Experience of Course Migration from Blackboard to Moodle LMS – A Case Study from UDSM

HASHIM TWAKYONDO§
Department of Computer Science and Engineering
College of Information and Communication Technologies
University of Dar-es-Salaam

MULEMBWA MUNAKU
Centre for Virtual Learning
College of Information and Communication Technologies
University of Dar-es-Salaam

ABSTRACT

The University of Dar-es-Salaam (UDSM) deployed the Blackboard Learning Management System (LMS) in 1998, and after ten years of usage it decided to switch to an Open Source (OSS) LMS, principally due to the high cost of annual licensing for the proprietary system. At this time, OSS LMSs were receiving significant attention, particularly from institutions in developing countries who were seeking to alleviate costs (Cavus et al, 2007). Gozdiskowski and Chen (2007) point out that OSS LMSs were developing popularity in higher education because apart from the obviously lower associated costs, they adhered to other important OSS principles such as potential for customization and are often community driven and therefore community serving.

The institutional migration of courses from one Learning Management System (LMS) or Virtual Learning Environment (VLE) to another is a process that requires careful planning, involves both technical and managerial issues, and may be affected by several factors including user perception. In this paper, the experience of the University of Dar-es-Salaam (UDSM) in migrating courses from Blackboard to Moodle LMS's is explored primarily through aspects relating to institutional organization, staff development, as well as some technical issues experienced during the exercise.

In addition, this paper explores and analyzes the processes and outcomes of the migration initiative experienced at UDSM with a view to guiding internal future planning. While it emphasized that choice of

§ Author's Address: Twaakyondo, Hashim M. Department of Computer Science and Engineering, College of Information and Communication Technologies, University of Dar-es-Salaam and Mulebwa Munaku, Centre for Virtual Learning, College of Information and Communication Technologies, University of Dar-es-Salaam

International Journal of Computing and ICT Research, ISSN 1818-1139 (Print), ISSN 1996-1065 (Online), Vol.6, Issue 2, pp.33-45, December 2012.

the migration approach will depend on local available resources and particular environmental contexts, this experience could also provide other higher education institutions with a tried and tested migration process model for replication in similar projects.

Categories and Subject Descriptors:K.3.1 [**Computers and Education**] Computer Uses in Education; K.6.1 [**Management of Computing and Information Systems**]Project and People Management.

General Terms: Management
Additional Key Words and Phrases: *LMS Migration, Course Migration, Moodle Migration, UDSM Case study, Blackboard Migration*

IJCIR Reference Format:
Twaakyondo, M. Hashim and Mulebwa Munaku. Experience of Course Migration from Blackboard to Moodle LMS – A Case Study from UDSM. Journal of Computing and ICT Research, Vol. 6 , Issue 2 , pp 33-45. http://www.ijcir.org/volume6-issue2/articler4.pdf.

1. INTRODUCTION

Advances in Information and Communication Technologies (ICTs) have shaped our thinking and practice in education. The advocacy for and pervasive use of ICTs in education have been perceived both negatively and positively. Critics are skeptical about what they regard as an invasion of schools and classrooms by business conglomerates. They see all the advertisements about what technology can do to improve educational practice as being business gymnastics.

Higher Learning Institutions (HLIs) have adopted several systems that enhance the delivery of academic programmes. This includes the deployment of Learning Management Systems that automate the administration, documentation, tracking, and reporting of training events. Alias and Zainuddin [2005] defined a learning management system (LMS) as "a software application or Web-based technology used to plan, implement, and assess a specific learning process" (p. 28). Mohawk College [2009] suggested that an "L.M.S. can be broadly described as a web-accessible platform for the 'anytime' delivery, tracking and management of education and training. The deployment of LMS in Higher Learning Institutions varies in that some use proprietary LMS while others use Open source LMS. In recent years, Open Source LMS have become popular and widely used by many HLI's. Deployment of LMS includes processes and approaches, user perception management, technical issues, course and user migration.

The University of Dar-es-Salaam (UDSM) deployed the Blackboard Learning Management System (LMS) in 1998, and after ten years of usage it decided to switch to an Open Source (OSS) LMS, principally due to high cost of annual licensing for the proprietary system. In this regard, UDSM made the decision to resort to Open Source LMS. Initially KEWL LMS was installed and tested. It was realized that some of the features of KEWL were still under development and hence UDSM decided to opt for a more robust and stable LMS. Hence, Moodle Open Source LMS (which has a strong international user community) was installed in 2008 and few pilot courses were tested before the system was fully adopted, an exercise that took advantage of and benefited from the Partnership for Higher Education in Africa – Educational Technology Initiative (PHEA - ETI) project.

