Journal of Health Informatics in Developing Countries

www.jhidc.org
Vol. 6 No. 2, 2012

Submitted: April 5, 2012 *Accepted: May 12, 2012*

Opportunities and Challenges of Open Source Software Integration in Developing Countries: Case of Zanzibar Health Sector

Abubakar D BAKAR[a,b,1], Yahya H SHEIKH[b,2], Abu Bakar MD SULTAN[a,3]
[a]*Department of Information System, Faculty of Computer Science & Information Technology, University Putra Malaysia, Selangor, Malaysia*
[b]*Department of Computer Science and Information Technology The State University of Zanzibar, Zanzibar, Tanzania*

Abstract: This paper describes the opportunities and related challenges of integrating Open Source Software process in organization. It focuses on technical and organizational part of the integration practice in Open Source Software philosophy. Thus, several issues about opportunities and challenges of integration have been identified, including the homogeneity of the systems in place and cooperation nature of integration. In essence, integration has proved to be the solution to several technical and administrative capacity problems that face health sector in Zanzibar.

Keywords: Integration process, open source software, homogeneous, heterogeneous.

1. Introduction

One of the most current significant discussions in software technology milieu is Open Source Software (OSS). This is a process which struck conventional computer software development practice and adaptation in the developing countries. According to [1][2] OSS is the advance process that has built unit of block of human interrelation and activities in their daily lives. With the current financial situation facing public sector of developing countries, the process has triggered administrators to improve their plans, analysis and monitoring capabilities [3].

Recently, the healthcare sector has witnessed a shift from proprietary software to OSS, a major shift being in developing countries. This highly supports the present fragmented systems in the sector. The healthcare sector of developing countries comprises different health programmes. For the sake of maintaining accountability

[1] Corresponding Author: abubakar.bakar@suza.ac.tz,

[2] Corresponding Author: yahya.sheikh@suza.ac.tz;

[3] Corresponding Author: abakar@fsktm.upm.edu.my.

each programme often adopts its own system. Practically this is a misconception in the field of Information Systems (IS) as it may cause problems that were intended to be solved. Therefore, integration of these information systems becomes inevitable. This not only helps the technical improvements but also enhances the optimal use of the present manpower.

One of the success stories of OSS adopting in Africa is the use of District Health Information Software version 2(DHIS). DHIS 2 is free and open source software developed by Health Information Systems Programme (HISP) and used in various countries across the continent. Zanzibar is among early adopters of the software. DHIS 2 has been used by the Ministry of Health to collect routine data related to diseases and health services provision. DHIS 2 collects aggregated statistics from small health facilities and hospitals. To widen its reach in data collection and use the Ministry adopted two more software; Human Resource Information System (iHRIS) that is used to manage its staff and OpenMRS, a medical record system for hospital inpatient departments.

However, the major challenge of running these break-up systems is the availability of common data system where the ministry can rely on rather than duplicates from each system. The objective this study is to identify challenges and opportunities of open source software integration with the case study from Zanzibar information system.

2. Open Source Software

2.1. Open Source Software: General Concepts

Recent development in IT has heightened the need for change among software users. For instance, the software flag has changed its direction from commercial adaptation strategy, whereby a product is only available from a single vendor [4] into bazaar approaches where sustaining the system is shared among community [5]. The availability of source code and sovereignty of modifying source code helps the individuals and organizations to feel OSS more convenient to them.

Furthermore, Open Source Software (OSS) has also proved to be appropriate technology that promote self-enhancing diversity of production models, communication paths, and interactive communities by fearing lawful action from legal firms [6][7]. This OSS autonomy has also been explained by [8] and related its development as either cathedral or bazaar style. He describes cathedral and bazaar style analog to market place where many people contribute to the single product in sale. Therefore, OSS community from different locations is motivated to contribute into the software that is online and the user receives assistance from different point for free. Osterloh and Rota [9] add that the use of this technology as learning environment whereby the user does not bind on vendor demands of license fee.

