found that the communication aspect is not implemented in Tigo Kilimo and Z-Kilimo. Also, they are not interactive compared to M-FAIS. Furthermore, the agricultural contents in Tigo Kilimo and Z-Kilimo are not catering for the agricultural information needs for a specific location in Tanzania (i.e. they are generalized). Thus, to harness the potential of ICTs in linking different systems to support information needs of different actors of agricultural value chains there is a call for more researches to explore how ICT systems can be implemented to fill the identified gap in knowledge. It is in this view that this paper tries to present the M-FAIS.

The main objective of this study was to develop the M-FAIS to enhance agricultural extension services delivery. To meet this objective, the literature review was done to assess different architecture of mobile phone based information system and analyze how the current agricultural extension system that delivers advisory services to farmers can be supported by mobile phones.

Based on challenges facing agricultural extension services in Tanzania (Obinne 1997; Swanson et al. 1998; Suzuki 2000; Sonoko 2001; Rutatora and Matee 2001; Arokoyo 2003; URT 2006; World Bank 2008; Mvumi 2010), the research question set for this study was “How can mobile phone improve the delivery of extension services in Tanzania using cost effective architectural design?”. This study answers the question from an ICT technological perspective. It differs from our early articles which answered the same question using socio-technical perspectives (Sanga et al. 2014a; Sanga et al. 2014b; Sanga et al. 2014c; Sanga et al. 2014d).

2 MOBILE PHONE BASED SYSTEMS

2.1 An overview

Mobile based information system users send and receive services over mobile network via short message service (SMS). When two mobile phones exchange SMS, the SMS from the sending mobile is first stored in a short message center (SMSC) of a mobile operator which then forwards it to the destination mobile. The SMSC handles routing of SMS through several other SMSC and regulates traffic of wireless SMS until it reaches the desired recipient. This means that in case that the recipient is not available; the SMS is stored and can be sent later when the recipient is available. SMS supports national and international roaming. This means that you can send SMS to any other GSM mobile user around the world. According to Mavrakis (2004), there are two types of SMS namely Short message Mobile Terminated (SMT) and Short message Mobile Originated (SMO). SMT is the ability of a network to transmit a SMS to a mobile phone. The message can be sent by phone or by a software application. In other hand, SMO is the ability of a network to transmit a SMS sent by a mobile phone. The message can be sent to a phone or to a software application as shown in the Figure 1 below.

Figure 1: Sending and receiving SMS via mobile network

SMS applications are widely used in two methods, Pull and Push. A PUSH SMS application disseminates information to users without their prior requests. For instance SMS based result checking system that sends results to farmers without the farmers’ prompt. Advantage of this method is farmers receive their agricultural market information as soon
as they are out. PULL SMS application requires the user to send a request for the given information, and then the system process the request and sends back the result. This approach is based on service invocation as standardized through web-service technology.

2.2 Componential architectures of Mobile based system

There are several componential architectures of mobile based information system which are distinguished in terms of devices and technologies used. The following section discusses different architectures, presents comparison and finally, provides the evaluation of suitable architecture for the developing of M-FAIS.

2.2.1 Mobile based information system using a GSM modem

According to Zhang et al. (2008), the architecture of mobile based information system using a GSM modem is as shown in Figure 2 below:

![Figure 2: Architecture of Mobile based information system based on a GSM modem (Adapted from Zhang et al. 2008)](image)

The main components of the system as described by Zhang et al (2008) is as follows:

a. **Cell phone terminal**: A device capable of sending and receiving SMS. SMS is a technology that enables the sending and receiving of messages between mobile phones. A major advantage of SMS is that it is supported by 100% of GSM modems.

b. **GSM Modem**: Connect a GSM modem to a computer system and use AT commands to capture and send SMS text messages. In terms of programming, sending and receiving SMS messages through a GSM modem are similar since instructions are sent to the GSM modem in the form of AT commands.

c. **Transmission Module**: Since the GSM modem is connected to the computer through the serial port, the system requires a good mechanism to finish message transmission. Double buffering is a technique used by many device drivers to minimize the delay in input/output operations which use a buffer. Within this, the data acquisition device is able to write data at the same time as the application is reading data out.

d. **Database interface module**: This module connects the transmission module and the database. The database interface should possess the following data tables: a receiving data table, a sending data table, a sending unsuccessful data table, a sending successful data table. Top application software can use this database interface to perform additional functions.

e. **Database**: A database information management system manages database and rearranging the database information and communicates with users using a database interface. It means that the information management system is an application based on the GSM modem SMS.

