

Economic Impact of Free and Open Source Software - A Study in India

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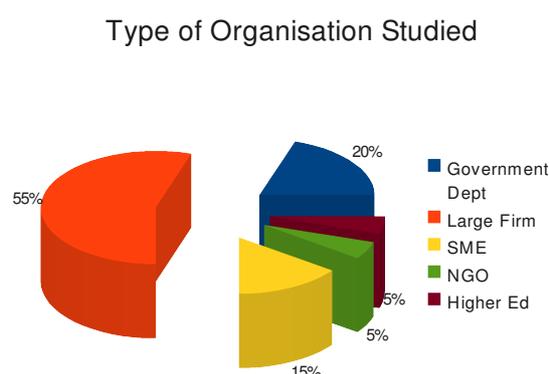
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Executive Summary

- A study based on twenty case studies of Indian organisations drawn from government departments, commercial firms and educational institutions. A break-up of the organisations is depicted in the figure below.



- FOSS is used by all the twenty organisations. FOSS use may be as an operating system on a desktop or server, or as an application.
- Some of the benefits realized by the organisations studied are as follows:
 - The IT @ School project of Kerala replaced Windows software with FOSS on 50,000 desktops in schools across the state. Tangible benefits amounted to Rs 490 million (\$ 10.2 million¹).
 - Great Market (name changed), a large e-commerce firm, adopted FOSS for servers, MIS development, document management and for desktops. The savings from desktops alone came to Rs 3 million (\$ 63 thousand).
 - Life Insurance Corporation (LIC), one of the largest insurers in India, with an IT infrastructure of 3500 servers and 30,000 desktops, saved about Rs 420 million (\$ 8.75 million) by adopting FOSS.
 - The New India Assurance company, a general insurance firm, having 1100 offices, and an IT infrastructure of 1500 servers and 7000 desktops saved about Rs 800 million (\$ 16.67 million) in tangible and intangible costs.
 - GGG (name changed) is a medium-sized e-commerce solutions IT firm

¹ A conversion rate of \$1 = Rs 48 is assumed (exchange rate in late May 2009).

- that relies heavily on FOSS. GGG saved about Rs 3.6 millions (\$ 75 thousand) by using FOSS on its desktops.
- IT for Change is an NGO with about 30 employees. They use FOSS extensively on all their servers and desktops and estimated tangible savings of about Rs 0.12 million (\$ 2.5 thousand) per annum (on an IT budget of Rs 2.1 million (\$ 44 thousand)).
 - IIC (affiliated with Delhi University) is an institution of higher education that has adopted FOSS. The tangible and intangible benefits for an infrastructure of 100 desktops and 5 servers is about Rs 1.75 million (\$ 36 thousand).
 - The most important reason for adopting FOSS was to save costs on the acquisition of IT. This factor was evident, with varying degrees of importance, in 18 of the 20 organisations studied.
 - The economic impact of FOSS was measured by three principal means:
 - FOSS as a substitute for more expensive desktop operating systems and office productivity applications
 - FOSS as a substitute for more expensive server software
 - FOSS enabled cost savings from complementary products such as anti-virus software required on Windows desktops
 - The forecast cost savings in the year 2010 from replacement of proprietary software with FOSS software is depicted in the table below. All numbers are estimates in Rs millions.

Replacement by FOSS	Cost Savings
50% of desktop operating system sold in the retail market with FOSS alternative. Saving assumed to be Rs 3600 per unit	Rs 9,847 million (\$ 205 million)
50% of desktop office productivity tools sold in the retail market with FOSS products. Saving assumed to be Rs 16500 per unit.	Rs 45,152 million (\$ 940 million)
50% of desktop software sold in the enterprise market with FOSS products. Saving assumed to be Rs 20000 per unit.	Rs 46,388 million (\$ 966 million)
Total	Rs 101,387 million (\$ 2111 million)

- At a very conservative estimate the cost savings for use of FOSS on servers, as an operating system or as an application, is likely to Rs 1,380

million (\$ 28.75 million) in 2010.

- Anti-virus software sales in 2010 is likely to touch Rs 20,000 million (\$ 714 million). This is a conservative estimate based on ceteris paribus assumptions (that all else will remain the same). This entire amount is a cost that can be avoided if FOSS products are adopted.
- The ability to innovate with FOSS has very strong intangible benefits. These benefits have to do with being able to try out new software, learn new skills, create new products, and be able to distribute freely.

Table of Contents

Executive Summary.....	ii
Introduction.....	1
Scope and Methodology.....	3
Data.....	4
Analysis.....	5
Impact of FOSS in Select Organisations.....	5
IT @ School, Kerala.....	5
Great Market.....	8
Life Insurance Corporation of India.....	10
New India Assurance Company.....	12
GGG.....	14
IT for Change.....	15
Institute of Informatics and Communication.....	16
Analysis of Case Data.....	18
Administration Issues.....	23
Projected Economic Impact of FOSS.....	24
FOSS as Desktop Operating System.....	24
Enterprise Sales.....	32
Anti-virus Savings.....	34
FOSS Replacement on Servers.....	37
Summary of Projected Economic Impact of FOSS.....	39
Innovation.....	42
Policy Implications.....	44
Appendix: Method for Measuring the Economic Impact of FOSS.....	46

Illustration Index

PC Sales in the Past.....	25
PC Sales in Future.....	25
Savings from replacing Windows operating system priced at Rs 3600 with FOSS	27
Savings from replacing Home edition Microsoft Office, priced at Rs 3065 per package, with FOSS - 3 scenarios.....	29
Savings in replacing the Professional Edition of MS Office, priced at Rs 16,500 per package, with FOSS - 3 scenarios.....	30
Savings in replacing the Ultimate edition MS Office, priced at Rs 26,800 per package, with FOSS - 30% replacement.....	31
Trend in Enterprise PC sales in India (Source: Manufacturer's Association of Information Technology (MAIT), 2007-2008 Annual Review).....	32
Savings in Enterprise PC sales with FOSS replacement, at 50% level, at Rs 20000 per unit.....	33
Anti-virus sales in India in period 2001-2008.....	35
Projection of anti-virus sales in India.....	36
Server sales in India (Source: Manufacturer's Association of Information Technology(MAIT), 2007-2008 Annual Review).....	37
Forecast of Server Sales based on past trend.....	38

Index of Tables

Organisations Studied (* name changed at the request of respondent).....	4
Overview of Organisations Studied.....	18
Cost Criteria Considered for FOSS Adoption.....	19
Price Comparison of Desktop Software as mentioned by respondents.....	22
Price Comparison of Server/Enterprise Software as mentioned by respondents.	22

Introduction

It is widely believed that Free and Open Source software (FOSS) has an important and lasting role to play in a developing country such as India. FOSS has already made a strong impact as it has been adopted by many businesses, educational institutions, government departments, and individual users. The various software packages and applications available in FOSS have assumed a serious and non-hobbyist position vis-a-vis proprietary software. Many Indian government departments and businesses have now made it policy to use and deploy FOSS wherever possible. In this context it is important to ask whether the adoption of FOSS has a specific economic impact and whether the adoption decisions are justified by sound economic rationale.

The economic impact of any technology introduction is studied by considering the impact that the technology has on the adoptive population. FOSS is a competitive technology to proprietary software. It differs in the manner in which it is produced and distributed. For many cases, it is a substitute for proprietary software; the most important and substantive economic impact of FOSS is as a substitute for proprietary software.

It should be pointed out here that there is some difference in the meanings and values associated with terms such as “open source” and “free software.” While adherents of the “free software” term emphasize the ethical and philosophical aspects of community use and development of software, the “open source” adherents emphasize the pragmatic and business-friendly aspects of this technology. There is much in common between the adherents of both the

phrases, in their outlook on issues such as open standards and patents. In this report the term FOSS is used to reflect these common values, as well as to reflect a term that has currency in the community in India.

Conducting an impact field study of this nature is difficult. Managers and IT officers who responded to us about FOSS also warned us that teasing out the exact impact is difficult - does the cost reduction come from using FOSS or from a number of other factors that could have been an influence? We were sensitive to this subtle and difficult issue and analysed the data accordingly.

At a personal level, this study has been very rewarding in providing an opportunity to ask those questions that are often overlooked in the sometimes rather shrill debates around FOSS versus proprietary software (one such being that FOSS is about very cheap and high quality software as much as it is about making and distributing software in a democratic manner). The cold, hard logic of numbers are often able to convey a message that no amount of words and discussion can do; and they are persuasive without the trappings of "ideology." This study is , as was intended, exploratory in nature and future work will address, with more rigour, the fundamental issues raised and conclusions arrived at in this report.

Scope and Methodology

This study examines the economic impact of FOSS technology for organisations in India. Organisations are selected from government, education and commercial segments. In the commercial segment firms are selected from small and medium enterprises (SMEs) and from large firms, including large multi-national firms. Government organisations include government departments and public sector undertakings (PSUs).

The method is that of directly studying organisations that have adopted FOSS and measuring, in multiple ways, the impact the technology has had. Some organisations that have not adopted FOSS are also studied to understand the reasons why FOSS was excluded by them.

The case study methodology is adopted for studying the organisations. This methodology entails a detailed and context-specific analysis of the organisation that unravels the conditions under which FOSS was adopted and the manner in which the decisions were made. The methodology relies on both primary data obtained from interviews of personnel in the organisations as well as secondary data and reports available in the public domain.

Data

Case studies of the following organisations were conducted.