The systems were running in parallel hence the need for migrating users and courses from Blackboard to Moodle. The biggest challenge was how to perform the migration in a systematic way so as to avoid negativity from faculty and students with the environment, or other unforeseen circumstances that will lead to lose confidence in Moodle

2. THEORETICAL PERSPECTIVES

2.1. LMS deployments in Universities

Learning management systems have been available in their current form since the early 1990s. Internationally, LMSs have become nearly ubiquitous across the higher education sector as a core component of e-learning (also referred to as blended learning) [Pina 2010]. There are more than 90 different types of LMSs available [Pina 2010]. Selecting an LMS is a critical decision for any University, and is likely to have a major impact on teaching and learning policies over a number of years. As mentioned above, LMSs are available in two broad categories: propriety (paid for) and open source.

In this context, LMS deployment requires specific planning and attention. Different institutions have approached LMS deployment and integration differently. Saeedikiya[2010] suggests six stages in LMS implementation, namely: diagnosis, decision making, design, development, delivery and post delivery, in the implementation of e-learning in traditional universities. Khan [2004], also suggests six stages namely: planning, design, development, evaluation, delivery and maintenance. The stages cited by Saeedikiya and Khan above also provided guidance in terms of how institutions may approach course migration processes as both of them emphasize the need for planning and designing. At UDSM, these planning issues were considered and a four-stage model reported in Figure 1 that comes later in this paper was adopted.

2.2. Reasons why institutions are moving to open source software

The open source LMSs have received significant attention, especially from institutions in developing countries because, to them, the ability to acquire educational software without paying license fees is an important advantage [Cavus at el 2007]. Gozdiskowski and Chen [2007] state that open source systems are developing popularity in higher education "because they have a much lower cost, can be more customized, make license management easier, and they are community-driven and community serving" [Gozdiskowski & Chen, 2007, p.1] compared to the expense of commercial learning management systems. They argue that the speedy growth and community acceptance of open source products can lead to the creation of effective and reliable systems which measure up favorably to commercial software. Gozdiskowski and Chen [2007] argue "many open source projects appear to be highly organized and provide tool-support focused upon enhancing human collaboration, creativity, skill, and learning" [Gozdiskowski & Chen, 2007, p.1]. This process can lead to the development of superior software compared to the conventional process where a limited number of programmers have access to the source code Lawrie &Gacek, [2002] cited in Gozdiskowski & Chen, [2007].

Pan et al. [2007] in comparing higher education to "a 'greenhouse' for growing open source projects" [Pan et al. 2007, p.7], report that higher education is beginning to welcome open source by ensuing development of innovative products [Abel, 2005: Wheeler, 2004 cited in Pan et al. 2007]. Also, rationale for a university's choice to implement an open source learning management system is illustrated in a study reported by Stewart et al. (2007) where three learning management systems WebCT, LotusNotes and Moodle were trailed at Athabasca University, Canada. Moodle was chosen due to its performance with an unambiguous lead according to various performance criteria examined by evaluators which included:

"flexibility in start and end dates for students enrolling in courses"; "support for paced and individualized study courses"; "affordability for students"; "accessibility for students with disabilities"; "access at different connection speeds" instructional design; systems administration functions; and teaching and learning criteria including "workable assignment drop box"; and "accommodation of XML and mobile device delivery" Stewart et al.. [2007, p.2].

2.3. General Challenges and lessons in LMS migration

Fitzgerald and Kenny [2003] describe the lessons learned during the course of migrating to an open source software solution. The two main obstacles encountered were: (i) change required in the mind-set of users when deploying the open source software solution and (ii) resistance from staff who feared being deskilled by moving away from a popular proprietary system. On the other hand Drozdik et al., [2005], urges that while migration to open source offers cost savings in the long run, deploying the new technology may involve considerable expenses.

KBSt [2003] identified the critical factors that lead to the sustainable success of a migration project. A migration project is successful if the desired aims and results for all stakeholders are achieved within the planned and agreed time and budget frames. The factors that contribute to the success of migration projects that were identified by KBSt [2003] includes Identification of clear-cut aims for the migration project, involvement and positioning of management and decision-making level, early information, involvement of target groups / staff and Creating a high degree of user acceptance for the target environment.

Other factors identified by KBSt [2003] includes:

- Structured time, project and resource planning, including project controlling
- Organizational measures to prepare the migration process, and establish a qualified project team
- Detailed stock-taking, including a definition of functional requirements
- Optimum project and service selection
- Well-timed, sustainable training
- Quality management and documentation

Some of these challenges and lessons were also observed and further discussed in this paper on challenges and lessons learnt in section 4.

3. UDSM MIGRATION APPROACH AND PROCESSES

3.1. Migration process

The course migration process at UDSM involved a series of steps categorized in four different stages namely preparatory stage, status identification stage, course and user migration stage, and evaluation stage as shown in Figure 1. This process model was created by UDSM through consultative meetings with several stakeholders in view of examining the best workable process within the context of the institution.

