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Free and Open Source Software for Disaster Management: A Case Study of Sahana Disaster Management System of Sri Lanka

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Information and Communications Technology and
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Abstract

Free and open source software is increasingly being used in many spheres of development including disaster management. With the economic downturn, stakeholders at both ends of the technology divide are turning to free and open source software solutions.

Despite the successes of open source, few challenges including sustainability remain a problem. While use of open source varies between "developed" and "developing" nations, cheaper cost and vendor independence have been cited as the key factors in favour of its use.

The paper illustrates empowerment of communities in developing nations through appropriate open source applications. Explicitly, the paper describes the functioning of the "Sahana" disaster management system deployed during the 2004, Indian Ocean Tsunami. Sahana used free and open source software to create number of functionalities. Success of these functionalities has contributed to efficient and effective management of disaster relief.

The paper offers a set of generic policy options for the use of open source in disaster management.

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EXECUTIVE SUMMARY

With climate change imperatives and increase propensity to natural disasters, the world, and in particular, the Asian and Pacific region is becoming more vulnerable to disasters. One of the key short comings identified during the recent disasters is lack of ICT solutions for disaster rescue and recovery. While number of disaster information systems are available, few would provide a robust system for data management support and functionality for disaster management.

The World Summit on Information Society (WSIS) and the World Conference on Disaster Reduction endorsed the role of ICTs in effective disaster reduction. Finding affordable ICT solutions for disaster reduction is a challenge to many nations in the Asian and Pacific region.

Free and open source software (FOSS) is increasingly being used in many spheres of ICT solutions including disaster management. With the current economic downturn, stakeholders at both ends of the technology divide are turning to open source solutions. While free and open source software has established itself as a driving force despite its late entry to IT industry, few challenges including sustainability remain a concern. Free and open source software is not in competition with proprietary software but its role in the IT environment is supplementary to commercial software. Cheaper cost and vendor independence have been cited as the two key deciding factors in favour of free and open source software use. Use of free and open source software vary significantly between the "developed" and the "developing" nations. While the issue of sustainability of free and open source software appears to be more stable within developed nations, developing nations tends to depend heavily on "projects" or external support for sustainability. Nevertheless, open source community worldwide has remained faithful to the concept and practice of free and open source software. Sharing the source code, studying, modifying and redistributing have been the strength of its diversity. Open source appears to have its niche applications in the public sector and among many development agencies including NGOs in developing countries.

This paper illustrates how open source has empowered communities in developing nations through effective interventions in agriculture, marketing, communication, environmental and disaster management pursuits. Essentially, these interventions have largely contributed to bridging the digital divide, enhanced income and preserved the natural eco systems in developing nations. The paper explicitly describes the functioning of the "Sahana" disaster management system which was put into action during the 2004, Indian Ocean Tsunami. Sahana used free and open source software to create number of functionalities. Success of these functionalities has contributed to efficient and effective management of disaster relief. Subsequently, Sahana disaster management system was adapted in the Pakistan earthquake, Philippines mudslide and

Indonesian earthquake among many other similar occurrences. Although Sahana was initially meant to be a post disaster management tool, it is now being modified to accommodate disaster preparedness functionality as well.

Sahana can run on any hardware which can run windows, Linux or Unix, it uses MySQL as the database and has the ability to handle significantly large amount of data and perform well.

The paper ends with a set of generic policy options for the Asian and Pacific region on use of free and open source software for disaster management with special reference to Sahana disaster management system. Further research could validate the importance of some of these policy options.

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A. Introduction

The World Summit on the Information Society (WSIS) in its Declaration of Principles adopted in 2003, committed to build a people centred inclusive and development–oriented information society. It recognized that everyone can create access, utilize and share information and knowledge, enabling individuals and communities to achieve their full potential in promoting sustainable development and improve their quality of life.[1]

The WSIS plan of action recognized the nature of natural disasters and its impact on economic development which may hinder the attainment of summit objectives. Sharing information and communication practices play a key role in the realization of effective disaster risk reduction activities. Besides, the Hyogo Framework for Action (HFA), endorsed by the United Nations member states at the World Conference on Disasters Reduction, Kobe, Japan, in 2005, considered the role of ICTs in response to the need for universal and equitable access to weather, climate and water information, forecasts and warnings in order to reduce loss of life and property caused by natural disasters. In these contexts, information and communication technologies (ICTs) have proven to be an effective tool to identify emerging causes of disaster risks. This study looks at affordable ICT solutions which can be applied for disaster risk reduction and recovery. The study highlights the role of "Free and Open Source Software" (FOSS) and its contribution towards effective and efficient disaster management

In 2007, the United Nations Intergovernmental Panel on Climate Change (IPCC) predicted an increase intensity of tropical cyclone activity and increase incidence of extreme sea level rise in the 21st century[2]. In May 2008, tropical cyclone Nagis caused an estimated 140,000 mortalities in Myanmar, primarily due to a storm surge in the low lying areas of Irrawaddy delta.[3] It was followed by a powerful earth quack in Suchuan province in China killing at least 87,556 people with an estimated economic loss of US$ 30 billion.[4]

One of the key shortcomings in these disasters and the ones that preceded, like 2004, Asian Tsunami and 2005 Asian earthquakes was lack of ICT solutions for disaster rescue and recovery. Large scale disasters of this magnitude are typically followed by the need to effectively manage massive amounts of knowledge and information. This includes data on disaster victims, damages to buildings, weather and geographical data, etc. Besides, large scale disasters attract multiple organizations, including aid agencies, NGOs, INGOs and government agencies. This leads to diversity of agencies and the need to coordinate for effective disaster management.

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[1] ITU, *Declaration of Principles, Building the Information Society: A Global Challenge in the New Millennium* (Geneva, World Summit on the Information Society, 2003).

[2] IPCC, *Climate Change 2007: Synthesis Report* (Geneva, 2007) pp. 13-53.

[3] United Nations, *2009 Global Assessment Report on Disaster Risk Reduction: Risk and Poverty in a Changing Climate; Invest Today for a Safer Tomorrow* (2009).

[4] Ibid.

Despite the recognition of good disaster management systems, the few systems which are widely available appears to be non web-based and uses proprietary non standard database technology.[5] Research suggests that there are disaster information systems which focus on specific applications such as imagery and GIS data, early warning models using sensor data and mobile ad hoc networks and messaging, etc. However, there are no systems which provide information systems or data management support for the basic functionality of disaster management like, registering organizations, locating missing persons or requesting for assistance.[6] With an effective ICT solution, it was recognized that tracing of missing people, coordinating emergency aid and response teams would be more efficient and effective.

Sahana is a Free and Open Source Software application which can provide a comprehensive solution for disaster information management, relief and recovery operations. Sahana was developed by a non-profit NGO within a very short period of time to suit the requirements of the Tsunami recovery programme in Sri Lanka. It was subsequently supported by the Swedish International Development Corporation Agency (SIDA) to upgrade the system for global applications in large scale disasters. The system was widely used and deployed in the 2005 Pakistan earthquake and 2006, mudslide disaster in the Philippines. Success of Sahana as a disaster management system can be attributed to the bond between the FOSS philosophy and the humanitarian requirement of disasters. Hence, it was called the "Humanitarian FOSS"

In a vibrant information technology society, users and developers were seeking for cheaper and more independent software applications. The conventional proprietary software that was used in the business world placed limitations which restricted users to share the software and by denying the source code prevented them from changing it. The corporate sector did not trust the free software concept as they were accustomed to proprietary software, while the free software proponents took an uncompromising stand on restrictive user rights by the proprietary software makers. To compromise the difference between the two sectors, a more pragmatic preposition was made in the form of a definition. This came to be the beginning of the Open Source Software (OSS) movement[7]. Free and open source software essentially refers to software being in the open domain and can be reviewed by a multiplicity of developers and users. Although free and open source software is not zero priced, it is free as *gratis* or freedom to use as in *libre*.

This paper discusses the development and application of open source software and review case studies to understand the successes and challenges faced by free and open source software development and applications in the Asian and Pacific region. The paper will consider the rational for development and use of free and open source software in the current economic crisis. Particularly, the paper will use the experience of Sahana disaster

[5]   Mifan Careem, Chamindra De Silva, Ravindra De Silva, Louiqa Raschid and Sanjiva Weerawarana, *Sahana: Overview of a Disaster Management System* (Sri Lanka, Lanka Software Foundation, 2006).
[6]   Ibid.
[7]   Suchetha Wijenayake, "FOSS Concept of Development", for Practical Action, released under the creative commons 3.0 attribution share-alike license, http://www.creativecommons.org/licenses/by-sa/3.0/, 2009.

management system developed in Sri Lanka to analyze the feasibility of using Sahana as accepted software for disaster management in the Asian and Pacific region. Paper will highlight some key issues of strengths and weaknesses of using free and open source software as a disaster management system and propose policy option for the region. As majority of the ESCAP member countries are from the developing world, this paper looks at free and open source software platform from a "development" perspective.