Organisation/Department	Type	FOSS User
Axis Bank	Large Commercial Firm	Yes
National Stock Exchange	Large Commercial Firm	Yes
Life Insurance Corporation	Large Commercial Firm	Yes
Great Market*	Large Commercial Firm	Yes
New India Assurance Co.	Large Commercial Firm	Yes
ZXY India*	Large Commercial Firm	Yes
BCD Telecommunications*	Large Commercial Firm	Yes
JKL Semiconductors*	Large Commercial Firm	Yes
CDE India*	Large Commercial Firm	Yes
IT@School	Government Department	Yes
Press Information Bureau	Government Department	Yes
Principal Controller of Defence Accounts	Government Department	Yes
Directorate of Advertising and Visual Publicity	Government Department	Yes
Institute of Informatics & Communication	Higher Education Institute	Yes
GGG*	Small/Medium Enterprise	Yes
IF Systems*	Small/Medium Enterprise	Yes
M Technologies Pvt. Ltd.*	Small/Medium Enterprise	Yes
E Networks Pvt. Ltd.*	Small/Medium Enterprise	Yes
OPQ Holdings Ltd (Bangalore)*	Small/Medium Enterprise	Yes
IT for Change	Non-Governmental Organisation	Yes
St Joseph's College of Business	Higher Education Institute	No
HNL *	Large Commercial Firm	No
FGH*	Large Commercial Firm	No
SND*	Large Commercial Firm	No

Table 1: Organisations Studied (* name changed at the request of respondent)

Analysis

IMPACT OF FOSS IN SELECT ORGANISATIONS

IT @ School, Kerala

The IT @ School project is run by a department of the same name in the state of Kerala. The project replaced the Windows operating system on 50,000 desktop computers in 2800 schools across the state with a FOSS operating system. This move from a particular operating system that the teachers were familiar with to a new one required extensive training of the teachers and the support staff. The switch over was initiated in 2006 and by 2008 the systems had been changed in all 2800 schools. The costs incurred and the costs saved are indicated in the table below.

Cost Item	FOSS Use	Microsoft Platform Use
50000 PCs, hardware for 2800 schools	Same	Same
50000 Operating Systems (licensing costs)	0	Rs 10,000/- per unit, Rs 500 million (Rs 10000 includes the price of the Operating System as well as desktop software)
Training of 200 Master Trainers	Rs 8000/- per trainer, total Rs 1.6 million	
Training of 5600 IT School coordinators	Travel expenses	

As the highlighted row in the table indicates, the biggest cost saving, according to the project manager, was in the purchase price of the Operating System. Had IT @ School purchased the Windows operating system they would have incurred a

cost of Rs 10,000 per unit, whereas for the FOSS option the price is zero.

The cost of switching over to the FOSS system was significant. It involved training 200 Master Trainers (who trained teachers in their districts) and 5600 IT school coordinators (who were responsible for the IT functions at their schools). The cost of training the Master Trainers was borne by IT @ School, whereas the cost of training the school coordinators was borne by the schools themselves. The costs for the latter were mostly travel costs, for attending workshops.

Other costs of ongoing maintenance and support are also being incurred by the state. IT @ School has outsourced a part of these activities, however it is being found that the schools themselves have found local means by which to attend to their maintenance and support needs. These costs, we learned from our field interviews, are no different from those that they would have incurred had they stayed with the Windows platform.

FOSS has intangible benefits over proprietary software like Windows. The availability of source code allows development of application software for school subjects such as science, mathematics, history, etc. This is possible with proprietary software too, however the large availability of pre-existing tools that can be easily accessed helps this project. Supporting vendors and partners can build tools based on the requirements of the schools and department. A FOSS platform ensures that all supporting tools are freely and easily available. This work has already begun in Kerala with the development and use of tools for teaching science. To support this effort textbooks are also being developed.

Local language access improved with FOSS as fonts were developed by the community and included with all applications. This requires access to source code that is not possible with proprietary software.

The overall economic benefit of the IT @ School project may be summarized as follows:

Tangible Benefits	Intangible Benefits
Cost savings from Free Operating System deployment plus Scalability - use for FOSS in other classes in the schools minus Training Costs minus Support Costs = Rs 490 million for 2800 schools (approximately) (\$ 10.2 million)	Development of support software applications Local language customisation Teacher confidence

Tangible benefits are derived from the direct costs savings by using FOSS (operating system and applications), less the support and training costs for switching. Intangible benefits arise from the ability and freedom to develop supporting applications, language customisation and improvement in teacher confidence.

Thus, the IT @ School project has benefited the state of Kerala by about Rs 490 million. This figure is a minimum value as the exact value of the intangible benefits is hard to quantify.

Great Market

Great Market (GM, name changed) is the e-commerce arm of a retail conglomerate in India. The company, which was incorporated in 2006, deals in different consumer goods categories like apparels, designer goods, jewellery and watches, electronic goods, and entertainment products etc. Located in Mumbai, the company has about 150 employees.

Great Market's FOSS strategy was top-down, where they focused on central, and important, servers that were converted to Open Source operating systems (RedHat Linux). They use linux on 50 servers, out of a total of 90 in the organisation. The remaining servers run Window, HP and Solaris operating systems. As a next step GM moved the internal software development (such as MIS and other utility software) to the FOSS platform. In both cases the transitions were successful. Recently, they have started using an open source document management tool (Solr) based on the search tool Lucene (also open source).

The real challenge came when the management decided to use Open Office instead of MS Office for all the 150 desktops that they had. The challenge lay in overcoming the inertia for change from employees who were much more comfortable with MS Office than with the new tool. They conducted various training sessions, provided online tutorials so that employees could quickly learn the system with minimal loss of productivity. "And this was a management directive as well as it was a significant cost-saver saving close to Rs. 3 million,"

said Mr. B, the Chief Technology Officer.

The main reason for moving to FOSS software was stability and security, and not costs. Another important reason to switch was access to the latest and state-of-the-art technology that could be updated quickly and at very low cost.

In short, the tangible gains from using FOSS are Rs 3 million for GM, however they have significant intangible gains resulting from increased security, scalability, stability and access to state-of-the-art technology.

Tangible Benefits	Intangible Benefits
More than 50% of servers migrated to FOSS with cost savings. Replacement of MS Office with Open Office on desktops alone saved Rs 3 million.	Increased security, scalability, stability and access to state-of-the-art technology.

Life Insurance Corporation of India

Life Insurance Corporation of India (LIC) is one of the largest insurers in India and was created to spread life insurance widely and, in particular, to the rural areas with a view to reach all insurable persons in the country, in order to provide them adequate financial cover at a reasonable cost. Today LIC functions with 2048 fully computerized Branch Offices, 100 Divisional offices, 7 Zonal offices and the Corporate office. LIC's Wide Area Network covers 100 divisional offices and connects all the branches through a Metro Area Network.

LIC was a pioneer organization in India to introduce and leverage information technology in their business. Data pertaining to almost 100 million policies is being held on computers in LIC. In 1995, it initiated a massive computerisation drive with a view to enhancing customer responsiveness and services. This service enabled policyholders to receive immediate policy status reports, prompt acceptance of their premium payments, and to get a revival quotation or a loan quotation on demand. All the 2048 branches across the country were covered under front-end operations, thus making all the divisional offices achieve the distinction of 100% branch computerization. All the branches are connected to the zonal and divisional offices through Wide Area Network (WAN) while the offices in the same city are connected via a Metropolitan Area Network (MAN). Each branch has one dedicated server while the divisional and zonal office have about 10 servers each and the central corporate office has about 50 servers. Thus, in total, the server count is close to 3500. Each branch has about 20 to 30 workstations. The total desktop count is close to 30,000.

LIC is one of the pioneers in FOSS deployments in India, having started in 2001. It began by moving servers to Linux, and then moved desktops to Linux too. In a pilot in 2003, LIC deployed Linux on some of its servers and saved Rs 120 million. Subsequently, in 2003-04 it migrated all its servers to Linux. Later, LIC migrated almost 60% of its desktops to Linux and open source based applications.

LIC's tangible cost savings are summarised in the table below. These computations are based on extrapolations of the data provided by LIC.

Item	Cost Saving
Servers - Initial saving for fraction of servers is assumed to be double for the entire migration.	Rs 240 million (\$ 5 million)
Desktop migration to FOSS operating system and FOSS applications. Computed for 60% of 30,000 desktops, @ Rs 10,000/- saving per desktop.	Rs 180 million (\$ 3.75 million)
Total	Rs 420 million (\$ 8.75 million)

New India Assurance Company

New India Assurance Company Limited (NIA) is a public sector general insurance company. The company has a range of more than 150 products and is one of the largest non-life insurance companies, not only in India, but also in the Afro-Asian region. Its network of 1,100 offices, while being headquartered in Mumbai, is spread over 26 regions, with over 22,000 employees.

NIA invests heavily in information technology and the yearly IT budget is about Rs. 200 Crores. Of this, Rs. 60 Crores is spent on hardware and Rs. 50 Crores on software while the remaining sum is spent on managed services. They use about 1500 servers. The desktop count is close to 7000.

NIA's FOSS experiment started when they deployed a corporate mailing solution using open source mailing solution of SendMail. "We began with 600 users and scaled to 3000 users without additional hardware. And this entire system was built under Rs. 25 Lacs inclusive of software and hardware costs saving a lot of money," says Mr. D K Sinha, Chief Manager, IT at NIA. After the success of this venture, NIA decided to go wholeheartedly with Linux. Soon, the company migrated all its servers - about 1500 - to Linux. This success was followed by a move to convert desktops to Linux and although this met with resistance from users, NIA managed to convert 4000 out of 7000 desktops to Linux.

