

Adoption of Free and Open Source Software in India

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Abstract

The significance and robustness of Free and Open Source Software (FOSS) are now well known at stages of development as well as deployment. It's natural to assume that the products of FOSS to be deployed as a preference over the commercially available proprietary software. However, proprietary software not only exists but is also thriving. The present paper looks into the aspect of adoption of FOSS, with special emphasis to India. The two natural arena for adoption- Governance and Academia are chosen for study. The policy initiatives, frameworks and challenges in the implementation of FOSS in these two areas are discussed, while giving instances of its successful adoption. The study also discusses in brief the adoption of FOSS in business enterprise, where its adoption is dynamic and accelerated. Several challenges in adoption of FOSS over proprietary software are also pointed out.

Keywords: Adoption, FOSS, Proprietary software

INTRODUCTION

The Free and Open Source Software (FOSS) movement attained prominence in the 1980s, primarily to unshackle the restrictions imposed on the use of copy righted software, now known as CSS (Closed Source Software). Today, although one may not be aware, FOSS is actually providing for the computational requirements for a large spectrum of products and services which make the modern, technologically intensive digital life possible. Most of the smart phones (android based), servers and portals, ATMs, supercomputers, databases etc around the world are FOSS driven. In India, two humongous citizen-specific projects – Aadhar's online infrastructure and the railway booking website utilizes the Linux servers. The FOSS provides a myriad of advantages over the CSS at all stages – development, distribution and research, which have been extensively mentioned in the literature [1-5]. Given the intrinsic freedom of usage, customization, propagation and the relative cost effectiveness which all products of FOSS offers, the adoption of FOSS by a country like India could have been a natural and prudent choice as the nation endeavours to upscale the use of IT (information technologies) in its pursuit of digital governance. In this context, one may be betting on India

becoming the global FOSS hub. It's evident to expect that the India is a fertile ground for the nurturing of a strong and mature FOSS ecosystem. A FOSS ecosystem comprises of a multitude of stakeholders – government, academic institutions like schools and colleges, FOSS solution providers and the FOSS community. Moreover, in India there is no dearth of business opportunities for providing IT solutions to enterprise. This is because India is only next to China in having the largest base of Internet users, notwithstanding the fact that 80 per cent of its population still needs to go online. When this is seen in the background of the availability in the last two decades of large number of reliable and robust FOSS products, which provides solutions for all domains, wherein the CSS have hitherto provided the services (Refer Table 1) the above expectation is certainly not misplaced.

So, where does India stand on the adoption of free software? The adoption of FOSS in India, until now can be described as patchy and sporadic, without a concerted push to adopt FOSS in the daily computational needs of various spheres viz., Governance, academia and business enterprise. However, it must be mentioned here that although the growth of FOSS in India has witnessed a faster rate than the past, the FOSS ecosystem is far from the threshold level of maturity. This has resulted into a narrow user base for FOSS in India. The government's efforts for FOSS adoption have been varied. While some efforts are subtle, voluntary and staggered, some migrations to FOSS have been hard and coercive. In most cases, migration to FOSS are justified from the perspectives of cost and security and its salient features of being participative, egalitarian and democratic is not emphasized sufficiently. While the goal of making India a global hub for FOSS is laudable, it becomes necessary to examine the extent of adoption and the associated challenges in the migration to FOSS for the computational needs of the digital society which we envisage in India. The present paper surveys the extent of adoption of FOSS in the three major areas of the Indian society i.e., Governance, academia and business enterprise. The study also attempts to identify the impediments in each of these spheres which are inhibiting the development of a supportive and mature ecosystem around FOSS which can harness FOSS to its full potential.

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Table 1: A representative list of typical FOSS products vis-à-vis their CSS counterpart