1. Genesis of software

"To have the choice between proprietary software packages, is being able to chose your master, Freedom means not having a master"

- Richard M. Stallman (founder of the Free Software Foundation)

The idea of "free software" emerged at a time when large software makers were trying to control the use of software and impose conditions. This was unacceptable for those who freely used software, modified and redistributed. It is in this social environment; Richard Stallman introduced his concept of free software that was based on four primary tenets[8]. These four "freedoms" were:
- The freedom to use the software
- The freedom to study the software
- The freedom to copy and share the software
- The freedom to modify and redistribute the software.

The four freedoms form the basis of the GNU[9] general public license (GPL), for the foundation of the free and open source software movement.

FOSS, is an umbrella term, it covers many licenses used by free software and opens source software. The two sections are different though there are many areas of overlap. The licensing system is different for the two initiatives. The Free Software Foundation (FSF) for the free software license and Open Sources Initiative (OSI) for the open sources software license.

2. Concept of free and open source software

The fundamental principle of FOSS is the freedom associated with developing software. The ability to use, study, freely copy and redistribute any software is the core of the FOSS concept. Freedom to access the sources code is fundamental to development of free and open source software. The FOSS developers are mostly volunteers who are willing to sacrifice their time for a noble cause. In most cases there is no payment attached to FOSS development. However, there are few instances when developers have been paid. The possibility of being able to improve on software freely and redistribute it

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[8]   Ibid.
[9]   GNU General Public License (GNU GPL or simply GPL) is a widely used free software license originally written by Richard Stallman for the GNU project. <http://www.en.wikipedia.org/wiki/ GNU_General_Public_License>

among the development community contributes significantly towards capacity building among local population. Conceptually, free and open source software is a *renewable* resource.

3. The Open Source Niche

Many governments around the world have begun to consider the use of free and open source software as an important part of their strategic thrust in information technology, requiring that its use be considered when it provides a feasible alternative to propriety software. Developing countries in particular with the resources constraints they face, view free and open source software as a means to reduce the cost of IT investments and increase its productivity. The imperatives to adopt free and open source software in these countries, particularly in public the sector are motivated by the desire for independence, security and autonomy and as a means to address intellectual property rights enforcement[10]. Open source plays a key role among development agencies including NGOs and INGOs.

4. Definition

There are numerous definitions in literature for free and open source software. For easy understanding this paper will quote two definitions.

First, free and open source software refers to software that is distributed under a license that is recognized either as free software[11] by the Free Software Foundation (FSF) or free and open source software[12] by the Open Source Initiative (OSI). Free and open source software has its roots in free software.[13] Since the early days of computer, software has been freely exchanged with its source code by researchers and academics. These users freely modified the source code and distributed the modified code among other users. This method of free sharing inspired the Free Software Movement. Thus, the Free Software Federation (FSF) defines free software[14] as software distributed under license that possesses the four fundamental freedoms[15] as described earlier.

The second definition states that, in late 1990s free and open source software was derived from "free software". This refers to "free of restrictions", thus the phrase, "free and open source software" as it is commonly used. While the free software movement promotes the user's freedom as an ethical issue, the philosophy of open source focuses on

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[10] Sanjiva Weerawarana and Jivaka Weeratunga, *Open Source in Developing Countries* (Sweden, Sida, 2004).

[11] "Software License", Free Software Foundation, http://www.fsf.org/licensing/licenses/index_html#SoftwareLicenses.

[12] "Open Source License", Open Source Initiative, http://www.opensource.org/license/.

[13] Nah Soo Hoe, *Breaking Barriers: The Potential of Free and Open Software for Sustainable Human Development; A Compilation of Case Studies from Across the World* (UNDP, http://www.apdip.net/publications/ict4d/BreakingBarriers.pdf, 2006).

[14] "The Free Software Definition", Free Software Foundation, http://www.fsf.org/licensing/essys/free-sw.html.

[15] Freedom to run software, freedom to study and adapt freedom to improve and freedom to redistribute.

practical benefits when users share with each other. Nearly all free and open source software is free software, but with some exceptions. Proponents of this definition[16] refer to free and open source software as software which is distributed with the source code so that users including vendors can modify for their own purposes. Most open source licenses allow software to be redistributed without restrictions under the same licensing conditions.

5. The open systems

The use of free and open source software has many benefits. Open and free distribution of data and information are the fundamental achievements. This has led to technology that can be modified, localized, customized and redistributed without paying any license fee. In turn, this has led to creation of a group of people who are willing and able to modify software and meet the needs of the end-user. This group of people could create a demand in the market and be compensated adequately. Thus, they see potential in developing free and open source software as a business opportunity. The fact that they do not have to pay license fee or use unlicensed software copies encourage them in creating free and open source software. This eventually leads to the core of the "open sources concept", creating a "free culture". A culture of people who are willing to work for the common good of communities also improves their marketability in global knowledge market.

Open Source and Motivation

Review of free and open source software applications leads one to believe that the driving force of open sources is individual motivation of some highly committed software developers purely on account of their personnel interest and the pleasure of programming. On addressing the issues of free and open source software applications, a moot question among many open sources developers is the issue of sustainability in the long run, thus, it is important to comprehend the underline drivers of open source phenomenon. In an open economic environment it is the contention of many that "self actualization" and "altruism" alone are inadequate to drive the motivation among the developers. Clearly, there is a significant economic motivation besides self interest. Improving future sources of income, creating a niche market for open source developers and creating personal brand equity are equally important aspects for future sustainability of free and open source software development. Much debate has been in the air on which of the two drivers are more powerful to motivate open source developers. Although open source belongs to a "free culture" its sustainability appears to rest on economic returns, including building human capital and self-marketing. The open source domain has two clearly defined categories. Hobbyist and students who are the most intrinsically motivated while the second category is the salaried contract programmers who are seeking economic returns. Thus, the open source movement can draw from a diverse set of motivations, which can help sustain the movement in future. However, economic returns to developers will play a key role in future sustainability.

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[16] http://encyclopedia2.thefreedictionary.com/open+source+concept

Although there is a strong economic motivation to sustain free and open source software, one cannot discount the strong socio-political culture embedded in the "free culture" of open sources. Research carried out by Hans and Ou indicate the majority of developers sighted a sense of belonging and the need to help the community (altruism) as key motivational factors. Besides, ideology and competitiveness were the drivers of this group. Ideologically, open source developers support the notion of narrowing global inequities and digital divide by providing information technology free to the developing communities in the world.

B. Role and scope of free and open source software systems

Open source is fast becoming popular in contemporary ICT development. The application of open source technologies has expanded significantly in scope and usage over a relatively short period. Even though the concept of open source was introduced in mid 1980s, many of the concepts behind open sources had been around much earlier[17].

In the early days, free and open source software focused on developing implementation of Unix software utilities and networking protocols that were unencumbered by proprietary licensing restrictions. Compilers, editors, transport protocols were the focus of activity. However, over time developers recognized that by sharing the source code they could develop software that was functionally equivalent to commercial software. Their work spread to complete database management and computer operating systems. With more developer participation, projects became more varied and ambitious. Open sources community encouraged active participation of individuals, building on each others work, thus, adding new functionality and releasing for use. This differs dramatically from long release cycles and close processes of traditional software.[18] This resulted in high degree of confidence in technology produced.

In the later part of the 20th century, open source started to become an important component of information technology. Building on the foundation, free and open source software became an important part of the enterprise architecture. As the range of software applications in open source started to expand, organizational profile of users expanded from research, academia, defence, public sector, commercial companies to enterprises. However, adoption of open source varies, some adopted faster than others. Expansion of open source has been driven by investments, contributions and participation by major vendors. These activities validated the open source approach and helped users to feel more comfortable as open source was a mainstream approach to software development.[19] Diversity of open source plays a crucial role in development of human rights and

[17] "The GNU General Public License protects software freedoms", Free Software Foundation , http://gnu.org/press/2001-05-04-GPL.html, May 2001.

[18] Ibid.

[19] Forrester Consulting , *Open Source Software's Expanding Role in the Enterprises: Companies Adopt Open Source as Standard; A Forrester Consulting Study Commissioned by Unisys Corporation* (http://www1.unisys.com:8081/eprise/main/admin/corporate/doc/Forrester_research-open_source_buying_behaviors.pdf, March 2007).

democracy[20]. Open source can facilitate right to access to information as enshrined in the principles of human rights.

