THE STATE OF FREE & OPEN SOURCE SOFTWARE IN INDIA

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SUPPORTED BY: OMIDYAR NETWORK INDIA

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Preface

The most profound technologies are ones that disappear. They weave themselves into the fabric of every day life until they are indistinguishable from it

Mark Weiser
Former CTO of Xerox PARC

One of the most inspiring developments in the last 20 years has been the growth of Free and Open Source Software (FOSS) worldwide. The fact that groups of people can come together, form communities and create world class software code without barriers of geography, and give it away for free, is one of the finest examples of the possibilities enabled by the Internet. From its beginnings as a niche, geeky movement, FOSS has grown into to something that powers your smartphone, the smartwatch on your wrist, the e-government applications, search engines and social media networks that you use, and even the Mars Rover, FOSS has truly woven itself into the fabric of our everyday lives.

As Nadia Eghbal writes in Roads and Bridges The Unseen Labor Behind our Digital Infrastructure, *By making a voluntary investment in our underlying infrastructure, developers made it easier for others to build software. By giving it away for free instead of charging for it, they fueled an information revolution. Developers did not do this for altruistic reasons. They did it because it was the best way to solve their own problems. The story of open source software is one of the great modern day triumphs of the public good.*

Like the rest of the world, India too has benefited enormously from these public goods. Some of India's largest-government projects, and most technology startups have been built on top of FOSS. FOSS communities in India have also organized themselves to solve India's challenges like digital inclusion by creating Indian language fonts, dictionaries and other essential tools that are widely used across the country.

The Government of India has formulated several policies that support FOSS in e-government, encouraging the development of e-gov apps in the collaborative open source development

model, supporting open standards that are critical for FOSS, and discouraging software patents that are an existential threat to FOSS.

At the industry level, some of India's largest software services companies extensively leverage FOSS. Many SMEs have also specialized in providing services around specialized FOSS software like Drupal and others. It seems that all the ingredients that can make a FOSS revolution happen exist, but the catalytic force that can unleash all this potential is missing. Policies exist on paper, with implementation far behind. We consume FOSS without taking leadership, and driving the FOSS development process. Globally, leading technologies like Artificial Intelligence, Internet of Things, 5G etc are being built on FOSS, etc but these same technologies are sold to us with proprietary wrappers at markups that are 60% or more.

The importance of FOSS can be seen in the fact that the best paying jobs in tech today are FOSS skills. Given this scenario, if we continue with a business as usual scenario, India will become an also-ran in the tech world. An alternative scenario is one where the government, industry, academia and the FOSS community work in concert to deploy FOSS for India's benefit. Government policy states that, all things being equal, preference will be given to FOSS. If this policy is implemented well, it can help grow the domestic market for FOSS systems and services. The FOSS industry can help the government by building technology stacks that are well supported and as easy to implement as Commercial Off The Shelf (COTS) software.

The government could identify strategic areas like 5G/6G, microprocessor technology, AI and others, and work with academia and the FOSS community to build indigenous capabilities.

This will help our country reduce electronics imports, insulate domestic industry from the risk of denial-of-technology regimes, and potentially build Indians companies that take their technology global. Government support for the work of the Indic computing FOSS community can bring millions of Indians who do not know English, into the mainstream of the digital age and expand the domestic IT market.

On their part, the industry and the FOSS community also need to organize themselves

better. For more than a decade, MNCs have been lobbying against India's Patent Law which does not allow software to be patented. Billions of dollars are at stake since a software patent regime will allow MNCs to collect significant royalties on technology sales in India. While FOSS is built around collaboration and the right to share code, software and business method patents are state granted monopolies. The two are fundamentally incompatible, and a reversal of India's patent policies could set back the FOSS ecosystem by decades. Therefore, there is a need for greater vigilance from the FOSS community on this front, and closer engagement with key policy makers. India is one of the few countries that has had a favorable FOSS policy in place for years. However, industry can drive home the advantage, only if it is able to organize itself better, and work closely with the government to ensure that the policy is implemented well.

It is also worth noting that India has the largest base of developers in the world, but its contributions to the global pool of source code has been miniscule. There are many reasons for this, but we must work to change this over the next 5-10 years. From astronomy to mathematics to yoga, India has a tradition of sharing its knowledge with the world, and Indian FOSS contributions could revive this profound tradition.

I am happy that Omidyar Network India and CivicData Lab have embarked on this study. In the past, there has not been enough documentation of the work that the Indian FOSS community has done.

Therefore, I hope that this study becomes an annual feature so that we can build a historical archive that helps us in future. I hope this report sparks off a conversation that takes the Indian FOSS community to greater heights in the coming years.

Venkatesh Hariharan
An avid FOSS advocate and
India representative for
Open Invention Network

The Role of FOSS in India's Digital Advancement

India is well positioned to become a vibrant hub for FOSS innovations. In India, 4G data subscribers have recently crossed more than 598 million of which 96% of them access the digital world via open-source based mobile operating systems

Free and open-source software (FOSS) is software that is freely licensed to use, copy, study, change, improve, and redistribute.

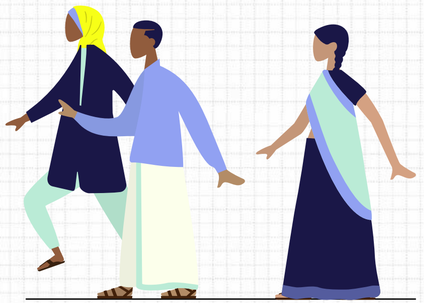
FOSS is an inclusive term that covers both “free software” and “open-source software”, which despite describing similar ownership models, have differing cultures and philosophies.

The “free software” model advocated by the Free Software Foundation [1] focuses on the fundamental freedoms a software must give to its users, commonly explained as “think of free as in free speech, not as in free beer”.

Whereas “open-source software” as described by Open Source Initiative (OSI) [2] emphasizes on the business-friendly development and use of code, harnessing strengths of the distributed development model. ”Free” and “Open” are different ideologies, but we believe they are not at odds. There is substantial overlap between the two.

If software products are the foundation of the digital economy, then the source code (the version of software as it is originally written i.e., typed into a computer) are its building blocks [3]. In the case of FOSS, these building blocks are made openly available for everyone to tinker, tweak, and improve as they like and to use as building blocks to build other things.

Digital excellence is therefore cumulative, achieved step by step by the continuous efforts of a vibrant community of contributors distributed all over the world. And because of these millions of contributors, most of our digital experiences are powered



[1] “Front Page” - Free Software Foundation - working together for free software, accessed October 20, 2020, https://www.fsf.org/.

[2] “News” | Open Source Initiative, accessed October 20, 2020, https://opensource.org.

[3] “Source Code Definition,” Source code definition by The Linux Information Project, accessed October 20, 2020, http://www.linfo.org/source_code.html.

by FOSS today. More than 85% of India's Internet runs on FOSS [4], we consume it daily to browse via Google [5], chat over WhatsApp [6], book train tickets from the Indian Railway Catering and Tourism Corporation (IRCTC) [7], perform bank transactions at the State Bank of India (SBI) [8] or watch a show on Netflix [9].

More than 85% of India's Internet runs on FOSS

FOSS offers new avenues for economic, technological and talent growth that are rooted in the commons-based peer production of information, knowledge, and culture [10].

The ownership and usage policies of software products are becoming intertwined with freedom and equity in society as people move to an increasingly digitally enabled existence.

FOSS has decentralized software production to a large extent, leading to greater inclusivity in software supply chains. On average, FOSS products are much more affordable than their proprietary counterparts and give increased personal control and freedom to creators and users alike. This is especially relevant in a world where communities look for representation and agency, and without which, the future of the digital economy may be controlled by a handful of people and corporations.

India is well positioned to become a vibrant hub for FOSS innovations. In India, 4G data subscribers have recently crossed more than 598 [11] million of which 96% of them access the digital world via open-source based mobile operating systems (primarily Android) [12].

With this level of usage, India has increasingly become an emerging market for mobile applications and related software, built to run on FOSS-enabled devices. According to GitHub, India now ranks 3rd in the world in terms of FOSS usage and

4 "Web Server Usage Distribution in the Top 1 Million Sites," Web Server technologies Web Usage Distribution, accessed October 20, 2020, https://trends.builtwith.com/web-server.

5 "Open Source by the Numbers at Google," Google Open Source Blog, accessed October 20, 2020, https://opensource.googleblog.com/2020/08/open-source-by-numbers-at-google.html

6 "Whatsapp Encryption Overview," https://scontent.whatsapp.net/v/t39.8562-34/89275998_627986927772871_4167828889579552768_n.pdf?_nc_sid=2fbf2a&_nc_ohc=yzp1baGk_8wAX9OhTuD&_nc_ht=scontent.whatsapp.net&oh=38e642c6e140d22d756c1cb633e8f-79c&oe=5F905251, December 19, 201

7 The Centre for Railway Information Systems (CRIS) books more, happier passengers with infrastructure powered by, accessed Oct 20, 2020 Red Hat.https://www.redhat.com/en/files/resources/en-rh-cris-books-more-happier-passengers-infrastructure-powered-by-red-hat-12022727.pdf.

8 Bhragu Haridas, "How Enterprises Are Leveraging Open Source Tech to Drive Digital Transformation - ET CIO," ETCIO.com, July 17, 2020, https://cio.economictimes.indiatimes.com/news/strategy-and-management/how-enterprises-are-leveraging-open-source-tech-to-drive-digital-transformation/77011012.

9 "Open Source," Netflix TechBlog, accessed October 20, 2020, https://netflixtechblog.com/tagged/open-source.infrastructure-powered-by-red-hat-12022727.pdf.

10 Yochai Benkler, "FREEDOM IN THE COMMONS: TOWARDS A POLITICAL ECONOMY OF INFORMATION," Duke Law Journal Vol. 52 (2003): p. 1245, https://scholarship.law.duke.edu/dlj/vol52/iss6/3/.

11 "India Mobile Broadband Index 2020," accessed Oct 2020, https://www.nokia.com/sites/default/files/2020-02/Nokia_MBiT_2020_Report%20%28web%29.pdf.

12 "Mobile Operating System Market Share India" | StatCounter Global Stats, accessed Oct 2020, https://gs.statcounter.com/os-market-share/mobile/chart.php?device=Mobile&device_hidden=mobile&statType_hidden=os_combined&region_hidden=IN&granularity=monthly&statType=Operating%20System&region=India&fromInt=201908&toInt=202008&fromMonthYear=2019-08&toMonthYear=2020-08&csv=1 infrastructure-powered-by-red-hat-12022727.pdf.

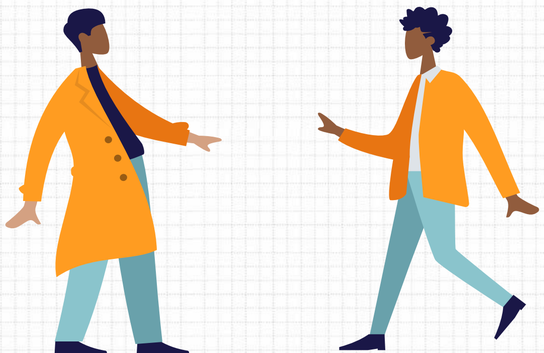
continues to witness an exponential boost with more developers preferring FOSS libraries and software solutions [13].

However, India still lags behind the global landscape in building sustainable home-grown projects and needs a strategic plan to incubate and proliferate domestic FOSS innovations worldwide [14].

Awareness of the ecosystem as well as a culture of contributing and growing code repositories in the open is missing. India's moderate contribution to FOSS is surprising since the country has a large and diverse Information Technology workforce of more than 4.36 million employees and an aggregate IT revenue surpassing US$180 billion in year 2019 [15].

The country's software industry has seen massive advancement in the last three decades and now constitutes approximately 8% of the country's GDP [16]. To translate these capabilities into rich FOSS contribution,leadership, and innovation there is a need to develop a robust strategic plan to shape the FOSS ecosystem in the country, and to implement this through coordinated action between stakeholders.

For this to happen, actors must be aware of and value the efforts, historical and present – of all partners in this ecosystem.



13 "The State of the Octoverse," The State of the Octoverse, accessed October 20, 2020, https://octoverse.github.com/.

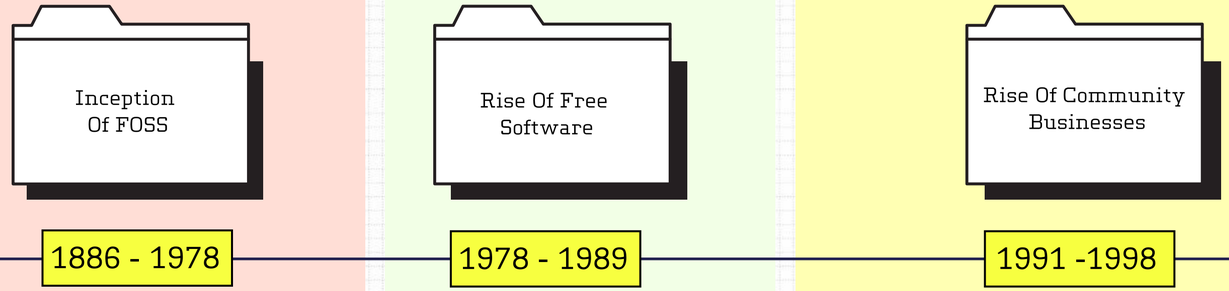
14 "Can India ever become a global FOSS hub", LINUX For You. September 2010. https://www.mindtree.com/sites/default/files/2017-10/306%20mindtree-thought-posts-can-india-ever-become-a-global-foss-hub_0.pdf

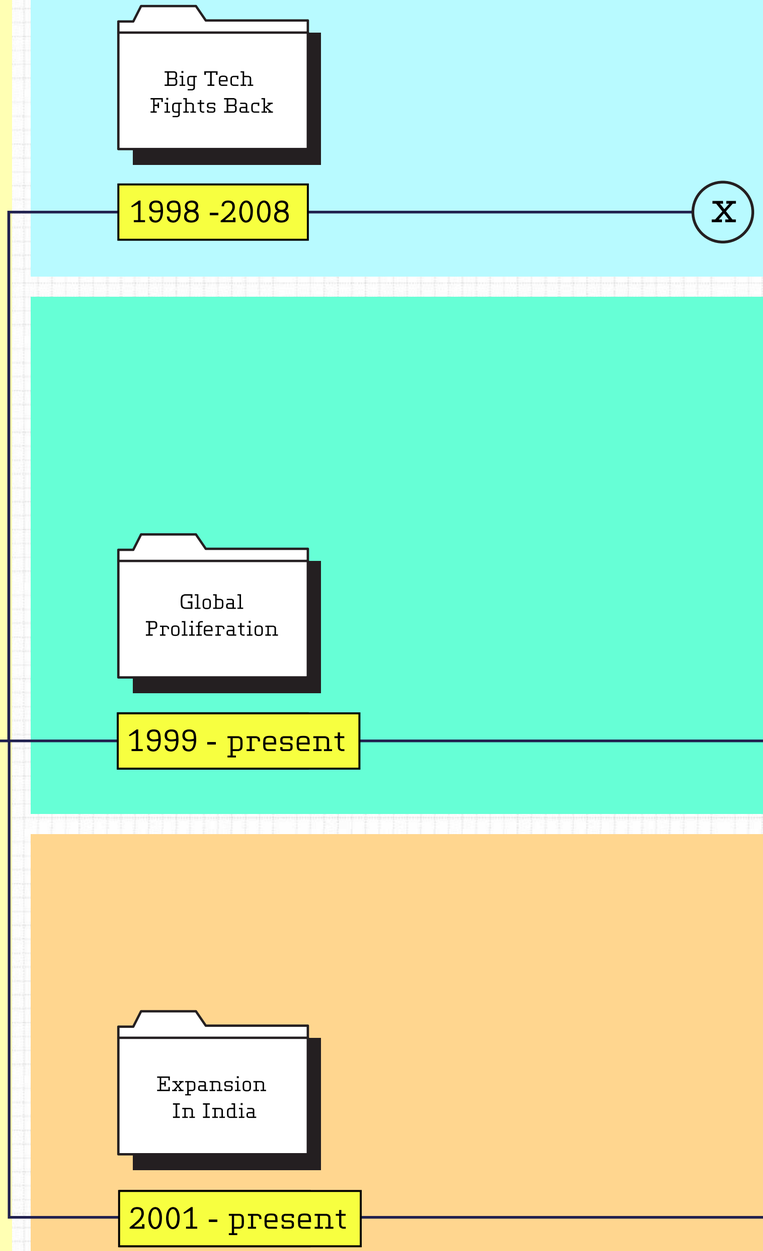
15 Samrat Sharma, "IT Industry May Become Lighthouse for India's Growth; Here's How Many IT Firms Operate in India," The Financial Express, February 17, 2020, https://www.financialexpress.com/industry/it-industry-may-become-lighthouse-for-indias-growth-heres-how-many-it-firms-operate-in-india/1870795/.