2.2.2 Mobile based information system using Wireless Application Protocol (WAP) technology

The architecture of mobile based information system using WAP technology is shown in Figure 3 (Ismail 2009). From the Figure 3 below, a user sends requests and receives information using mobile phone via WAP gateway. WAP gateway is the system that enables WAP supporting devices such as mobile phones to communicate directly with any system that delivers contents to WAP devices via Internet Protocol (IP) networks. The WAP Gateway then communicates with the server (WAP Content) installed in the mobile network. The server (WAP Content) communicates with the web server which finally extracts information from the information system.
2.2.3 Mobile based information system using IP SMS connection for real time retrieval of data

The architecture of mobile based information system using IP SMS connection according to Chakravati and Bhattacharyya (2009) is shown in Figure 4 below:

- Analytical engine: analyzes data interpret them and send information. The analytical engine is rule based and also pre-set.
- Transaction engine: display data, search data and process data on the basis of the request
- Supplemental engine: process data for data warehousing
- Security module: takes care of the confidentiality and privacy requirements
- Interfaces: connects system with information system, wireless network and data warehousing.

2.2.4 Mobile based information system based on Java 2 Platform Micro edition (J2ME) and Windows Embedded Compact (CE) applications

J2ME and Windows CE have the ability to wirelessly connect a mobile application to the Internet and wirelessly send and receive data (Figure 5). Such mobile application can be a client in a client/server multi-tier system, or it can be a standalone application without a connection to the server. J2ME and Windows CE provide the best platform for the implementation of business logic on the client (Fertalj and Horvat, 2007).
2.2.5 Comparison of componential architectures of mobile based information systems

The great advantage of using GSM modem for mobile based information system is that, Internet outages will not stop the system from sending or receiving messages while other architectures need the mobile network and all other devices to be working perfectly. GSM modem based SMS information systems are cost efficient in the sense that it is very easy to find a price plan, with low or zero cost SMS tariffs, while other architecture like the one using IP SMS connection and WAP technology are expensive. With the GSM modem, wireless SMS systems can be setup in a very short time while with others architectures like the one using WAP technology and IP SMS connection can be time-consuming in finding the appropriate mobile network operator to allow the system to connect to the appropriate short message service center [Zhang et al. 2008]. GSM modem architecture works with all types of mobile phones while other architecture like the one using WAP technology works only with WAP supporting mobile phones.

The Internet SMS connection architectures offer enormous advantages over the other architectures such as high speed connection, high signal strength, no physical device needed for connection and can serve more SMS messages per second. According to Milan [2010], WAP based architecture offer more functionality such as web browsing and multimedia applications. With WAP protocol data are transferred more efficiently in client server environment than in TCP/IP.

2.3 Service architectures of Mobile based system

There are two kinds of services which can be built to distribute the information through SMS namely: independent service and dependent service architectures.

2.3.1 Independent service architecture (ISA)

This architecture as shown in Figure 6 allows the use of a regular Subscriber Identity Module (SIM) card in which the system does not need to have any direct connection with phone operators SMSC or Aggregator Service for direct routing of packets. ISA based system allows SMS communication from all mobile operators. According to Adagunodo et al. (2009), this option is easy and fast to set up, it does not require authorization of the service provider or connection to any third party and the user is charged a standard SMS tariff.