This approach has emancipated most developing countries in their attempts to develop health information system to address the problem of sustainable among others and is one of the reason that simplify bug reporting and correction which is the major philosophy in Open Source Software [8]. The work presented in this paper could help the Zanzibar Ministry of health to use the technology and seizes its fruit. Moreover, the organizations holding more software can be guided to incorporate such technological knowhow for better and quality service delivery.

2.2. Fragmentation of Open Source Software in Health Sector

Problems associated with fragmented information systems in public organizations especially health sector justify the need for integration of various HIS operating within the sector. HIS in most developing countries like Zanzibar, face the problem of multiple and overlapping demands of autonomous unit and specific services ally programs that are the principal service providers [10][11][12].

The Ministry of health in Zanzibar adopted open source software solutions to utilize its characteristics of self supports and the peer contribution. However, such adoption requires improvement of existing services and the arising changes should fulfill an individual and organizational requirements, though in most public organization, new system are initiated without having knowledge on the existing systems [13]. Thus, the integration of an advanced technology and modification of the existing systems is inevitable to accommodate new requirement and compensate the shortage of staff at the ministry. Open Source discipline has demonstrated to be a solution for the most information system bureaucracy because it acts as an advisor in the efforts of integrating health system in the country.

3. Research Context and Methods

3.1. Study Context

This research was conducted in Zanzibar Tanzania. The healthcare sector in Zanzibar comprises a comprehensive data collection system primarily divided into three major components: First, routine data collection system that is based on monthly reporting from health districts and hospitals to the higher administrative organs. This system has software support of DHIS. Second, medical records comprising data on individual patients supported by OpenMRS record system, and third, is the human resource system –ZHRIS that handles the healthcare sector manpower information.

These components of information systems are funded by different donor with the Danish International Development Agency (DANIDA) taking the lead under the health sector reform strategy. These movements were the results of the Ministry efforts to try solving problems associated with proprietary software. The homogeneity and the freedom of making changes of these software have the great interest in studying the challenges and opportunities of Integration of Open Source software Integrations.

3.2. Research Design and Strategy

This study took place from 2005 to 2011. The first two authors participated in the project as part of local consultants' team at the Ministry of Health. During their six years duty in the ministry, authors participated fully from the beginning of the development and supporting the software solutions introduced. Researchers' local context and the consultant role provided the deep and wide range of area as well as the trustworthy to work and interact with stakeholders from different part of the ministry. The third author was involved in the writing process as well as consultancy to the first two authors in the period 2010 – 2012.

The study is based on Qualitative participatory action research. According to [14] [15] this approach can have great impact in providing knowledge and practical action if it is well conducted. In doing so, some literature summarized the characteristics of action research that are considered necessary. These are [16][15][17].

- The Research problems generated from the recognized community
- Community members that affected by the research should be evolved
- Teamwork (involvement) among member participating in the research process
- Research result should be in the form of recommendation for action and bringing change.

In our case the client infrastructures or research environment is the Health management Information System (HMIS) unit of the ministry of health Zanzibar. DHIS 2.0, OpenMRS and IHRIS systems has been used as tools for studying complex phenomenon within health context. The complexity of overlapping solutions was addressed by introducing deep analysis on how integration can structure well and easy management HIS in Zanzibar.

Community involvement and participation were highly considered. Meetings and frequent follow up conducted between authors and HMIS staffs promote collaboration and participation among the researchers and community concerned. The resulting recommendations can bring changes by removing redundant effort of utilizing three systems within the same environment.

Data were collected using qualitative methods that include personal experience, reflections, participant observations, document analysis, discussions, and meetings. Researchers also regarded as an instrument for data collection by defining data observed from the field during their participation and translate into plausible findings to establish the truth [18]. As explained by [19], this interpretation an approach is accompanied by ascertains evidence through keeping notes and analyzing based on interpretative approach.

3.3. Validating the Study

The study employed five types of action research validity that was mentioned by [20]; outcome validity, democratic validity, process validity, catalytic validity, and dialogical validity. In employing validation process research lead to the outcome of constructive

resolution of integrating three systems in order to solve the fragmented IS in the ministry. The knowledge has been provided on using the available opportunity of identical technology and context of the adopted solution. Democratic validity concerned with the ability of the stakeholders to participate fully in the research and value their solution [21][22]. The value of the ideas from the stakeholders and the acknowledgement and promoting the ideas in the development are the basic assumptions considered in the study [23].