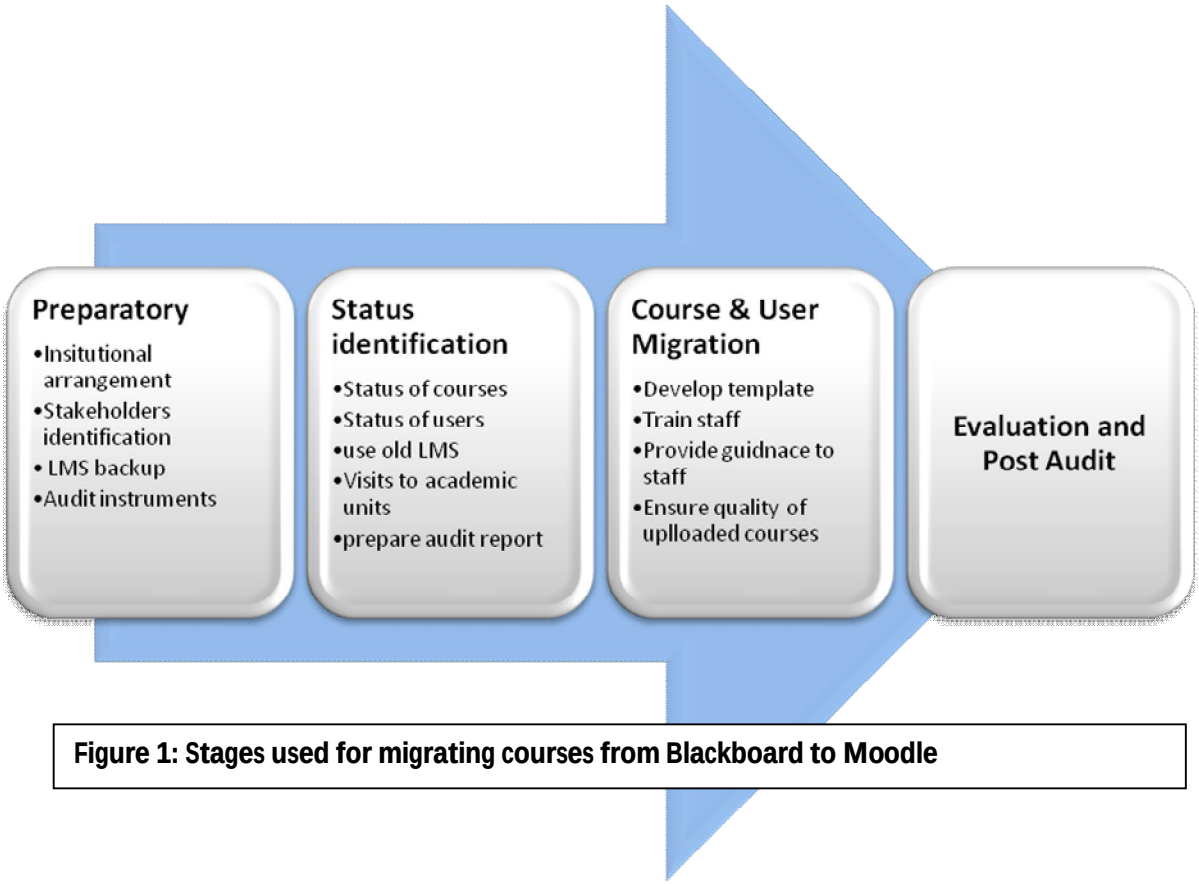

Figure 1: Stages used for migrating courses from Blackboard to Moodle

3.2. Preparatory Stage

The preparatory stage involved listing of activities that are necessary for the process for migrating courses. This includes technical preparations aimed at making sure that the LMS servers are up and running and accessible. The backups (online and offline) of Blackboard LMS in order to minimize the risk on the process once the server crashes. In addition, stakeholders were identified and roles defined during this stage as shown in Table 1.

Table 1: Stakeholders and their roles

Key stakeholders	Relationship / Role	Degree of influence
Deputy Vice-Chancellor: Academic	Decision-making at institutional level, driver of Educational Technology Strategy	High
Principal, College of Information and Communication Technologies (CoICT)	Decision-making at College level and the Chairman of the Project Steering Committee	High
Centre for Virtual Learning (CVL)	Implementation of the key projects	High

Deans of Schools / Colleges, Heads of Departments (academic units)	Owners of programmes in their respective units due to the fact that all courses within a programme are owned by academic units.	High
Academic staff with Courses in Blackboard	Creators / users of new educational technologies	High
Students	Users of new educational technologies. Need to be trained and registered to use the migrated courses	Medium
Partnership of Higher Education in Africa (PHEA)	Financial assistance	High
South African Institute of Distance Education (SAIDE)	Technical Support	Medium

An audit instrument was created for the purpose of having consistency on the information collected by staff involved in the audit exercise. The sample of information collected is shown in Table 2.