Figure 5: Architecture of Mobile based information system using J2ME and Windows CE applications
(Adapted from Fertalj and Horvat, 2007)

Figure 6: Independent Service Architecture (ISA)
2.3.2 Dependent Service Architecture (DSA)

This involves having the application server connect to the service providers SMS Center (SMSC) through a constant Internet connection. When users send their request, it goes to the SMSC, which automatically forwards the message to the application server over the Internet. The organization’s SMS servers are connected to the SMS network through specialized connectors and gateways connected to the SMSC of mobile operators thus, messages can be communicated through connected mobile operators only. This option provides benefits such as the service provider can provide a special tariff and a dedicated line for the system. Also, it supports even a very heavy load (i.e. up to millions of SMS messages in a short time) [Mavrakis 2004]. The Figure 7 below illustrates the DSA.

Figure 7: Dependent service architecture (DSA)

From the above review, the mobile based information system using a GSM modem and ISA is more appropriate in this research study since it is cost effective, support all kinds of mobile phones and does not depend on the particular mobile network operators (Msanjila and Muhiche, 2011).

The proposed system is different from that of Tigo called Tigo kilimo and also, that of Zantel telecommunication company called Z-Kilimo*. These systems are static, thus different from the M-FAIS which is dynamic.

3. DESIGN OF THE M-FAIS

3.1 General Architectural Design

M-FAIS was designed using a GSM modem and ISA. It uses both push and pull methods depending on nature of information. The Figure 8 below illustrates.

Figure 8: General architecture of M-FAIS

* http://www.gsma.com/mobilefordevelopment/wp-content/uploads/2014/03/mAgri-Seminar-at-MWC-2014_Service- Profiles.pdf#page=1&zoom=auto,0.843
3.2 M-FAIS Componential Design

There are many encapsulated components and nodes that need to work in harmony so that M-FAIS works effective. FAISmain (SmsInfo) thread plays the centre role for this purpose. It launches the system GUI for input/output operations, SmSender for message sending, SmsReceiver for receiving requests and DbHandler for communicating with the database. On the other hand, the system will use javax.com library to facilitate serial communication with the Modem. The system depends on third party software (SerialSplitter) for splitting com ports for SMS sending and receiving operations. Not only this but also there is another module for handling information searching, this is done by database module. Figure 9 below presents a pictorial view of M-FAIS componential structure.

Since the SMS receiving and SMSreplying components are the ones that interact with the user, they are further described as follows:

3.2.1 SMS receiving component

The mechanism developed for receiving messages continuously listens to dedicated GSM modems serial ports for incoming messages. If message received at the port is the user SMS request, its type is set to “sms” and formatted to specific internal system template (CnmiSms) for easy retrieval of its contents (username, password, message, phone number). The formatted message is added in the list of received SMS waiting to be processed, in the SMS array (SmsReceived). Otherwise, the system will set received message type to “system” and leave it for being processed with other objects. Figure 10 shows algorithm for the receiving SMS component.

3.2.2 SMS replying component

The mechanism for sending replies to users (SmsSender) continuously checks for availability of message waiting to be sent in waiting queue. When there is a message, the system retrieves it and extracting recipient number, the message content and consequently sends the message. If message sent status is successfully the thread system involves a service for reporting the sent successfully status, if the status of the message which was sent is failure due to insufficient credit, the system invoke the service for sending alert to the administrator. Figure 11 shows algorithm for replying SMS component.
3.3 Design for Security and Error Handling

Though website and emails may be implemented by secure HTTPs for authentication, their use in public network with open systems protocols, as a backbone, make the stored information vulnerable to malicious attack. The developed M-FAIS used private network (Mobile Service Operator network) as infrastructure for transmission of information. On the other hand, the level and application of security in SMS based system depends on the nature of the system, if the
system is meant for public use they do not need user authentication. The example for this system is the Google SMS applications which serve as search engines.

To account for reliability the system was designed such that it checks feedback of sent messages through request/response approach as standardizes in the web service technology. For example, if delivery failure occurs due to insufficient credit the system will notify the administrator by either beeping or sending alert message to his/her mobile phone. In case of error messages from the user, the system sends him/her relevant information about the error and the possible causes.