16 "Indian IT-BPO Industry" NASSCOM, accessed October 20, 2020, https://web.archive.org/web/20121220032358/http://www.nasscom.in/indian-itbpo-industry.

Chronicling the FOSS movement in India

Based on our conversations and reading, we classified the FOSS movement into six eras mentioned below.





[Click here for the complete FOSS Timline]

The origins of the FOSS movement in India can be found in the early 1990s with the community efforts of pioneers like C.V. Radhakrishnan, late Atul Chitnis, Nagarjuna G, K. S. S. Nambooripad, Satish Babu, Raj Mathur and more. By early 2000s, India witnessed germination of a variety of Indian Linux User Groups (ILUGs) groups and Free Software User Groups (FSUGs) spanning different cities and towns.

We have also seen several software localization initiatives in Indian languages and “Freedom Walks” covering 1200+ kilometers promoting free software usage [17]. FOSS communities continue to grow organically, engaging developers from diverse programming backgrounds to come together, learn and code.

FOSS has also led to some major policy shifts in governments across the globe. While, it began trickling into Indian policy and administration at the turn of the century, and has been growing in importance since.

Countries and supranational unions (like the European Union) [18] have adopted FOSS in different capacities like the Federal Source Code policy in the USA [19], or the Bulgarian, German, Ecuadorian government officials or the French Gendarmerie completely switching over to FOSS [20,21,22,23].

In India, The Kerala government has been a leader in supporting FOSS, first by showing its official support with the State IT Policy in 2001[24] which led to various government agencies in Kerala including the Kerala State Electricity Board [25] as well as the Government Secretariat [26] moving to machines that ran fully on Linux. In 2009 it set up the International Centre for Free and Open Source Software (ICFOSS) [27]. These changes have been saving the Kerala government about Rs 300 crores every year [28].

In 2011, the Indian Supreme court moved all its activities to Ubuntu and encouraged all the other courts in the country to transition as well [29].

17 “Freedom Walk: To Claim, Ensure and Preserve Freedom!,” Freedom Walk, accessed October 20, 2020, http://www.freedomwalk.in/.

18 AC Consultants, “The Economic and Social Impact of Software and Services on Competitiveness and Innovation,” Shaping Europe’s digital future - European Commission, April 3, 2017, https://ec.europa.eu/digital-single-market/en/news/economic-and-social-impact-software-and-services-competitiveness-and-innovation.

19 Tony Scott, “Federal Source Code Policy - United State of America”, Aug 8, 2016. https://web.archive.org/web/20160920231938/https://www.whitehouse.gov/sites/default/files/omb/memoranda/2016/m_16_21.pdf

20 Devin Coldewey, “Bulgaria Now Requires (Some) Government Software to Be Open Source,” TechCrunch (TechCrunch, July 6, 2016), https://techcrunch.com/2016/07/05/bulgaria-now-requires-some-government-software-to-be-open-source/.

21 “[News] Ecuador Ahead of the World with Democracy of Knowledge,”accessed October 20, 2020, http://compgroups.net/comp.os.linux.advocacy/-news-ecuador-ahead-of-the-world-with/1773288.

22 Nick Heath, “How Munich rejected Steve Ballmer and kicked Microsoft out of the city”, Tech Republic, Nov 18 2013, Accessed Nov 18, 2020, https://www.techrepublic.com/article/how-munich-rejected-steve-ballmer-and-kicked-microsoft-out-of-the-city/

23 Paul Ryan, “French Police: We Saved Millions of Euros by Adopting Ubuntu,” Ars Technica, March 12, 2009, https://arstechnica.com/information-technology/2009/03/french-police-saves-millions-of-euros-by-adopting-ubuntu/.

24 “Kerala State IT Policy”, 2001, http://unpan1.un.org/intradoc/groups/public/documents/apcity/unpan002950.pdf

25 “FOSS experience of KSEB”, ICFOSS, accessed October 2020, https://icfoss.in/doc/FOSS_Transition_Policy/FOSS%20experience.pdf

26 Vinson Kurian, “Kerala Legislature Announces Smooth Transition to Free Software,” The Hindu BusinessLine, March 12, 2018, https://www.thehindubusinessline.com/news/national/kerala-legislature-announces-smooth-transition-to-free-software/article20821938.ece1.

27 “Home,” ICFOSS, accessed October 20, 2020, https://icfoss.in/.

28 Abhishek Prakash, “With FOSS, Indian State of Kerala Saves $58 Million Each Year,” It’s FOSS, March 9, 2017, https://itsfoss.com/open-source-kerala/.

29 Diksha P Gupta. “Indian Supreme Court Opts for Ubuntu 10.04 - LINUX For You,” Open Source For You, August 25, 2016, https://www.opensourceforu.com/2011/11/indian-supreme-court-opts-for-ubuntu-10-04/.

And, in 2015, Indian government as part of its Digital India programme announced a “policy on the adoption of open source software for the Government of India” [30] as well as policy on “Collaborative Application Development by Opening the Source Code of Government Application” to show its commitment towards further developing the country as a digitally empowered society and a knowledge economy using FOSS.

The policy has come up against some critique especially with respect to the implementation framework for the policy [31].

Over the last decade, FOSS has continued to push and thrive in areas as diverse as the web, mobile computing, embedded systems, robotics, computer graphics, gaming, virtual reality, big data. This has led to co-option of FOSS by big businesses, especially those running on the internet, FOSS suddenly became quite ubiquitous. Now large firms like Microsoft have done a 180 on their FOSS stance. In India, most large companies (Tata Consultancy Service, Wipro, Infosys) now use FOSS technology quite frequently. This decade has also seen the rise of homegrown FOSS projects like Calibre [32], ERPNext [33], Chatwoot [34].

[30] “Digital India Programme: Ministry of Electronics & Information Technology(MeitY) Government of India,” Digitalindia, October 5, 2020, https://www.digitalindia.gov.in/.

[31] “FOSS for Public Use: Free and Open Source Software for Digital India” SFLC, accessed Oct 2020. https://cis-india.org/openness/blog-old/meeting-notes-on-foss-roundtable.pdf

[32] “Calibre E-Book Management,” calibre, accessed October 20, 2020, https://calibre-ebook.com/.

[33] Erpnext.com, “Open Source Cloud ERP,” ERPNext, accessed October 20, 2020, https://erpnext.com/.

[34] “Provide Exceptional Customer Support Over,” Chatwoot, accessed October 20, 2020, https://www.chatwoot.com/.

Indian FOSS Ecosystem & its Challenges

As we look ahead to chart where the FOSS movement in India can go, we must acknowledge the challenges and opportunities that lie in this journey ahead.

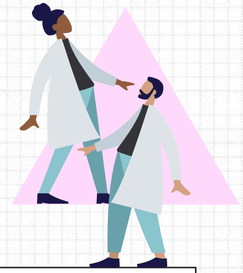
The key actors in the FOSS movement are individual volunteers and consultants, FOSS groups, schools, higher educational and research institutes, online educational actors, micro small and medium tech enterprises, global tech firms, local and state governments, national governments, FOSS funders, and FOSS investors.

FOSS & Community

- FOSS Groups
- Funders
- Non Profit Organisations
- Volunteers

FOSS & Businesses

- Global Tech Firms
- Micro, Small & Medium Enterprises
- Consultants



FOSS & Education

- Higher Education & Research Institutes
- Online Education
- Schools

FOSS & Governments

- National Governments
- State & Local Governments

In the past, we have witnessed these stakeholder groups come together around some important efforts. These moments of collaboration led to a boost in localization of code in Indian languages including liaising with the Bureau of Indian Standards (BIS) to support open interoperable file formats [35].

From our discussions with the community it has also been apparent that they played a substantial role in helping draft key state and national policies in relation to FOSS.

Looking ahead, these actors must address a few key challenges in working towards a common vision of creating a vibrant FOSS community in India.

These are:

- Collaboration
- Literacy
- Mentorship
- Policy making

[35] John Ribeiro, "India Rejects Office Open XML Again," InfoWorld (IDG News Service, March 21, 2008), https://www.infoworld.com/article/2642706/india-rejects-office-open-xml-again.html.

Collaboration

There are plenty of small thriving FOSS communities but there is not as much collaboration or co-creation between them to yield a louder voice. While there are a lot of thriving regional FOSS communities, there are not many spaces or figureheads who can unite contributors and communities around a common goal while providing pathways to get there. This makes it difficult to retain developers and attract a diverse and inclusive talent pool. We continue to see lack of funds, low retention rate, high burnout, and lack of incentives making most FOSS communities struggle to sustain.

Literacy

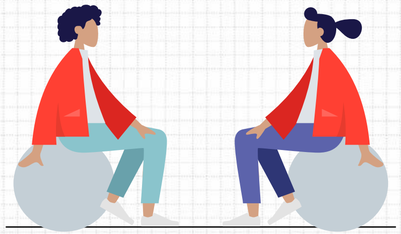
FOSS literacy and capacity of our youth has not kept its pace with the emerging market demands. While almost all major academic development tools are FOSS (such as R [36], Python [37], LaTex [38]) there is still not enough formalization of FOSS curriculums and programmes in public and private education institutes. This is particularly true for programmes in regional languages which have dissuaded uptake and retention of FOSS by students and early-stage developers for whom English is not a first language, which makes up more than 80% of the population [39]. Competing demand for resources and unavailability of localised content further hinders adoption at the grassroot level. There is also a need to communicate the values and principles of FOSS to young learners, fostering a collaborative culture of contribution.

Mentorship

The Indian tech business ecosystem lacks an enabling environment to support and grow FOSS innovations. The various Indian big tech players, especially IT enabled Service (ITeS) companies still remain quite agnostic when choosing to keep their underlying code open source or not, especially with regards to their key services and offerings. There is also a large gap in transitioning from being an active part of the community to building a successful business around FOSS. Most entrepreneurs focused on FOSS have limited support and mentorship options available in terms of legal compliances, financial sustainability, procurement opportunities and more.

Policy making

While India has a FOSS policy for e-governance, there are major gaps in implementing it in practice. Even after having a progressive FOSS policy and framework, governments are not yet able to engage India's vast developer community to co-create open-source digital assets. Both regional and national government agencies still lack sufficient tech capacity to drive FOSS initiatives.



36 "The R Project for Statistical Computing," R, accessed October 20, 2020, https://www.r-project.org/.

37 "Our Community," Python.org, accessed October 20, 2020, https://www.python.org/community/.

38 "A Document Preparation System," LaTeX, accessed October 20, 2020, https://www.latex-project.org/.

39 "Indian at a glance", MoHUA, accessed November 13, 2020, https://www.censusindia.gov.in/Census_Data_2001/India_at_glance/glance.aspx.

Recommendations to step up India's FOSS game

To address some of the above mentioned challenges, we propose 4Cs for FOSS growth for various stakeholders to:

- Build **Capacity**
- **Consume** Ethically
- **Contribute** Regularly, *and*
- **Co-Create** & Grow

Based on the research including interviews, discussions and reading circles conducted as part of this study, we believe the following recommendations can be undertaken by the four key actors to support FOSS ecosystem in India:

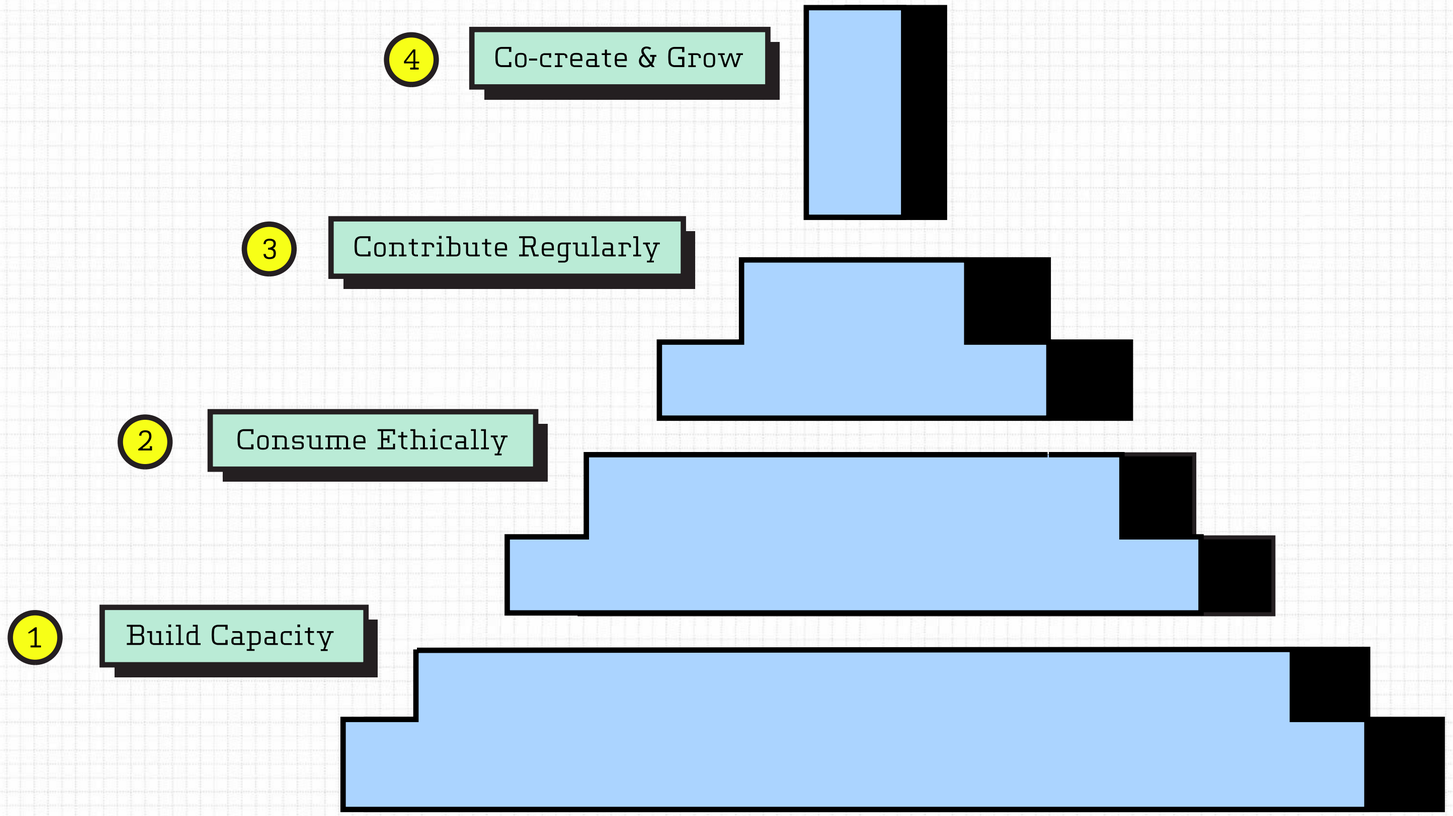


Figure 1: The 4Cs of FOSS Growth for Major Stakeholders

FOSS & Communities

FOSS Groups

Regional & National level FOSS intrest groups across India

Eg:

- *Free Software Foundation*
- *FOSS@Amritra*
- *PyLadies Delhi*

Volunteers

Individuals volunteering time to contribute to the ecosystem and mobilising community

Eg:

- *Aruna Sankaranarayanan*
- *Balasubramanian D*
- *Cherry G Mathews*
- *Kamal Velan*

Non- Profit Organisation

Help in grassroot adoption of FOSS by recommending policy and governance frameworks and funding and promoting FOSS initiatives

Eg:

- *Centre for Internet and Society*
- *FOSS United Foundation*
- *eGovernments Foundation*
- *IT for Change*
- *Mozilla Foundation*
- *Software Freedom Law Centre*

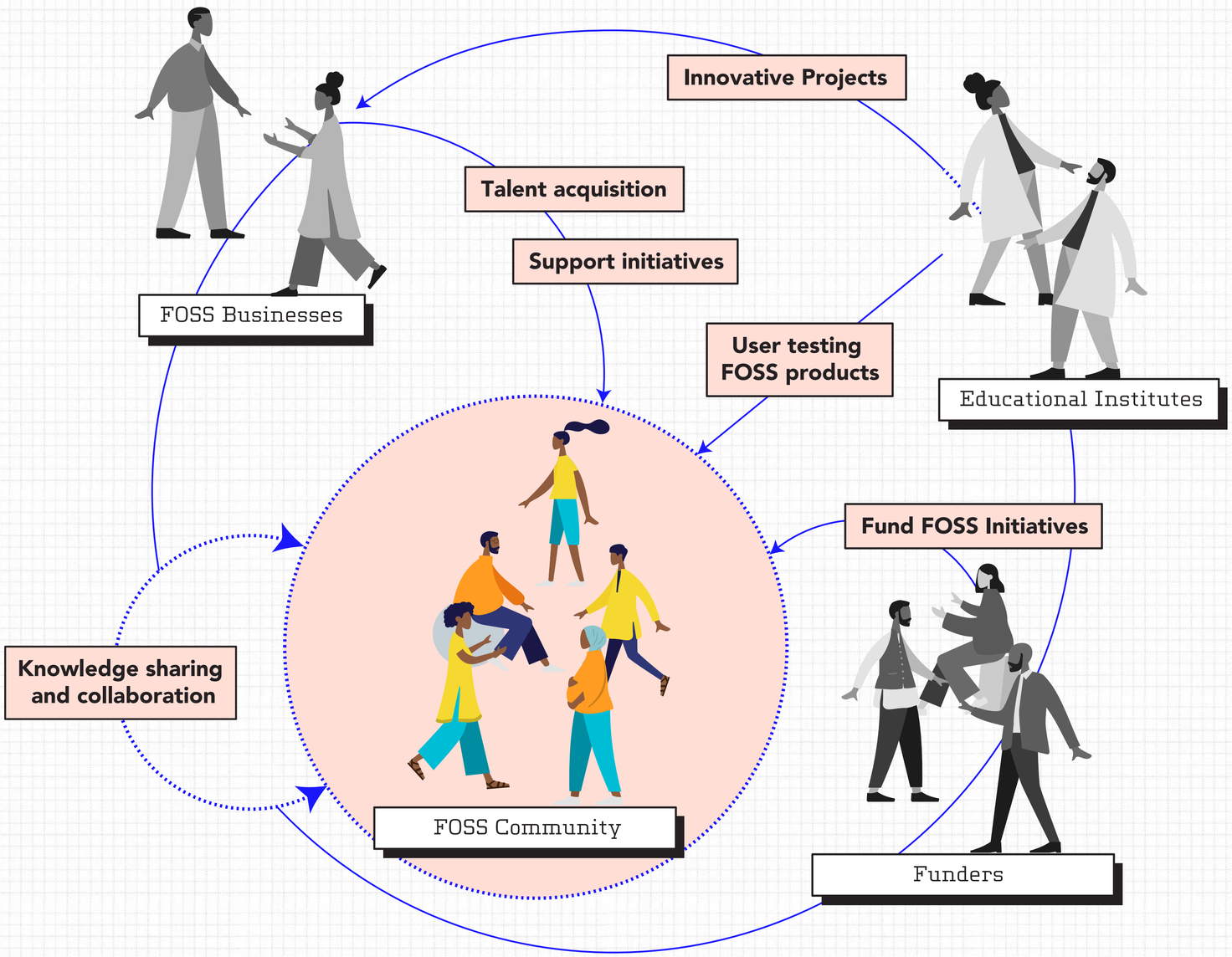


Figure 1: The Sphere of Influence for FOSS & Community

Help onboard new members to FOSS and mentor them to develop their individual and collective roadmaps, there is a need for a long term vision of personal and professional development to retain and sustain FOSS communities.

Eg: Outreachy

Software Freedom Conservancy organizes internship programs called Outreachy for typically underrepresented groups [41].

Build teams that can effectively engage with and mobilize the community. FOSS communities and projects need to actively and responsibly allocate funds and resources for community mobilization and other activities. Most Indian FOSS Leaders were originally developers who recognized this need and became community mobilisers. Building a well-supported team with shared responsibility prevents putting the pressure of such a critical role on a single person, who often feels the need to be constantly “on”, that leads to burnout and resignations.

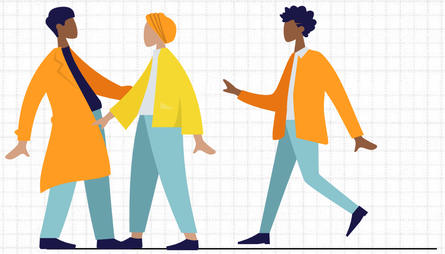
Eg: Succession Planning for FOSS Communities

A good example is the work of Vicky Brausser, a FOSS advocate who conducts succession planning training for FOSS Communities [40]

Incubate indigenous innovative FOSS based projects, creating structures of financial and legal support for FOSS communities to begin and foster projects that are driven by a need to solve a problem would increase project retention, contribution and support from within the community resulting in more robust and sustainable projects.

Eg: The Linux Foundation

The Linux Foundation, a non-profit technology consortium that supports the growth and promotion of the different projects and communities around Linux [42].



[40] “Internships Supporting Diversity in Tech,” Outreachy, accessed October 20, 2020, https://www.outreachy.org/.

[41] Vicky Brasseur, “For Project Safety Back up Your People, Not Just Your Data,” Opensource.com, April 16, 2018, https://opensource.com/article/18/4/passing-baton-succession-planning-foss-leadership.

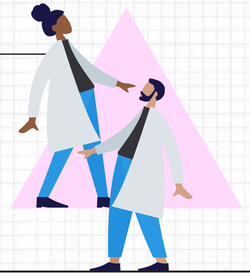
[42] “Supporting Open Source Ecosystems,” The Linux Foundation, accessed on October 15, 2020, https://www.linuxfoundation.org/.

FOSS & Education

Research & educational institutes, independant, public or private entities working to harness FOSS in academia

Eg:

- *Bhabha Atomic Research Centre*
- *Tata Institute of Fundamental Research*
- *IIT Bombay*

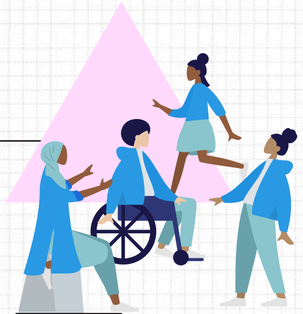


Higher Education & Research Institutues

Institutes imparting education and FOSS literacy to K - 12 children

Eg:

- *Govt. Schools in Assam*
- *Govt. Schools in Kerala*

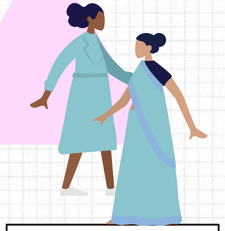


Schools

Online platforms imparting education and FOSS literacy

Eg:

- *Khan Academy*
- *Spoken Tutorial*



Online Education

FOSS & Education

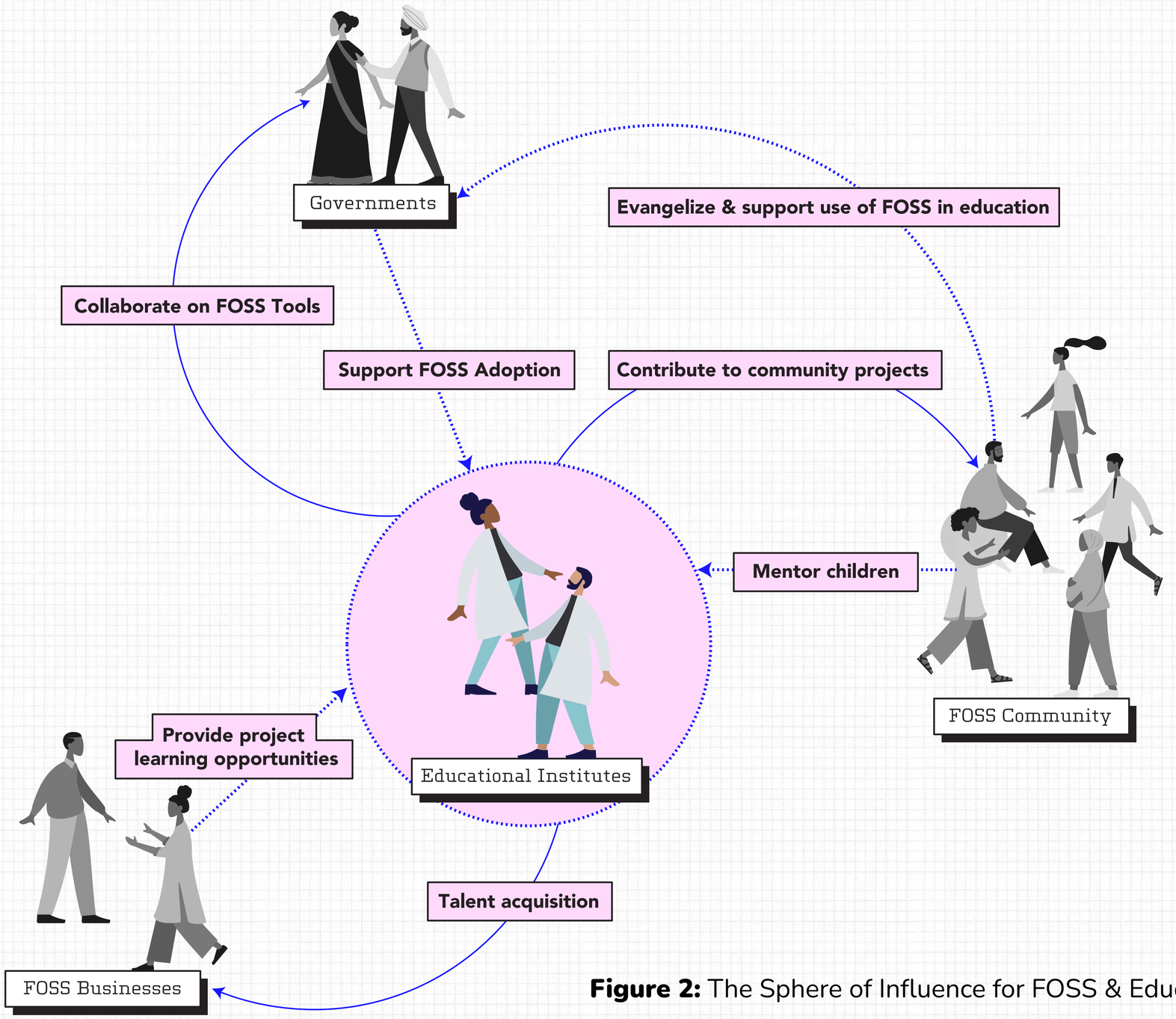


Figure 2: The Sphere of Influence for FOSS & Education

FOSS & Education

Build FOSS-led digital literacy programs empowering both educators and learners. A FOSS led curriculum needs to be created and adopted in schools to facilitate awareness and adoption around FOSS from an early age.

Eg: IT@School - The Kerala Model

IT@School, is a special purpose vehicle company funded by the Government of Kerala with the aim to fuel FOSS enabled Information and Communications Technology (ICT) education in the state [43].

Localize digital literacy curriculum to enable learners to learn and contribute in their native languages. Collaborate with the community to ensure localisation and adoption of such technologies.

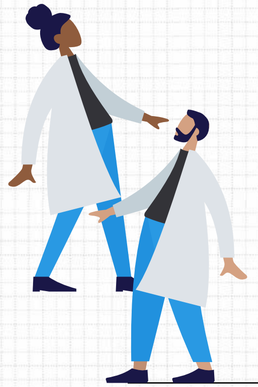
Eg: Spoken Tutorial

Spoken Tutorial, an educational content portal that teaches students FOSS [44]

Create programs to identify and grow FOSS communities in educational institutes. Focus on introducing students to FOSS development along with FOSS communities working in specific focus areas.

Eg: FOSSEE

The programm on Free/Libre and Open Source Software Education (FOSSEE), which works with communities while organizing conferences and forums [45].



[43] Biju Prabhakar and Arun M, "IT@ SCHOOL AND FREE SOFTWARE IN EDUCATION: THE KERALA MODEL," Information, Society, and Development, 2007. https://www.space-kerala.org/files/it-school.pdf.