In general all stakeholders evolved in the research process. As part of the local consultants' team, observations also took part through participation in the ongoing activities on the ground in theoretical and technical activities regarding software use in data collection in different sites of the ministry. In process validity, problem solving is proportional to the enduring learning and the improvement [24]. We participated in introducing all three software in place from starting, supporting technical activities like installation, diagnosis and on job trainings. These activities give us direct interactions with users from all levels of the ministry that ensure dialogue validity. This helps in building the trust and good relationship with user and other stakeholders working with the software and granted us opportunities to explore more things related to integration.

Researchers participated in several meeting such as data use workshop and other managerial meetings. In these gatherings data managers and other stakeholders from all districts were attended to share challenges and strategies that can help to improve HIS at the ministry. In ensuring dialogue validity, we observed and note down on the arguments and activities of individuals, for example, when people argue each other in the discussions as well as the individuals explanation on their experience and the challenges they overcome in their daily activities [25][26].

3.4. Handling Bias

Qualitative research design as any other methods is vulnerable to bias [27]. In action research as one of the qualitative design, a critic on bias has been hinted. In this process evaluation is done in term of local applicability. Thus, the peer review nature of the process granted all research powers to stakeholders, that is everyone contributed in finding the solution of the problem. Likewise, researchers can elicit and account the data generated during the process [28]. This participant validation seemed to be different with classic qualitative approach.

4. Description of Actors in an Integration Process

4.1. District Health Information Software (DHIS 2.0)

DHIS 2 is among three fragmented systems employed by the ministry of health in Zanzibar as routine row data collection and an analyzing tool starting from the district level and hospitals. Besides, this web based OSS solution has capability to track some of human resource data for doctors, nurses and other health staffs [29][30]. The solution developed using java framework together with MySQL or Postgress database. Built in Geographic Information System (GIS) capability provides online data based on

geographical dispersion. This visualized ability can also help stakeholders to project different kind of web reports. Its successor DHIS 1.4 was semi proprietary that was phased out in 2008 after the Ministry of health Zanzibar adopted DHIS2 to solve problems that they ware existing in previous version [11]. The first intake version was used as a pilot to some districts up to 2010, by the effort from local and with help of international consultants working in the global heath information research, Health Information System Project (HISP), the system rollout out across the whole country from 2010.

4.2. Open Medical Record System (OpenMRS)

The second actor of this HIS is OpenMRS which is also a Free Open Source Software developed using java framework and MySQL database in additional with the hibernate library. It is used by hospitals for managing health medical records in many developing countries. Some countries in Africa and Asia including Rwanda, and Kenya have implemented this system successfully in some of their health institutes [31][32].

The Ministry of health Zanzibar through its HMIS unit adopted this system as pilot in its referral hospital called Mnazi Mmoja to solve the problems regarding manual data handling in its medical record unit. Although the system installation was successful, its utilization was very minimal due to a limited technical capacity experienced in the medical record unit to runs such a system. Therefore, the implementation of OpenMRS faces strong challenges, due to the fact that even data entry exercise need complete support of few IT experts from National HMIS Unit.

4.3. Zanzibar Human Resource Information System (ZHRIS)

Human resource Information system is the third player in this health system scenario. It is human resources management tool that enables employers to design and manage a comprehensive human resources strategy. In meeting this strategy, the software intends to help the organization to make a plan using Computer technology [33]. The Ministry of health of Zanzibar has adopted a so called Zanzibar human resource information System to help managers and policy makers to answer quick questions on health care delivery in their respective authorities. Owing to its Free Open capability, the system attracted ministry to improve peoples' health care delivery. The system has been implemented and operated smoothly at human resource unit of the ministry since 2008. The adopted system seemed stable following technical assistance from United State Aid (USAID).