4. M-FAIS IMPLEMENTATION

The M-FAIS allows farmers to get advice in various agricultural issues such as agronomic practices, post-harvest operations, livestock husbandry, forestry, veterinary services, market and financial support services. The M-FAIS has two parts, namely: Web-based FAIS (W-FAIS) and Mobile-based FAIS (M-FAIS) (Sanga et al. 2014c). With an interactive mobile and web based system, farmers will be able to submit their request for information / knowledge by SMS and those questions will be stored in a database. The tele-centre officer or agricultural extension officer will answer the questions from farmers. This is for the case when they have an answer, otherwise – if the question is complex the system will forward the question to Knowledge Resource Centres (KRCs). This will be done through a web based system. The experts in KRCs will then answer the farmers’ questions directly. These functionalities have been implemented in W-FAIS and M-FAIS (Sanga et al. 2014b). The validation of the agricultural contents which was uploaded in W-FAIS and M-FAIS was done by developing maize promo which was aired in Kilosa Community Radio. This was also meant for those farmers who cannot use mobile phones.

Otherwise, the SMS module of this system serves as main channel of communication between farmers and experts. The technologies used for implementing the system are Apache, Java and MySQL as the Web server, server-side programming and database support respectively. Moreover, Huawei GSM/GPRS was used to connect M-FAIS and mobile phones and exchange messages.

4.1 M-FAIS Database

On building the system, MySQL DBMS was used to implement the database schema as shown in Figure 12 below.

![Figure 12: M-FAIS Database schema (Adapted from Sanga et al. 2014c)](image-url)
4.2 M-FAIS User Interfaces

The system involves three types of users namely farmer (people or group of people seeking advisory services in agriculture), expert and administrator. The main window of M-FAIS is as shown in Figure 13 below.

![Figure 13: Main Window](image)

4.2.1 Farmer

A farmer sends an SMS based question asking the expert about question of his/her interest in real time. After the question has been sent it will be received by the server as can be seen in the Figure 14 above. When the farmer asks the question which has already been asked before, the system will provide the desired result (if the question has already answer). Communication between farmer and the expert is completely done through SMS. So, mobile phone SMS program is used as input/output device during the conversation.

![Figure 14: Sending SMS question by a farmer](image)

4.2.2 Administrator

Administrator is responsible for configuring the system and making sure that the system runs in effective and efficient manner. Administrator tasks include configuration of the system and operate it. The Figures 15, 16 and 17 show port configuration, configuration completion and real time AT command windows.
4.2.3 Expert

An expert receives a question from the farmer on prompt as SMS messages in their mobile phones. The expert answers the farmer question through SMS and sends back the result to be relayed to farmer’s mobile phone. After the message has been sent to the system, the message will be received by the system and forwarded to respective farmer as shown in the Figure 18 below.
5. TESTING OF M-FAIS

To identify the correctness, completeness, security and quality of developed system, the unit test was conducted first. The system was then put through load tests in which it was hit with a number of simultaneous requests. The server handled up to 85 simultaneous requests without any problem. The average time to process the 30 requests is six seconds. The average time to prepare the connection between computer and mobile phone is three seconds and the average time to find the answer from database sent it to the mobile phone is two seconds. The obtained results meet the requirements of the context in which the system was intended to operate.

5.1 Advantages of M-FAIS are similar to those provided by W-FAIS (Sanga et al. 2014c):

- **Convenience** – Farmers ask questions and get answered at their own convenience.
- **Accessibility** – Farmers and experts can communicate through the system from any location (as long as they are within a network service reception area).
- **Portability** – All types of mobile phones support SMS.
- **Saves time** – SMS reduces the throughput as websites are sometimes unavailable due to congestion, or server down time. SMS provides a faster means of sending and receiving information.
- **Cheaper** – SMS is generally economical, and it is sometimes provided as a free service (at least for certain periods) by the service provider. Most providers also do not charge when users receive SMS.
- **Less human resources required** – Query results from farmers are processed automatically.
- **Mobility** – It is obvious that most mobile phone users have their phones with them everywhere they go, most people often leave their computer as home, or work sometimes, but they will always have their phone on them.