Table 2: Course Audit Template

College/School					
Department					
Course ID	**Name**	**Instructor**	**Contact information**	**Status**	**Comments**

3.3. Status Identification Stage

The stage included the identification of status of courses and users within Blackboard in order to determine potential courses to migrate. A potential course was defined as a course which has reasonable amount of subject content in it, seen either in course documents or for some, in courses uploaded in the system. Moreover, other potential courses were identified by having a sizeable user enrolment, high number of postings into the discussion board and the extent to which they seem teachable. On the other hand, a non-potential course was defined as a course with a skeleton consisting only a course name and instructor, yet devoid of any substantial content to facilitate learning. In some cases non-potential courses (sometimes referred to as incomplete courses) would have fictitious names, for instance, a course with a name like xyz, demo etc.

The primary source of data was the Blackboard Learning Management system (LMS) accessible via the Uniform Resource Locator (URL) – http://blackboard.udsm.ac.tz or http://teil.udsm.ac.tz. The audit team was supplied with administrative password which was used to obtain all necessary statistics. The username, course code and e-mail address form a unique pattern was the basis for tracking all users and courses in the

system. The course audit template (see Table 2) created during the preparatory stage was used to document the status of courses in Blackboard. The courses were thereafter grouped into three categories namely, course to be migrated without change, courses that needed improvement before migration, and those which would not be migrated. It was found that, a total of 415 courses were registered in Blackboard by March 2010 of which 146 were potential courses for migration to Moodle. However, a total of 120 (28.9%) courses were found suitable for migration after eliminating repetitive and unused courses. It was observed that 73 courses (60.8%) out of 120 courses earmarked for migrations were active while the remaining 39.2% were inactive courses. Thus, the migration project at UDSM therefore involved a target of 100 courses, spread across disciplines and Colleges.

The stage also involved determining the status of instructors teaching the courses. In this regard, the team visited various departments, schools (initially called faculties) and colleges to find the actual status of some courses that included issues like whether the course is still relevant and/or within the curriculum/syllabus. Also the visits intended to determine the current instructor teaching the course versus the instructor registered in Blackboard. Some of the instructors were contacted via e-mail as obtained within Blackboard system. The team also prepared a work sheet and distributed to all colleges/schools to find new staff who would be interested in developing and delivering their courses via Moodle LMS. It was observed that some instructors were no longer working for the university, others on leave or deceased.

One of the biggest challenges was inaccuracy of data on the Blackboard system. It was difficult to obtain the exact number of registered users and actual number of created courses in the system. For instance; the Blackboard system indicated 19,528 users regardless of their status in terms of using the system. However, it was noted some of the system users had more than one account with a deferent login name (in some cases an individual has five accounts). Furthermore, it was noted that some instructors issued a common username and password to all students. An example of this was the course CS660 (Introduction to Computers and Software Engineering) and dp411a (Electrical machines and drives II) where all the students used the same username cs660.

Another challenge was the way the courses were re-categorized due to the fact 229 courses (55.1%) were not categorized. However these uncategorized courses belong to faculties /schools/colleges. Some of the courses were wrongly classified such as the only indicated course in the Faculty of Law IS342 (Networking). The course belongs to computer science where courses start with **IS** code whilst law courses start with the code **LW**. This implies that the majority of courses were not re-organized properly in Blackboard Learning Management System (LMS).

In addition, information in the Blackboard system was not updated after first registration. This resulted in the existence of invalid instructor's contacts such as e-mail addresses in Blackboard. For example over fifty percent of the e-mails were no longer valid as users, had either fictitious e-mail addresses or had changed their e-mail addresses without updating the system. In some cases instructors did not register e-mail addresses.

3.4. Course and User Migration Stage

During this stage the project team examined several migration options and their associated advantages and disadvantages. Four different options from Colgate University** - Information Technology Services (ITS)

**http://www.colgate.edu/

unit shown in Table 3 were examined and analyzed. These migration options are redesign, copy-best effort, hybrid and consultative in which the significance of technical staff and faculty involvement is shown in Table 3.

Table 3: Explored Migration Options as adopted from Colgate University - Information Technology Services (ITS) unit.

Methodology	**Faculty Involvement**	**Technical Staff will:**	**Faculty will:**
Redesign (Starting fresh)	Significant	• Extract materials from Blackboard • Provide materials to faculty or upload them to Moodle • Assist faculty with course design advice/Moodle orientation	• Design Moodle course layout • Insert transferred materials into course
Copy - Best Effort (Use existing automated conversion tools)	Minimal	• Extract materials from Blackboard • Use existing conversion tools to create analogous Moodle course site, normally in the current semester's course • Query the faculty when automation questions arise	• Provide guidance as requested by migration staff • Verify the migrated site, reviewing layout and checking course content
Hybrid	Minimal	• Do both of the above	• Provide guidance as requested by migration staff • Verify the migrated site, reviewing layout and checking course content
Consultation (Collaborative effort)	Some	Arrange one or more meetings with faculty to review existing course, design a Moodle equivalent, and implement the new Moodle course site	• Meet with technical staff as needed to design and develop the course • Optionally, assist with the course implementation