[44] "Spoken Tutorial Project, IIT Bombay," Home, accessed October 20, 2020, https://spoken-tutorial.org/.

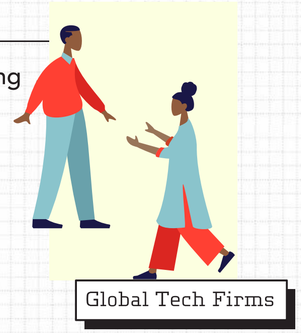
[45] "POSTER," FOSSEE, accessed October 20, 2020, https://fossee.in/.

FOSS & Business

Global tech firms having an Indian FOSS presence

Eg:

- *Amazon*
- *Google*
- *GitHub*
- *Red Hat*
- *Tata Consultancy Service*
- *Thoughtworks*
- *Wipro*



Global Tech Firms

Individuals contracted to work on FOSS projects within organisations

Eg:

- *Ankur Sethi*
- *Arun Raghavan*
- *Nirbheek Chauhan*
- *Steven Deobold*
- *Vaishali Thakkar*

Consultants

Start ups implementing FOSS based solutions in India

Eg:

- *Ashnik*
- *Bagisto*
- *Coopon*
- *Dhiway*
- *Frappe Technologies*
- *Hasura*

Micro, Small & Medium Enterprises

Organisations that allocates capital for FOSS with the expectation of a future financial return or to gain an advantage

Eg:

- *OSS Capital*
- *Strive VC*
- *3One4 Capital*

Investors

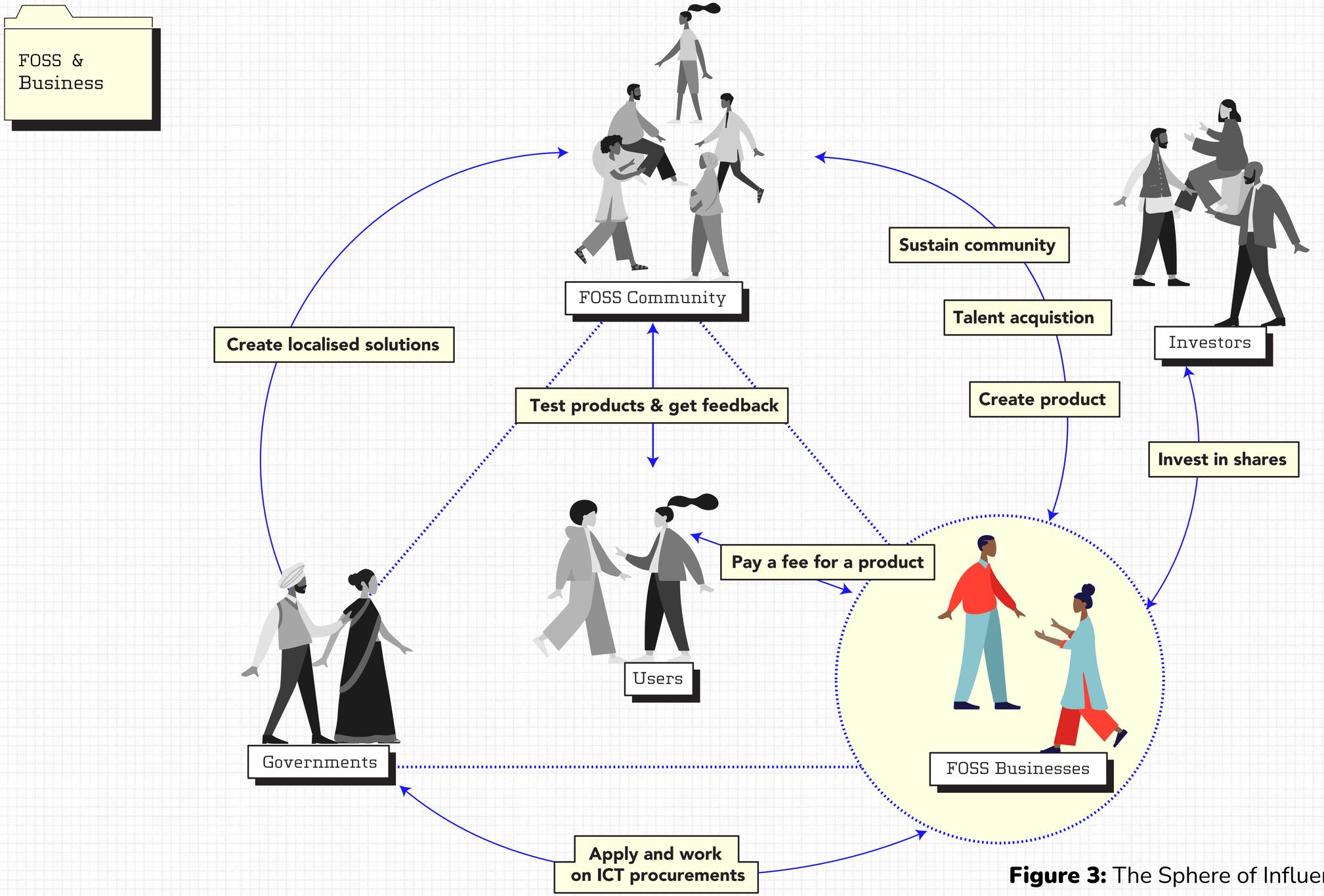


Figure 3: The Sphere of Influence for FOSS & Business

FOSS & Business

Support FOSS based start-ups to monetize their products/services. Indian FOSS companies have a unique opportunity to help customers migrate from proprietary closed-source software to mature FOSS alternatives and provide dedicated support. Ecosystem players like incubators, investors, and evangelists can help instil awareness, conduct training and provide technical support for FOSS start-ups to correctly utilize licenses, and create sustainable business models.

Eg: Coopon, Chiguru Tech, Tidelift & Open Collective

Continuous commitment is required to build legal, financial and growth structures for helping FOSS businesses of different kinds including FOSS-focussed Indian start-ups (like Coopon [46], Chiguru Tech [47]) and pro-FOSS financial offerings (like Tidelift [48], Open Collective [49]) that help create a means by which FOSS contributors can monetize their work.

Incentivize FOSS contributions from tech companies. Large tech players can create internal FOSS friendly policies to incentivize contributors from within their workforce to contribute to FOSS projects as in the case of the policies from Zalando (an e-commerce company) [50] and Netflix [51].

Eg: Zalando & Netflix

These organizations have strong FOSS contribution guidelines to help with their hiring.

Grassroots promotion of FOSS. Corporate Social Responsibility programmes can support FOSS contributions in the form of hackathons or conferences to crowdsource and germinate innovative ideas.

Eg: *India OS conference*

The India OS conference organized by Frappe Technologies [52] focusing on the creators and contributors to FOSS [53].

Co-create enterprise FOSS projects with the community. Businesses have a unique opportunity to collaborate with diverse communities to build large-scale FOSS projects.

Eg: *Apache Superset*

Apache Superset, a data visualization tool, which was first created by AirBnB and then entered the Apache incubator for sustained contribution from the community [54].

46 "We Are a Science and Technology Workers' Cooperative Working on Making Ethical Technology Available, Accessible and Affordable to the Masses," Coopon Scitech LLP, accessed October 20, 2020, https://cooponscitech.in/.

47 "Chiguru Technologies," Chiguru Technologies, accessed October 20, 2020, https://chiguru.tech/.

48 Tidelift, "Managed Open Source Software - the Tidelift Subscription," Tidelift, accessed October 20, 2020, https://www.tidelift.com/subscription/tidelift-tour.

49 "Open Collective," Open Collective - Make your community sustainable. Collect and spend money transparently., accessed October 20, 2020, https://opencollective.com/.

50 "Zalando Open Source: Contributing Upstream," Zalando Open Source | Contributing upstream, accessed October 20, 2020, https://opensource.zalando.com/docs/using/contributing/.

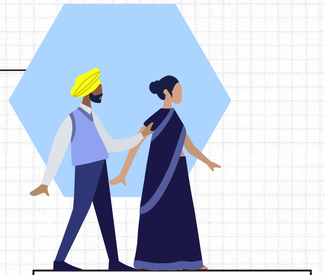
51 "Netflix Open Source," Netflix Open Source Software Center, accessed October 20, 2020, https://netflix.github.io/.

52 "Excellent Open Source Products and Services," Frappe, accessed October 20, 2020, https://frappe.io/.

53 "Why IndiaOS," IndiaOS, accessed October 20, 2020, https://indiaos.in/why-indiaos.

54 "Welcome," Welcome, accessed October 20, 2020, https://superset.apache.org/.

FOSS & Government

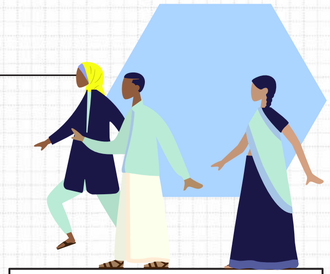


National Governments

Departments & agencies of central government using FOSS for nation wide adoption of ICT initiatives

Eg:

- *Centre for Development of Advanced Computing*
- *Indian Railway Catering & Tourism Corporation*
- *Ministry of Housing & Urban Affairs*
- *Supreme Court of India*



State & Local Governments

Regional government agencies driving grassroots adoption of FOSS led initiatives

Eg:

- *International Centre for Free and Open Source Software*
- *North Eastern Regional Centre of the National Institute of Rural Development*

FOSS & Government

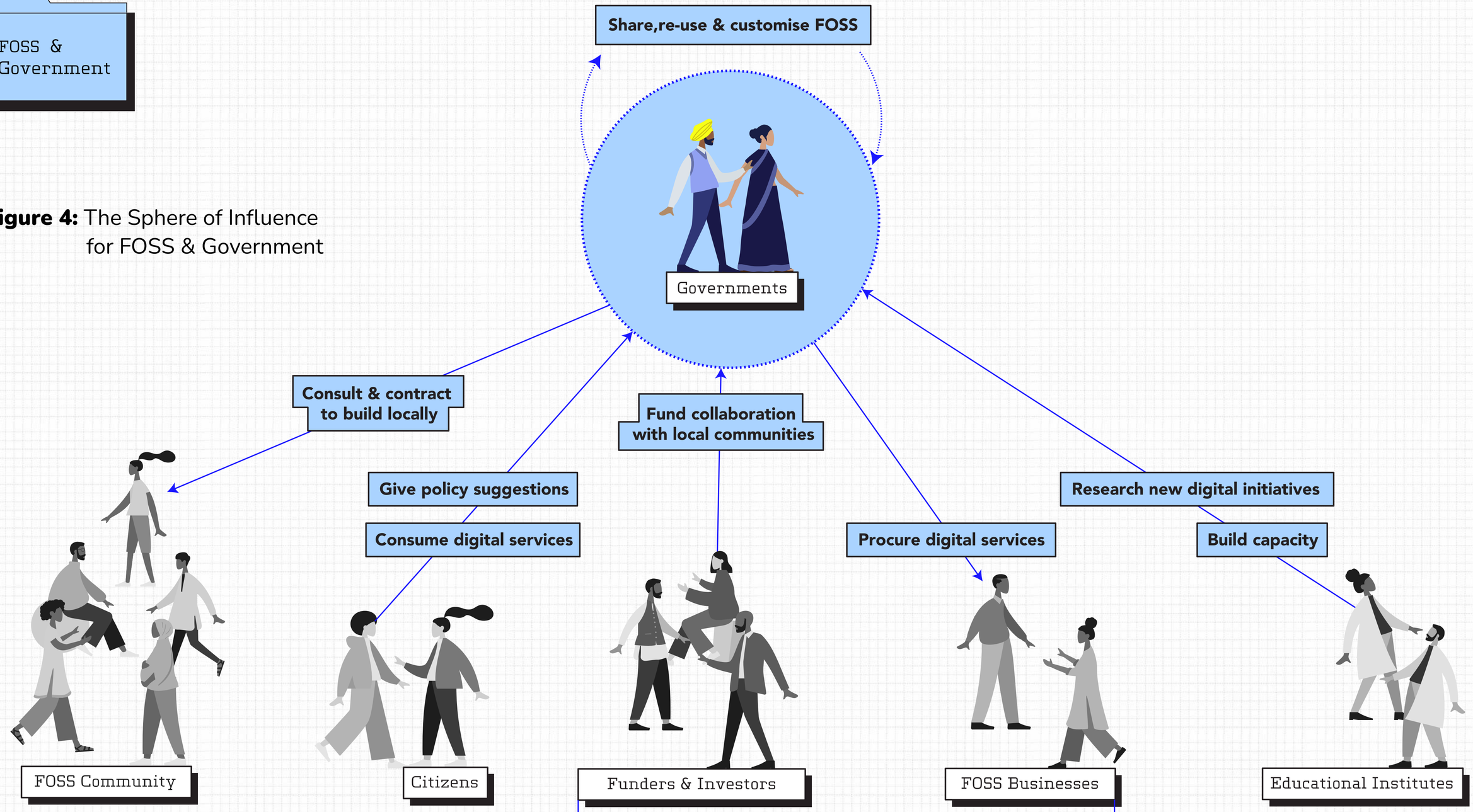


Figure 4: The Sphere of Influence for FOSS & Government

FOSS & Government

Work with FOSS companies to give more control and ownership to the state and reduce vendor lock-ins. Governments should pick private partners who are incentivised to work in the public's interest as opposed to companies that sell products and are incentivised to tie the government down and keep maintenance costs high. Services run by a government needs to be flexible and adaptable, however, direct partnership with product companies are aligned to create dependency. Therefore partnerships must occur through intermediaries with the specific mandate of avoiding vendor lock-in.

Another alternative for governments is to "own" the software they use and get private partners to develop the capacity and expertise within the government to maintain it. Either way, governments should use FOSS if they do not want to be tied down.

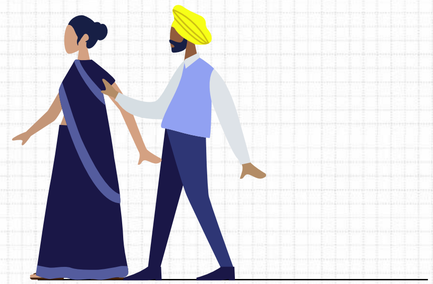
Eg: *Kerala Legislative Assembly*

> The Kerala Legislative Assembly moved all of their IT operations into GNU/Linux based systems with the assistance of Zyxware Technologies [55]

Build community-facing government teams on national and regional levels that work dedicatedly on FOSS, and work to increase their capacity and bandwidth over time through supported training and learning camps. Organize FOSS fellowships to attract more talent to this program on the existing and various upcoming digital transformation initiatives.

Eg: *ICFOSS*

> ICFOSS, an autonomous organization setup by the government of Kerala with the mandate of popularizing FOSS [56]. 18F, a digital services agency within the United States government which has a strong Open Source policy and presence [57].



[55] Kurian, "Kerala Legislature Announces Smooth Transition to Free Software," The Hindu BusinessLine, March 12, 2018, https://www.thehindubusinessline.com/news/national/kerala-legislature-announces-smooth-transition-to-free-software/article20821938.ece1.