5.2 The limitations of M-FAIS are:

- It is difficult to certify SMS results unlike paper results which are stamped. However, mobile operators provide numbers that bear a name of company or institution. This way user can be sure that the message originated from the right source.
- As a rule, length of a SMS message is 160 characters. This is a limitation in SMS technology. Therefore the messages are abbreviated depending on the availability of the space.
- The SMS technology does not guarantee set transmission times or guaranteed delivery of the message, therefore some messages may be delayed, blocked or lost in transmission.
- The cost of the message might be transferred to the sender (although toll-free lines can be acquired) and this is network dependent. It is also possible to reimburse such cost, and to operate volume based tariffs.
- Service operators might not have coverage in some areas, and some locations may be prevented with mobile-phone jammers and therefore preventing users from getting service signals.
- Not all farmers will have a mobile phone. However, this is negligible considering the amount of mobile phone owners.
- Not all farmers are literate, but illiterate farmers might get assistance from others in the family/community who are literate. In our case, Kilosa Community Radio was used to air the same agriculture information used in M-FAIS and W-FAIS.
- Gender difference in access and use of mobile phone is also a limiting factor. This is from the fact that men, women, including some disadvantaged groups (e.g. those with disability) might not secure equal access to agricultural information through mobile phones.

Despite of the above limitations still the authors found that mobile phones are very useful in dissemination and communicating agricultural information and knowledge. The justification for this being:

- Distances or remoteness of the farmers who need to be visited by few extension officers.
- Low Government budget to employ more extension officers.
- Few extension officers coupled with limited resources for them.
- Novelty of information and knowledge related to agricultural from researchers.
- Presence of many markets and therefore difficult to authenticate the reliability of market information circulating to different farmers in different location.
- Technological development (e.g. mushrooming of TV, community radio stations, mobile phones).
- Variability of information needs of different stakeholders / actors in various agricultural value chains.
- Booming of markets with different information flow systems.
i. Obsolete agricultural information – This calls for a unified way of collecting, aggregating, processing, disseminating and communicating agricultural information using low cost devices which are readily available to rural farmers.

6. CONCLUSION

The developed system can help farmers get diverse agricultural information from the actual source at their own convenient time through their cell phones. The system was developed using GSM modem independent service architecture. Apache, Java and Mysql were used as web server, server side programming language and DBMS respectively. The system was tested and it provided a promising performance which demonstrates its capability to support the conventional agricultural extension services through mobile phone. One peculiar characteristic of M-FAIS is that it runs to all different types of mobile phones. Thus, we recommend further testing of the system to evaluate its usefulness to the agriculture extension service delivery to farmers. Thus, the main contribution of this paper is on development of tool to support agriculture extension service through low cost mobile phone. The developed system was developed and tested using the concept of Living Lab (Cunningham et al. 2011) whereby researchers from Sokoine University of Agriculture, Norwegian University of Life Sciences, Uyole Agricultural Research Institute (ARI), Ministry of Agriculture, Cooperative and Food, Kilosa District, famers, Kilosa community radio, IT administrator from KIRSEC (community telecentre – owned by private sector and Ilonga ARI were involved in a partipatory action research (PAR) study (Sanga et al 2014a; Sanga et al 2014b; Sanga et al 2014c; Sanga et al 2014d). These researchers participatory involved from exploratory study, stakeholders analysis, inception workshop, baseline survey, system (M-FAIS and W-FAIS) development and testing as well as monitoring and evaluation.

Another avenue for further study is on assessment of how the system delivers extension services in an efficient way as perceived by the target group (i.e. farmers and other actors in maize value chain). To what degree men and women farmers are willing to pay for such a system or what kind of payment arrangement could be put in place also need to be studied.