Domain	CSS	OSS
ERP (Enterprise resource planning)	Oracle ERP, SAP ERP, Microsoft Dynamics	ADempiere, OFBiz, Dolibarr, ERPNext, WebERP, Opentaps
OS(Operating systems)	Microsoft Window, Mac OS, iOS	GNU/Linux, Android, Ubuntu
Internet Browser	Internet explorer, Safari	Mozilla firefox, Chromium
CMS (Content management systems)	Morello, Sharepoint	Joomla, Wordpress, Drupal
Office suites	Microsoft Office	Open Office
Web server	Microsoft IIS, Google server	Apache, Nginx
Cloud Infrastructure	Amazon web services, Microsoft Azure, VMWare	OpenStack, Eucalyptus
Virtualization	VMWare	VirtualBox, Xen, LinuxKVM
Database	SQL server, Oracle, DB2	MYSQL, PostgreSQL
Big Data	Google BigTable, Intersystem's Cache	Hadoop, MongoDB, Hbase, Spark, Redis NoSQL
Application servers	BEA Weblogic, IBM Websphere	Apache Tomcat, JBoss
IDE/Development	Visual Studio, ASP. Net	Eclipse, PHP
Scientific Solutions	MATLAB, Mathematica	Scilab, Octave, SageMath
Data Analysis	SPSS, SAS, Stata	R
HTML/CSS editor	Dreamweaver	BlueGriffon, SeaMonkey, Aloha
Graphic Program	Adobe Photoshop, AutoCAD	GIMP, FreeCAD, LibreCAD
Publishing	Microsoft Publisher	Scribus
Media Player	Window Media Player	VLC, Miro
GIS	ArcView, ArcWeb and ArcGIS	Grass GIS, Quantum GIS
Spatial Database	Oracle Spatial, Sybase	PostGIS
Digital repository	Dlib, AutoLib, Soul, Alice	Dspace, Eprint, Koha

FOSS IN GOVERNANCE

The Aadhaar piloted by the Unique Identification Authority of India (UIDAI) is one of India's most massive and prestigious e-governance services. It is strongly driven by IT products using FOSS. In the Aadhaar project a 12-digit individual number is issued by the Unique Identification Authority of India (UIDAI) on behalf of the Government of India to all citizens of India. This number serves as an authorized proof for both identity as well as address, throughout the country. The Aadhaar number provides a life-long unique identity. It is aimed to be an empowering tool for the poor and the marginalized section of the Indian society by providing access to services like

banking and welfare programmes of the government. Up till now, Aadhaar has been issued to around 89 per cent of the population of India. The systems in UIDAI have been recently upgraded to scale up to a capacity wherein it can process up to 1 million UID applications per day. The Aadhaar project is historic in the context of it being the largest e-governance citizen centric project besides having an unprecedented scale. For the Aadhaar project, the list of FOSS solutions being utilized is enumerated in Table 2. The Aadhaar project is a milestone for the success of FOSS in India. It can be further widened in scope to serve as a platform for implementation of prospective e-governance projects using FOSS.

Table 2: List of FOSS solutions being utilized by UIDAI for Aadhar project

S. No.	FOSS tools	Applications/purpose
1.	RabbitMQ	advanced message queuing protocol
2.	Hive	used for building the UIDAI data warehouse
3.	Mule	a light-weight integration platform for systems and services for both in-premises and cloud.
4.	Pentaho	for generation of reports and on-line analytical processing(OLAP)
5.	Hadoop stack	Processes big data of the order of several terabytes per day.
6.	Apache Tomcat	a Java Servlet container.

The Centre for Railway Information Systems (CRIS) has deployed Red Hat® Enterprise Linux® for online ticket bookings portal for the Indian Railways. It is now scaled up to cater to nearly 2 million passengers a day involving over 2,500 trains. It has proven to be robust and secure system which handles about 25,000 concurrent users during peak times. It could merely handle about 10,000 concurrent users before migrating to open standards. This migration to open standards has reduced transaction response times and has managed a record high of booking more than 65,000 tickets during peak hours [6]. The Indian Government has also utilized FOSS in some other key citizen-centric projects some of which are enumerated below:

- **DigiLocker:** DigiLocker is a free platform, provided by the Government of India to its citizens to store and access important documents. This aids in transparency in Governance while cutting red-tape in a secure environment. The DigiLocker deploys several open source tools [7].
- **CCTNS of the Police department:** The Crime and Criminal Tracking Network and System (CCTNS) is an initiative of the National Crime Records Bureau (NCRB) of the Government of India. It is a nation-wide network, which connects 20000 police stations across the country to track crimes and criminals in real time. The system was implemented on two platforms – one on JAVA (a FOSS stack) and another on propriety software (. Net). Different states chose different platforms, depending upon their existing system. The platform using the FOSS stack- Java had a substantial cost saving, although cost was not an issue as the entire budget was provided by the center to all states. The state of Jharkhand, which opted for the FOSS platform were successful in creating some additional products using FOSS [8].
- **Air India:** To realize the targeted financial benefits from the merger of the two state carriers -Air India and Indian Airlines in 2007, the consolidation of their IT systems assumed significance. The merged entity Air India utilized the SUSE Linux Enterprise Server for its z systems and Linux-ONE for its IT infrastructure. This has led to enhanced stability and performance of the messaging systems. It has managed more than 10,000 user emails serviced by mere two technical staff. No instability or crash has been reported in this system, which has resulted into better availability and high-performance for the end users, besides decreasing the operational cost [9].