C. Economics of free and open source software development

"Many would say that open sources authors are being exploited for their labour, and that no venture borne out of idealism can result in a permanent and ongoing solution."

- Eric Lee Green

This is the perceived notion of many in an open economy. Most believe that idealism has not been able to produce much besides egalitarian ideologies. However, this is debatable.

If one examines the market share of Linux (17 per cent) in the server open source market and Apache web server having a 53 per cent in the web server market, speaks volumes of their success in the open software market. It's obvious that the success of both Linux and Apache are due to its commercial viability.

In the early days of the development process, proponents did not fully understand the economics of free and open source software, thus they created a situation which believed that open source economic foundation was intangible. This made many people to believe that open source was not sustainable and would not scale up to meet the market needs of a new technology.[21] . However, researchers subsequently attempted to present open source as a *gift economy.* While many idealized the gift economy concept, the researchers who defined the "gift economy" attempted to explain the behaviour of programmers through their own private subcultures. These programmers (developers) were rewarded with intangible returns rather than monetary gains. In the current context, there is evidence to suggest that strong monetary incentives could be overriding intangible returns. Besides direct economic returns, a study done in Finland suggests that free and open source software can help young technology savvy generation to pick up the IT trade faster and be competitive in the open market. The research suggests that open source can contribute to cost saving, promoting education and building a solid base in developing countries[22].

In a competitive world, people look for alternative systems in the wake of high cost and reliability issues of other commercial software. This was when open source created new economic relationships between users and developers. There were interactive relationships between users and they could participate in the software development process. This enabled them to be software developers for each others. There were other relationships between vendors and customers which developed as a result of mutual interactions. As many vendors could access the same source code and support the product,

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[20] Pia Krakowski, *ICT and Free Open Source Software in Develop Countries* (Springer Boston, http://www.springerlink.com/content/b6x3644285111573/, 2009).

[21] Bruce Perens,. *The Emerging Economic Paradigm of Open Source* (Cyber Security Policy Research Institute, George Washington University, http://perens.com/works/articles/Economic.html, 2005)

[22] "Free Software a boon for developing nations: Report", Indo-Asian news service, 31 May 2003.

there was less exclusivity in customer-to-vendor relationship. As a result of these changes new suppliers arose and existing suppliers began to substitute open source products for proprietary software.

The public sharing of new creations, de facto ownership and software benefits were the anathema for commercial models. With truly independent peer reviews, increased level of user involvement and rapid release of schedules, open source had already built a technically successful operating system and a web server. These were shown to be practically effective. This was followed by a tremendous economic growth rate of 37-45 per cent and predicted to be a US$ 35 billion dollar market by 2008[23].

These figures argue that open source may be standing for previous demands in the software market. Otherwise there is no reason for the following phenomenon to be effective.

- The hobby project of a young student, Linux to take over the computer enterprise
- IBM, the epitome of conservative computer business to de-emphasis its billion US dollar "AIX" operating system in favour of OSS which is created by a lose coalition of developers without any binding or power, except for mutual respect.
- Some big companies face its first serious competition in a decade, programmers who give away their work free.

These events seem meaningless in a neo-economic liberalized model. But a new economic paradigm in technology production is developing.

Role of FOSS in economic downturn

The current financial crisis is affecting Asian and Pacific countries with an abundance of pressing challenges ranging from declining exports, increasing unemployment, closure of factories, decreasing remittances and current account deficits. These challenges leave the ESCAP member countries with fewer resources to achieve significant progress in internationally agreed goals such as meeting MDGs. However, some countries have pledged massive economic bail out packages to maintain country's socio-economic development. Investing in ICT development is the national policy of many member states. However, in a weak economic environment, such investments are sometimes ignored for other country priorities. Nevertheless, investing in ICT development has the potential to alleviate poverty, promote economic and social development and improve quality of life of people in rural and remote communities[24].

The discussion in this paper clearly indicates the social and economic advantages of adopting free and open source software in improving or upgrading country's ICT environment. One of the advantages of investing in free and open source software during times of economic down turn is the cost factor. Zero license fee or very minimal cost as

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[23] Bruce Perens,. *The Emerging Economic Paradigm of Open Source* (Cyber Security Policy Research Institute, George Washington University, http://perens.com/works/articles/Economic.html, 2005)

[24] ESCAP "ICT for the Economic and Social Development of Rural Communities", *Policy Brief on ICT Applications in the Knowledge Economy* , No. 3, December 2007.

licensing is a major economic benefit. However, in a survey of visitors conducted by "Computer Economics" identified that cost is not the most perceived advantage for shifting to open source[25]. Forty four per cent of the sample attributed reduced vendor dependency as the main advantage followed by 22 per cent for lower cost. Further, the survey indicated that with most type of free and open source software, support (training of programmers) and administration cost overshadow initial licensing and annual maintenance costs[26].

The survey results collaborate well with the behaviour of some of the major commercial enterprises in the United States. These enterprises attribute the shift to free and open source software due to performance improvement and reduce vendor dependency. The latter is a major concern for commercial enterprises. Vendors require users to shift to newer versions or pay extra for maintaining older versions. Most users believe that changing to open source is a significant net savings for commercial enterprises. With open source there is no licenses cost with each additional installation, thus there is zero marginal cost. As a result cost reduces with each new installation.

In the current economic and budget climate, development organizations are increasingly turning to free and open source software to maintain speed of innovation and reduce costs. While in many parts of the world including Asia and the Pacific, member states are offering stimulus packages to put the economy back on tract. It is in this state of the economy that private sector too should play its part to stimulate growth through innovative strategies. One of the options available to the private sector software companies is to tap the vast pool of free and open source software and write less of their own code and stop reinventing the wheel.[27] This will enable them to shift scares resources into more productive projects.

Research on Economic Downturn

A research conducted by Gartner Dataquest (March 2009) estimated that global IT spending at US$ 3.235 trillion. Further, the same source estimates that 20 per cent of global IT is spent on application development which amounts to US$ 647 billion. Based on Black Duck software company customer experience, research conservatively estimates 10 per cent of application development is redundant and could be offset by open source. This amounts to US$ 65 billion (10 per cent of US$ 647 billion application development costs) in potential savings that can be reinvested in productive development. The United States consumes approximately 1/3 of global IT spending which amounts to approximately US$ 22 billion as savings for other development. This is in effect is a potential stimulus package for innovation, larger than many of the programmes in the current United States administration of US$ 787 billion stimulus plan[28].

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25 "Key Advantages of Open Source is Not Cost Savings", *Computer Economics*, http://www.computereconomics.com/article.cfm?id=1043, May 2005.
26 This inference could change in developing countries where labour costs are cheaper than in the developed world.
27 "Estimation the Development Cost of Open Source Software", *Black Duck*, http://www.blackducksoftware.com/development-cost-of-open-source, 2009.
28 Ibid.

D. Advantages and disadvantages of free and open source software

The progressive development of free and open source software over a short period of time indicates its future potential. Especially, at a time of economic downturn, an uptake of open sources will be significant. Although number of factors contributes to its rapid adaptation, cheaper cost of free and open source software appears to be the main advantage. While vendor independence is highly rated as an advantage, its implications too amounts to cheaper cost of maintenance and free updates, besides having a pool of resource persons when using free and open source software as opposed to proprietary software. As cost is the major concern, majority of open source users are from the public sector, NGOs, academia and the research community. While cost does not discriminate users from developed and developing nations, other advantages like localization and customization support users from developing nations. Hence, it is evident that developing countries would benefit more by use of free and open source software.

Following section illustrates some of the advantages and disadvantages of using free and open source software applications.

- The primary advantage or benefit of using open source is that there is no licensing fee for using free and open source software. However, considering the total cost of ownership (TCO), which includes, administration, support and training, open source may be more costly than commercial software. This is purely on the basis of financial costs. If capacity building of local programmers and social benefits of localization is included, benefits will out weigh mere financial costs.

- Open source is less likely to be vendor dependant. There is no additional cost for updating software. It is open to a large pool of developers, Internet mailing lists, achieves and databases at no additional costs. However, there is no single source of information to rectify any trouble shooting. A simple question may result in multiple answers with no authoritative source. Some would argue that multiple sources of support is better than being tied to one source (vendor) who provides poor support or refuses to support in case of certain vintage software versions[29].

- Open source is beneficial in bridging the digital divide. Especially by providing a platform for non-English speaking population to develop IT skills and knowledge. Open source is easy to localize and customize. These are important considerations to any local adaptations.

- Due to its low cost and ready localization ability, free and open source software is a better tool for training local programmers.