7. ACKNOWLEDGEMENT

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Performance Evaluation of Clustering Algorithms in Wireless Sensor Networks

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ABSTRACT

Wireless Sensor Networks (WSNs) is one of the emerging and fast growing fields in the scientific world which has a wide range of applications like monitoring physical world events, preparing forecasts, severe environment detection, disaster relief, battlefield surveillance etc. WSNs are highly integrated technologies using sensors, microcontrollers and wireless networking capabilities that operate unattended in harsh environments with limited energy supplies. Thus network lifetime is constrained by the limited power supply of nodes. Clustering plays an effective role in judicious use of dwindling energy resources of the deployed sensor nodes. Nodes are grouped into clusters and a specific designated node, called the cluster head is responsible for its cluster. In this paper, we study the energy efficiency of clustering algorithms S-Web and LEACH. Our results show that the S-Web clustering achieves a noticeable improvement in the network lifetime.

Categories and Subject Descriptors: C.2.1 [Computer-Communication Networks]: Network Architecture and Design—Wireless communication;

Additional Keywords and phrases: Clustering, SWEB, Wireless Sensor Networks, LEACH, Network Lifetime.

IJCIR Reference Format:

1. INTRODUCTION

Recent advances in miniaturization and low-power design have led to the development of small-sized battery-operated sensors that are capable of detecting ambient conditions such as temperature and sound [Abbasi and Younis M. 2007]. A typical node of a WSN is equipped with four components: a sensor that performs the sensing of required events in a specific field, a radio transceiver that performs radio transmission and reception, a microcontroller: which is used for data processing and a battery that is a power unit providing energy for operation [Chaurasiya et al. 2011]. These sensor nodes can be deployed randomly to perform such applications as monitoring environment, battlefield reconnaissance, border protection and security surveillance, preparing forecasts, volcano monitoring etc.

The limited energy of each node, supplied from non-rechargeable batteries, with no form of recharging after deployment and the possibility of having damaged nodes during deployment is one of the most crucial problems in WSN. Given the importance of energy efficiency in WSNs, most of the algorithms proposed for WSNs concentrate mainly on maximizing the lifetime of the network by trying to minimize the energy consumption [Abbasi and Younis

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Clustering plays an effective role in judicious use of dwindling energy resources of the deployed sensor nodes, which groups nodes into clusters and a specific designated node, called the cluster head is responsible for collecting data from the nodes in its clusters, aggregating them and sending to the BS, where data can be retrieved later. Besides energy efficiency, clustering has many other advantages, it reduces the routing overhead, conserves communication bandwidth, stabilizes the network topology, supports network stability etc (Akkaya and Younis 2005; Sherali et al 2005; Umamaheswari and Radhamani 2012; Younis et al. 2003).

In this paper we analyze the energy efficiency of S-Web and LEACH clustering algorithms. The rest of the paper is organized as follows. Section 2 presents LEACH algorithm, section 3 describes S-Web algorithm, performance evaluation is in section 4. Finally section 5 concludes the paper.

2. LEACH
Low-Energy Adaptive Clustering Hierarchy or LEACH (Heinzelman et al. 2000) forms clusters by using a distributed algorithm, where nodes make autonomous decisions without any centralized control. Initially a node decides to be a CH with a probability $p$ and broadcasts its decision. Each non-CH node determines its cluster by choosing the CH that can be reached using the least communication energy. The algorithm provides a balancing of energy usage by random rotation of CHs. It forms clusters based on the received signal strength and uses the CH nodes as routers to the base-station. All the data processing such as data fusion and aggregation are local to the cluster. LEACH provides the following key areas of energy savings: No overhead is wasted making the decision of which node becomes cluster head as each node decides independent of other nodes, CDMA allows clusters to operate independently, as each cluster is assigned a different code, Each node calculates the minimum transmission energy to communicate with its cluster head and only transmits with that power level. Changing the CH is probabilistic in LEACH; there is a good chance that a node with very low energy gets selected as a CH. When this node dies, the whole cluster becomes non functional. LEACH also forms one-hop intra- and inter cluster topology where each node can transmit directly to the CH. Then the aggregated data is transmitted to the base station.