Source: https://sites.google.com/a/colgate.edu/moodle/Home/blackboard-content

The redesign approach involves technical staff extracting courses from Blackboard and uploading them into Moodle or giving the faculty to upload and just provide orientation on Moodle. Whilst it works, it does

not result in better courses in terms of quality. On the other hand, **The Copy – Best Effort approach** requires the use of automated conversion tools. However, since the course structures of Moodle are not fully compatible with Blackboard and since existing conversion tools are limited, this transfer process can not be fully or simply automated††. The **Hybrid** provides better content as it combines both copy-best effort and redesign approaches. Faculty will use the better-named, better-organized Redesign content as they update content uploaded via conversion tools. Finally the **consultative approach** requires arranging one or more meetings with faculty to review existing courses, design a Moodle equivalent, and implement the new Moodle course site. This is the best option due to involvement of faculty but it requires more resources.

A **consultative migration** option was adopted and thus, the stage involved a series of activities such as;

- Sensitization seminars that aimed at highlighting the need for course migration so as to have instructor's acceptance to the process.
- Downloading courses from Blackboard - The technical team downloaded all courses earmarked for migration from Blackboard and availed these courses to course instructors.
- Training sessions – Instructors were given the downloaded course files and were trained on how to create and re-upload the courses in Moodle LMS while following the created template. The aim of the template was to ensure quality and completeness of uploaded courses in Moodle. The information in the template included but was not limited to course objectives, schedules, assessment options, class activities, resources and references etc.
- Creation of course shells – The technical team created course shells, thereafter instructors used the course shells and their course spaces for uploading their improved courses.

The technical team registered all users based on their courses by making sure that all needed information is registered correctly. The use of automated tools for migrating users across learning platforms was not used due to incompleteness of information in Blackboard system. The use of such systems meant the importation of dummy information on users hence fresh registration was the most appropriate option. Based on this approach there were no technical difficulties experienced in the course of user registration.

A total of 96 courses were migrated while 23 new courses with good quality arose in the course of the migration process due to the awareness created as a result of involvement of all key stakeholders who were identified in the preparation stage. ***The challenges faced are discussed in the lesson leant section***.

3.5. Evaluation and Post Migration Audit

The evaluation and post audit of migrated courses was performed. This is a significant stage which enabled the University to realise the extent and success of the migration process. The audit team used a post migration audit template shown in Table 4.

Table 4: Post Migration Audit template

College/School	
Department	

††http://docs.moodle.org/22/en/Blackboard_migration

Course ID	Course Name	Instructor	Contact info	Instructor Information	Course Objective	Course calendar	No of Users	Course Modules	No of Assignment	No of Forums	No of Course Views	Remarks

4. CHALLENGES AND LESSONS LEARNT

There were several challenges faced and lessons learnt in the whole process of migrating courses from Blackboard to the Moodle Learning Management System, as discussed below.

a) Stakeholders involvement

The engagement of key stakeholders as identified in Table 1 was very important for the success of the migration process. Strategic involvement of stakeholders had resulted into achieving buy-in by university management and by educators. For instance, once the audit team visited the department to determine whether the instructors found in Blackboard were still teaching the courses, it was observed that some instructors were no longer working for the university, were on leave or deceased. It was likely that the instructors of 106 courses (out of 120 earmarked courses for migration) were still present and ready to shift their courses to new LMS. In addition, the heads of departments (identified initially as stakeholders) managed to provide alternative instructors for the remaining 14 courses.

Thus, the course migration exercise needs to be properly planned by determining the roles and early involvement of various stakeholders in the process.

b) Nature of Courses in Source LMS (Blackboard)

The Nature of the courses in source LMS (Blackboard) had a great impact in the migration process. For instance, in migration process it was found that 229 courses (55.1% of all courses in Blackboard) were not categorized despite the fact that they belonged to faculties/schools/colleges. Also, some of the courses were wrongly classified, hence the difficulties faced in obtaining actual information of the course from relevant departments. Some information of instructors such as contact information was either not registered or outdated. This brought challenges of contacting course instructors for the migration exercise.

There is a need to continuously update courses in LMS as well as having some contact information as mandatory fields (e.g e-mail, mobile phones etc) during registration of users in LMS's. This will help during migration process and you need to communicate with system users. Moreover, mechanisms need to be in place to avoid dummy information within LMS's – e.gdisableself registration.

c) Institutional policies on the use of LMS

Institutional policies of the use of LMS have impact in the migration process. Absence of such enforcement policies makes use of LMS voluntary for staff. For instance, initially some of the users at UDSM were reluctant to use the new system due to absence of institutional directives or policies on the matter. This was handled through specific directives issued by DVC Administration to all heads of academic units.