For NIA, FOSS adoption is not primarily to save costs. Even though, IT managers state that they must have saved an estimated 35% to 40% on IT expenditure

every year owing to FOSS. The FOSS adoption is driven by security and control over pirated software, and for easy adoption of updates and new versions.

To summarise, NIA main benefit from FOSS adoption is the continued savings they have, which are reflected in the reduced IT budget. The estimate is that of Rs 800 million per annum savings owing to FOSS.

Tangible Benefits	Intangible Benefits
Tangible benefits from adopting FOSS on servers and desktops is Rs 800 million (\$ 16.7 million).	Increased security, control over pirated software, easy updates.

GGG

GGG (name changed) is a small-medium enterprise (SME) that started up a few years ago and operates mainly as a provider for e-commerce solutions. It provides services to clients related to the design, hosting, development of e-commerce and Internet applications, and also maintains several e-commerce sites of its own. GGG has 120 employees and is based in Bangalore.

GGG operates mainly with FOSS software to set up sites for its clients and also for its own sites and internal administration. It runs 28 servers and all of them run on Linux. It owns 120 desktops, 46 of which are on the FOSS operating systems and use FOSS application software. GGG adopted FOSS mainly to save on costs and to have improved performance of their servers. Another advantage of FOSS servers is that of scalability.

GGG's estimate is that for a typical desktop running office and multi-media applications the cost savings from using an Open Source operating system and applications is about Rs 78800. This cost includes prices of a proprietary operating system, an office suite, PDF file creation software, and media creation and manipulation software. For 46 desktops this amounts to a saving of Rs 3.625 million.

Tangible Benefits	Intangible Benefits
Savings of Rs 3.6 million from using FOSS on desktops and servers.	Improved performance.

IT for Change

IT for Change (ITfC) is a non-governmental organisation (NGO) in Bangalore that is engaged in social issues of IT and its use for development. It sees its role as that of a change agent, bringing for social and economic issues that are important for consideration in the emerging knowledge society. ITfC's principal activities are research and advocacy.

ITfC currently has about 30 employees. For its information technology infrastructure it uses 20 desktops and 2 servers. All the desktops and servers run on FOSS operating systems. ITfC's main reason to adopt FOSS was more related to their advocacy activities and their need to influence other NGOs and organisations than to save costs. Even then ITfC has saved close to Rs 6000 per desktop while adopting FOSS. This amounts to a total saving of about Rs 0.12 million, on the overall budget of about Rs 2.1 million for IT.

They have faced minor problems related to finding appropriate hardware drivers (for connecting peripherals such digital cameras to the desktops), however, the advantages of FOSS far outweigh these problems. FOSS has helped with reducing the threat of virus/worms on their networks and computers, with easy upgradation of software when required, and the convenience of distributing the software to their clients and partner organisations as needed.

Tangible Benefits	Intangible Benefits
Saving of Rs 0.12 million per annum on annual IT budget.	Helps with advocacy on IT benefits, reduced threat of viruses, easy upgradation, convenience of distribution.

Institute of Informatics and Communication

The Institute of Informatics and Communication (IIC) is a part of the University of Delhi South Campus, and is primarily involved with imparting information technology education to Masters level students. The IIC has integrated FOSS within its curriculum, where students not only learn about FOSS and its components but also practice FOSS usage through training and support activities around the campus. Students have thus been able to fully integrate FOSS in their academic and career profiles

The FOSS initiative was originated by Dr Sanjeev Singh, a faculty at the IIC, about a decade ago. He was instrumental in advocating FOSS, planning and implementing the infrastructure within the institute and fostering the learning environment centred around free and open thinking and innovation.

Dr Singh emphasizes the intangible aspects of FOSS over the tangible one - for instance, he says that an important reason for organisations to adopt FOSS is that then they will be able to make technology choices on their own, based on their experiences with freely available software, rather than be guided and influenced by vendors of proprietary software. For educational institutions this also means that students can be introduced to new and cutting-edge technology without resort to expensive purchases.

IIC has about 100 desktops on its premises, all of which run dual-boot operating systems that include a Linux component. They have 5 servers running on Open Source. IIC has saved Rs 15000-20000 per desktop for operating system and

application software, and upto about Rs 50000 per server.

Tangible Benefits	Intangible Benefits
Savings for FOSS on desktops - Rs 1.5 million. Savings for FOSS on servers - Rs 0.25 million.	Learning environment of free and open thinking and innovation. Ability to choose technology, not driven by vendors.
Total = Rs 1.75 million	

ANALYSIS OF CASE DATA

This section presents a detailed analysis of the case data. 20 case studies, of organisations that had adopted FOSS, are used for this analysis. The intention of the case studies was to inquire about FOSS usage using an unstructured set of questions, rather than pose structured questions for a quantitative analysis. The analysis below examines certain issues arising from the data available in the cases. Basic summary statistics are provided.

A summary of the organisations studied is as follows:

Organisation	Number of cases	No. of Employees (range)	IT Budget (range)
Government Department	4	800 - 40000	
Large Commercial Firm (including multi-nationals)	9	150 - 120,000	Rs 400 million - Rs 100 billion (2 billion USD)
Small-Medium Enterprises	5	20 - 120	Rs 1.0 million - Rs 5.5 million
Non-Governmental Organisation	1	30	Rs 2.0 million
Higher Education Institute	1		Rs 10 million

Table 2: Overview of Organisations Studied

The most important reason for adopting FOSS is to reduce costs. 18 out of 20 respondents mentioned this as a factor for choosing FOSS. Although, some clearly mentioned that this was not the most important factor, it clearly is an issue that influenced the adoption decision.

Other reasons mentioned for adopting FOSS include improved performance, security, stability etc. Cost remains the most important reason, however other factors are important for various types of organisation. The factors mentioned are:

- Improved performance - this includes aspects of stability, interoperability, operational ease and maintenance. Some organisations running FOSS on core servers mentioned the mission-critical nature of applications for which the choice of FOSS was made.
- Scalability - many organisations selected FOSS for scaling up their operations when needed. This is facilitated by the licensing and distribution aspects of FOSS.
- Security - FOSS products attracted some organisations owing to their security features. Many mentioned this as helping with administration also. This is particularly attractive to those adopting FOSS for desktop use.
- No vendor lock-in - this aspect of FOSS implies that the open source nature of the product enabled the client organisation avoid lock-in with a single vendor.

When cost calculations were conducted for FOSS adoption, the calculations involved a number of factors, these are mentioned in the table below.

Costs	Mentioned by
License costs	11
Service costs	9
Distribution costs, maintenance costs, integration costs	7
Migration, upgrade costs	6
Exit costs	2

Table 3: Cost Criteria Considered for FOSS Adoption

- License costs are the costs of buying licenses, or buying software. Commercial software licenses are sold on a per seat, per server, per desktop, per concurrent user or per use basis. These costs may be one time costs, on purchase of license, or incurred on an annual basis, as a renewable license. Upgrade costs are related to licenses, as these are incurred when software is upgraded to new versions and license charges have to be met.
- Service costs are charges for acquiring external or internal support for maintaining the software. This is important for FOSS as organisations are acquiring these for the first time and need technical support for running and using the software.
- Distribution costs refer to the savings/expenses incurred while distributing the software within the organisation. Some licenses prevent distribution, and hence the advantages of FOSS are in reducing distribution costs as FOSS can be easily shared.
- Integration costs are those incurred while introducing new technology, such as FOSS, and then having it work with existing technology in the organisation. Integration will include modifying data and programs to suitable forms and also training of personnel.
- Migration costs are incurred when data that was created with an old software has to be converted to that which can be used with the new software. Migration may be required for programs also, particularly when they have to be used on new operating systems.
- Exit costs are incurred when data or programs have to be abandoned and work is required to modify the data/program to new or non-digital forms.

This cost is incurred very rarely by the respondents.

18 of the 20 FOSS-using organisations studied for this project used a total of 157731 desktops and 6689 servers. These totals exclude the numbers for the two large commercial firms that are in the IT industry and use a lot of hardware for production purposes. The totals reflect the values for organisations that use IT for assisting their internal functioning and operations, where IT is not their main line of business. It is important to note that these totals cover a very large range of businesses and functions that range from education to e-commerce and defence accounts.

Of the desktops being used, 48% are using FOSS. Of the servers being used, 86% are using FOSS. FOSS has commanded a much better competitive position in the server market than in the desktop market, and it is where most of the FOSS vendors have also concentrated their sales. The server market is also more conscious of the advantages that FOSS provides and competitively evaluates it in light of the other offerings. The desktop market, on the other hand, operates largely in the commodity space, in that the requirements of desktop operating systems and application software are not very stringent, and rarely mission critical, and it is here that FOSS penetration can be the highest.

Respondents were asked to provide competitive pricing of various software available in both FOSS and in proprietary forms. The responses are from the perspective of the organisation and unique requirements for which prices were sought. There is thus a wide variability in the prices mentioned, and these are shown in the tables below.