FOSS Enabling Policy Initiatives by the Government

In the year 2015, the Union government promulgated its open source policy, the first of its kind which says

“All future requests for proposals (RFPs) of e-Governance projects shall include a mandatory clause for considering Open Source Software (OSS) as a preferred option in comparison to Closed Source Software (CSS)”.

All government agencies under the Union of India are mandated under this policy compulsorily, while it is kept optional for state governments. This policy framework is envisaged to bring into its ambit the Digital India – the Prime Minister’s signature programme that “aims to make Government services digitally accessible to citizens in their localities and to ensure efficiency, transparency and reliability of such services at affordable costs”. Of course, the goal is laudable, and free software is a great facilitator for providing a low total cost of ownership to these services. Before the formulation of an express open source policy in 2015 as mentioned above, the government has attempted several other policy initiatives. Some of the precursors to the open source policy (2015) are listed below:

1. *Policy on Open Standards for e-Governance (2010)* - The policy is envisaged to identify open standards for implementation of e-governance solutions. It seeks standardization and consistency in the open standards in order to enable interoperability between various systems designed and developed by different agencies. The policy seeks to “cooperate, collaborate and integrate information across different departments” [10]. The standardization is targeted to bring all prospective systems of e-governance together at interface as well as data-archival level. This policy initiative was inclusive of businesses in various modes between the Government and the corporate in India. The standardization made it mandatory that erstwhile as well as existing systems conform to open standards when interacting with other systems, while ensuring that newer versions too adhere to the standards. A Manual on the Implementation of Policy on Open Standards for e-Governance was devised along with the policy to facilitate the implementation.

2. *The National Policy on Information Technology (2012)* – Besides other policy statement, one of the stated objectives of the policy is the “adoption of open standards and promotion of open source and open technologies” [11].
 3. *Policy on Adoption of Open Source Software for Government of India (2014)*: The policy was the initiative of the Department of Electronics and Information Technology (GoI) with the aim to encourage the adoption and usage of open source software in all government organisations formally. The policy statement read “the Government of India shall endeavour to adopt Open Source Software in all e-Governance systems implemented by various Government organizations, as a preferred option in comparison to Closed Source Software. It stipulated mandatory compliance for all government organisations under the Centre, as well as under state governments which chose to adopt the policy. The Government has also undertaken to collaborate with academia and developers of Open Source Software, to ensure that technological capabilities are available at the lowest costs” [10].
 4. *Policy on Open Application Programming Interfaces for Government of India*- The policy seeks to encourage the use of open Application Programming Interfaces (APIs), which promotes interoperability among software among all e-governance systems [12].
- The National Resource Centre for Free and Open Source Software (NRCFOSS) has been established by Department of Information Technology, Ministry of Communications & Information Technology, Government of India in April 2005 at the Anna University Campus at Chennai. The institution’s mandate is to mandate was to give a boost to the Indian Software industry and bridge the digital divide prevalent in the country. NRCFOSS with the help of C-DAC, Chennai has successfully developed a linux based operating system – BOSS (Bharat Operating System Solutions) which allows complete localisations for Indian perspective. Tamil Nadu government issued a circular in November, 2011 to compulsorily install BOSS in all its offices.[14]
 - ePDS in Andhra Pradesh - To mitigate the inefficiencies in the Indian public distribution systems the Andhra Pradesh Government has launched ePDS - an application, in the year 2015. This application uses PostgresSQL to record the data. It has held over 51.5 million records and handles of over 4 million transactions per day. [15] This application has permitted higher-scalability, higher-availability, higher-concurrency and reliability in the process of providing civil supplies in the state while ensuring very low latency.

It can be clearly discerned that the decision-makers in the Government of India are fully aware about the potential of FOSS in governance and administration. This has translated into several initiatives on FOSS adoption in governance at the level of policy. Several frameworks too have been designed to take these policies forward. A Framework for Adoption of Open Source Software was devised in 2015, which provided for accelerated adoption of open source software, with clear prioritization in application in identified chosen areas. It also made available an illustrative list of OSS/ OSS stacks for various functionalities required in implementation of the applications. The Department of Electronics and Information Technology (GoI) has developed a document titled “Technical Standards for Interoperability Framework for eGovernance in India” which provides guidance for technical interoperability for e-governance systems in areas prioritised by the government’s policy. It also provides the essential technical standards which can enable the applications to interoperate [13]. The policy initiatives and the framework provided therein have led to setting up of some institutions and launching of various programmes in furtherance of implementation of FOSS in Governance. These are listed as follows.