5. Discussion

5.1. Open Source Software Integration

Information systems integration in any organization should be carefully implemented in order to streamline service delivery. Technically, integration refers to the degree of interoperability and interconnectivity among technical components or software, and

regards standardization at a certain level. This is considered to be more efficient approach because each system has separate services in integration process and adding interface properties for standardized respective systems [34][35][36]. According to [37], Open Source, Integration is more than combination of components or Software. It is in fact one step towards collaboration activities among autonomous things and communities.

5.2. Open Source Software Integration: Zanzibar Context

Numerous studies in software report wide gulf of integration for heterogeneity systems [38][39][40]. In essence, the Zanzibar Ministry of health seemed to have more prospects on implementing integration process because of three actors' homogeneity that store information with the same technical and legal system.

Philosophically, all three actors collect and analyze related data from the same milieu. Practically, the authority is burdened because only few people at the top management analyze all three systems information flow loll in the pyramid nature.

Technologically, all three systems are web based, using Open Source technology both in its back and front ends, used MySQL databases and java application in their front end that makes the integration of the positive impact because it favors both the client and the server side. This will catalyze innovation, self supports and reduce cost because the Zanzibar ministry of health suffers shortage of IT skilled staff and other related fields.

Moreover, integration is inevitable as it increases data quality by removing redundant data collected from different sources. Finally, the Zanzibar Ministry of Health will understand the better ways of managing adopted open source systems for quality health care delivery. This is in line with Health Metrics Network (HMN) emphasizes of integrating data warehouse to store data across programs that shared related information between them [41]. Figure 1 bellow shows the integrated model for data warehouse which comprises information storage area consisting data repository that bring together multiple databases from various data sources and provide easy and equal access to relevant information for all stakeholders.

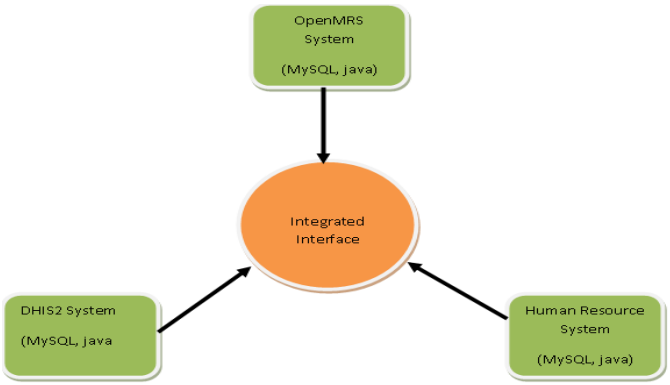

Figure 1: Integration architecture for the actors in HIS Zanzibar

Wherever there are successes there are also challenges to work on. Integration process faces numerous challenges that need to be addressed in order to experience smooth standardization of the components [42]. Within the ministry some health programmes still run their own software owing to little trust in HMIS unit performance [10]. These programs hindered the effort of streamlining the HIS which sometimes health programs emerge to present different data from that available in the HMIS main repository. Therefore HMIS has a great task of build trust to the allied health programmes in order to take them onboard of integration process.

In completing the integration process, it means that the isolation from the vendors of respective integrated components. This can lead the ministry to depend only on their technical staffs since the communications with OSS communities will automatically disrupt. Therefore ministry practitioner should be well equipped in technical in order to work independently without the help from respective individual components. The tables bellow outline challenges and opportunities of integrating OSS in developing countries that observed in the study.

Table 1: OSS Integration challenges and opportunities

Opportunities	**Challenges**
Homogeneity of the systems in both theoretical and technical seemed to favor integration process [43].	Shortage of technical ICT staffs to handle the integrated system.
Eliminate redundancy of entering data into three different systems by facilitating interoperability.	The rigidity of some health programs managers [10].
Reduction of loads of handling three systems especially in the health sectors where there are few technical staffs.	Management of integration process seemed to be challenges in bringing stakeholders from all actors on the same tracks [13].
Integrating related OSS within the same reduces the total cost of ownership.	
Increase Efficiency, eliminating bureaucracy and ensuring data quality (HMN, 2008).	Communication with OSS communities that support respective integrated components will be disrupted.
Data warehouse comprises an integrated information storage area that consists of a data repository bringing together multiple systems provide easy and equal access to relevant information for all stakeholders	

6. Conclusion and Future Work

This paper discussed the opportunities and challenges of developing countries regarding the utilization of available limited resources in the public organization. It addresses integration strategies that reduce cost and simplify accessibility of scattered information in different systems within the same organization context.