Desktop Software	FOSS Price	Proprietary Price
Desktop Operating System	Rs. 0 - 1000	Rs 3000 - Rs 13750
Desktop Publishing software	0	Rs 10000 - Rs 50000
Office software	0	Rs 2000 - Rs 15000
PDF Creation	0	Rs 5000 - Rs 17500
Media Creation/Player	0	Few thousands - Rs 42000
Photo Editing	0	Few thousands - Rs 50000

Table 4: Price Comparison of Desktop Software as mentioned by respondents

Server/Enterprise Software	FOSS Price	Proprietary Price
Web Server	0	Rs 10000 - Rs 0.7 million
Database Server	0	Rs 10000 - Rs 0.3 million
Content Management System	0	Rs 10000 - Rs 0.4 million
CRM	0	Rs 25000 - Rs 0.5 million
ERP	0 - Rs 0.2 million	Rs 25000 - many millions

Table 5: Price Comparison of Server/Enterprise Software as mentioned by respondents

Note: Table 5 indicates that prices for most types of FOSS-based servers, as seen by respondents, are zero. Some commercial FOSS vendors, Red Hat for instance, have specialised servers available at a price. FOSS vendors price their products based on the services and additional features they package. However, many users perceive these prices to be much lower than proprietary servers, as the licensing and upgrade costs are very low. Also, users sometimes download FOSS servers at no cost, provided they are able to do the installation and management themselves.

Administration Issues

Data from the cases reveals that amongst the strongest challenges for FOSS administration are - training of personnel, availability of trained personnel, and certification facilities. About 50% of the respondents believe that training is an important challenge for FOSS administration. Availability of trained personnel is an issue, although for some of the larger firms this was not important - they are able to attract FOSS-savvy personnel. Many also mentioned the lack of training and certification facilities as challenges to FOSS adoption.

Projected Economic Impact of FOSS

FOSS as Desktop Operating System

We anticipate that FOSS will make a significant impact as a replacement for desktop operating systems, particularly Microsoft Windows. This implies a significant cost saving as is evident from the case data.

The volume sales of personal computers in India for the last ten years, from 1998 to 2008 is shown in the graph below. This data corresponds to the retail sales of PCs at different distribution channels across the country - this represents sales to small office/home office (SOHO), small businesses (SMEs) and home use. This data thus excludes large enterprise desktop sales (covered later). The data was obtained from EuroMonitor reports (2008).

The graph (Illustration 1) shows that PC sales have grown exponentially from about 430,000 units in 1998 to about 3.6 million units in 2008.

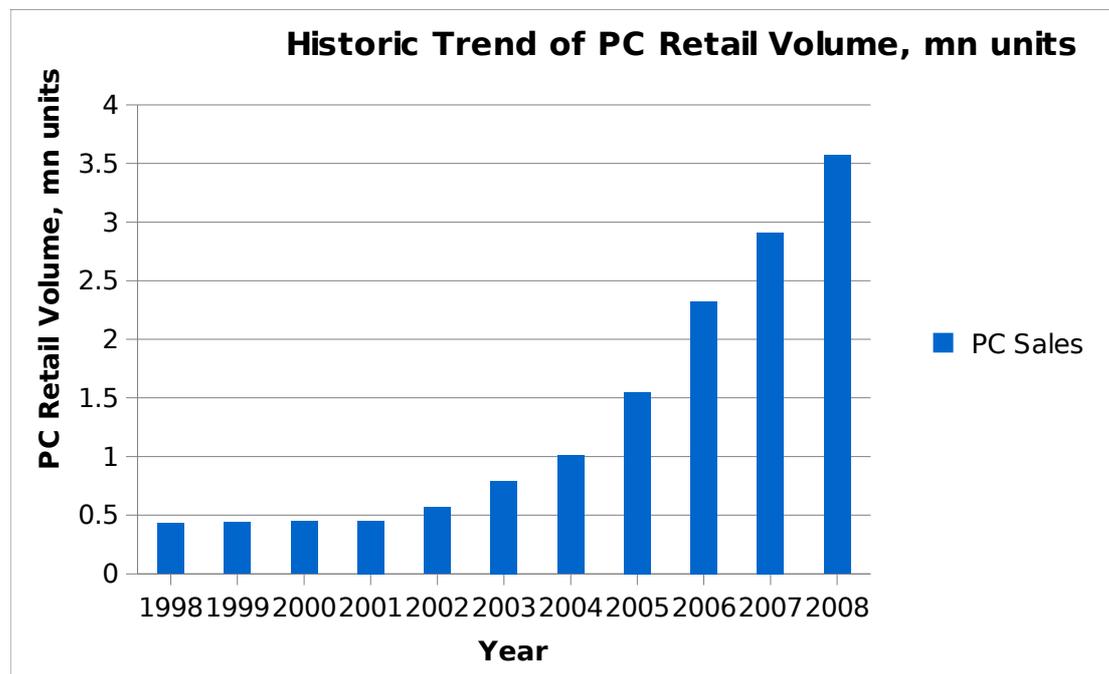


Illustration 1: PC Sales in the Past (Source: EuroMonitor reports (2008))

The forecast for PC sales in the next few years is depicted in the graph (Illustration 2) below.

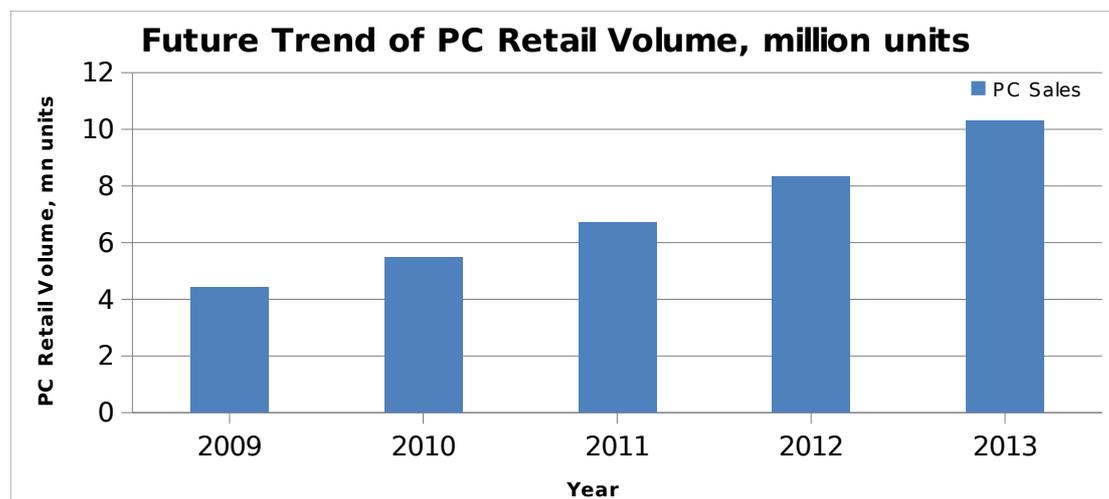


Illustration 2: PC Sales in Future

The chart above shows that the retail sales of PCs are forecast to be about 5.5 million units in 2010 and about 10.31 million units in 2013.

The analysis of the case data shows that much of the desktop operating systems can be replaced with FOSS operating systems. We assume a base price of Rs 3600 per unit for Windows operating system based on two criteria: one, this price is on the lower side as the range of prices of the system varies from Rs 2000 to Rs 13750; second, this was a specific price used by a respondent for replacing many desktops.

With a base price of Rs 3600 of the operating system, we compute the savings that can be achieved for three scenarios: one in which 30% of the desktops are replaced with FOSS; the second in which 50% of the desktops are replaced with FOSS; and the third in which 70% of the desktops are replaced with FOSS. These scenarios are viable and will vary for each organisation and context. The cost savings with these three scenarios is depicted in the chart below.

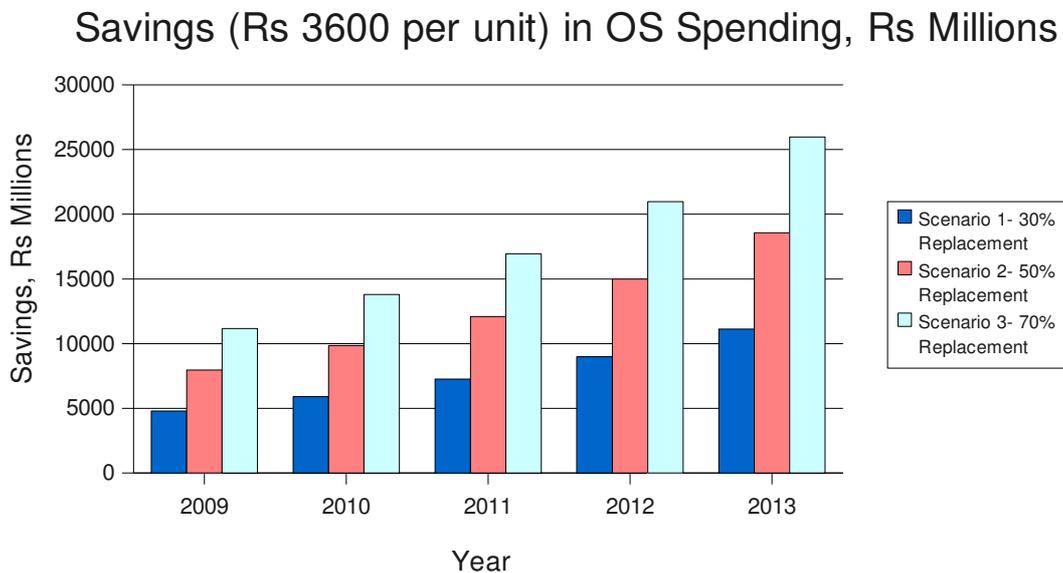


Illustration 3: Savings from replacing Windows operating system priced at Rs 3600 with FOSS

The analysis in the above graph may be interpreted as follows: In 2010, the savings obtained from having 30% of the desktop operating systems replaced with a FOSS alternative will be Rs 5,910 million. If half of the desktops (50%) are fitted with a FOSS operating system, the savings will be Rs 9,847 million; if 70% of the desktops have a FOSS operating system then the savings will be Rs 13,800 million. Corresponding figures for the years 2011, 2012, and 2013 may be read off the bar graphs (for instance, at a replacement level of 70% in 2013, the savings will be to the tune of over Rs 25 billion!). These calculations are based on the projected growth of PC sales, as forecast in Illustration 2.