Thus, there is need to have institutional policies that enforce the deployment and use of Learning Management System. In addition, before the migration process, specific directives need to be given to all heads of units for the users to comply as the support from top management of the institutions adds value in the process.

d) Handling Technical Issues and Support mechanisms

Support mechanisms for LMS users are essential for building positive user perceptions on the use of LMS in teaching and learning. The support would either be technical or pedagogical as it was realized that some instructors did not want to migrate their courses due to lack of end user support while using Blackboard. For instance, in 2005 Blackboard LMS crashed and most lecturers lost their course materials. By then, the support structures at UDSM were not well established. These bad experiences impacted negatively on the process of course migration.

In addition, technical difficulties such as connectivity problems arose during the process of course migration. Offline facilities (e.g Poodle) were used to address connectivity issues. In this direction, there is a need of establishing good support structures that will assist in helping system users before, during and after the process of migrating courses. Technical support needs to make sure the system is available and necessary back-up is taken from time to time

e) Institutional Reforms

LMS maintenance and updating need to respond quickly to institutional reforms as it may impact the process of course migration. During the course of migration, there were several institutional reforms such as course modularization and institutional structural changes. The former had led into new curricular of some programmes while the later brought changes by demolishing faculties and establishing schools and departments. The structural changes had implications on course categorisation in the LMS. Despite the fact that these changes were done in 2008, they were not reflected in the LMS two years later and the courses in Blackboard were grouped in faculties that no longer existed.

Thus, there is a need of reflecting institutional changes in LMS systems to make easier the migration process.

f) . Quality of Courses in LMS

The migration process revealed that creating quality courses needs to be emphasized and planned for in the design of the migration processes. This includes having quality criteria and mechanisms to achieve the desired quality parameters. Modalities for involvement of academic staff need to be examined due to the fact that academic staff as key stakeholder have significant contribution on the output of the courses. For example, many academic staff at UDSM were very busy with other teaching, research or public service activities. This brought a lot of challenges as the success of the process depends so much on staff time devoted for the activity. The desired quality of many courses could not be achieved due to staff workload.

g) Pedagogical issues

Migration processes need not be technological driven as reflected in the UDSM LMS model. The model included a training component that focuses on both technical and pedagogical issues. The question remains, what kind of academic staff development should be pursued once the migration team has moved on? What we have learned is that the training to academic staff should provide reaction against the dull, under resourced, IT driven, passive service approach to course migration. It is more than just advocating a pedagogical stance. It is about academics taking ownership of what they do, carefully crafting a pedagogy adapted to a very flexible medium, and adding excitement, engagement and specificity to a bland institutional environment. The Trainings need to be designed so as to encourage ownership and unique pedagogical craftsmanship.

5. CONCLUSION

Like most Higher Learning Institutions, UDSM has successfully migrated courses from Blackboard to Moodle LMS. The experience in the process revel that it should not focus only on technological aspects but lather pedagogical issues need also to be taken on board from the design of the process. This is mainly due to the fact that there is really nothing significantly different about teaching through an open source LMS versus a commercial LMS. What is different is the tool itself, and the support and ease of use offered by competing systems.

The Four different options described in section 3 (Table 3) may be adopted by institutions willing to migrate their course from one LMS to another but the choice of the approach should depend on resources available and several experiences drawn for the case of university of Dar-es-Salaam and highlighted in the paper. Despite the choice on the approach there are issues that need to be critically examined that include stakeholder identification and involvement, institutional commitments and arrangements that include good support mechanisms. It is thus expected that other institutions will find this case study useful for systematic approach in LMS migration.

ACKNOWLEDGMENTS

The authors would like to thank UDSM top management for the support of the whole exercise of migration. Thank SAIDE team for their support in writing this paper, specifically Ephraim Mhlanga and Brenda Mallison. We must also thank support and funding from PHEA which made the execution of the exercise take place. Finally we must not forget UDSM academic staff and CVL staff who participated in the migration activity of their courses, for their valuable inputs.

REFERENCES

ALIAS, N. A., & ZAINUDDIN A. M. (2005). Innovation for better teaching and learning: Adopting the learning management system. *Malaysian Online Journal of Instructional Technology*, 2(2), p.27-40.

BLACKBOARD Courses Audit Report (UDSM), June 2010

CAVUS, N., UZUNBOYLU H., and IBRAHIM D. 2007. Assessing the success of students using a learning management system and together with a collaborative tool in web based teaching of programming languages. *J EducComput Res. 2007*, 36(3): 301–321. . Accessed 6/04/2012.

FITZGERALD, B., & KENNY, T. 2003. Open source software in the trenches: Lessons from a largescale OSS implementation. *Twenty-Fourth International Conference on Information Systems*. Seattle, Washington, USA.Wordpress and SEO specialist.