This practice highlighted the benefits of the software integration. It called for the Ministry of Health in Zanzibar to integrate existing three homogeneous open source software systems that are in place in order to facilitate quality service delivery. This is done without ignoring identified technical challenges and user capacity problem especially after the disasters of economic recession hit the world. In addition to that, the researchers can go further in working with autonomous systems or components to cover discourse in programming models.

References

[1] M. Malik, C. Paton, Why is there is a Lack of Open Source Initiatives for Electronic Health Record Systems in Pakistan? *Journal of Health Informatics in Developing Countries* **2** (2008).

[2] IDA, *Open Source Migration Guidelines, Interchange of Data between Administration*, European Community Net Project, OSPL/EEC-01.10. Version 1.0, 2003.

[3] J. H. Lungo, F. M. Igira, Development of Health Information System in Zanzibar: Practical Implications, *Journal of Health Informatics in Developing Countries* **2** (2008), 25-32.

[4] S. Ajila, D. Wu, Empirical Study of the Effects of Open Source Adoption on Software Development Economics, *Journal of Systems and Software*, **80** (2007), 1517–1529.

[5] A. Dreiling, H. Klaus, M. Rosemann, B. Wyssusek, Contemplating Open Source Enterprise System, *WISE 2004, LNCS 3306* (2004), 466–471.

[6] M. Henley, R. Kemp, Open Source Software: An Introduction, *Journal of Computer Law and Security Report* **24** (2008), 77-85.

[7] A. Bonaccorsi, C. Rossi, Why Open Source Software can Succeed, *Research Policy* **32** (2003), 1243-1258.

[8] E. Raymond, the Cathedral and the Bazaar. *Knowledge, Technology & Policy* **12** (1999), 23-49.

[9] M. Osterloh, S. Rota, Open Source Software Development – Just Another case of Collective Invention? *Research Policy* **36** (2007), 157-171.

[10] A. D. Bakar, and Y. H. Sheikh, Open Source Software Solution for Healthcare: The Case of Health Information System in Zanzibar, *AFRICOMM 2011 - Third International ICST Conference on e-Infrastructure and e-Services for Developing Countries, Zanzibar, Tanzania* (2011), 146-155.

[11] E. Nyella, Challenges in Health Information Systems Integration: Zanzibar Experience *Journal of Health Informatics in Developing Countries* **6** (2011), 356-360.

[12] B. Oluwatolania, A. Philip, Lack of Integration in Software Systems for Health Practitioners in Nigeria: The Way Forward, *Journal of Health Informatics in Developing Countries* **4** (2010), 45-51.

[13] W. Rossak, A. Peter, Some Thoughts on Systems Integration: A Conceptual Framework, *Journal of System Integration* **1** (1991), 97-114.

[14] P. Baxter, J. Jack, Qualitative Case Study Methodology: Study Design and Implementation for Novice Researchers, *the Qualitative Report* **13** (2008), 544-559.

[15] M. Robin, Is Validity Really an Issue for Participatory Action Research? Studies in Cultures, *Organizations and Societies* **4** (1998), 211-236.

[16] G. W. Carter, *Community Organization in Action*, Association Press, New York, 1959.

[17] P. Coughlan, D. Coghlan, Action Research for Operations Management, *International Journal of Operations & Production Management* **22** (2002), 220-240.

[18] R. J. Barrett, the Researcher as Instrument: Learning to Conduct Qualitative Research through Analyzing and Interpreting a Choral Rehearsal, *Music Education Research* **9** (2007), 417–433.

[19] N. Golafshani, Understanding Reliability and Validity in Qualitative Research, *Qualitative Report* **8** (2003), 597-607.

[20] P. Reason, H. Bradbury, Handbook of action research, Thousand Oaks, CA: Sage, 2001.

[21] W. Yoland, *Do It Yourself Social Research*, Victorian Council of Social Service and Melbourne Family Care Organization, Melbourne 1984.