- Free and open source software is flexible. In a situation where licensed software costs more than the hardware it runs, open source is a good alternative. Since it can run on low end hardware it needs low levels of maintenance. Hence, it is a good way to create gateways to information, especially among developing nations.

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[29] "Advantages and disadvantages of the open source software such as Linux", *Open source technology*, http://opensourcetechnologies.blogspot.com/2008/06/advantages-and-disadvantages-of-open.html, 22 June 2008.

- The source code of open source being in the open domain, allows it for quick fixes in case of faults but it also exposes bad source code to hackers. However, potential threat from hackers to open source may be negligible.
- Long learning curve is a drawback in open source. Although it is worthwhile learning open source, it takes more time to master.
- Due to the nature of free and open source software deployment, there is a dearth of open source experts in case of troubleshooting.
- There is no clear ownership for free and open source software. As it's a "global public good" responsibility lies in the cyberspace. This can be a problem especially in developing nations where support for IT applications is frequently required.
- The most used open source operating system, Linux, may not be compatible with some of the latest hardware. With a vibrant open source community these lapses can be quickly attended.

E. Users and developers of open source

Free and open source software and collaborative development have grown from an academic and research orientation in early 1980s into a major economic and development force transforming the way software is created today. The economics of open sources combined with the pool of open source projects and increase competitiveness are driving open sources into the mainstream.

Undoubtedly, free and open source software development is indebted to the "spirit of volunteerism" from a large number of software enthusiasts who continue to contribute to development and spread of open source. This does not mean that open source is only for "small scale" or "low end" users. There is a growing belief that, because most open sources developers are unpaid, their work is subservient to commercially accepted proprietary software developers. However, due to the rapid development and deployment, the open sources community has established an ensuring technology over the past decade.

Open source developers fall into two categories. One, the core contributors who generate the creative code: new improvement and additions that amount to major improvement in a piece of software. This category of programmers comes from small companies, universities and government agencies. The second category is those who detect small defects (bugs). This section of users (or developers) detect bugs, suggests fixes and improvements and test code for particular computing environments[30].

Although big companies are the great consumers of free and open source software, they are low contributors. While most of the big companies increasingly deploy Apache, Eclipse, JBoss Linux and mySQL, contributions from their programmers to open source platform has been small. This could be attributed to the cultural divide between open

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[30] Charles Babcock, "Open source software: Who gives and who takes?", *InformationWeek*, http://www.informationweek.com/news/software/open_source/showArticle.jhtml?articleID=187202790, 15 May 2006.

source and commercial software developers. One of the key reasons identified for the low contribution for open source from companies is due to maintenance rights of software they develop. Working under General Public License, which governs development of free and open source software, programmers will not hold any maintenance rights. Companies also believe that if their programmers do contribute to open source, it could be because they are under utilized. However, there are number of big companies, like Morgan Stanley and Bear Stearns who regularly submitted bug fixes and tested code for Apache and Tomcat serves.

Google has been one of the biggest beneficiaries of open source. They acknowledges that shifting to open source has improved on speed, reduced inefficiency, saves time and makes economic sense[31]. Likewise there are many big companies who get their software and support from commercial open source suppliers but prefer to maintain low profile as code contributors.

One the other hand, one of the contentions regarding developing countries is that, these countries are fundamentally different to the developed nations, thus, they have the moral right to adopts different policies. The argument runs along the line, that local users cannot use expensive software therefore they should be contended with open source which is less expensive and more compatible to run on older version of computer hardware, which are cheaper to use. Although cost is a major concern for developing nations, the shift towards open source is also influenced by developing local capacity, free access to copy and redistribute and less complications with intellectual property right issues. Deployment of open source is not limited by geographic locations or economic status of users. The foreign ministry in Germany is changing all its desktop system to GNU/Linux and other open source systems. The change is attributed to low cost of open source and easy localization, in missions where other languages are used[32]. The following section on review of free and open source software elaborate the extent to which open source is used in various applications among the Asian and Pacific member states.

F. Adaptation of existing good applications of open source

In this section, the paper attempts to highlight several case studies of free and open source software applications in Asian and the Pacific countries and one African country. The common tread in all case studies is that they used free and open source software to improve livelihoods. Use of open source was primarily because it was cheaper than proprietary software, better potential to localize, freedom to share, modify and redistribute without having to go through a process of licensing and all have the clear intention of bridging the digital divide.

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[31] Matt Asay, "Why Google loves open source", *Cnet News*, http://news.cnet.com/8301-13505_3-10164896-16.html, 16 February 2009.

[32] Gijs Hillenius, "DE: Foreign Ministry: Cost of open source desktop maintenance is by far the lowest", *Open Source Observatory and Repository European* (OSOR), http://www.osor.eu/news/de-foreign-ministry-cost-of-open-source-desktop-maintenance-is-by-far-the-lowest, 27 October 2007.

The case studies can be categorized depending on their objectives:

- Two case studies from India and Malaysia deploy free and open source software to improve productivity of rice and wheat crop in India and connecting farmers to buyers in Malaysia.

- Two case studies from Sri Lanka (expanded as a good practice for disaster management) and Fiji using free and open source software for disaster management and reducing vulnerability respectively.

- One case study form Indonesia to localize GNU/Linux operating system.

- Creating educational and business opportunities in South Africa, and

- Managing the environment in Galápagos in Ecuador.

1. Identifying and controlling weeds in the Indo-Gangetic Plain

One of the main problems faced by poor farmers in the Indo Gangetic Plains (IGP) is weed infestation in rice and wheat fields. It is a common practice among farmers to approach trades to get advice on chemical applications for weed control. Usually this happens due to poor understanding of weed types and their remedial measures. This practice could lead wrong prescription of herbicides and loss of production. The Open Source Simple Computer for Agriculture in Rural Areas (OSCAR) project conducted by the French Institute of Pondicherry (IFP) has prototyped an application of free and open source software for weed identification applicable to four countries in the IGP namely, India, Pakistan, Bangladesh and Nepal. With a large cultural diversity, the need was to develop a software solution which could be localized to suit all languages and cultures in the region. Free and open source software adopts well into the cultural diversity. OSCAR was designated to work on GNU/Linux operating system which was flexible and easy to customize. OSCAR, being a free and open source software application, promotes aggregation of information from different stakeholders among the participating countries. With a wide diversity in language and culture, open source provided the platform to allow different types of weeds and especially their control measures to be included in OSCAR. In this context, inclusion of traditional knowledge in weed control from different countries was facilitated through free and open source software applications. These considerations allowed diverse set of stakeholders, researchers, agronomists, pathologists, and student community and development organizations to contribute to development of the software. It would not have been practical to have a common application platform for the entire region if proprietary software was used[33].

Adoption of OSCAR has received an overwhelming interest from the research community in the target countries. The provision of customization to fit into the own environment has evoked much interest in OSCAR. Being a successful application, OSCAR will encourage participation of local authorities including the *gram panchayat* (village councils) members, cooperatives, farmer's organizations, women's groups and

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[33] OSCAR India, "Identifying and controlling weeds", in Nah Soo Hoe, *Breaking Barriers: The Potential of Free and Open Software for Sustainable Human Development; A Compilation of Case Studies from Across the World* (UNDP, http://www.apdip.net/publications/ict4d/BreakingBarriers.pdf, 2006), pp. 51-55.

self help groups to build their capacity. This will help village level organization to manage their resources and improve knowledge at village level institutions.

2. Online trading of agricultural products in Malaysia

The Agribazaar initiative in Malaysia, is an attempting to enable farmers, fisherman, breeders, producers, traders and manufacturers to buy and sell their products online. Open source platform was chosen for this initiative because it is a cost-effective solution with high degree of security and low maintenance[34]. The use of open source in the initiative will encourage local capacity building in ICT technology and software development. Proprietary software was not used as the project (Malaysian Institute of Microeconomic Systems) intended to showcase the application of open source in agribusiness initiatives, leading to bridging the digital divide. Success of this initiative will enhance productivity and competeveness in the agriculture sector of Malaysia. Besides, it is expected to increase the ICT literacy and income of rural communities. The increase in ICT literacy is expected to develop a resource pool of local talent with the ability to develop local software applications for social development. The initiative also expects the user community to take ownership of the initiative with little or no dependence on commercial vendors. Free and open source software offers a cost-effective way to achieve this target.

3. Reducing vulnerability in Pacific Islands

Reducing vulnerability in the Pacific countries is an initiative by the South Pacific Applied Geoscience Commission (SOPAC). It seeks to address reducing vulnerability among the Pacific member states by developing an ICT based integrated planning and management tool. Although use of commercial proprietary software was a possible option to be deployed for the purpose, very high cost of such application made SOPAC, the implementing organization to employ a open source platform. Besides, the use of free and open source software makes it affordable and practical to build and deploy the GeoCMS applications in every participating country. This will lead to local capacity building in ICT and local beneficiaries are able to learn and understand the technology, thus, encouraging local ownership and sustainability.