[56] "Home," ICFOSS, accessed October 20, 2020, https://icfoss.in/.

[57] "Digital Service Delivery: Open Source Policy," 18F, accessed October 20, 2020, https://18f.gsa.gov/open-source-policy/.

FOSS & Government

Work closely with communities to enable co-creation of FOSS-driven open digital ecosystems
to build robust digital infrastructure, interoperable, open-source GovTech applications, open standards, digital policies and practices.

Eg: *SPACE, Kerala*

The government of Kerala works closely with SPACE and other local FOSS communities to implement key digital policies and services in the state[58].

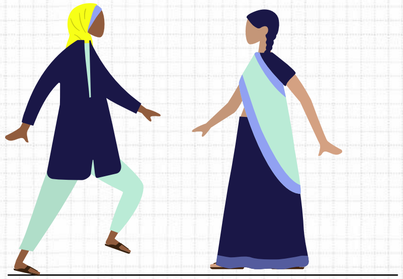
Make the source code of all public facing government software open source, and enable scrutiny by public interest FOSS communities.
This will help create transparency, accountability and trust in government technology, identify and correct bugs and improve it over time.

Eg: *Bulgaria, United Kingdom & Free Software Foundation in Europe*

The electronic governance act in Bulgaria requires all government software to be FOSS [59]

Government Digital Service of the United Kingdom makes everything open by default [60].

The Free Software Foundation in Europe has petitioned for all government software in Europe to be FOSS with some results [61].



[58] "Society For Promotion of Alternative Computing and Employment," Society For Promotion of Alternative Computing and Employment, accessed October 20, 2020, http://www.space-kerala.org/.

[59] Devin Coldewey, "Bulgaria Now Requires (Some) Government Software to Be Open Source," TechCrunch (TechCrunch, July 6, 2016), https://techcrunch.com/2016/07/05/bulgaria-now-requires-some-government-software-to-be-open-source/.

[60] "Government Digital Service," GitHub, accessed October 20, 2020, https://github.com/alphagov.

[61] Free Software Foundation Europe (FSFE), "Public Money, Public Code," Public Money, Public Code, accessed October 20, 2020, https://publiccode.eu/.

Sustained Collaborations to Build Future Pathways for FOSS in India

The current pandemic has amplified FOSS's importance due to the movement's ability to bring diverse actors together to build, localize and deploy crisis response solutions.

Indian FOSS communities have been very active in responding to the health and economic crisis caused by COVID-19.

Due to the purposeful and collaborative nature of the FOSS community, reusable applications can be quickly prototyped and constantly improved. These qualities are essential during times of emergency when there is limited time for research and development. Examples of needs that FOSS communities have responded to during this crisis include monitoring the virus outbreak [62], building necessary community awareness, tools to crowdsource information on hospital capacity, help volunteers to coordinate et cetera [63].

Restrictions to physical/public spaces during the pandemic, has created a real need for digital learning spaces and services that are accessible and egalitarian. FOSS has a real chance to enable this change and create more equitable learning solutions [64,65,66].

Even governments are gearing towards releasing the source code of some of their efforts in the open to build the necessary trust in their service, Ireland, for example, stands out as a shining example of FOSS in the public sector. Its contact tracing app was installed by around 1 million people in the first

62 "Coronavirus in India: Latest Map and Case Count," Coronavirus Outbreak in India, accessed October 20, 2020, https://www.covid19india.org/.

63 "Coronasafe Network," Coronasafe Network, accessed October 20, 2020, https://coronasafe.network/.

64 Guidance on Open Educational Practices during school closures, utilizing OER under COVID-19 pandemic in line with UNESCO OER Recommendation. May 2020. https://iite.unesco.org/wp-content/uploads/2020/05/Guidance-on-Open-Educational-Practices-during-School-Closures-English-Version-V1_0.pdf.

65 Cathy Li, "The COVID-19 Pandemic Has Changed Education Forever. This Is How," accessed October 20, 2020, http://www.weforum.org/agenda/2020/04/coronavirus-education-global-covid19-online-digital-learning/.

66 Kashika Chadha. "Digital Literacy in India: Structural Constraints and NEP 2020". Sep 4 2020, https://www-sprf-in.cdn.ampproject.org/c/s/www.sprf.in/amp/digital-literacy-in-india-structural-constraints-and-the-nep-2020.

36 hours and, due to its success, the code used to build it was subsequently given to the Linux Foundation, enabling other regions to emulate its success [67].

Similarly, Arogya Setu, the contact tracing app was also released in the open by Indian government after a lot of protests from the community [68].

While these efforts are more important during the pandemic than ever before, they should not end with the emergency.

The factors that make FOSS uniquely positioned to deliver during the pandemic, are the same ones that make **FOSS an ideal choice for developing open-source digital ecosystems with a long-term vision.** We have a unique opportunity to build scalable & replicable FOSS public goods like civic-engagement platforms, information management systems, and analytical tools. FOSS communities are vital to co-create citizen centric digital services and shared infrastructure. Their strong participation will ensure transparency, build trustworthiness, and help localize solutions to support regional needs and inclusion.

While we are already at a historical peak of consuming open source software in one form or the other in our lives, it's now time to invest more in creating a sustainable and inclusive FOSS ecosystem. The recent developments signal India becoming a fertile ground for FOSS innovations, with more actors joining hands to build public interest technologies, scalable tech-driven businesses and to ensure better service delivery.

A strategic investment in growing the FOSS ecosystem will not only help us onboard the next half billion internet users in our digital journey of growth, but will also create safe, diverse and open environments for citizens to participate, co-create and grow together.

67 "Ireland Donates Contact Tracing App to Linux Foundation," NearForm Enterprise Software Solution Development, October 13, 2020, https://www.nearform.com/blog/ireland-donates-contact-tracing-app-to-linux-foundation/.

68 "Aarogya Setu," GitHub, accessed October 20, 2020, https://github.com/AarogyaSetu.

Glossary

A list of terms and abbreviations mentioned in the report

Key Terms

Breaking down Free and Open Source Software (FOSS)
Free and Open Source Software is an inclusive term that covers both *free software* and *open-source software*. The *free software* model advocated by the Free Software Foundation, focuses on the four fundamental freedoms [69]:

- **Freedom 0:** The freedom to run the program as you wish, for any purpose
- **Freedom 1:** The freedom to study how the program works, and change it so it does your computing as you wish. Access to the source code is a precondition for this.
- **Freedom 2:** The freedom to redistribute copies so you can help others.
- **Freedom 3:** The freedom to distribute copies of your modified versions to others.

By doing this you can give the whole community a chance to benefit from your changes. Access to the source code is a precondition for this.

Open-source software on the other hand, as described by Open Source Initiative (OSI), emphasizes on the *business-friendly* development and use of code and harnessing strengths of the distributed development model [70].

While there is almost complete overlap in the free software & the open source licenses, the values espoused are different but not mutually exclusive

[69] "Front Page - Free Software Foundation - Working Together for Free Software," Front Page - Free Software Foundation - working together for free software, accessed October 20, 2020, https://www.fsf.org/.

[70] October in 2019 was packed with opportunities to catch up -- in person -- with many of our open source friends. This year is different, "News," News | Open Source Initiative, accessed October 20, 2020, https://opensource.org/.

Open source is a development methodology; free software is a social movement.

Richard Stallman

Free software movement activist and programmer

As Stallman wrote [71] “Open source is a development methodology; free software is a social movement.”

Thus, in order to better capture growth of both of these cultures and philosophies in the country, the report will use the term FOSS to describe the diverse community and major developments associated with it. FOSS advocates for following key aspects of software development for its users over its proprietary counterparts:

- Zero cost to try out software along with substantially lower cost of wide scale adoption, thus enabling users to better compare software and make informed choices.
- Privacy, Security and Ethical trust-based software development is at its core, enabling the contributor community to constantly engage in identifying and fixing bugs, threats and potential malpractices. Unlike their closed source software counterparts, where there is a possibility to build backdoors, covert and undesirable features into the software.
- Promotes customization, localization, personalization of software as per needs of their users, giving them control to change and distribute the code as per their needs.
- Fosters co-creation and participation to have a community-shared development roadmap for building a feature-rich and efficient software

[71] Richard Stallman, “Gnu.org,” [A GNU head] , accessed October 20, 2020, https://www.gnu.org/philosophy/open-source-misses-the-point.en.html.

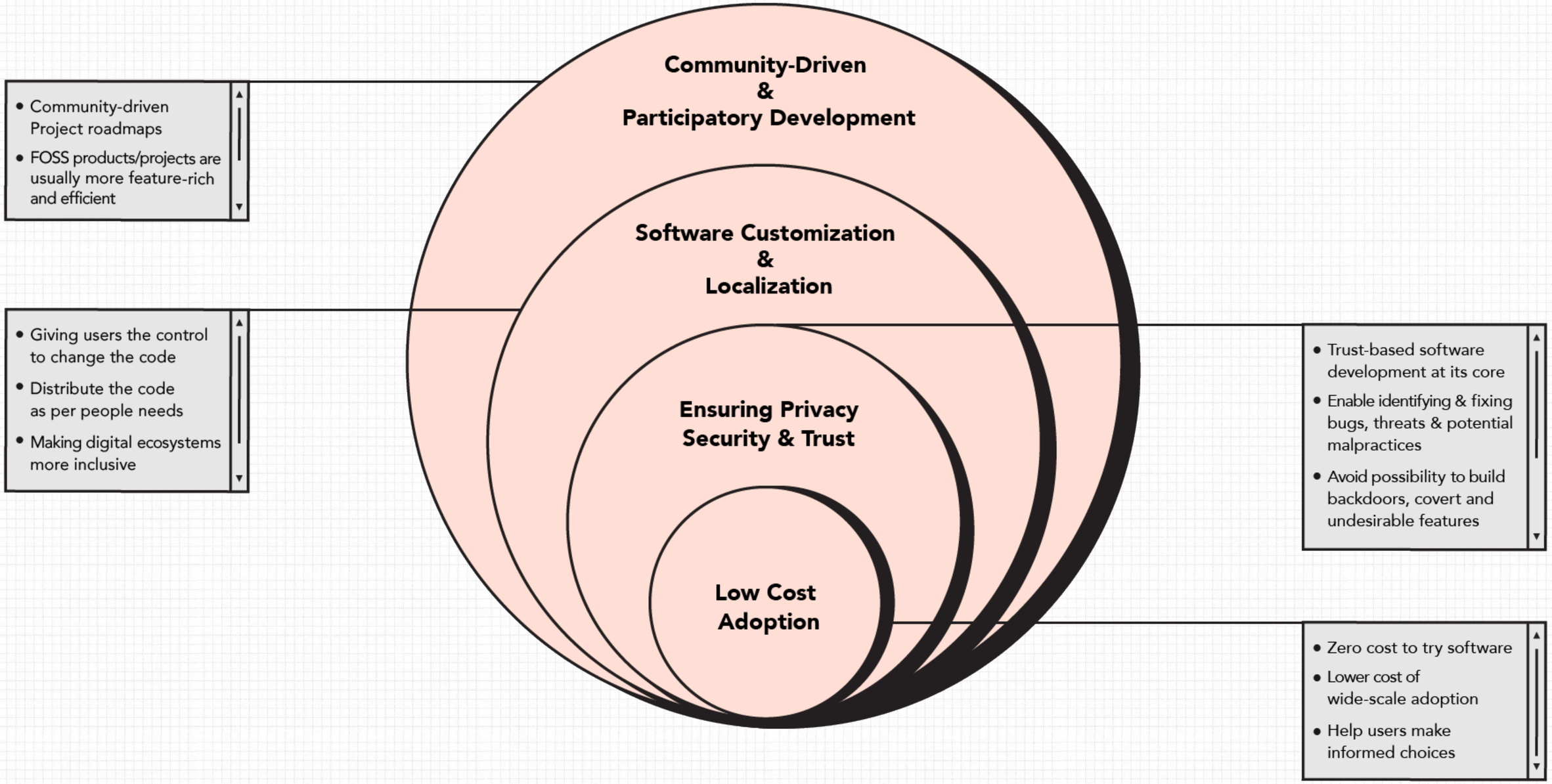


Figure 5: Layers of benefits offered by FOSS Development to its Users

Understanding FOSS Licenses

Copyrights and patents are forms of Intellectual Property (IP) that gives distributors of the software the ability to place limitations on the licensed software [72].

The terms “free software” and “open-source software” refer to software licensed under terms satisfying the specific criteria set forth by the Free Software Foundation and Open Source Initiative, respectively. While the differences between Free and Open Source software are meaningful in the philosophical sense, with respect to licenses, there is almost a complete overlap between them.

There are now hundreds of FOSS licenses available for different FOSS packages available for reuse that lie along this spectrum from closed to open. [73,74]

Eg:

GPL (GNU General Public License): Where you have to release source code if you link against and distribute the binary, but don’t if you just provide a service

A-GPL (Affero General Public License): Where you have to allow the source to be downloaded even if you never distribute the binary but do provide a service

L-GPL (Lesser - GNU General Public License): Where you don’t have to release source code as long as you don’t modify the library itself

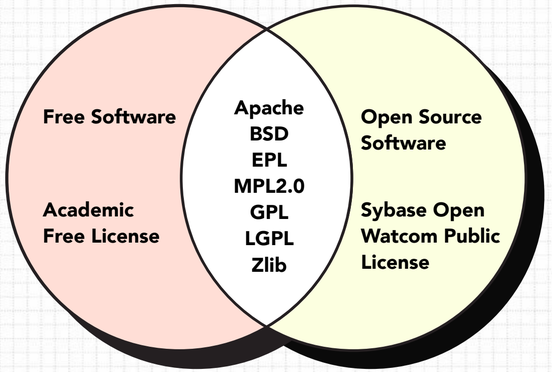
Binaries

When referring to a software program, binaries are compiled code that allow a program to be installed without having to compile the source code [75].

Copyleft

“Copyleft” is a play on the term “copyright”. It was first introduced by the free software foundation as a critique on the use of copyright.

The GNU General Public License (GPL) espouses this philosophy as it requires distributors of GPL licensed software to make the source code for both the GPL software and any derivative work based on the GPL software available for royalty free use, copying, and further distribution under the terms of the GPL [76].



Abbreviations

BSD - Berkley Software Distribution
EPL - Eclipse Public Distribution
MPL - Mozilla Public License
GPL - GNU Public License
LGPL - Lesser GNU Public License

72 “Home,” copyright alliance, August 17, 2020, https://copyrightalliance.org/.

73 “Gnu.org,” [GNU head] , accessed October 20, 2020, https://www.gnu.org/licenses/license-list.html.

74 “Choose an Open Source License,” Choose a License, accessed October 20, 2020, https://choosealicense.com/.

75 jrarajrara 55511, “What Are Binaries?,” Software Engineering Stack Exchange, February 1, 1961, https://softwareengineering.stackexchange.com/questions/121224/what-are-binaries.

76 Ben Cotton, “What Is Copyleft?,” Opensource.com, accessed October 20, 2020, https://opensource.com/resources/what-is-copyleft.