Extending the same logic to office productivity tools we can compute the savings. Open Office is a free office suite that has almost the same functionality as that of Microsoft Office. Research shows that most users are un-sophisticated users of

office products and barely use a fraction of the total features provided^{2 3} in a professional product like Microsoft Office. In this situation there is a high possibility of organisations replacing an expensive product with a free one that has the same functionality. This outcome is not altogether without problems though, as there will be issues of data migration and integration as mentioned above.

For this analysis we consider Microsoft office products at three price points - as the range is from Rs 3025 to Rs 26,800⁴, depending on the type of product and licence - which are Rs 3025 (the Home edition), Rs 16,500 (the Professional edition) and Rs 26800 (the Ultimate edition). The savings for the three price ranges are depicted in the charts below.

2 Barry R. Lawson , Kenneth R. Baker, Stephen G. Powell, Lynn Foster-Johnson, 2009, "A comparison of spreadsheet users with different levels of experience" in *Omega: The International Journal of Management Science*, Vol 37, pp 579-590.

3 Yolanda E. Chan a, Veda C. Storey, 1996, "The use of spreadsheets in organizations: Determinants and consequences " in *Information and Management*, Vol 31, pp 119-134.

4 As available from <http://www.priceindia.in/software/microsoft-office-price/> (viewed on 3-4-09).

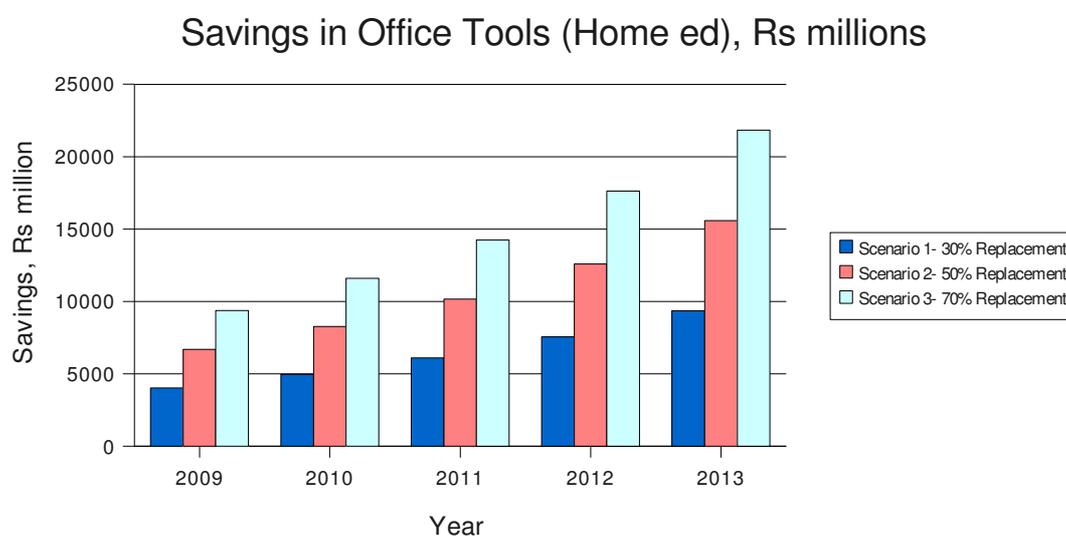


Illustration 4: Savings from replacing Home edition Microsoft Office, priced at Rs 3025 per package, with FOSS - 3 scenarios

Illustration 4 above shows that if the Home edition of Microsoft Office, which is priced at Rs 3025 per unit, is replaced by the free Open Office there will be considerable savings for users. The replacement is considered at three levels – where 30% of the users replace with Open Office, where 50% replace, and where 70% replace. Using the forecast of PC sales from Illustration 2, we can compute the cost savings for all the three replacement scenarios. The graph above shows that in 2010, for instance, the savings will be Rs 4967 million at the 30% replacement level, Rs 8278 million at the 50% replacement level and Rs 11589 million at the 70% replacement level.

We consider similar replacement scenarios for the next, more expensive, version of Microsoft Office, the Professional Edition, which is priced at Rs 16,500.

Illustration 5, below, shows that in the year 2010, if users replace MS Office Professional Edition with Open Office, the savings will be – Rs 27,091 million at the 30% replacement level, Rs 45,152 million at the 50% replacement level, and

Rs 63,213 million at the 70% replacement level.

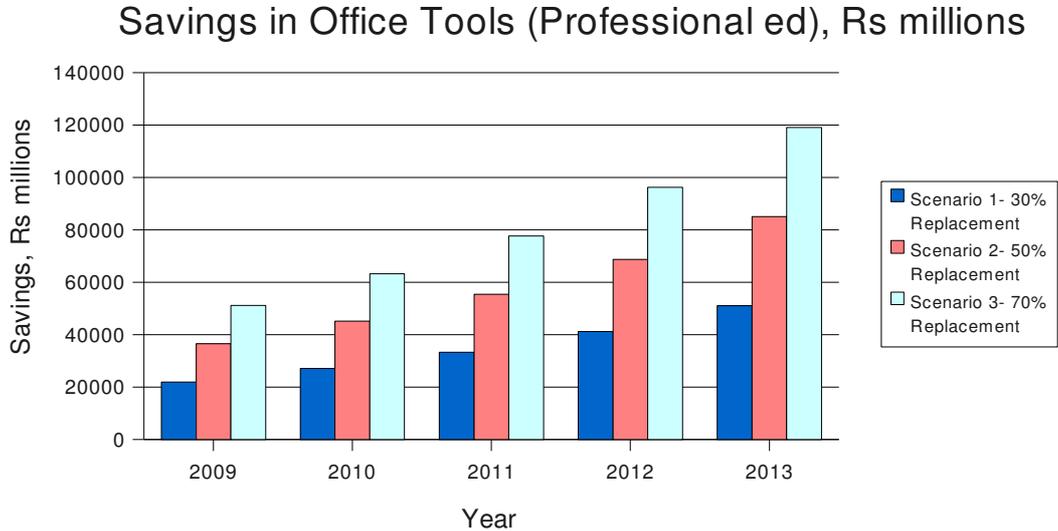


Illustration 5: Savings in replacing the Professional Edition of MS Office, priced at Rs 16,500 per package, with FOSS - 3 scenarios

For the most expensive version of Microsoft Office, the Ultimate Edition, we consider only a 30% replacement scenario as this is a premium product and organisations would replace this rarely, only when they are certain that their work requirements could be met by Open Office. (Organisations would also buy this product only when there is a clear and direct need for the special features.)

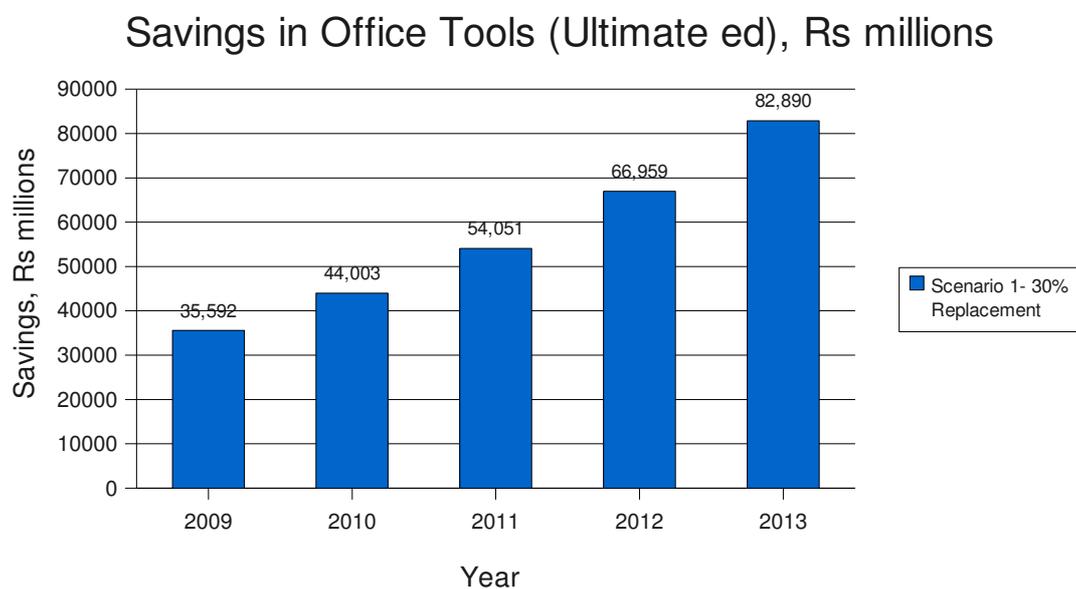


Illustration 6: Savings in replacing the Ultimate edition MS Office, priced at Rs 26,800 per package, with FOSS - 30% replacement

Illustration 6 shows that in the year 2010, for instance, the savings achieved by replacing the Ultimate Edition of MS Office with Open Office, at a 30% replacement level, will be Rs 44,003 million.