One of the key drawbacks identified among Pacific member countries with regards to reducing vulnerability was lack of reliable data and information. The initiative by SOPAC was an attempt to map vital information of Pacific member states to be used at times of disasters.

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[34] AgribBazaar, Malaysia, "Connecting Farmers and Buyers", in Nah Soo Hoe, *Breaking Barriers: The Potential of Free and Open Software for Sustainable Human Development; A Compilation of Case Studies from Across the World* (UNDP, http://www.apdip.net/publications/ict4d/BreakingBarriers.pdf, 2006), pp. 41-46.
"".

A key feature of the SOPAC initiative was GeoCMS[35], which facilitates collection and sharing of geographical data among Pacific member states. At the time of the initiative, there was no software available to create a GeoCMS, thus, two existing open source applications; Tikiwiki and Mapserver were used for the development of the new software. With the GeoCMS it was possible to publish their geographic data in the Internet and share among other Pacific countries. This helped vulnerability reduction in member states due to prior availability of knowledge. The use of open source platform for reducing vulnerability has become more affordable and practical to participating member countries. It is interesting to note the emphasis on local capacity building in ICT through the use of open source based applications.

By creating a GeoCMS, Pacific member states are now able to share crucial information with rest of the world. This has facilitated interventions in disaster preparedness and prevention. Especially, advance information is vital before sending experts to member countries on missions. The information has also been useful in formulating new school curricula related to environment development and climate change.

4. Building an indigenous GNU/Linux

Indonesia, in an attempt to introduce affordable licensed software for standard computer use is building an Indonesian GNU/Linux called BlankOn Linux. This is one of the initiatives of Indonesian Linux Foundation (ILF). Although the literacy rate in Indonesia is nearly 88 per cent[36] knowledge of English is expected to be very low. This has led to low use of computers. Thus the main objective of the ILF is to introduce the local Indonesian version of BlankOn Linux to attract more people to desk top environment and other applications. With the introduction of the BlankOn Linux, Indonesian Linux Foundation expects more people to use FOSS based applications as an alternative to illegal software currently in use. This will provide affordable legal software which is easy to install and comes in one single CD. The foundation is targeting new computer users, schools and Internet kiosks to start the new initiative. Office applications, Internet and multimedia are some of the standard usages in the computer environment. BlankOn Linux multimedia applications have been packaged so that they support most proprietary multimedia formats. It is believed that GNU/Linux is relatively immune to common computer viruses. Through this initiative the Indonesian government attempts to bridge the digital divide and encourage people to use more licensed software.

5. Managing the environment in Galápagos

The versatility of open source applications is put into practice in Galápagos Islands in Ecuador. The initiative here is to develop an environment management pprogramme

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[35] GeoCMS is a CMS where objects (users, images, articles, blogs etc) can have a latitude-longitude position to be displayed on an online interactive map. In addition, the online maps link to information pages on the data represented in the maps. http://en.wikipedia.org/wiki/Geospatial_Content

36   Fasli Jalal and Nina Sardjunani, *Increasing literacy in Indonesia: Background paper prepared for the Education for All Global Monitoring Report 2006; Literacy for Life* (UNESCAO, 2006/ED/EFA/MRT/PI/45). http://unesdoc.unesco.org/images/0014/001460/146011e.pdf

with the use of software. The Galápagos national park, home to many endemic flora and fauna is under threat from illegal fishing and tourists activities. In order to minimize these activities and preserve the biodiversity, park employed an open source based tools to develop a system of networks which connects the park with the main island. The open source tools were used because it is versatile, cost-effective, easy to maintain and can be used without any licensing fee. Besides, open source was favoured over proprietary software due to vendor independence and security. Since the implementation of the initiative, data and information from the park have been collected regularly and transmitted to people concerned. The open source applications provided support for planning and surveillance of the park. Although use of open source was an advantage for the national park, the challenged faced was conversion of user expectation into a functional software application.

6. Education and business opportunities in South Africa

The African Virtual Open Initiative and Resources (AVOR) project is a collaborative effort among several higher education institutions to create education and business opportunities to contribute towards development of Africa. It has taken an existing e-learning educational platform; Knowledge Environment for Web-based Learning (KEWL) modified it to run on an open source platform. The resultant new version KEWL.NextGen is based entirely on open source principles. The AVOR initiative allows many institutions, organizations and volunteers in Africa to contribute towards KEWL.NextGen. The core team at AVOR has been able to offer open source related assistance to local governments, educational institutions and business sector. Thus, the open source initiative has encouraged capacity building among many national organizations in Africa. Since the success of the new open source based tool, University of Western Cape (UWC) in South Africa has fully institutionalized the initiative. This includes creating of an e-learning strategy and e-learning support units with appropriate resources and training. The staff at UWC has begun using KEWL.NextGen and the older version KEWL is being phased out.

All these case studies narrate a success story of using free and open source software. As mentioned before reasons for success are manifold. While cost considerations are of paramount interest, vendor independence is becoming a key issue in the shift towards free and open source software. Given the non-sensitive nature of data and information, none of the studies highlight reliability or/and security as an issue of concern. However, one of the main concerns of many initiatives is "sustainability" of the open source platform. In many instances the initiatives depends on self motivation of few interested individuals. In Indonesia, it was specifically mentioned that sustaining open source initiatives without full time developers will be the greatest challenge for the future.

G. Challenges to FOSS platforms

1. Resistance to change

Resistance to change among people is a major challenge faced by the open source movement. Professional, technicians, office staff and others who are exposed to IT and computer use through proprietary software are apprehensive of change to new environments including free and open source software. The shift or change could be motivated through awareness and training. This would entail financial and time costs associated with training. However, if people are unwilling to substitute proprietary applications with open source, all efforts to install an open source platform will be lost.

Fear of interoperability with propriety software too may cause reluctance on the part of individuals and organizations to use FOSS based applications.

Associated with resistance to change is the long learning curve of free and open source software applications. As a result, a familiarization period will be necessary before developers become productive and efficient.

2. Public good versus commodity

Status (ownership) of open source is not clearly defined. It does not have any clear ownership nor does it generate adequate revenue to be self sustaining. However, open source has come along way from being an alternative software tool for academia and research. Currently it is a major economic and development force. The very nature of open source has transformed it into a "global public good" with open access to users, to study, modify and redistribute. Although there are reservations on its ability to make sustainable profits and transform into a software industry, the global uptake of free and open source software appear to ensure its sustainability as a global public good. The enthusiasm and volunteering among the open source community seems to grow even among the big companies. In the current context of economic downturn more companies and enterprises are opting to invest in low cost options. Hence, with a minimal proportion of paid open source programmers, open source platform is on course to maintain as a "global public good" than a "commodity" or a profit making "industry"

3. Community collaboration

The culture of free and open source software relies heavily on community collaborations and involvement. To be a successful open source platform, the open source community needs to be identified and held together to work for the progress of open sources applications. This is not an easy task as the open source community is widely dispersed and loosely connected. Hence, coordinating a diverse community is a big challenge.

4. Physical infrastructure

Although the role of open source appears to fit more in the developing countries, most developing countries face physical ICT infrastructure development challenges. Often Internet connectivity is a major problem. Therefore, open source platforms may have to be redesigned to be less dependant on advance ICT infrastructure.

H. Sustainability

Sustainability appears to be at the core of the speculative dissuasion on long term significance of free and open source software movement. Strength of the open source movement depends on the open source community. Clearly, the strength of the open source community varies between the developed and developing nations. Among the developing nations, open source community is still in a state of flux. Many developing countries who had performed well in open source applications were dependant on projects. Consequently, the open source programmers were sustained by projects. Many of the programmers in developing countries worked on open source application in their spare time while being engaged in their paid occupations. With small number of carders involved in open source applications, maintaining this carder is of paramount importance to the open source platform. This is a major challenge for developing nations. However, in developed nations, large companies are rapidly changing to free and open source software due to various reasons. While vendor independence and cost play a major role in decision making, other factors like security and customization too contribute in a small way. Hence, the issue of sustainability of open source among developed nations does not appear to be a serious issue. Although there is no clear business model to sustain open source among developed nations, as long as cost is a concern free and open source software market appears to be in the right direction.