[22] N. S. Rajendran, Dealing with Biases in Qualitative Research: A Balancing Act for Researchers, *Qualitative Research Convention 2001, Navigating Challenges, Kuala Lumpur Malaysia* (2001), 1-15.

[23] W. Stam, When does Community Participation Enhance the Performance of Open Source Software Companies? *Research Policy* **38** (2009), 1288–1299.

[24] P. Newton, D. Burgess, Exploring Types of Educational Action Research: Implications for Research Validity, *International Journal of Qualitative Methods* **7**(2008), 18-30.

[25] J. Marshall, P. Reason, Quality in Research as ‘‘Taking an Attitude of Inquiry’’, *Management Research News* **30** (2007), 368-380.

[26] J. W. Creswell, D. L. Miller, Determining Validity in Qualitative Inquiry. *Theory into Practice* **39** (2000), 124-131.

[27] J. Daly, J. Lumley, Bias in Qualitative Research Designs, *Australian and New Zealand Journal of Public Health* **26** (2002), 299-300.

[28] A. Cornwall, R. Jewkes, What is Participatory Research*? Social Science Medical* **41** (1995), 1667-1676.

[29] J. Braa, H. Muquinge, Building Collaborative Networks in Africa on Health Information Systems and Open Source Software Development – *Experiences from the HISP/BEANISH network* (2007).

[30] M. Lars, *DHIS-2 - A Globally Distributed Development Process*. "Abstract of Thesis submitted to University of Oslo", 2005.

[31] L. Celli, L. Sarmenta, J. Rotberg, A. Marcelo, G. Clifford, (2009), Mobile Care (Moca) for Remote Diagnosis and Screening, *Journal of Health Informatics in Developing Countries* **3** (2009), 17-21.

[32] C. Allen, D. Jazayeri, J. Miranda, P. Biondich, B. Mamlin, B. Wolfe, C. Seebregts, N. Lesh, "Experience in Implementing the OpenMRS Medical Record System to Support HIV treatment in Rwanda". *Studies in Health Technology and Informatics*, **129** (2007) 529-533.

[33] A. A. Boateng, *the Role of Human Resource Information Systems (HRIS) in Strategic Human Resource Management (SHRM)*, Master of Science Theses in Accounting, Swedish School of Economics and Business Administration, 2007.

[34] S. Sahay, E. Monteiro, M. Aanestad, Towards Political Perspective of Integration in IS Research: The Case of Health Information System in India, *Information Technology for Development* **15** (2009), 83-94.

[35] R. Djavanshir, R. Khorramshahgol, Key Process Areas in Systems Integration, *IEEE Computer Society* **9** (2007), 24-27.

[36] G. Gannod, S. Mudiam, T. Lindquist, Automated Support for Service-based Software Development and Integration, *The Journal of Systems and Software* **74** (2004), 65–72.

[37] N. Suri, A. Jhumka, M. Hiller, A. Pataricza, S. Islam, C. Sârbu, A Software Integration Approach for Designing and Assessing Dependable Embedded Systems, *The Journal of Systems and Software* **83** (2010), 1780-1800.

[38] J. Park, S. Ram, Information Systems Interoperability: What Lies Beneath? ACM *Transactions on Information Systems* **22** (2004), 595–632.

[39] K. Stol, M. Babar, P. Avgeriou, B. Fitzgerald, A comparative study of challenges in integrating Open Source Software and Inner Source Software, *Information and Software Technology* **53** (2011), 1319-1336.

[40] W. Hasselbring, Information System Integration, *Communications of the ACM* **43**(2000), 33-38.

[41] HMN, *Framework and Standards for Country Health Information Systems*, Health Metric Network, World Health Organization, 20 Avenue Appia, 1211 Geneva 27, Switzerland, Second Edition, 2008.

[42] R. Lewis, Year 2000- a Systems Integration Challenge, *BT Technology Journal* **15** (1997), 151-159.

[43] N. Pettis, Y. Lu, A Homogeneous Architecture for Power Policy Integration in Operating Systems, *IEEE Transactions on Computers* **58 (2009),** 945-955.