GOZDISKOWSKI, M, CHEN, W 2007, 'Open Source Software in Virtual University Development: An Overview' In C. Montgomerie& J. Seale (Eds.) Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2007, Chesapeake, VA, pp. 603-605.

KBSt. 2003. Migration guide–A guide to migrating the basic software components on servers and workstation computers, 57. http://www.kbst.bund.de/Anlage303777/pdf_datei.pdf.

KHAN, B. H. 2004. People, process and product continuum in e-learning: The e-learning P3 model. Educational Technology, 44(5): 33-40.

MOHAWK College. (January 2009). Final report of the LMS project. Retrieved from http://lmsreview.mohawkcollege.ca/docs/LMSreviewFinalReport_ModifiedBrief.pdf

MOODLE(2000). Accessed on September 11, 2011. http://moodle.org/

PINA, A. (2010). An Overview of Learning Management Systems. Learning Management System Technologies and Software Solutions for On-line Teaching: Tools and Applications. Y. Kats. Pennsylvania, IGI Global.

SAEEDIKIYA, M., MOOGHALI, A., and SETOODEH, B. 2010. Stages of the Implementation of E-Learning in Traditional Universities, Edulearn10 Proceedings, Pp. 6620-6624. http://library.iated.org/view/saeedikiya2010sta. Accessed 17/03/2012.

STWEWART, B. et al (2007) Choosing MOODLE: An Evaluation of Learning Management Systems at Athabasca University. *International Journal of Distance Education Technologies* (IJDET). Vol. 5(3)

Filling the Digital Divide in Rural Connectivity: Case for Last Mile Mobile Broadband Subscription

CHRISTOPHER A. MOTURI and CHARLES T. NYOTA‡‡,
School of Computing and Informatics, University of Nairobi, Kenya

ABSTRACT
Access to Information and Communication Technologies (ICTs) has been found to have a correlation with socio-economic development and gross domestic product. Despite efforts by governments across Africa to revamp the telecommunications sector e.g. the establishment of submarine cables, there is a widening gap between citizens with easy access to ICTs and those without. This study sought to investigate how to promote greater accessibility and higher uptake of broadband services in rural areas. This will minimize the digital divide of the underserved and unserved parts.

A model prototype for last mile mobile broadband subscription for rural Kenya was developed to enable mobile phone users purchase broadband services thus improving access to ICT in rural Kenya. This represents a model last mile connectivity as the closest network where majority of the people live.

In developing this prototype, existing subscription technologies were studied, a conceptual model developed, integration to the existing M-Pesa money transfer technology explored, existing connectivity methods studied, connectivity tokens designed, and linkage through modems using mobile phone achieved.

The prototype was tested by a link to WiMAX network via a local Internet Service Provider (KDN Butterfly). Files of different sizes were uploaded and downloaded. The time taken was measured using a bandwidth manager. The experiment was repeated with a Global System for Mobile Communications (GSM) broadband provided by a different service provider (Safaricom). The study showed that WiMAX broadband was faster than Safaricom GSM.

This research contributes a solution towards alleviating the broadband access gap experienced in rural areas of Africa. The provision of broadband Internet access through wireless technologies as an approach towards solving the digital divide that exist in rural areas has been demonstrated using the prototype developed. This solution would assist governments in planning and developing an appropriate policy on rural broadband access initiatives.

Key words: Last Mile, Mobile Broadband, WiMAX, Digital Divide

‡‡ Author's Address: Christopher A. Moturi and Charles T. Nyota. *School of Computing and Informatics, University of Nairobi, Kenya. Email: moturi@uonbi.ac.ke; charlesnyota@yahoo.com*

International Journal of Computing and ICT Research, ISSN 1818-1139 (Print), ISSN 1996-1065 (Online), Vol.6, Issue 2, pp. 46-63, December 2012.

IJCIR Reference Format:
Christopher A. Moturi and Charles T. Nyota. Filling the Digital Divide in Rural Connectivity: Case for Last Mile Mobile Broadband Subscription. International Journal of Computing and ICT Research, Vol. 6 Issue 2, pp 46-63. http://www.ijcir.org/volume6-issue2/articler5.pdf.

1. INTRODUCTION

According to the United Nations Report (2010), over 77 per cent of the population in developing countries is able to receive a mobile phone signal. The digital divide between developed and developing countries continues to widen for technologies that drive modern information sharing such as broadband Internet connection (Sang et al 2007). On the demand side, the barriers to take-up broadband in developing countries are: affordability of broadband services and computing equipment; unreliable electricity supplies; and the paucity of local content. On the supply side, the limiting factors are: the shortage of and high price of international bandwidth; lack of incentives for operators to invest in rural roll-outs; limitations on access to spectrum; and the lack of a supportive, reliable and regulatory environment. There has been mass-market adoption of broadband in an increasing number of countries in the developed world, while take-up of broadband in many countries in Africa including Kenya, has been negligible, causing the broadband access gap to widen considerably. Wireless broadband technologies, such as HSPA and WiMAX, have a key role in filling the gap of broadband access in developing markets. According to CCK (2010), these technologies depend on the use of spectrum for the roll-out of wireless networks and therefore require regulatory intervention. In order to get connectivity in rural Kenya, cash is used to pay for scratch cards that are fed into slow GSM Networks. There are limited mechanisms of collecting users into a unified single system which could avail unprecedented bargaining power to consumers of broadband services.