I. Sahana Disaster Management System in Sri Lanka and other countries

The severity of global disaster occurrences and the propensity of disaster to affect developing countries disproportionately, points to an urgent need for the establishment of an institutional framework and a robust Information Communication System. In this context, short comings of ICT solutions were evident in Tsunami (2004), SARS (2003) and Pakistan earthquake (2005)[37] for effective disaster rescue and recovery.

Sahana is a web-based free and open source software especially designed for disaster management. It has the potential to address problems in coordination of relief supplies, manage camps, inventories supplies, find missing people and manage volunteers, to name a few of its functions.

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[37] Mifan Careem, Chamindra De Silva, Ravindra De Silva, Louiqa Raschid and Sanjiva Weerawarana, *Sahana: Overview of a Disaster Management System* (Sri Lanka, Lanka Software Foundation, 2006).

1. Background

Sahana emerged in Sri Lanka as result of the 2004 Indian Ocean Tsunami. In the immediate aftermath of the Tsunami, there was an outpour of international and local relief for nearly 1 million people who were displaced and assets valued at US$ 900 million were destroyed[38]. Women were affected disproportionately in the Tsunami. Some reports estimated four times more deaths among women than men and in certain parts of the Eastern cost of Sri Lanka, 80 per cent of the dead were women. It was soon realized that without IT based solution it was difficult to coordinate the massive amount of information and also manage the influx of relief. The existing IT systems in Sri Lanka were not time tested for a disaster of this magnitude and none were web-based solutions[39]. To fill in the void, Sahana, a free and open source software based disaster management system was established. In the Sri Lankan national Language (Sinhala) *Sahana means assistance at the time of distress.* The system was versatile to address the common issues that surface during disasters. It could help victims to find missing people, manage humanitarian aid and effectively support coordination among various organizations and institutions in relief and reconstruction. Sahana was initiated by a non profit making NGO involved in research and development in free and open source software development. The phase II of Sahana was funded by Swedish International Development Cooperation Agency (SIDA) to mainstream Sahana in global applications. Keeping in line with the philosophy of free and open source software foundation, Sahana is available for free download and users could modify, improve and redistribute. It is estimated that the latest release of the Sahana system has been downloaded approximately 8000 times since 2006. Sahana system is also available on compact disc which may be used without installing in the hard drive. It can also run on stand alone single laptop for an individual user.

2. Concept of Sahana Disaster Management System

Sahana is based on the ideals of humanitarian free and open source software. It is primarily intended to bring relief more effectively and efficiently to Tsunami affected victims. Sahana hopes to alleviate human suffering and save lives through effective IT solutions, empower victims and their families to help themselves, protect data on victims to prevent data abuse and coordinate efforts of diverse actors in disaster response.

3. Role of Sahana in disaster management

As a free and open source software solution, Sahana was able to provide an effective IT based solution in the post Tsunami relief and recovery phase. Nevertheless, its long

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[38] M.A.L.R. Perera, "Ex Ante Preparedness for Disaster Management: Sahana in Sri Lanka", in Samia Am in, and Markus Goldstein, eds., *Data Against Natural Disaster* (World Bank, http://siteresources.worldbank.org/INTPOVERTY/Resources/335642-1130251872237/9780821374528.pdf , 2008), pp. 273-297.

[39] Ibid.

term objectives include addressing disaster prevention, preparedness, relief and recovery. It hopes to address the prevention and recovery through the following steps:

- Through an interface to generate CAP (Common Alerting Protocol) messages
- The messaging module to send alert through SMS or e mail to group of people
- Pre-populating the organizational module in anticipation of disaster
- Registering respondents and volunteers and tracking them in advance
- Pre-plotting and setting up evacuation points

Incidentally, in the process of development, Sahana has been customized for disaster preparedness in New York City, where it is customized and pre-populated with data to manage any evacuation process[40].

Sahana disaster management system is versatile. It can be installed in 5 minutes. The portable version of Sahana does not need to be installed as it comes pre-set-up and requires only to copy and click for execution. However, customization may take few days to few weeks based on changes needed and deployment model as deemed for the specific development. Sahana can be deployed in multiple ways from running off a USB to a server farm.

4. Sahana application description

Sahana is a suite of web-based applications that provide solutions to different problems with regards to information and managing coordination issues during post-disasters. Besides being a database for information, the value it provides is in the well structured and usable interface and the data design, making management of information simple[41].

In Sahana phase II, 8 modules were released which addresses the key problems identified in disaster recovery and relief[42]. These modules are: missing person's registry, organizational registry, request/pledge management system, camp registry, inventory management, catalog, messaging and volunteer coordination. Following are the four core modules deployed by Sahana during post Tsunami operations[43]. These are followed by the optional modules (see Annex I)

Missing person's registry
Problem 1 - helping families and next of kin to find each other
Solution 1 - Sahana missing person's directory
http://demo.sahana.lk/cvs/index.php?mod=mpr

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[40] Personal communication with Mr Chamindra de Silva, founder Sahana Disaster management system (May 2009).

[41] Chamindra de Silva, *Sahana Free Open Sources Disaster Management System: Project Overview*, Draft 0.9 (Lanka Software Foundation, http://chamindra.googlepages.com/Sahana-Project-Overview-0.9.pdf, 2006).

[42] Ibid.

[43] For information on downloads of all modules, refer http://siteresources.worldbank.org/ INTPOVERTY/Resources/335642-1130251872237/9780821374528.pdf

Organizational registry
Problem 2 - Coordination all aid groups and helping them to operate
            effectively as one
Solution 2 - Sahana organizational registry
http://demo.sahana.lk/cvs/index.php?mod=or

Shelter registry
Problem 3 - capturing the location of all camps and shelters
Solution 3 - The Sahana camp Registry
http://demo.sahana.lk/cvs/index.php?mod=cr&act=default

Sahana request/aid management
Problem 4 - Effective utilizing the pledged aid
Solution 4 - Sahana request management system
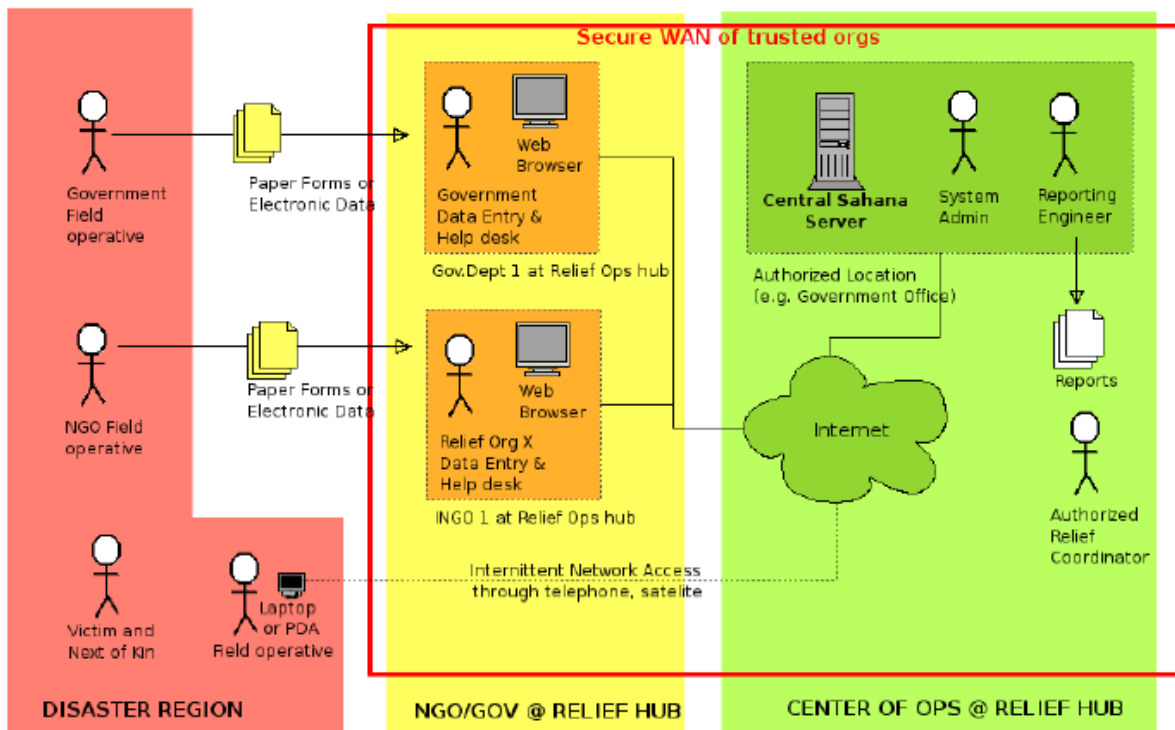http://demo.sahana.lk/cvs/index.php?mod=rms&act=default

Source: *Sahana Demo Module Database 2007.*

5. Sahana deployment strategy

The Sahana system can be deployed on a variety of models. From working totally within a single notebook computer (with or without portable wireless connection) to a fully distributed network platform.