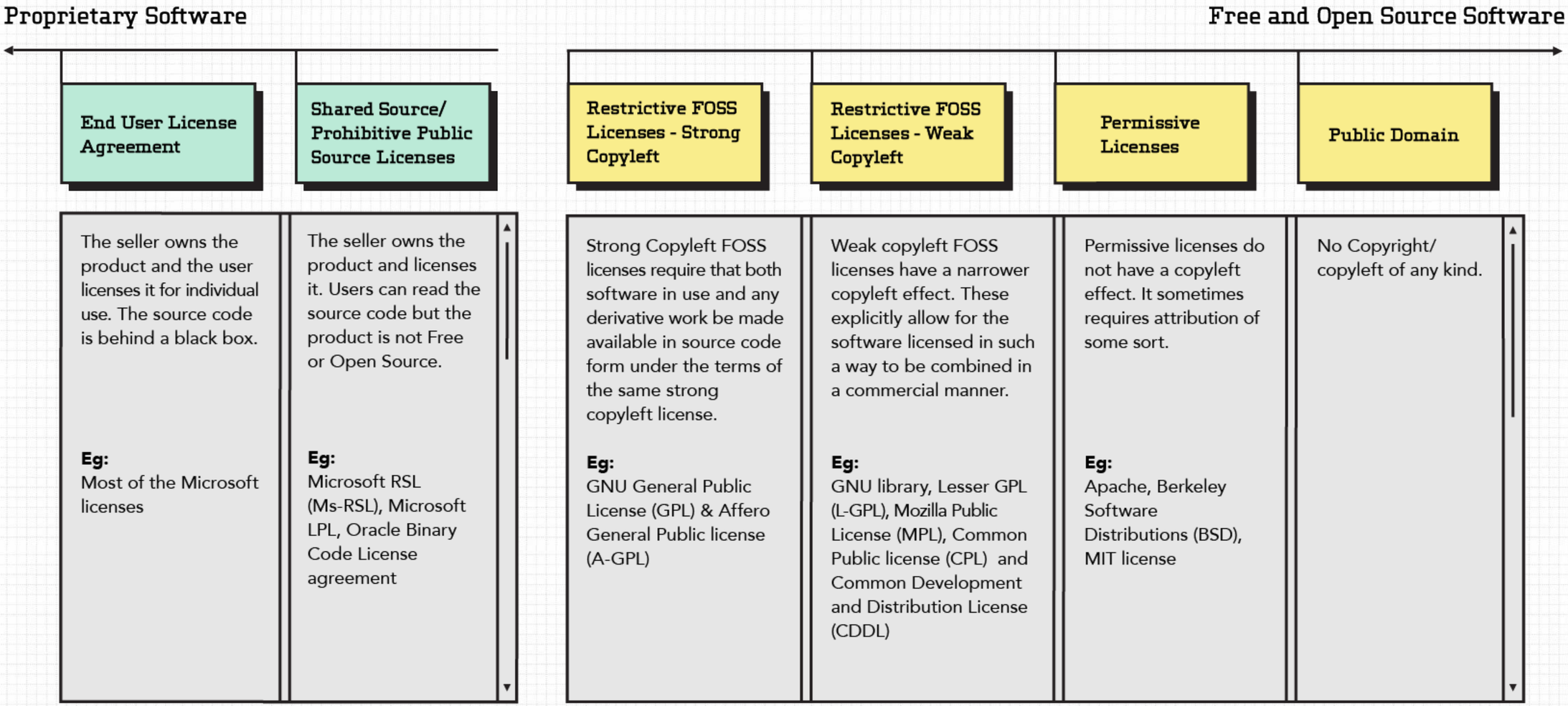


Figure 6: Various software licences and examples

Glossary (Terminology & Abbreviations)

Abbreviations

A-GPL - Affero GNU General Public License

AI - Artificial Intelligence

AIM - Atal Innovation Mission

ARPA - Advanced Research Projects Agency

ATD - Appium Test Distribution

ATL - Atal Tinkering Labs

ATM - Automated Teller Machines

AT&T - American Telephone and Telegraph Company

AWS- Amazon Web Services

BARC - Bhabha Atomic Research Centre

BIS - Bureau of Indian Standards

BSD - Berkeley Software Distribution (license)

C-DAC - Center for Development of Advanced Computing

CDDL - Common Development and Distribution License

CIS - Centre for Internet and Society

CITRIS - Center for Information Technology Research in the Interest of Society

CKAN - Comprehensive Knowledge Archive Network

CPL - Common Public License

CMS - Content Management System

CORD-19 - Covid 19 Open Research Dataset

COSA - Clinic for Open Source Arts

COSS - Commercial Open Source Software

COTS - Commercial Off The Shelf

CSO - Civil Society Organizations

CUBE - Collaboratively Understanding Biology Education

DIKSHA - Digital Infrastructure for School Education

EPL - Eclipse Public License

ERP - Enterprise Resource Planning

EU - European Union

F/LOSS - Free Libre & Open Source Software

FOSS - Free & Open Source Software

FOSSEE - Free/Libre & Open Source Education

FSM - Free Software Movement

FSUG - Free Software User Group

GDP - Gross Domestic Product

GDS - Government Digital Service

GNOME - GNU Network Object Model Environment

GNU - GNU's Not Unix!

GoI - Government of India

GPL - GNU General Public License

GraphQL - Graph Query Language

GSoC - Google Summer of Code

HBCSE - Homi Bhabha Centre for Science Education

HCI - Human Computer Interaction

HOTOSM - Humanitarian Open Street Maps

HTTP - Hypertext Transfer Protocol

IBM - International Business Machines

ICFOSS - International Centre for Free and Open Source Software

ICT - Information and Communications Technology

IIIT-B - International Institution of Information Technology

IIM - Indian Institute of Management

IISc - Indian Institute of Science

IIT - Indian Institute of Technology

ILUG - Indian Linux User Groups

INPE - Instituto Nacional de Pesquisas Espaciais

IoT - Internet of Things

IP - Intellectual Property

IRCTC - Indian Railway Catering and Tourism Corporation

ISO - International Organization for Standardization

IT - Information Technology

ITeS - IT enabled Services

K-12 - Kindergarten through to 12th

K-14 - Kindergarten through to Associate degree

KDE - Kool Desktop Environment

KITE - The Kerala Infrastructure and Technology for Education

KPMG - Klynveld Peat Marwick Goerdeler

LAMP - Linux/instead of UNIX, Apache, MySQL or PostgreSQL/instead of Oracle and PHP

L-GPL - Lesser GNU Public License

LIC - Life Insurance Company

LIGO - Laser Interferometer Gravitational Wave Observatory

LSAT - Law School Admission Test

LUG - Linux User Group

MEITY - Ministry of Electronics and Information Technology

MHRD - The Ministry of Education, formerly the Ministry of Human Resource Development

IKM - Information Kerala Mission

MIT AI Lab - Massachusetts Institute of Technology Artificial Intelligence Lab

MITS - Massachusetts Institute of Technology Artificial Intelligence Lab

MNC - Multinational Corporations

MOOC - Massive Open Online Courses

MOSIP - Modular Open Source Identity Platform

MOSS - Mozilla Open Source Support

MoU - Memorandum of Understanding

MPL - Mozilla Public License

Ms-RFL - Microsoft Reference Source License

MSME - Micro Small Medium Enterprises

MySQL - My Structured Query Language

NASA - National Aeronautics and Space Administration

NASSCOM - National Association of Software and Service Companies

NCERT - National Council of Educational Research and Training

NEP - National Education Policy

NETF - National Education Technology Forum

NIRDPR-NERC - North Eastern Regional Centre of the National Institute of Rural Development

NMEICT - National Mission on Education through Information and Communication Technology

NPTEL - National Programme on Technology Enhanced Learning

NRCFOSS - National Resource Center for Free and Open Source Software

OER - Open Education Resources

OSM - Open Street Maps

OSI - Open Source Initiative

OSS - Open Source Software

OSSICS - Open Software Solutions Industrial Cooperative Society

PARC - Palo Alto Research Center; formerly Xerox PARC

PHP - Hypertext Preprocessor

R&D - Research & Development

RFP - Request For Proposal

RTE - Right of Children to Free and Compulsory Education Act

SAT - Scholastic Assessment Test

SBI - State Bank of India

SDPK - Skill Delivery Platform of Kerala

SFLC - Software Freedom Law Centre

SPACE - Society for Promotion of Alternative Computing & Employment

STADE - Space Technology Application Dev. ecosystem

STEM - Science, Technology, Engineering and Mathematics

TCS - Tata Consultancy Services

TIFR - Tata Institute of Fundamental Fundamental Research

TUG - TeX User Groups

UI/UX - User Interface/User Experience

UNDP - United Nations Development Programme

UNIX - Uniplexed Information and Computing Service

USB - Universal Serial Bus

Chapter 01

Introduction

1.1 India and the FOSS Landscape

From finding fraud in terabytes of data generated at Bombay Stock Exchange to running major e-governance projects like IRCTC in the country, FOSS has been powering growth in different forms at scale.

As of August 2020, more than 85% of India's internet is powered by free and open source software [77]. Today, FOSS enables billions of users across the globe to connect in the digital and real world, it powers the operating system in our smartphones, makes web applications and servers secure to use and enables timely functioning of ATM machines.

It has proven itself a boon for various developing economies, helping them to better manage their digital infrastructure costs and ensuring safer public service delivery to its citizens.

India plays a vital role in the global FOSS landscape. We are the world's third largest base of technologists[78] (after US & China) building a variety of software using open source repositories. FOSS is prominently used in major industries in the country including finance, retail, education, healthcare, transport and more. Vibrant developer communities, research groups, academia, private sector and government services have been adopting and building FOSS based interventions.

From finding fraud in terabytes of data generated at Bombay Stock Exchange [79] to running major e-governance projects like IRCTC in the country [80], FOSS has been powering growth in different forms at scale.

Despite evident economic and social benefits of FOSS, India still lags behind when it comes to leading FOSS innovations, contributing back into popular projects and building open source code that can be used globally [81].

[77] Web Server Usage Distribution in the Top 1 Million Sites," Web Server technologies Web Usage Distribution, accessed October 20, 2020, https://trends.builtwith.com/web-server.

[78] "The State of the Octoverse," The State of the Octoverse, accessed October 20, 2020, https://octoverse.github.com/.

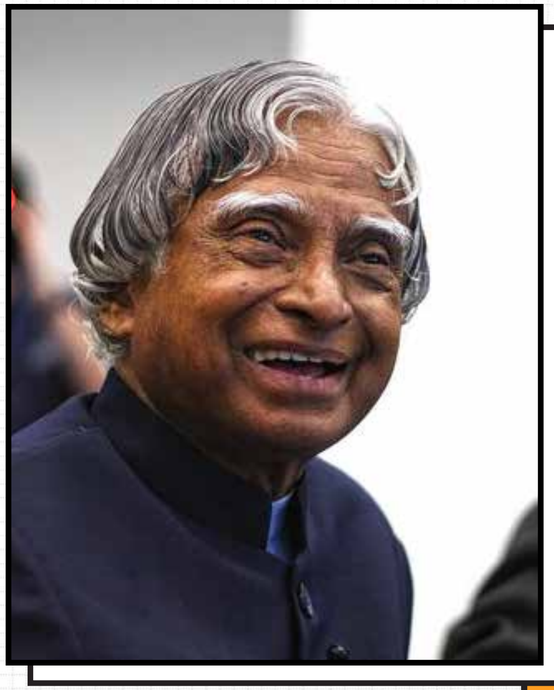
[79] Sangram Aglave, "Open source Is What Makes Bombay Stock Exchange the Fastest Exchange Says BSE IT Chief Kersi Tavadia," BW CIOWORLD, December 2018, http://bwcio.businessworld.in/article/Opensource-is-what-makes-Bombay-Stock-Exchange-the-fastest-exchange-says-BSE-IT-Chief-Kersi-Tavadia/18-12-2018-165155/.

[80] The Centre for Railway Information Systems (CRIS) books more, happier passengers with infrastructure powered by, accessed Oct 20, 2020 Red Hat.https://www.redhat.com/en/files/resources/en-rh-cris-books-more-happier-passengers-infrastructure-powered-by-red-hat-12022727.pdf.

[81] Ajinkya Deshmuk, "#SoftwareFreedom: India's Lukewarm Relationship with FOSS Needs to Change, " The Wire, September 2016, https://thewire.in/government/softwarefreedom-indias-lukewarm-relationship-with-foss-needs-to-change.

These constraints are restricting us to leverage our talent and build solutions for the growing first-time technology users in the country.

In 2003, former President of India, late Dr. A.P.J Abdul Kalam, gave a speech calling out that India needs to strategically move away from proprietary software and we need to pave a strong pathway for FOSS for the benefit of our billion Indian citizens.



The most unfortunate thing is that India still seems to believe in proprietary solutions. Further spread of IT which is influencing the daily life of individuals would have a devastating effect on the lives of society due to any small shift in business practice involving these proprietary solutions. It is precisely for these reasons open source software needs to be built which would be cost effective for the entire society. In India, ***open source code software will have to come and stay in a big way for the benefit of our billion people.***

- Dr. APJ Abdul Kalam

1.2 The Need for Mapping the State of FOSS in India

Since the last decade, FOSS continues to push and thrive in areas as diverse as the web, mobile computing, embedded systems, robotics, computer graphics, gaming, virtual reality, big data, artificial intelligence, and cloud server infrastructures.

The roots of FOSS in India date back to late 1980s and early 1990s, with the mushrooming of TeX Users Groups (TUGs) [82], Indian Linux User Groups (ILUGs) [83] and Free Software User Groups (FSUGs) across the country. These local communities became centres of activity for people to gather, share ideas, and co-create software. Over the last few decades, FOSS in the country has been powering huge social movements. India witnessed ”Freedom Walks” covering 1200+ kilometres promoting activism in software freedom [84].

Between 2006-2008, countries around the world were approving Microsoft’s Open Office XML as an ISO standard. During this time, the technical committee in the Bureau of Indian Standards (BIS) voted against it. The technical committee was made up of local communities, big tech companies, NASSCOM et cetera. It was a landmark vote, a David & Goliath Moment with 13-5 against. The five mostly coming from NASSCOM, Tata Consultancy Services (TCS), Wipro and Infosys who voted in favor of Open XML becoming an ISO standard [85].
The community also ran a successful campaign to stop the introduction of Software Patents in India in 2005 (Patent Amendment bill 2005) [86].

There are many such stories around this movement, that remain undocumented but have been crucial in shaping India’s journey. In this report we have attempted to chronicle some of these narratives. We see this as a first step towards creating a living archive for coming generations to learn about our FOSS heritage.

82 “TeX Users Group (TUG),” TeX Users Group (TUG), accessed October 21, 2020, https://www.tug.org/.

83 Gnukish, “Linux User Groups in India,” LinuxQuestions.org, 2005, https://www.linuxquestions.org/questions/linux-user-groups-lug-51/linux-user-groups-in-india-334877/.

84 “Freedom Walk: To Claim, Ensure and Preserve Freedom!,” Freedom Walk, accessed October 20, 2020, http://www.freedomwalk.in/.