Enterprise Sales

The sales data for PCs was based on retail sales. We now turn to enterprise sales data for PCs. Enterprise sales refer to bulk sales made to large enterprises, governments, etc. that do not show up in retail sales data. The trends for enterprise sales are depicted below.

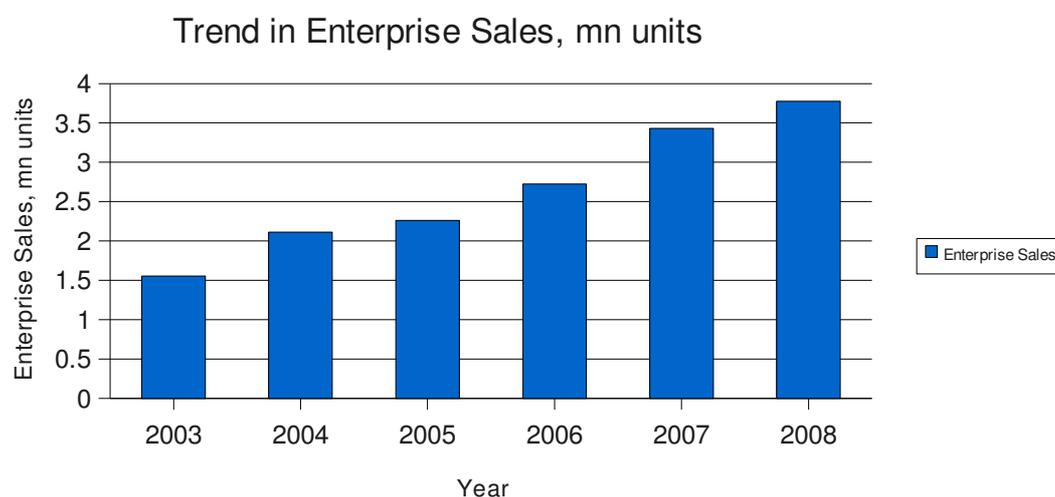


Illustration 7: Trend in Enterprise PC sales in India (Source: Manufacturer's Association of Information Technology (MAIT), 2007-2008 Annual Review).

Using a trend line, it is possible to forecast sales for enterprise PC sales.

Enterprise sales have a lower predicted rate of growth than retail sales. Using a FOSS replacement value of Rs 20000 per unit the cost savings are projected as shown in the graph below. The assumption is made that 50% of the PC sales will involve FOSS replacement (for operating system and office software).

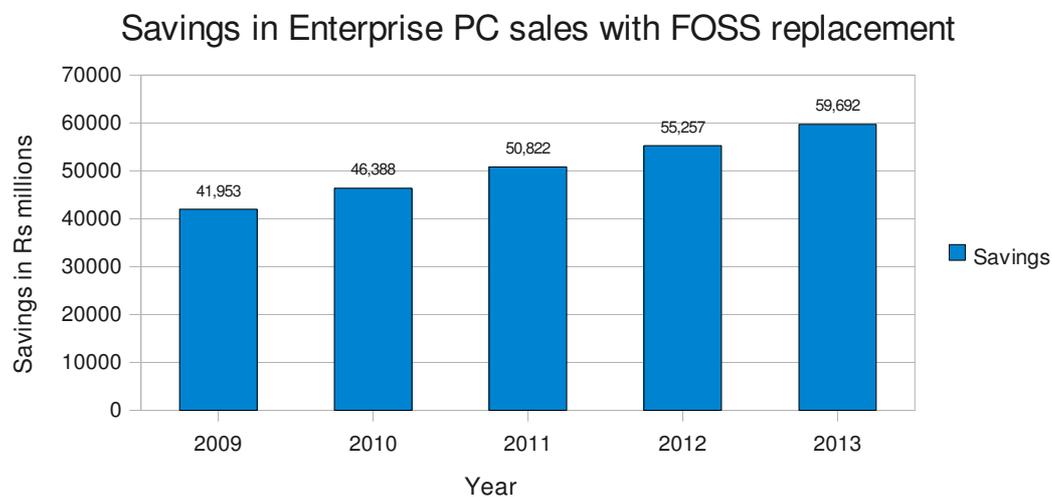


Illustration 8: Savings in Enterprise PC sales with FOSS replacement, at 50% level, at Rs 20000 per unit.

Illustration 8 above shows that in 2010 the savings that enterprises will incur if they replace half their new PCs with FOSS is Rs 46,388 million.

The 50% replacement figure is taken as the most likely estimate for replacement with FOSS technologies based on the data obtained from the case studies.

Anti-virus Savings

Virus attacks on desktop computers and servers is now a common phenomena in organisations across the world and also in India. A Computer Security Institute/FBI report in 2006 stated that the loss from virus-related problems for about 300 firms in the US was close to \$50 million. This was an underestimate as many firms did not report virus-related losses in order to protect their reputations.

Indian firms too have reported massive losses owing to attacks from viruses and worms. One estimate places the recovery time at an average of 29 hours from each serious virus attack (Express Computer, March 2004).

From the case studies it is evident that one of the savings that is realized with using FOSS operating systems on the desktop is that of the cost of anti-virus software. Usage of the Windows operating system requires anti-virus software as that is most prone to computer virus attacks. It is well known that neither the Apple operating system nor the FOSS systems require any anti-virus support.

Anti-virus sales in India have been growing strongly⁵, as is depicted in the chart

5 Various sources: According to Express Computer (23 March, 2009), the Indian security software market grew by approximately 25% in 2008 compared to 35.2% in 2007. According to industry sources, the Indian security market to touch Rs 4810 million end of the year 2008. A Nasscom-IDC report (2002) put the total anti-virus software market at Rs 313 million in 2001. Express Computer has reported that this segment was Rs 397 million in 2002, Rs 504 million in 2003 and Rs 640 million in 2004 not including the grey market. According to a **24-7 PressRelease** (Jan 3, 2009), the Indian IT security market in 2006-2007 was totaled at nearly Rs. 2340 million (US\$ 46.8 million), and by 2010 end, it is forecast to surge to Rs. 23,220 million (US\$ 464.4 million) According to Frost & Sullivan (In Express Computer, 23 March

below.

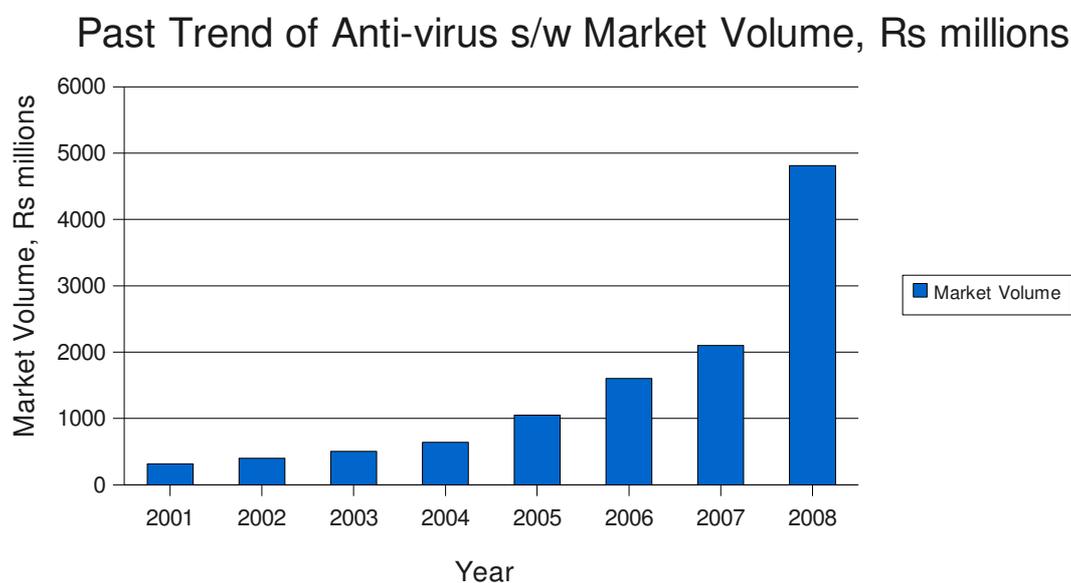


Illustration 9: Anti-virus sales in India in period 2001-2008.

Illustration 9 shows that anti-virus sales in India have grown from Rs 313 million in 2001 to Rs 4,810 million in 2008. The sales in India have grown dramatically in the last few years.

In a recent report, Symantec, one of the largest anti-virus software vendors in India, stated that virus activity is at an all-time high in India and is increasing⁶. The report further stated in increase of 250% in the number of infected computers (from an earlier year), arising mainly from increased Internet access.

The forecast for anti-virus software sales shows a steady increase (see Illustration 10 - by 2010 it is likely to be close to Rs 20,000 million, and by 2013

2009), the overall network security market in India is likely to grow at a CAGR of 25% until 2010.

6 Network Computing New Network, April 22, 2009.

the figure is likely to be Rs 38,000 million). These computations assume ceteris paribus conditions in terms of spending and usage of the existing operating systems.