Figure 1: A Possible Sahana Deployment

(a) Large scale deployment

The following diagram illustrates large scale deployment involving multiple stakeholder groups. It is often the case that disaster coordination hub is away from the site of disaster. With deployment of Sahana, the network based operation is often possible even though the affected site (region) might have their telecommunication infrastructure destroyed.

In such an event access can be provided to the affected region with the support from mobile service providers who provide wireless LAN based satellite based connectivity to networks.

(b) Lightweight deployment

If large scale infrastructure does not exist, Sahana being a "lightweight" solution can efficiently scale down to a standalone laptop and a secure portable wireless access point, if short-range network collaboration is required. Such is the case in many disaster coordination hubs when power and Internet are disrupted after disasters. In the absence of a power supply, Shana is tested to work with a standalone laptop at 130 watts which can be easily supplied through a solar panel. Besides, none of the applications depend on being connected to the Internet.

Sahana has the ability to synchronize data between multiple instances. It allows the respondents or district officers to capture data from victims and exchange with other field offices, headquarters or sharing data in UBS flash drives or CDs

(c) Access to information to the Sahana database

Access to information and data depends on the deployment model. Sahana has application and data base security. Additionally a firewall and isolation of modules by access is recommended, i.e., some models can be hosted on internal servers versus those shared with trusted entities. Generally it is always advisable to conduct a security audit on the deployment of the system.

(See Annex I. Sahana Deployment Architecture)

(d) Compatibility with hardware and large scale data sensitivity

Sahana runs on Windows as well as Linux tested on X86 based hardware architecture. Handling data is more to do with the databases with regards to Sahana, multiple Sahana web servers (server farms) connect to the databases. Sahana uses open source MySQL database by default. However, Sahana can be easily customized to connect to Oracle or most of the popular databases. Data sensitivity is handled in the Sahana system by application level security (role based access to modules) and an access control based on data sensitivity.

J. Impact of Sahana system

Introduction of the Sahana system made relief efforts more efficient. It improved rapid information sharing and coordination to avoid redundancy, wastage and to provide

aid to the right place at the right time. Besides, it provided situational awareness on tracing people and aid distribution which acted as a decision support for policy makers. This resulted in less over laps and more efficient distribution of relief among the victims. Due to the success of Sahana system in alleviating human suffering during Tsunami, it was adopted by Pakistan, Philippines and Indonesia to manage their respective disasters. Besides, Lebanon and Ecuador too supposed to have adopted Sahana, though it can not be confirmed [44]. The largest local NGO in Sri Lanka, the Sarvodaya movement, customized and pre-deployed Sahana in preparation for future disasters. The new module on child protection by Terre des Hommes too was based on Sahana system.

Sahana has been identified as a "humanitarian FOSS" by the international disaster community due to its humanitarian nature of work. The Free Software Foundation (FSF) of Richard Stallman (creator of FSF) has recognized Sahana as a free and open source software to "help alleviate human suffering" and was duly recognized as a social asset.

K. Advantages of Sahana for Asia and the Pacific

In the context of Information Communication Technology adaptations, there are number of reasons why Sahana software finds it a natural fit in the humanitarian domain. Sahana can be of immense help to Asian and Pacific member countries, where 42 per cent of the world disasters have occurred during the past three decades.

- There are very few countries in the region who would invest in disaster management when there are no imminent disasters. Other high priority concerns would take precedence for scares resource allocations. In this context, Sahana, provides the best option as it is already being developed and customized for disaster management. It offers low cost, volunteer supplemented, global system for disaster management.

- There is little commercial interest in developing open source solutions during humanitarian disasters when proprietary software is freely available. But Sahana could be downloaded free and use without any licensing fees.

- Sahana is a *global public good* it is available for anyone who desires to help in any humanitarian cause.

- The global IT community may readily volunteer to improve (or customize) the system if the need arise.

- Sahana offers a global transparent system where inputs and outputs of disaster relief will be transparent to all stakeholders.

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[44] Chamindra de Silva, *Sahana Free Open Sources Disaster Management System: Project Overview*, Draft 0.9 (Lanka Software Foundation, http://chamindra.googlepages.com/Sahana-Project-Overview-0.9.pdf, 2006).

L. Institutional arrangement for Sahana Disaster Management System

As mentioned earlier in the paper, Sahana disaster management system was conceptualized by a group of professionals who were keen on developing a humanitarian FOSS to help Tsumani victims. As such it was created within the NGO domain in Sri Lanka. Although open source is not mentioned in the ICT policy of Sri Lanka, success of Sahana could induce a policy review to include the Sahana disaster management system as a policy option at times of natural disasters. The Information Communication Technology Agency (ICTA) of Sri Lanka, recognizes the work of Lanka Software Foundation (LSF) and offers support when required. The ICTA also offer financial grants in terms of seed funding to NGOs and private companies working on software development. Currently there is an attempt to divest the Sahana disaster management system out of the Lanka Software Foundation and form a new foundation called "Sahana Foundation" where it will be projected as a "global public good" with funding from external sources. The new foundation is expected to be registered in the United States, though 80-90 per cent of technical support to the new foundation will come from Sri Lanka. The copy rights of Sahana will be protected to Lanka Software Foundation. Thus, Sahana will be a global public good with the custodianship firmly vested with the Sri Lankan open source community.

If Sahana remains in the public domain, it will face a number of challenges.

- Lack of clear institutional ownership. Since the development of Sahana in 2004, institutions responsible for disaster management have changed five times [45]. Frequent changes in ministries are a common phenomenon in multiparty democracies. However, these changes do have a negative impact on initiatives like Sahana which needs a stable platform and consistent commitment. Lack of a clear ownership can impede deployment of Sahana, especially when it's a global public good. Experience suggests that in the Pakistan earthquake, Sahana had to prove its ownership due to security and geopolitical sensitivity between India and Pakistan.

- Apprehension to open transparency. One of the strengths of Sahana is transparency. Adoption of a common, government wide system would lead to transparency which could be used to monitor progress of relief process. Gaps between pledges and actual funds received, fund disbursements and actual expenditure are sensitive information to those responsible in relief management.

- Reliability and stability. Sahana has proved it as a successful open source platform for disaster management but the public sector stakeholders would prefer it to be more time tested. Although Sahana has world wide reputation as a successful disaster management free and open source software, government sector organisations in Sri Lanka and few NGOs doubt the robustness of free and open source software. Especially the local ability to maintain and carryout trouble shooting downstream. They also fear that since Sahana is free, the developers have

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[45] Starting from the Center for National Operations under the Presidential secretariat in 2005, it is currently under the Disaster Management Center (Agency under the Ministry of Human Rights and Disaster management).

no obligation to maintain in case of software problems. All government departments possess time tested management information systems tailored to the needs of the officials. To adopt an untested system can be unappealing this in turn could impede acceptance of Sahana.

- The generation gap between the Sahana developers and users, especially in the state sector. Older generation of users will naturally be skeptical in the face of new out of the box innovations. Thus, promotion and use of Sahana as a disaster management support tool will be a challenging task.

M. Sustainability of Sahana and future potential

Many different ways of sustaining Sahana has been proposed. It is important to recognize that incidence of natural disasters is on the increase. Over the last two decades, there had been a 13 per cent increase in mortality and 35 per cent increase in economic loss. If these are any indications for the future, Sahana will play a crucial role. Commitment of financial resources and mainstreaming are the way forward for Sahana. Though this may be slow in some countries, others like, Philippines have taken Sahana on board and included in their National Disaster Management Policy[46]. However, in the absence of clear ownership to Sahana disaster management system, the Lanka software foundation (LSF) will have to take the defacto ownership. In the initial stages of its new found status as a "global public good" in the cyberspace, role of LSF will have to be clearly defined. Although use of Sahana as a disaster management tool in uncontested, the Sahana itself will have to be championed by a recognized agency. What is doubtful at present is who will take the lead to champion the cause? Future sustainability of Sahana in the development context therefore will depend on strong institutional backing at least in the short term.

N. Policy option for the region

The Sahana initiative has proved without doubt the viability of open source solutions for humanitarian applications. It has the strength to coordinate multiple clients during a typical disaster and perform other humanitarian functions simultaneously. Hence, Sahana provides the ideal platform for inter organisational data sharing during disasters.