The utilization of the National Fiber Optic Cable to facilitate access to ICT services is below the expected level both in rural and urban areas. The low rate of development in rural Kenya has multiple and mutually reinforcing causes which are exacerbated further by the lack of access to ICT. The people living in rural areas lack access to information about income earning opportunities, market prices for the goods they produce, health, their rights and public welfare. They lack access to knowledge, education and skills to improve their livelihood, and a voice in the political and development processes that can shape their lives (CCK, 2010).

The aim of this research was therefore to find out how to promote greater accessibility and higher take-up of broadband services in rural areas using WiMAX technology thus maximizing utilization of National Fiber Optic Networks. In order to achieve this, Kenya was used as a case study.

A model prototype for last mile mobile broadband subscription for rural Kenya has been developed to enable mobile phone users purchase a broadband service thus improving access to ICT in rural areas. The prototype represents a model last mile connectivity which is the closest network where the majority of the people in Africa live. The design of the prototype applies a connectivity layout similar to the one designed by Lu, Wang, and Madihian [2007].

In developing this prototype, existing subscription technologies were studied, a conceptual model developed, integration to the existing M-Pesa money transfer technology explored, existing connectivity methods studied, connectivity tokens designed, and linkage through modems using mobile phone achieved.

The prototype was tested through simulation to ensure the subscriptions and M-Pesa payments are functional and effective, the provision of token allocations via the mobile phone to a user in the rural is possible, and compare the performance of broadband versus the GSM modem.

International Fiber Optic Network is significant in enabling the country's broadband infrastructure to offer investors tremendous opportunities for their business. This will lead to more investment in all facets of the economy. The aim is to improve rural based businesses that provide ICT goods and services to majority of citizens through village kiosks that are run and managed by local entrepreneurs. Some of the services that can be provided are computer education, e-government, health insurance, e-commerce, and microfinance. A standard mobile broadband Internet access to the last mile home connectivity provides a uniform standard way of inter-module communication that is reliable and free from the current propagation delay found with satellite telecommunication.

2. LITERATURE REVIEW

The research reviewed literature on the existing subscription systems and found that dialup connectivity was commonly used for Internet access [Kenya Data Networks, 2009]. Dialup connections result in slow connections, high effects of noise, and congestion in the telephone line, thus making Internet access unreliable. To solve the problem there is need for a common database so that all details of subscribers need to be stored in a single database as suggested by Spool [2005]. Mobile devices are intended to experience displacement while maintaining functionality [Rebolj, 2002]. The growth of mobile phone technology has increased their style, functionality, capacity, application areas, features and usability. Subscription systems based on broadband is more effective than dial up lines or fixed lines [Begh and Kagioglou, 2004]. It is possible to increase the efficiency of registration of new subscribers by involving the centralized database approach [Cheng and Chen, 2002]. Mobile phones can have an influence in rural telecommunication [Flanagan et al, 2001a]. Pervasive computing is made possible by wireless mobile communication between embedded systems, handheld mobile devices, and stationery devices [Flanagan et al, 2001b]. The subscription module is faster than current existing manual subscription where a broadband user must physically look for Internet Service Provider agents to buy scratch cards. Sometimes these agents are scarce in rural areas.

This research, therefore, sought to design and implement a prototype that can enhance registration of subscribers and contribute to future planning on broadband requirements in rural areas.

To automate payments for broadband services, the research study focused on how to integrate M-Pesa payment to the prototype. This study focused on the factors influencing the mobile payments usage by the micro business operators and applied the theory of Technology Acceptance Model, a theoretical model that explains how users come to accept and use a technology. Adoption of mobile money payment in urban areas in China found that two primary determinants for adopting and using new technology was influence by variables such as security concerns, cost, convenience, and satisfaction [Lu et al, 2003]. M-Pesa integration to the prototype required to be secure. There was need to provide a service that incorporated use of a PIN and secret code financial transactions.

The IEEE 802.16 standard, also known as Worldwide Interoperability for Microwave Access (WiMAX), has emerged as the strongest for broadband wireless technology with the promises to offer guaranteed quality of service to wireless users. The design of WiMAX technology is aimed at providing last mile wireless broadband access at a cheaper cost [Murphy, 2006]. The "last mile" is the final leg of delivering connectivity from the service provider to a user in rural areas. This leg is typically seen as an expensive undertaking because of the considerable costs of wires and cables.

Varshney and Vetter [2002] in their research on prototype testing found that many businesses have