- Analogous to the platform Sourceforge, the GOI too established a platform – Openforge on 2nd May, 2017. This platform provided for collaborative open source development with sharing and reuse of eGovernance applications so that they are more interoperable. This encouraged innovation, lowered cost while ensuring high quality.

From, the above it can be observed that the policies and frameworks for implementation of FOSS by the Government of India has received adequate attention in the last decade and there is no dearth of support among the policymakers for a rapid migration to e-Governance using FOSS powered IT tools. This can be adequately summed by the then president of India, Dr. Abdul Kalam who extensively had talked about the power of open source software and said that “open-source software offers the developing nations the best opportunity to modernize”[16]. Unfortunately, there has not been an authorized study or survey to quantify the extent of FOSS adoption in the realm of Governance. However, it can be safely concluded that the power of FOSS in E-Governance is far from achieving its potential and most efforts can be best termed as situational and sporadic. One of the main hurdles identified in FOSS adoption in the Government has been the reliance on vendors, either through the SI (System Integration) or the BOOT (Built-Own-Operate-transfer) model to meet the project deadlines. It discourages the do-it-yourself approach, as this would certainly require more time and resources. The dependence on vendors is bound to favour propriety software even if an alternative FOSS is available. Other challenges in FOSS implementation in Government includes prevalence of myths about FOSS and the lack of choice of the user, as decision making is strictly hierarchal – mostly taken by ‘higher-ups’ [8].

FOSS Adoption in Academia

There can be no argument that “Knowledge is power”. Thus, dissemination of knowledge needs greater democratization to promote egalitarianism. The open philosophy which all FOSS products espouse resonates with the principle of academic freedom and the ubiquitous dissemination of information prevalent in the academic sphere. “The advance in all of the arts

and sciences, indeed the sum total of human knowledge, is the result of the open sharing of ideas, theories, studies and research. Yet throughout many school systems, the software in use on computers is closed and locked, making educators partners in the censorship of the foundational information of this new age” [17].

Moreover, software is a necessary ingredient of any research and development work and the use of proprietary software in such investigations does not find consistency in the twin principles of scientific research i.e., verifiability and replicability as the computational result by proprietary software is not subject to scrutiny. On the other hand, the research findings, obtained using OSS can always be verified, as the source code is made available to the user. The availability of source code of the software enables the user to evaluate and further modify the software. This provides students a unique learning-opportunity of real codes of high quality. On the contrary, for proprietary software either the source code is not available or usually available in binary form, thus making their scrutiny impossible for the users. Besides, lowering cost and being reliable and secure, FOSS is the natural and organic choice of the Academia because it promotes innovations, build long term capacity and provides possibility of localization and alternative to illegal copying [18].

Adoption of FOSS in education system of India has found a considerable favour among the academia precisely because of the above stated reasons. One of the earliest policy frameworks in this regard - National mission on education through information and communication technology, 2009 sought to give a fillip to FOSS in education by mandating deployment of open source simulation and application software like Scilab, ORCAD etc. This was presumably done to replace the CSS like MATLAB, AUTOCAD, SPSS etc. which are exorbitantly priced beyond the scope of Indian educational setup [19]. The replacement was essential for employability as well as affordability. This policy also emphasized customization of OSS to conform to the Indian education. This policy laid down the foundation for the National Policy on ICT in school education (2012), which clearly laid down that “A software environment favouring pedagogy of learning which promotes active learning, participatory and collaborative practices and sharing of knowledge is essential to nurture a creative society. Free and Open Source Software – operating system and software applications will be preferred in order to expand the range of learning, creation and sharing” [19]. It is apparent that the positive role of FOSS in education has been clearly understood by the policy makers. These policy initiatives did pave way to the following successful implementation of FOSS in education.

- In the year 2009 Ministry of Human Resource Development, GoI (MHRD) set up the Open Source Courseware Animations Repository (OSCAR), which is a repository of freely downloadable, web-based interactive learning applications powered by OSS for both college and school students. The College level applications included subjects of Science and engineering, while the school level component had Science and Mathematics [20].