3. S-WEB
Sensor Web or S-Web (Poliah et al. 2008) organizes sensors into clusters based on their geographical location without requiring the sensors to have a Global Positioning System or actively locate themselves. The S-Web enables nodes to route data packets while consuming low energy in a decentralized manner. The model is self-organizing and distributed without the need of global network knowledge. Each cluster is identified by angle order ($\beta$) and the order of Signal Strength threshold ($\delta$). The BS in S-WEB will send beacon signals for every $\alpha$ degree angle, one at a time. Sensors that receive the beacons at time slot $i$ will measure their signal strength to determine their relative distances to the BS. Let $T$ be a predefined distance (which is inversely proportional to the received signal strength). All sensors which receive beacon signals at angle order $\beta_i = i\alpha$ with signal strength of $\delta_j*T$ (within sector $j$) will be in the same group/cluster, denoted as $(\beta_i,\delta_j)$. Nodes with the same $(\beta,\delta)$ belong to the same cluster. Since nodes in the same cluster know about each other, the role of being a CH can be rotated to prolong the lifespan of CH.

4. PERFORMANCE EVALUATION
We implement the S-Web and LEACH clustering algorithms and consider 20 sensors deployed randomly in the area 40 X 40 m² field and the BS located at the position (0, 0). Scanning angle $\alpha$ is 10 degree and maximum sensor distance to BS is 70 m. All nodes have the same initial energy of 0.5 Joule. The radio model used for energy consumption is presented in (Heinzelman et al. 2000). A data packet here has $k = 2000$ bits. We assume that the sensors do not have data to send all the time. We also assume all nodes are homogeneous and they have the same capabilities.

This section is divided into several scenarios, energy efficiency of each scenario analyzed and corresponding network lifetimes estimated. The result shown is the average of number of hops and energy consumed per message. To evaluate the WSN lifespan, we use a round as a measure unit. A round is defined as when 200 messages reach their destination.

a. First scenario (Normal Node to Normal Node)
In the first scenario, we consider communication between any random pair of normal nodes. Table 1 is the performance result of communication between pairs of normal nodes.
Table 1: Communication Normal Node to Normal Node

<table>
<thead>
<tr>
<th></th>
<th>Energy (µJ)</th>
<th>Hops</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEACH</td>
<td>3812.28</td>
<td>6</td>
</tr>
<tr>
<td>S-Web</td>
<td>1932.86</td>
<td>3</td>
</tr>
</tbody>
</table>

S-Web has lower average number of hops and energy consumption per message than LEACH. The reason for high energy consumption in LEACH is that the cluster heads are only aware of the nodes in their own cluster. Also the BS does not have global network knowledge. However, in S-Web, the cluster heads in addition to maintaining the local cluster information also contain limited global topology information. Thus, frequent communication with BS is avoided and energy saved.

Fig. 1 illustrates network lifetime, in terms of percentage number of nodes alive against number of rounds. Fig. 1 shows, the network lifetime increases from 13 rounds in LEACH to 24 rounds in S-Web.

![Network Lifetime Normal Node to Normal Node](image)

b. Second scenario (Normal Node to Cluster Head)

In the second scenario, we consider communication between a random pair of normal node and cluster head. Table 2 shows the energy expended for the two algorithms.

Table 2: Communication Normal Node to Cluster Head

<table>
<thead>
<tr>
<th></th>
<th>Energy (µJ)</th>
<th>Hops</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEACH</td>
<td>1937.32</td>
<td>3</td>
</tr>
<tr>
<td>S-Web</td>
<td>807.06</td>
<td>2</td>
</tr>
</tbody>
</table>

Since a cluster head itself forms the destination of data here, the energy consumption is less compared to the previous scenario. Here also, S-Web performs better because cluster heads maintain limited global topology whereas cluster heads in LEACH clustering scheme require querying the BS to contact the cluster heads of other regions. Fig. 2 shows network lifetime, in terms of percentage number of nodes alive against number of rounds.