85 John Ribeiro, “India Rejects Office Open XML Again,” InfoWorld (IDG News Service, March 21, 2008), https://www.infoworld.com/article/2642706/india-rejects-office-open-xml-again.html.

86 “Say No To Software Patents,” FOSS Community India, accessed October 21, 2020, https://fci.fandom.com/wiki/Say_No_To_Software_Patents.

87 Prerna Sindwani, “From TCS and Infosys to Microsoft

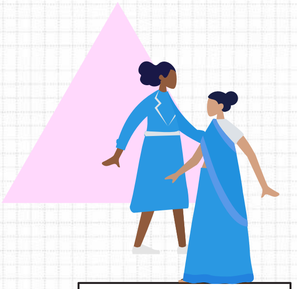
THE FOSS ECOSYSTEM

A diverse range of stakeholders have been a part of India's FOSS journey, and played a crucial role in shaping the FOSS ecosystem.

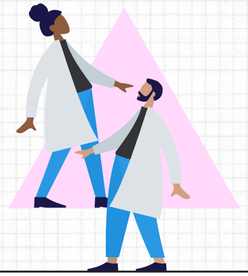
National Governments

Global Tech Firms

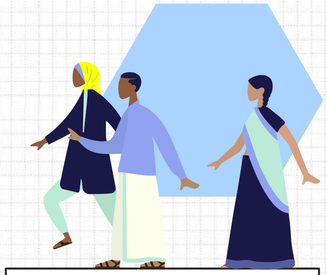
Investors



Online Education



Higher Education & Research Institutues



State & Local Governments

Volunteers

Micro, Small & Medium Enterprises

Schools

FOSS Groups

Non- Profit Organisations

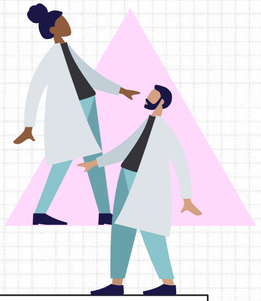
Consultants

The Stakeholder Buckets

These varied stakeholders could be grouped into the following stakeholder buckets.

FOSS & Community

- FOSS Groups
- Funders
- Non Profit Organisations
- Volunteers



FOSS & Education

- Higher Education & Research Institutes
- Online Education
- Schools

FOSS & Businesses

- Global Tech Firms
- Micro, Small & Medium Enterprises
- Consultants

FOSS & Governments

- National Governments
- State & Local Governments

1.3 Major Promises FOSS brings for India

A thriving, co-creative and participatory FOSS ecosystem can unlock a number of benefits for India. If the above mentioned key stakeholders can come together and collaborate to build a sustainable FOSS ecosystem, we believe it will propel growth in following areas:

Technology Growth

With a prospering FOSS ecosystem we would be able to build more robust digital infrastructure for key sectors like Health, Education, Finance, Agriculture and others. Largely because of the transparent nature of FOSS where the source code is available to investigate, critique, and improve, we can further enable more data-driven decision making alongside privacy centric, secure, ethical, and trust based computing. Due to the ability to fork the code and modify it, we could also onboard more users by delivering our digital services in more Indian Languages.

Economic Growth

We would be able to substantially reduce the cost of ownership and maintenance of our public and private digital infrastructure and services. This is because FOSS allows for reuse instead of investment in new software for each use case.

FOSS also enables customization, localization, and personalization of software for different types of users. Major software buyers including government agencies will be able to avoid vendor lock-ins and reduce switching costs, while newer players like MSMEs will have a better ease of tech adoption because of the strong backing of community support on the stacks they build on top of.

Talent Growth

FOSS promotes a commons-based peer production of information, knowledge and culture. It will help our youth further inculcate key skills like leadership, collaboration, and participation. As of 2020, India's IT workforce accounts for 4.36 million employees [87]. With wider adoption of FOSS India's technology talent can develop market ready skills and have opportunities for collaboration across sectors and geographies.

and Kissflow - This Is What Top Execs Have to Say about Productivity in Remote Working," Business Insider, June 22, 2020, https://www.businessinsider.in/business/corporates/news/tcs-infosys-and-microsoft-execs-share-ideas-on-world-productivity-day/articleshow/76462291.cms.

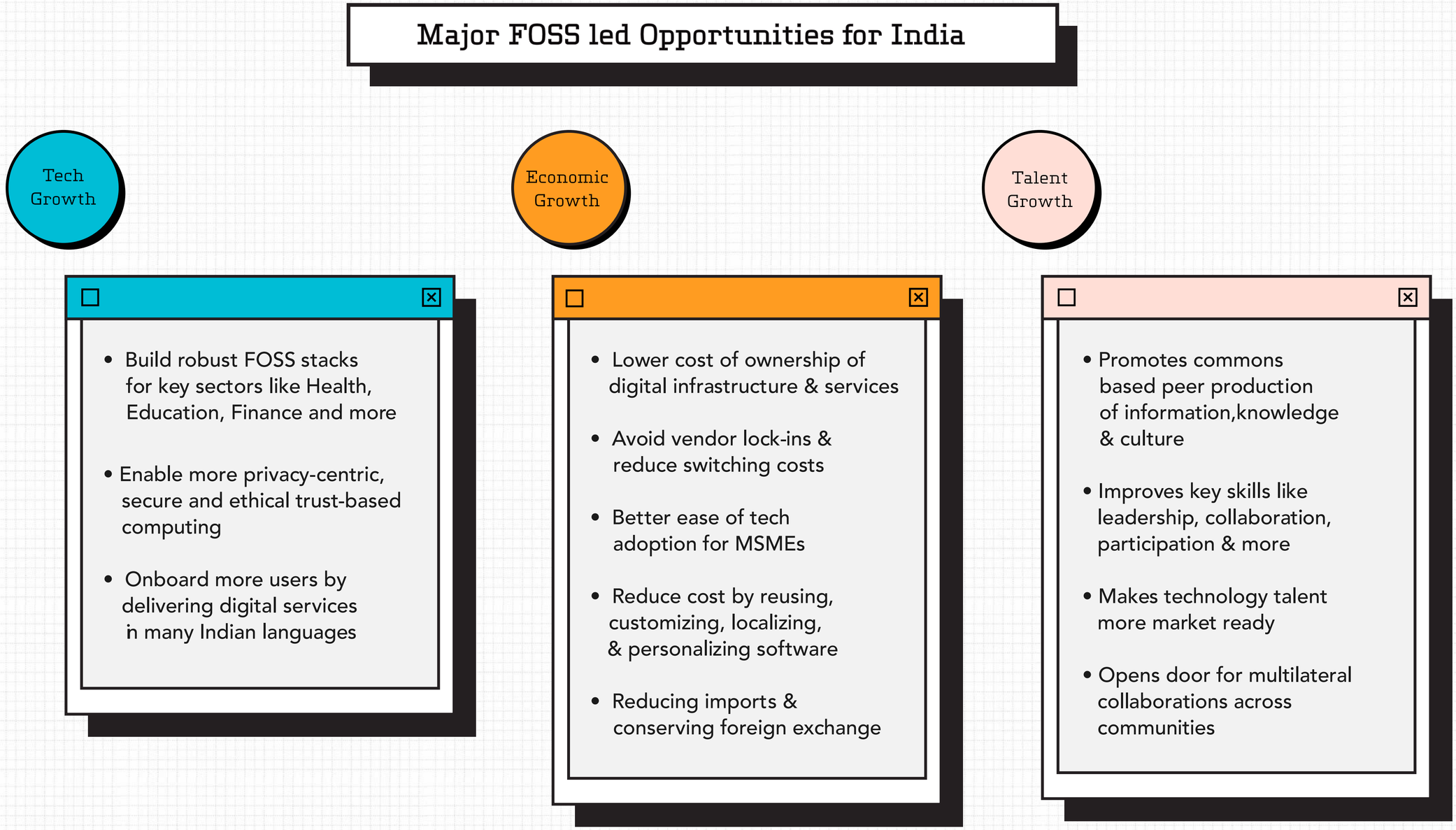
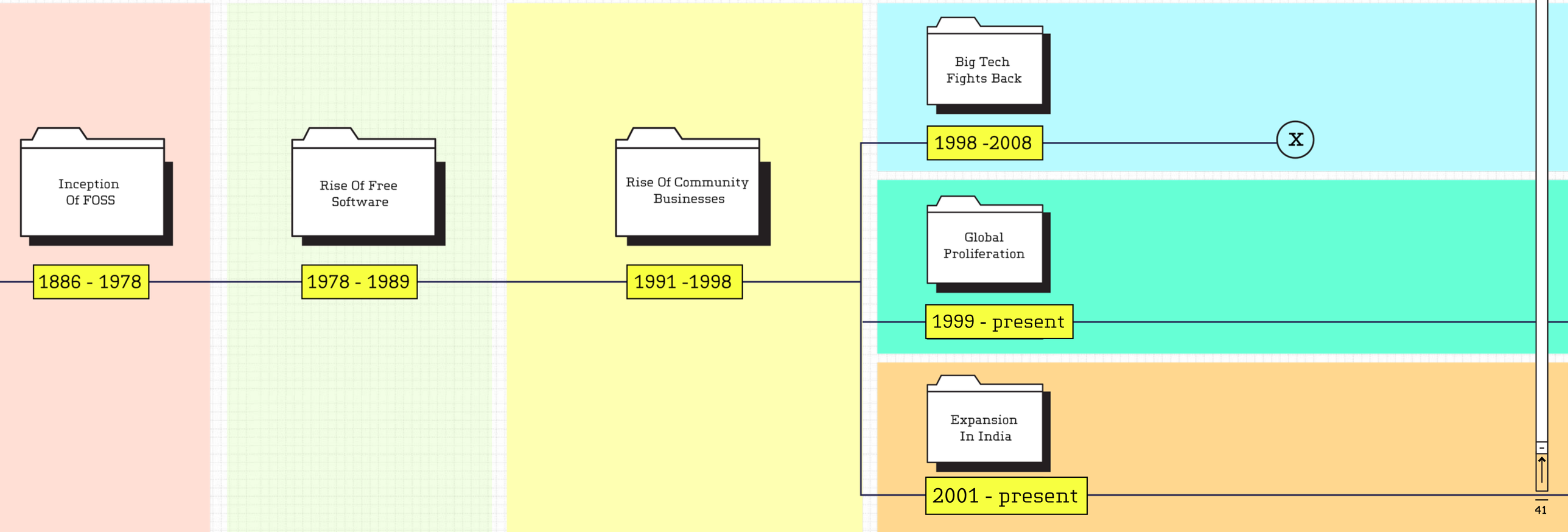


Figure 7: Areas for Major FOSS led Opportunities in India

1.4 Chronicling the FOSS movement in India

Based on our conversations and reading, we classified the FOSS movement:

The 6 eras of FOSS



Bird's Eye View of the FOSS timeline

Best viewed as 2 page spread

1886 — Switzerland, Berne
Berne Convention introduces the concept of copyright

1953 — United States
First example of FOSS: A-2 systems

1955 — United States
First example of Community: SHARE

1978 — United States
Donald Knuth creates TeX

1980 — Kerala, Thiruvananthapuram
TeX comes to India

1978 — Maharashtra, Bombay
Centre for Education and Documentation is set up in Bombay, India

1983 — United States
The GNU Project
A free software, mass collaboration project announced

1983 — United States
Operating Systems and Machine Readable code become copyrightable: Apple Computer, Inc. v. Franklin Computer Corp.

1985 — United States
Establishment of Free Software Foundation

1987 — United States, Massachusetts, Boston
GNU General Public License is created

1987 — India, Maharashtra, Pune
India establishes C-DAC as a part of the programme to build an indigenous supercomputer

1990 — Maharashtra, Bombay
Linux spreads through PC-Quest in India

1991 — Finland
The Linux kernel is released

1993 — United States
Red Hat is founded by Bob Young & Marc Ewing

Inception Of FOSS

Rise Of Free Software

Rise Of Commun

Expansion In India

India

Steve Ballmer calls Linux "a cancer"

Halloween Documents leaked from Microsoft

Samizdat: And Other Issues Regarding the 'Source' of Open Source Code

ISO accepts OOXML

1998 2001 2004 2008 X

Global Proliferation

United States, California, San Francisco

The Linux Foundation is set up

Linus Torvalds begins work on Git

Microsoft gets a seat on the Linux Foundation

Microsoft acquires GitHub for $7.5 Billion

IBM acquires Red Hat for $34 Billion

United States, California, Palo Alto

The Open Source Initiative is set up

United States, California, Palo Alto

The birth of "Open Source"

United Kingdom

The Raspberry Pi is developed

1997 1998 1999 2000 2005 2008 2012 2016 2018 2019

United States, California, Palo Alto

The Apache Software Foundation is set up

Google goes big on FOSS with Android & Chromium

India

Linux User Groups

India Linux Users Group Delhi

Bangalore Linux User Group

Expansion in India

Kerala, Trivandrum

Richard Stallman inaugurates the FSF India, the first in Asia

First FOSS.in conference

NRCFOSS set up by GoI to popularize FOSS in India

ICFOSS is set up by Kerala Govt. to promote FOSS usage

Courts in India switch to Ubuntu

Framework for adoption of OSS is released by GoI

India says no to OOXML as an open standard

FOSS businesses grow in India

2001 2005 2008 2009 2011 2015 2018

nity Businesses

Inception Of FOSS

$_ Public domain software is prevalent around the world. **We see the first known examples of FOSS and community.** UNIX OS is realeased into the world, with conditions applied.

$_ **Bill Gates writes an "Open Letter to Hobbyists"** expressing dismay against sharing of software without license fee.

1886

Switzerland, Berne

Berne Convention introduces the concept of copyright

Director General of the World Intellectual Property Organization

Signed by 179 countries, The Berne Convention formally mandated several aspects of modern copyright law; it introduced the concept that a copyright exists the moment a work is "fixed", rather than requiring registration.

1950s - 1960s

Public Domain Software

1953

United States

A2 System: The first example of FOSS

Grace Murray Hopper's work on the A0- System and leading the UNIVAC division of Remington Rand helps the development of A2-, the first example of FOSS.

Fig 01: Grace Murray Hopper

1955

United States. Los Angeles

SHARE: First example of community

Some users of the IBM 701 computer systems, voluntarily founded a group called SHARE. Technical information about programming languages, operating systems, database system was distributed through magnetic tapes.