- The state of Kerala spearheaded the implementation of FOSS in its offices and schools from the year 2001. It, wished to harvest its benefit in a big way in the field of education by launching the distribution IT@School prepared by its central education department. The IT@School distribution was originally based on Debian, but later on migrated to Ubuntu included FOSS packages like Geogebra, Kalzium etc which were used for interactive learning of geometry and chemistry of the school curriculum [8]. The IT@School distribution can be dubbed as a success story of adoption of FOSS in ICT education process because besides causing massive cost saving, it also provided the intangible benefits which included honing of do-it-yourself culture among the students and the teachers. This clearly enriched the teaching-learning environment in Kerala schools as compared to their counterparts in other states.
- The technological infrastructure is entirely FOSS based for the National Mission on Education through Information and Communication Technology (NMEICT) is a scheme sponsored by the central government to harness the benefits of ICT in education for all students in Higher Education Institutions in any time- anywhere mode.

From the experiences of FOSS in the realm of education, it can be safely inferred that FOSS can be made compulsory in schools and colleges as it not only improves the teaching-learning of ICT concepts, it can be leveraged to teach other subjects too. There are after all, no academic reasons to use propriety software in education because it leads to censorship of information rather than its dissemination – an antithesis to education. The intrinsic nature of FOSS which allows sharing and freedom in both use and economic sense should be the preferred tool for dissemination of knowledge using technology for India, with its diverse population heaped in complexities. It is clear that instances of use of FOSS in education – for a vast and diverse country like India are too few for comfort and proactive measures are necessary for a rapid adoption of FOSS in education.

FOSS in Business Enterprise

There is a considerable increase in open source adoption in India encompassing enterprises and government segments, besides the booming digital businesses. It is well placed to enable business adopt next generation technologies as it has successfully paved for many technological advances, which includes Artificial Intelligence (AI), blockchain, IoT, cloud, mobility and social networking. Indian enterprises are making open source as an integral part of their business strategy that encourages business innovation and thus driving digital transformation of the economy. Some of the business enterprises which made good of the FOSS migration are mentioned below:

- **BSE, Mumbai:** The open source technology from Red Hat has been successfully used in the Bombay Stock Exchange (BSE) for building a new trading system. As a result, BSE has up-scaled its operation to

400 million orders per day from the erstwhile 10 million per day. Thus, it has managed to achieve the fastest trading speed in the world, and thereby was also successful in reducing its total cost of ownership (TCO) by 90%.[21] as compared to the time when it used propriety software in its trading operations.

- The Life Insurance Corporation (LIC), which is the largest life insurers in the country has migrated its entire IT infrastructure consisting of 30,000 desktops and 3,500 servers with their FOSS counterpart, thereby saving a whopping \$8.75 million USD.
- The largest non-life insurance company in India -The New India Assurance Company had an impressive IT infrastructure, which consisted of about 1,500 servers and 7,000 desktops. It also saved around \$16.67 million US Dollars by migrating its entire IT system to one which is powered by FOSS.

The open source development paradigm has had a democratizing influence in the tech industry throughout the world and the Indian info-tech industry has too followed suit, mainly because it allows developers to benefit and build –on from the entire body of work of the development communities rather than starting from scratch [1, 22]. Open source has been in existence since long, but its formal adoption by businesses enterprise in India has picked up significantly since the early 2000s in the form of start-ups in info-tech, providing a broad spectrum of services. Although the Open source development was initially launched to provide an alternative to the commercial applications of propriety software, now various business models have been devised such that the use of OSS is a viable business proposition too [23, 24].

CONCLUDING REMARKS

The significance and the benefits that accrue due to usage of Free and Open Source Software are now well understood and beyond debate in the fields of Governance and Academia throughout the world. It is especially significant for India, a developing democratic economy where resources are scarce and the state is involved in various welfare measures for its citizens. Governance and Academia are the two natural arenas for the deployment of FOSS. The adoption of FOSS in these fields in India is however far below its potential. This is mainly because it has remained a knowledge intensive tool, besides being shrouded in myths. Lately, the Government of India has adopted myriads of policies for development and deployment of FOSS in its operations of eGovernance, digital-India and education. Unfortunately, the policy initiatives have not been backed by implementation. It has still remained driven by individual zeal which is most of the times dubbed as ‘adventurism’. There has been some bright spots too – the state of Kerala has successfully harnessed FOSS in education as well as administration leading to ‘more learning’ in education and secure, cost-effective administration. The advent of technology driven economy has given a very strong boost to adoption of OSS in business enterprise, which has latched up the FOSS in a big way. Needless to mention, the adoption of FOSS in business remains miniscule, given the scale of Indian economy. The adoption of FOSS in India needs to be scaled up by various

policy initiatives backed by strong and zealous implementation. At the same time the FOSS community needs to tailor itself to the growing challenge from propriety software by devising new and innovative financial models for business, such that they can compete with the propriety software on equal footing.

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