![Network Lifetime Normal Node to Cluster Head](image)
Owing to lesser energy consumption, the lifetime of both the algorithms has extended, more so for S-Web. For the given scenario, the network lifetime increases from 25 rounds in LEACH to 60 rounds in S-Web.

c. **Third scenario (Cluster Head to Normal Node)**

In this scenario, the source and destination of message have been reversed compared to scenario B. Table 3 shows the performance result for this scenario.

<table>
<thead>
<tr>
<th>Energy (µJ)</th>
<th>Hops</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEACH</td>
<td>3191.94</td>
</tr>
<tr>
<td>S-Web</td>
<td>792.23</td>
</tr>
</tbody>
</table>

For the S-Web algorithm, the current scenario is analogous to the second scenario, so energy consumption would be approximately the same. However, in case of LEACH algorithm, when a node needs to communicate to a node belonging to other cluster, its cluster head has to query the BS to know addresses of other cluster heads. Moreover the BS itself does not contain global network topology information. This explains the high energy difference for LEACH algorithm between the current scenario, 3191.94 µJ as against the second scenario, 1937.32 µJ. The network lifetime of the two algorithms is show in the Fig. 3.

As the graph indicates, the lifetime of S-Web has remained largely unchanged while as for LEACH, it drops from 25 rounds (second scenario) to 18 rounds. Overall, network lifetime increases from 25 rounds in LEACH to 60 rounds in S-Web.

d. **Fourth scenario (Cluster Head to Cluster Head)**

In the fourth scenario, we consider communication between cluster heads randomly. This is the simplest among all the scenarios. Table 4 shows energy expended for this scenario.

<table>
<thead>
<tr>
<th>Energy (µJ)</th>
<th>Hops</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEACH</td>
<td>1312.79</td>
</tr>
<tr>
<td>S-Web</td>
<td>422.95</td>
</tr>
</tbody>
</table>

Here a cluster head itself forms both the source and destination of data, hence energy consumption is the minimum. Fig. 4 shows the corresponding network lifetime.
As can been seen from the Fig. 4, the lifetime of both the algorithms has largely extended, 40 rounds in LEACH and 120 rounds in S-Web.

e. Fifth scenario (Random)

This scenario represents a high level abstraction of the previous scenarios in which communication takes place between a random pair of sensors. This scenario captures the overall trend of the network lifetime in the two algorithms. Table 5 is the performance result of communication between random pairs of nodes.

<table>
<thead>
<tr>
<th></th>
<th>Energy (µJ)</th>
<th>Hops</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEACH</td>
<td>2563.58</td>
<td>4</td>
</tr>
<tr>
<td>S-Web</td>
<td>988.77</td>
<td>2</td>
</tr>
</tbody>
</table>

The average energy consumption of LEACH is observed to be 2563.58µJ whereas in case of S-Web it is 988.77µJ. S-Web, thus has a lower overall average number of hops and energy consumption per message than LEACH.

As the Fig. 5 clearly indicates, S-Web clustering mechanism achieves a noticeable improvement in the network lifetime. For the random scenario, the network lifetime increases from 27 rounds in LEACH to 50 rounds in S-Web. This is because sensors in S-Web can communicate with each other directly without having to go to the BS. The cluster heads in S-Web, in addition to the local topology information, also maintain information about the status of cluster heads in other clusters. This decoupling of BS from routing decisions greatly helps in improving the network lifetime.
5. CONCLUSION

Energy efficiency is a critical design issue in WSNs particularly when they operate unattended in harsh environments. Clustering plays an effective role in prolonging the lifetime of WSNs by making efficient use of the limited energy resources. In this paper, we implemented S-Web and LEACH clustering algorithms and considered several scenarios to compare their energy efficiency. The simulation results show that S-Web achieves a noticeable improvement in prolonging the lifetime of a wireless sensor network than LEACH. Energy intensive setup phase, lack of routing information and global topology information at CH and BS respectively, account for high energy consumption in LEACH.

6.0 REFERENCES