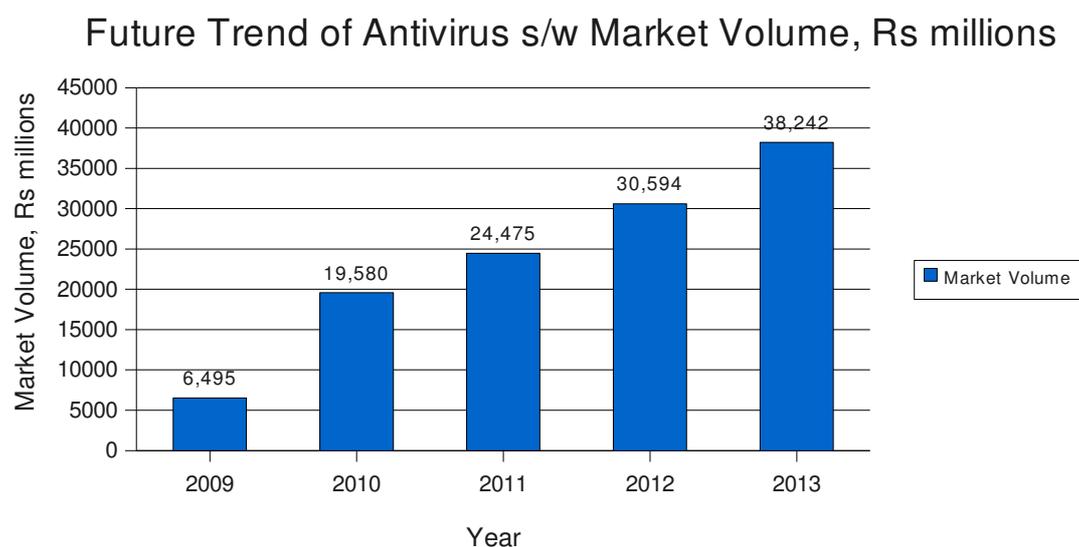


Illustration 10: Projection of anti-virus sales in India

Much of the Rs 20 billion to be spent on anti-virus software can be saved if users adopt FOSS operating systems. However, anti-virus software costs are not the only losses incurred from virus attacks. The greater loss is from productivity losses owing to downtime of computers. For large organisations that have a dense IT infrastructure, productivity losses from virus and worm attacks can be very damaging and serious - losses accrue from lost data, harm done to firm's brand and image, negative impact on overall customer loyalty and on the competitive position of the firm.

We estimate that Rs 20 billion is a lower bound on the savings that are possible from adopting FOSS software, as measured by the savings from virus-related problems.

FOSS Replacement on Servers

FOSS is primarily used on servers around the world. The case studies show that most large organisations that have adopted FOSS did so first on servers, either as operating systems hosting application products, or as enterprise class products.

There is a very wide variety of server sizes and requirements that organisations work with and have needs for. It is not possible to identify a single generic FOSS application that could replace a generic software on servers, any replacement would depend heavily on the context and the situation. Also, any migration to FOSS on servers is likely to be quite complex requiring attention to migration, integration, scalability, and training issues.

Server sales show an increasing trend, with 56,544 units sold in 2003 and 122,178 units sold in 2008 (see Illustration 11).

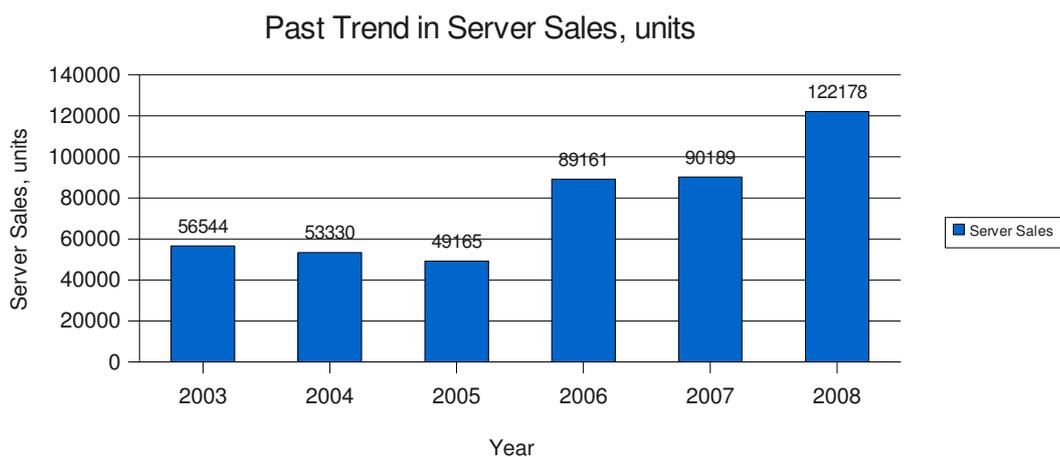


Illustration 11: Server sales in India (Source: Manufacturer's Association of Information Technology(MAIT), 2007-2008 Annual Review).

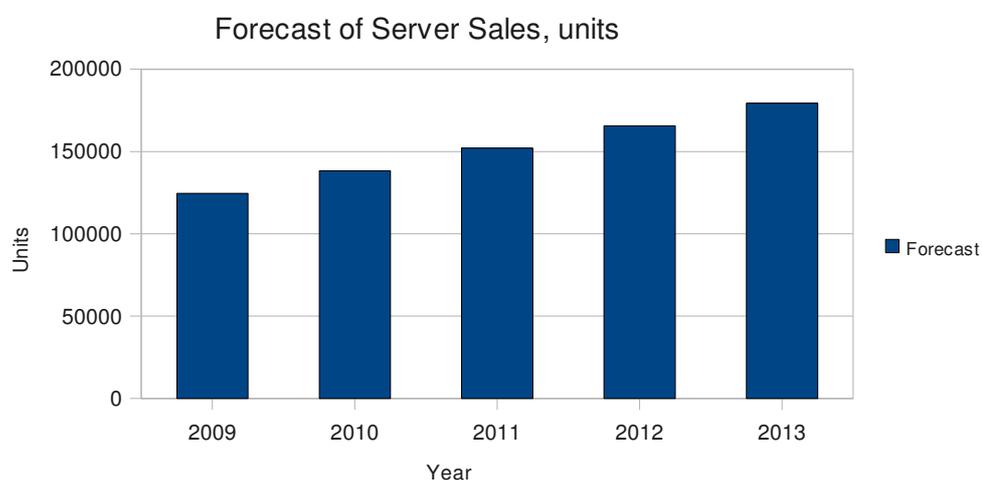


Illustration 12: Forecast of Server Sales based on past trend.

A trend line fitted to the data predicts that the sale in 2010 will be 138000 units and in 2013 it will be 179000 units (see Illustration 12 above). Table 5 shows that the most conservative estimate for the costs savings on FOSS on servers is Rs 10000. If we assume this saving rate - the savings in 2010 will be Rs 1,380 million and in 2013 they will be Rs 1,790 million (we assume 100% replacement of existing server software with FOSS). However, if we assume a more reasonable cost saving of at least Rs 100,000 then the estimates increase to many billions.

Summary of Projected Economic Impact of FOSS

The economic impact of FOSS is measured by computing the cost savings that will be possible if proprietary software is replaced by free software. The computations are done for software on PCs and servers.

Computations of cost savings resulting from replacing proprietary and commercial software with FOSS is done by first forecasting PC sales in the retail market, and then estimating the savings by considering three scenarios. The first is one in which it is assumed that 30% of the PCs will be replaced with FOSS software. The other two scenarios consider 50% and 70% replacement respectively.

We first consider replacing the operating systems on the PCs with a FOSS alternative. We assume that the proprietary operating system costs Rs 3600 per PC licence. When considered for the 50% scenario in the year 2010, in which it is assumed that 50% of the PCs sold will use FOSS, the savings amount to Rs 9847 million.

Projected retail PC sales in 2010	5.47 million units
50% of projected retail PC sales in 2010	2.735 million units
Savings per PC for operating system costs	Rs 3600 per unit
Total savings for OS software at 50% projected sales of retail PCs in 2010	Rs 9847 million

Cost savings resulting from replacing desktop productivity software with FOSS alternatives is also computed on the basis of forecasts. Microsoft Office is

available in three price bands - at Rs 3025, at Rs 16,500, and at Rs 26,800 per unit. If these are replaced with Open Office, for example, the prices indicate the savings possible. We consider, again, three replacement scenarios. For the scenario where 50% of the middle price band product is replaced, in the year 2010, the cost savings are Rs 45,152 million.

Projected retail PC sales in 2010	5.47 million units
50% of projected retail PC sales in 2010	2.735 million units
Savings per PC for replacement of Office Suite with FOSS product	Rs 16,500 per unit
Total savings for office software at 50% projected sales of retail PCs in 2010	Rs 45,152 million

We consider next PC sales in the enterprise market, which is different from retail sales, and constitutes bulk orders placed directly by institutions. We assume that the savings achieved will be Rs 20,000 per unit for both operating system and office productivity tools. In the year 2010, for a scenario where 50% of the enterprise PCs are replaced with FOSS, the total savings will be Rs 43,388 million.

Projected enterprise PC sales in 2010	4.6388 million units
50% of projected enterprise PC sales in 2010	2.3194 million units
Savings per PC for replacement of operating system and Office Suite with FOSS products	Rs 20,000 per unit
Total savings at 50% projected sales of enterprise PCs in 2010	Rs 46,388 million

Cost savings can be also achieved from not having to buy complementary

software on PCs. Anti-virus software sales in India are likely to be about Rs 20 billion in the year 2010. This is mainly procured to protect proprietary operating systems used on PCs, like Windows. With FOSS desktop operating systems, this money can be saved entirely.

Projected savings in Anti-virus software costs	Rs 20 billion
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FOSS is used mainly on servers currently. In future, as servers sales grows, with a likely growth in FOSS products replacing proprietary products, it is likely that large savings can be achieved. With a conservative estimate of Rs 10,000 per server, the savings for the year 2010 are likely to be Rs 1,380 million.