Therefore it is relevant to consider:
- Application of open source based systems for data sharing as a policy option among the member states in Asian and Pacific region at times of natural disasters
- Conduct capacity building and training on Sahana disaster management applications for Asian and Pacific stakeholders

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[46] Fouad Bajwa, "Future disaster management with Sahana", International Free open source Software Foundation (iFOSSF), http://www.ifossf.org/future_disaster_management_with_sahana (2009).

- Improve efforts to introduce Sahana among the member states as a core disaster management tool
- Exchange expertise among member states to improve knowledge sharing on issues of disaster management and use of Sahana
- Convince member states to include open source based applications (with special reference to Sahana) in respective disaster management policies
- Develop policies for data security and privacy during different phases of disasters (with special reference to Sahana disaster management system)

O. Conclusion

The use of free and open source software in development is fast gaining momentum in the world. It has been successfully applied in all fields of development including disaster management. Although the concept and the practical use of free and open source software have been accepted, long term sustainability remains a concern. The ICT society now needs to devise ways and means to maintain the use of open source which has been an asset to the developing countries and particularly to the poorer communities. With the recognition of ICT as a tool for poverty alleviation and sustainable development, open source platform needs to be nurtured, especially at a time when economies round the world are on the decline. Open source could be used as an effective tool to meet the twin challenges of poverty alleviation and economic down turn. The ICT community and the open source platform should capitalize on the least cost options of open source to beat the economic crisis and boost development. Member states of the Asian and Pacific region have to be receptive and sensitive to these challenges if the region is to forge ahead with cost-effective solutions of ICT usage and meeting the MDGs.

The region is blessed, as one of its member states has developed a least cost IT solutions to manage natural disasters. Hence, supporting the development of Sahana disaster management system could be a core objective in the regional agenda to fight against natural disasters.

If Sahana disaster management system is to be accepted as policy for managing future disasters, respective governments need to internalize free and open source software in their respective ICT policies and accept Sahana on principle as a tool for disaster management in all future disasters in the region. ESCAP being at the center of regional development, will be in the best position to motivate the change among member states and to accept free and open source software and Sahana as an effective disaster management platform for the region

ANNEX

Annex 1: Sahana Deployment Architecture[47]

The FOSS Sahana Disaster Management system is developed using LAMP (Linux-Apache-MySQL-PHP/Postgres) under the open source concept. LAMP and open source have proven its value in mission critical community applications. Sahana was basically developed from scratch. The code was written in PHP and it rests on the Sahana application framework, also written in PHP. This is a generic framework for ease of development and development of customer modules.

Figure 2, below indicates the layered architecture of Sahana , consisting of Sahana application framework at the core surrounded by libraries and APIs. This in turn is wrapped by a set of modules, both core and optional. The architecture is depicted as a layered diagram, where the outer layers have the ability to use the functionality of the inner layers.

Figure 2. Overview of Sahana Architecture
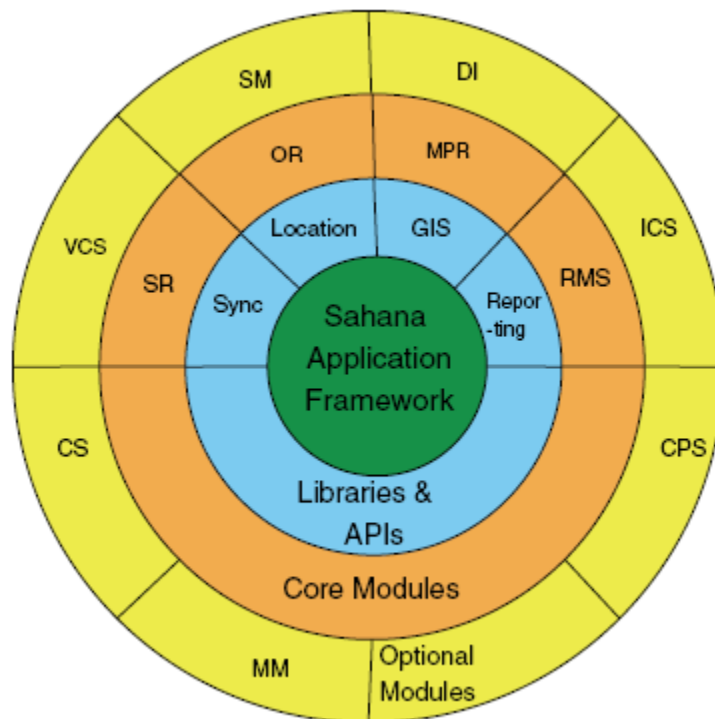
The Sahana application framework provides the following features.

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47   Mifan Careem, Chamindra De Silva, Ravindra De Silva, Louiqa Raschid and Sanjiva Weerawarana, *Sahana: Overview of a Disast*er Management System, Proceedings of the International Conference on Information and Automation, December 15-17, 2006, Colombo, Sri Lanka (Sri Lanka, Lanka Software Foundation, ftp://ftp.umiacs.umd.edu/pub/louiqa/PUB06/Sahana6.pdf, 2006).

- A flexible and modular architecture, including a front-end controller that makes it easier to manage and synchronize system-wide tasks and events
- Support for security at the modular and framework level and support for internationalization and localization of content
- Web-based and console-based commands to ease set-up and configuration of Sahana and its database
- Support for automatic detection of new modules, and dynamic plug and play installation and activation and configuration of 3rd party modules
- A theme and a layout engine and HTML template libraries for simple GUI development and customization. Support for accessing the schema and metadata and the data of a common database
- Administration functionality and modular administration

Sahana application framework is wrapped by a set of libraries and APIs that provide a set of core and optional capabilities to the framework and modules. This includes the following.

- Location API: Location hierarchy selection and storage
- GIS API: GIS mapping interface and spatial capability
- Reporting API: Automated and customer reporting capability
- Synchronization API: Provides database synchronization between Sahana instances.

The core modules of Sahana are built on top of the Sahana application framework and libraries. The optional modules take up the outermost layer and are installed upon request.

The core modules are:
- Organizational Registry (OR):   Keeps tract of all the relief organizations working in the region.
- Request Management System (RMS): A repository where relief organizations, relief workers, government agencies and camp managers can match requests of aid with the pledges of support.
- Shelter Registry (SR):   A registry of shelters and camps. Keeps attract of locations of all camps and shelters, and has data on the facilities that they provide
- Missing person's registry (MPR):   A bulletin board like capability of both missing and found people.

The optional module of Sahana consists of the following:
- Volunteer coordination system (VCS)
- Child protection system (CPS)

- Inventory control and catalog system (ICS&CS)
  - Situation mapping (SM):   Collaborative mapping applications for disaster monitoring.
  - Data import (DI):   data import utility to support interpretability with other applications and databases
  - Mobile massaging (MM):   Multi-format messaging capabilities for Sahana.

Figure 3 indicates the component diagram of Sahana with relation to the LAMP platform and programming environment. The base consists of the operating system, which hosts the database servers and Apache web server, PHP, the language used to develop Sahana, is included as an Apache module.

Sahana also makes use of several 3rd party libraries for its operations. Some of these libraries are bundled with Sahana, including XAJAX and NuSOAP shown at the top of the libraries section. Some other libraries must be provided by the deployment environment, i.e., UMN/Mapserver 3rd party libraries shown at the bottom of the section, PHP GD and PHP GACL are Apache modules which need to be included within the Apache web server by the deployment environment.

Figure 3. Component Architecture
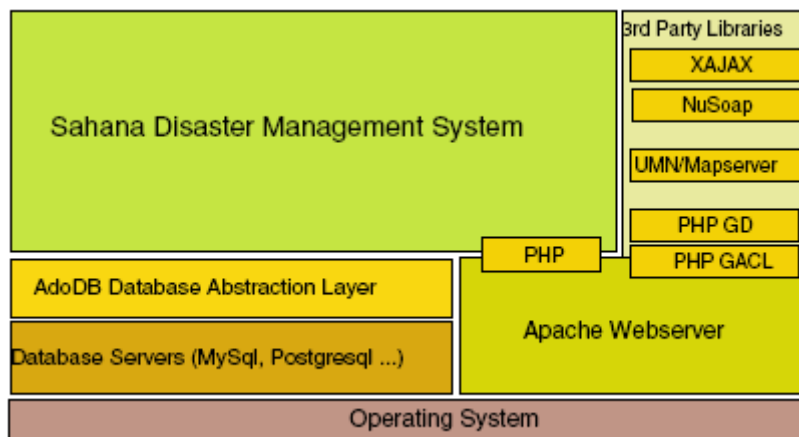
The database layer is accessed through the AdoDB abstraction layer; this provides database independence to Sahana. Module developers have the leisure of using the abstraction layer instead of worrying about the underlying database server and server specific API calls and queries. Currently Sahana supports My SQL and PostgreSQL

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