Projected total server sales in 2010	138000 units
Savings per server with usage of FOSS products (a conservative estimate)	Rs 10,000 per unit
Total savings based on projected sales of servers in 2010	Rs 1380 million

Innovation

The ability to innovate, tinker with, change and create new software remains one of the most powerful benefits of FOSS. It is estimated that the value of one Linux distribution is about \$10.8 billion⁷. This is based on the development cost of the distribution that contains 200 million lines of software code. This immense cost is reflective of the value that the ability to innovate creates.

This aspect of FOSS revealed itself in many interviews and discussions with users in organisations. This ability has strong economic impacts that are often intangible and not easily quantifiable. The impacts have to do with the ability to try out and experiment with different software for particular applications, enable others to experiment with the software, distribute and install the software on multiple computers, try different versions and variations of the same software, and mix-and-match software for a specific purpose.

The specific manner in which the innovation potential of FOSS is reflected in the case data is summarised below:

- For the IT @ School case FOSS enables creation of software for teaching various science subjects and also for creating local language fonts. The free access to source code and the ability to experiment with different platforms is important. Many schools in Kerala have already started using and building specific applications for teaching purposes. They create customised packages from existing FOSS tools for their special needs.

⁷ “Estimating the Total Development Cost of a Linux Distribution,” by A. McPherson, B. Proffitt and R. Hale-Evans. Linux Foundation Report. 2008.

- In the IIC case, FOSS products are used to enable students to experiment with to learn software. FOSS products are not vendor driven, and so enable users to make choices on their own.
- The NIA experimented with FOSS-based emailing solutions, to understand the migration process, the costs and cost-savings involved, the ability to scale. Success with FOSS prompted them to adopt more FOSS products.
- IF Systems, an IT testing start-up based in Bangalore, use FOSS-based tools to bid for testing contracts. FOSS tools can be acquired easily and skills can be built up reasonably quickly. IF Systems has to balance software acquisition costs, to build internal skills, versus the ability to bid for and get projects requiring those skills. FOSS enables them to have reasonable flexibility, as they can download, use and learn the software quickly, without having the lock-in that commercial software imposes.
- BCD Telecommunications, a very large multi-national firm, has an entire division that is dedicated to building FOSS-based products for their internal use.

The ability to innovate on processes, on technology configurations, on technology products, etc define the innovative potential of FOSS. These translate to direct economic benefits to organisations, however the benefits are strategic in nature (and not easy to quantify).

Policy Implications

With clear evidence of highly positive economic implications of FOSS adoption, it is worthwhile considering policy implications obtaining from this study.

1. **FOSS in Schools:** The IT @ School project of Kerala shows that adoption of FOSS in schools is not only feasible, but also has strong economic implications. If we extrapolate the savings of Rs 490 million from 2800 schools in Kerala to the rest of India (India has 152000 high schools⁸), this entails a saving of about Rs 26.6 billion. A clear policy implication is that governments at the state and at the centre should actively encourage adoption of FOSS in schools. This will save money, and also encourage a culture of experimentation, innovation and learning.
2. **Government Departments:** Government departments across India, whether within a particular state or at the centre have emphasized computerisation and IT adoption at all levels. FOSS can be leveraged effectively, as is demonstrated in the case studies, for cost reduction and for trouble-free operations (protection from viruses). FOSS adoption considerations have to be policy driven wherein all IT acquisitions by departments must actively consider FOSS-based technologies as a clear alternative; request-for-proposals and call-for-tenders must make it mandatory to include FOSS technologies.
3. **Knowledge about FOSS:** With the large possible savings in foreign exchange, resulting from replacement of imported goods with free ones, it is imperative that the government inform the public about the benefits

8 Source: Economic Survey of India 2007-08, page A-121.

and advantages of FOSS. Research⁹ has established that one reason that employees of government departments do not consider FOSS is lack of awareness and knowledge. This can be overcome only by active dissemination of knowledge about FOSS.

4. Ability to 'sample' FOSS: Both government and private sector organisations have to create facilities, such as laboratories or workshops, where employees and users can sample and test FOSS technologies. This will help in demonstrating the potential of FOSS and convince users about its viability. It will also counter un-founded and naïve notions about FOSS products and their usability.

9 "Barriers to Adoption of FOSS in Central Government Offices in India," by R. Singh, PGPPM Dissertation, Indian Institute of Management Bangalore, 2009.

Appendix: Method for Measuring the Economic Impact of FOSS

This brief note presents the framework used for measuring the economic impact of FOSS. The basic assumptions used for the calculations presented in the report are outlined.

Software is primarily an intermediate good, in that it is not directly consumed but helps in the production of goods that may be consumed¹⁰. The economic impact of software is thus largely a result of the increased factor productivity and the reduction in transaction costs that it introduces. Measuring increase in productivity due to software is a challenging task, primarily because of the subtle manner in which software impacts manufacturing and services (access to information, ability to manage, ability to coordinate and control, etc).

Software as a product, and a final good, has a different impact on the economy. Its manufacture and sale generates revenues, while its purchase and maintenance entails costs. This aspect of software is directly measurable as the revenues and costs incurred by organisations are recorded and accounted for.

FOSS introduces subtle variations in software's role as an intermediate good.

Some properties of FOSS, as opposed to proprietary software are:

Property	FOSS	Proprietary Software
Manufacture	FOSS is made in a distributed manner by persons who are	Proprietary software is typically made by persons from

¹⁰ "The Manufacturing Delusion," by Eric Raymond in *The Magic Cauldron*, <http://www.catb.org/~esr/writings/magic-cauldron/magic-cauldron.html#toc3>, 1999.

Economic Impact of FOSS in India

	mostly not from the same organisation.	the same organisation.
Distribution	FOSS is distributed openly and freely, mainly via the Internet. The distribution is bound by licensing terms that enable sharing and further distribution.	This software is controlled by licenses that restrict distribution. Software may be obtained via the Internet, but usually cannot be shared.
Modification	FOSS enables substantial modification as its entire source code is available.	This software can be customized to the limit of the provisions made. Source code is not available.
Products	FOSS includes the entire gamut of software products, both application and systems software. Within product categories, there is vast competition.	Proprietary software too includes the entire range of application and systems software. The competition within product categories is lower, allowing monopoly products to flourish.

Software's incarnation as a final product too has differences in free and proprietary software.

Property	FOSS	Proprietary Software
Price	FOSS is often available as a zero-price download. While the source code is freely available, vendors often offer support, customization, training and other related services at a price.	Mainly priced software, however, zero-price software is also available (very few).
Complementary products	Complementary products (such as software for playing videos or editing pictures) are also available for free.	Complementary products are usually priced and expensive.
Competition	Competition is on features mainly, not on prices.	Competition on features and prices.
Licensing	Licensing enables sale and free distribution.	Licensing is usually restrictive, curbing redistribution.

To measure the economic impact of FOSS it is necessary to account for both the

productivity gains incurred as well as the cost reductions achieved by the software. The following is a list of criteria that may be used to measure the economic impact of FOSS. This is not an exhaustive list. The list includes cost, operating and intangible criteria. Operating and intangible criteria are derived from usage of FOSS.

Cost Criteria

Cost reductions achieved from acquiring and installing FOSS, mainly obtained from using zero-price software or lower cost packages. This is primary software available as packages such as operating systems or office suites.

Cost reductions achieved from not having to install complementary software such as security and virus protection software. This software is available as packages, and assists the primary software although it is not essential that this software be used. Cost reductions are mainly achieved from the need of not having to install complementary software.

Cost reductions from upgrading of software as new versions are made available and are installed to meet the needs of new hardware.

Switching costs associated with moving from one type of software to another. It is well known that once a particular kind of primary software is adopted, organisations incur a lock-in to the product and to change to another kind (for example, from a proprietary operating system to a free operating system or vice versa) a cost has to be incurred. This cost is associated with training users on the new software, migrating data to a new format, modifying software to meet the

needs of the organisation, and so on. Switching costs are usually higher if the lock-in period is longer or more people in the organisation are locked-in to the older system.

Operating Criteria

Benefits associated with being able to customise FOSS to the needs of the organisation. This benefit is possible if the source code is used by the organisation to tailor the software to its needs. For commercial organisations this could entail competitive advantages over rivals.

Benefits associated with being able to distribute the (possibly modified) software within the organisation. The advantage of FOSS is not only in terms of costs, but also in terms of the ease and convenience that are possible for distribution across departments, and the standardisation and centralised management that is made possible.

Benefits associated with easier servicing and upgrade of software. This has to do with the ease with which software applications can be upgraded across the organisation, and the managing the multiple versions of software that may begin to creep across the organisation.

Benefits associated with compatibility with regard to data standards and data governance. FOSS, in most cases, conforms to open data standards that are accepted across the world. This helps large organisations ensure their data is accessible and relevant across the world and across functions.

Intangible Criteria

The culture of sharing defined by FOSS affects the nature of information sharing within organisations. This helps with knowledge dissemination and knowledge management within the organisation. The peer recognition that employees derive helps to motivate them to further innovate and contribute to the organisation.

FOSS invariably sensitises people to the licensing issues of software and helps create a sense of responsibility. This prevents use of restricted or pirated software that has legal implications for organisations. Further, this implications for society as a whole as it encourages use and proliferation of legal products.

FOSS has immense innovation potential. It provides a platform for creative formation of software and aggregations of applications. It enables organisations and individuals to experiment with, tinker with and play around with different combinations of hardware, software and applications. This has a potential to create immense benefits for the organisation and for the society as a whole.