1969

United States, New Jersey, Murray Hill

UNIX OS distribution kicks-off

Bell Labs, Ken Thompson and Dennis Ritchie

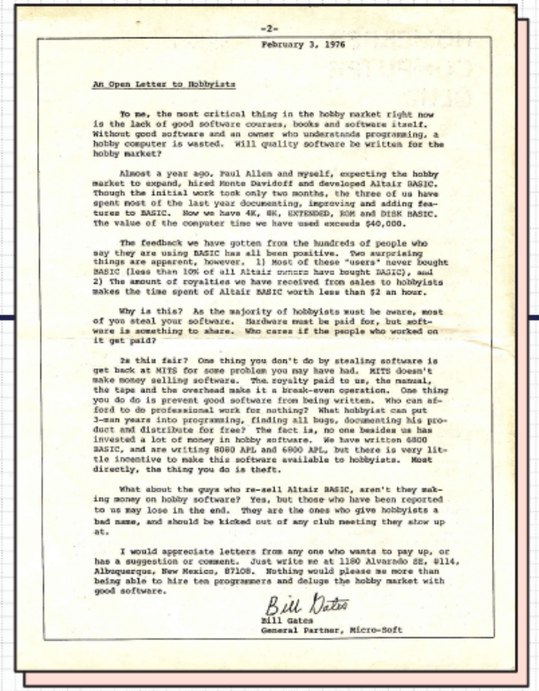
AT&T distributed early versions of Unix at no cost to government and academic researchers, without permission to redistribute or to distribute modified versions. In 1980s they also started charging for system patches.

1976

United States, New Mexico, Albuquerque

Bill Gates writes an "Open Letter to Hobbyists"

In 1976 Bill Gates wrote an essay entitled "Open Letter to Hobbyists" in which he expressed dismay at the widespread sharing of Microsoft's product Altair BASIC by hobbyists without paying its licensing fee.



-2-

February 3, 1976

An Open Letter to Hobbyists

To me, the most critical thing in the hobby market right now is the lack of good software courses, books and software itself. Without good software and an owner who understands programming, a hobby computer is wasted. Will quality software be written for the hobby market?

Almost a year ago, Paul Allen and myself, expecting the hobby market to expand, hired Monte Davidoff and developed Altair BASIC. Though the initial work took only two months, the three of us have spent most of the last year documenting, improving and adding features to BASIC. Now we have 4K, 8K, EXTENDED, ROM and DISK BASIC. The value of the computer time we have used exceeds $40,000.

The feedback we have gotten from the hundreds of people who say they are using BASIC has all been positive. Two surprising things are apparent, however. 1) Most of these "users" never bought BASIC (less than 10% of all Altair owners have bought BASIC), and 2) The amount of royalties we have received from sales to hobbyists makes the time spent of Altair BASIC worth less than $2 an hour.

Why is this? As the majority of hobbyists must be aware, most of you steal your software. Hardware must be paid for, but software is something to share. Who cares if the people who worked on it get paid?

Is this fair? One thing you don't do by stealing software is get back at MITS for some problem you may have had. MITS doesn't make money selling software. The royalty paid to us, the manual, the tape and the overhead make it a break-even operation. One thing you do do is prevent good software from being written. Who can afford to do professional work for nothing? What hobbyist can put 3-man years into programming, finding all bugs, documenting his product and distribute for free? The fact is, no one besides us has invested a lot of money in hobby software. We have written 6800 BASIC, and are writing 8080 APL and 6800 APL, but there is very little incentive to make this software available to hobbyists. Most directly, the thing you do is theft.

What about the guys who re-sell Altair BASIC, aren't they making money on hobby software? Yes, but those who have been reported to us may lose in the end. They are the ones who give hobbyists a bad name, and should be kicked out of any club meeting they show up at.

I would appreciate letters from any one who wants to pay up, or has a suggestion or comment. Just write me at 1180 Alvarado SE, #114, Albuquerque, New Mexico, 87108. Nothing would please me more than being able to hire ten programmers and deluge the hobby market with good software.

Bill Gates

Bill Gates
General Partner, Micro-Soft

Rise Of Free Software

$_ TeX is created by Donald Knuth. **The inception on Free Software Movement** takes place with Richard Stallman at the helm.

$_ **Copyright is now applicable to Operation Systems** and machine readable code. The basis for modern copyright law is established.

$_ Centre for Education and Documentation is set up in India.

$_ **India is introducted to TeX** and C-DAC was founded in response to international superpowers.

1978

TeX

United States

Donald Knuth creates TeX

A system designed by Donald Knuth for typesetting complex mathematical formulae with the source code in the public domain it has been noted as one of the most sophisticated digital typographical systems.

Maharashtra, Bombay

Centre for Education and Documentation is set up to promote the use of FOSS among non-profits and journalists

1980

Kerala, Thiruvananthapuram

TeX comes to India

Prof. K.S.S. Nambooripad ; Department of Mathematics, University of Kerala

Kerala is introduced to the idea of free software with Prof. Namburipad encouraging his students to learn and use TeX, especially for preparing their theses. Brought in fourteen floppy disks from the United States. It could be used on a number of computers without any legal problem because it had no licences it was in the public domain.

1982

United States

Andrew Fluegelman coins the term Freeware : Proprietary software, distributed at no monetary cost to the end user

Fig 02: Richard Stallman

1983

United States

The GNU Project
A free software, mass collaboration project announced

United States

Operating Systems and Machine Readable code become copyrightable - Apple Computer, Inc. v. Franklin Computer Corp.

United States Court of Appeals for the Third Circuit

The first time an appellate level court in the United States held that a computer's operating system could be protected by copyright. As second impact, this ruling clarified that binary code, the machine readable form of software, was copyrightable too and not only the human-readable source code form of software.

1985

United States

Establishment of Free Software Foundation

The word "free" in our name does not refer to price; it refers to freedom.

United States, Massachusetts, Boston

GNU General Public License is created

1987

United States

Software is now by default copyright-protected; Berne Convention Implementation Act of 1988

1989

India, Maharashtra, Pune

India establishes C-DAC, which goes on to spearheading FOSS initiativse within the country through NRCFOSS

Pune University Campus, Ganesh Khind

Originally the Centre for Development of Advanced Computing Technology (C-DACT), C-DAC was set up in response to issues purchasing supercomputers from foreign sources. After being denied a Cray supercomputer by the United States in 1987, due to military use concerns, India started a programme to develop an indigenous supercomputer. C-DAC was created as part of this programme.

Rise Of Community & Businesses

$_ **Linus Torvalds creates** and releases the Linux Kernel to the world

$_ With the release of the Linux kernel, **Red Hat is created** which sells a Linux distribution and would in a decade **become one of the largest FOSS companies in the word.**

$_ **Linux also comes to India** and Linux User Groups pop up all over India.

$_ **Eric Raymond** (author of the essay *The Cathedral and the Bazaar*) looked for a way to rebrand the Free software movement to emphasize the business potential of sharing and collaborating on software and **introduces the term "Open Source"**

1991

Finland

The Linux kernel was released

Linus Torvalds, University of Helsinki

The Linux kernel was released as freely modifiable source code in 1991. The license was not a free software license, but with version 0.12 in February 1992, was relicensed the project under the GNU General Public License.

India

Linux spreads through PC-Quest in India

Computer magazines like PC-Quest boost interest in FOSS (or Linux) by regularly writing articles, and sharing software on CDs and DVDs from this field. Among the early writers are the late Atul Chitnis.

1992

United States, New Mexico, Albuquerque

Unix Wars; USL vs BSDi a culmination of intellectual property battle for UNIX OS

United States

386BSD (Jolix): First FOSS BSD Unix released independent of the AT&T license

1993

United States

Red Hat is established by Bob Young & Marc Ewing

Bob Young & Marc Ewing

Red Hat, Inc. , an American multinational software company that provides open source software products to enterprises. Evolves into one of the largest open source software companies in the world.

1995

The first release of a widely used FOSS relational database management system MySQL

1996

The origin of Red Hat Linux

X/Open & Open Software Foundation merge to form the Open Group

1997

India

Linux India mailing list set up by Thats

Arun Sharma and Karra Dakshinamurthy

Linux India, a network of mailing lists is founded to help propagate and learn the Linux operating system and associated tools. In the early days, the electronic mailing lists were under the adminship of Sudhakar Chandrasekharan also known as Thaths.

Eric Raymond publishes The Cathedral and the Bazaar

United States, California, Palo Alto

The birth of "Open Source"

In 1997, Eric Raymond published The Cathedral and the Bazaar, a reflective analysis of the hacker community and Free software principles, a factor in motivating Netscape Communications Corporation to release Netscape Communicator Internet suite as Free software

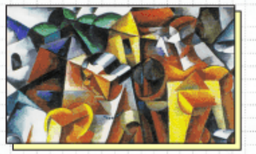


Fig 03: Cathedral & Bazaar Cover

1998

India

Linux User Groups

India Linux Users Group Delhi

Bangalore Linux User Group

Fig 04: FOSS communities crop up across India

Global Proliferation

$_ **The Open Source Initiative is set up** in 1999 by Bruce Perens and Eric S Raymond to promote the use of FOSS. Both VA Linux and Red Hat become publicly traded companies indicating the mainstreaming of FOSS with large IPO's

$_ The early 2000s also saw the set up of many foundations such as the Linux Foundation, Apache Software Foundation, Mozilla Foundation.

$_ The Mid2000-s sees Git (a distributed version control software) being released by Linus Torvalds and soon after GitHub, a closed version of the same.

$_ In 2008, Google enters the fray by open-sourcing the AndroidOS, Chromium and Chromium OS

$_ And finally around 2014, Microsoft does a 180 by adopting more FOSS: Open the .Net framework, gets a seat in the Linux Foundation, sponsors the Open Source Initiative, and finally acquires GitHub. Meanwhile IBM acquires Red Hat.

$_ Now, more than half of top10 projects on Github (with respect to contributions) are owned by large corporations such as Google, Facebook, Amazon, Microsoft etc...

1999

United States, California, Palo Alto

The Open Source Initiative is set up

Bruce Perens and Eric S. Raymond

The Open Source Initiative (OSI) was set up to promotes the usage of Open Source Software. The organization was part of a group inspired by the Netscape Communications Corporation publishing the source code for its flagship Netscape Communicator product.

Red Hat and VA Linux become publicaly traded FOSS businesses

SourceForge is founded by Geeknet, Inc., creating the first web-based source code repository for FOSS developers to host & manage projects for free

United States, Massachusetts, Wakefield

The Apache group sets up the Apache Software Foundation

2000

United States, California, San Francisco

The Linux Foundation is set up

Linus Torvalds

Set up with the goal to empower FOSS projects, accelerate technology development and commercial adoption The project was is an initiative that was taken in 2000 via the OSDL which later merged with the Free Standards Group.

2003

United States, California, Palo Alto

The Mozilla Foundation is set up to ensure the organizations survival

2005

Linus Torvalds begins work on Git, the distributed version control software

Linus Torvalds

Git development began after many developers of the Linux kernel gave up access to BitKeeper, a proprietary source-control management (SCM). The copyright holder of BitKeeper, Larry McVoy, withdrew free use of the product after claiming that Andrew Tridgell had created SourcePuller by reverse engineering the BitKeeper protocols.

2007

OpenJDK released by Oracle as Open Source

2008

Google goes big on FOSS

Android OS is released under Open Source

Open Source Chromium browser is launched

OpenSource stripped down distribution of linux - Chromium OS is released

GitHub, hosting for software development and version control using Git is released.

2010

United Kingdom

The Document Foundation releases LibreOffice

2012

Court finds Google not guilty of patent infringment

United Kingdom

The Raspberry Pi is developed

2014

Microsoft OpenSources .NET framework

2016

Microsoft gets a seat on the Linux Foundation

2017

Microsoft is a leading contributor to FOSS projects and sponsors OSI

Microsoft shifts gears

2018

IBM acquires Red Hat for $34 Billion making it the largest software acquisition

Microsoft acquires GitHub for $7.5 Billion

2019

Big Tech Fights Back

$_ In the late 1990s, Microsoft came to view the growing FOSS movement as a large threat and from that period, a set of memos were leaked called the "Halloween documents" that discussed strategies to extinguish FOSS and Steve Ballmer (CEO of Microsoft) calls FOSS as a cancer.

$_ The International Organization for Standardization accepts Microsoft's Office Open XML as a standard for open document formats *(it was rejected by India twice)*

1990

Halloween Documents leaked from Microsoft

Internal strategy memos from Microsoft, known as the Halloween documents, describe the company's potential approaches to stopping open source momentum. One strategy was "embrace-extend-extinguish", in which Microsoft would adopt standard technology, add proprietary extensions, and upon establishing a customer base, would lock consumers into the proprietary extension to assert a monopoly of the space.

2001

From Lindows to Linspire

Based on and inspired by the Wine API, an open source project created in 1993 to bring Windows applications to Linux.

In 2002, Microsoft sued Lindows for a violation against the Windows trademark, but the court rejected Microsoft's claim. However, in a settlement Microsoft paid 20 million USD for the Lindows trademark and Lindows changed its name to Linspire.

Steve Ballmer calls Linux "a cancer"

In 2001, Microsoft's CEO, Steve Ballmer, even referred to Linux as "a cancer that attaches itself in an intellectual property sense to everything it touches". Ballmer contended that open source was in no way a viable business model for commercial companies.

2003

SCO–Linux disputes

SCO, a proprietary Unix and former Linux distribution vendor alleged that Unix intellectual property had been inappropriately copied into the Linux kernel, and sued IBM, claiming that it bore responsibility for this.

However, SCO's allegations lacked specificity. Some in the media reported them as credible, and many critics of SCO believed the allegations to be highly dubious at best.

2004

Samizdat: And Other Issues Regarding the 'Source' of Open Source Code

In 2004, Alexis de Tocqueville Institution (ADTI) announced its intent to publish a book, Samizdat: And Other Issues Regarding the 'Source' of Open Source Code, showing that the Linux kernel was based on code stolen from Unix, in essence using the argument that it was impossible to believe that Linus Torvalds could produce something as sophisticated as the Linux kernel. The book was never published, after it was widely criticised and that ADTI did not try to contact Linus Torvalds, or ever put the allegations to him to allow a response.

2008

ISO accepts OOXML

ISO published Microsoft's Office Open XML as an international standard, which crucially meant that it, and therefore Microsoft Office, could be used in projects where the use of open standards were mandated by law or by policy. Critics of the standardisation process, including some members of ISO national committees involved in the process itself, alleged irregularities and procedural violations in the process.

X

Expansion In India

$_ **The Open Source Initiative is set up** in 1999 by Bruce Perens and Eric S Raymond to promote the use of FOSS. Both VA Linux and Red Hat become publicly traded companies indicating the mainstreaming of FOSS with large IPO's

$_ The early 2000s also saw the set up of many foundations such as the Linux foundation, Apache Software Foundation, Mozilla Foundation.

$_ The Mid2000-s sees Git (a distributed version control software) being released by Linus Torvalds and soon after GitHub, a closed version of the same.

$_ In 2008, Google enters the fray by open-sourcing the AndroidOS, Chromium and Chromium OS

$_ And finally around 2014, Microsoft does a 180 by adopting more FOSS: Open the .Net framework, gets a seat in the Linux foundation, sponsors the Open Source Initiative, and finally acquires GitHub. Meanwhile IBM acquires Red Hat.

$_ Now, more than half of top 10 projects on Github (w.r.t contributions) are owned by large corporations such as Google, Facebook, Amazon, Microsoft etc...

FREE SOFTWARE FOUNDATION OF INDIA

Kerala, Trivandrum

Richard Stallman inaugurates Free Software Foundation India, the first in Asia at the Freedom First! Conference on Free Software

foss.in

First FOSS.in conference which would become one of the biggest events in Asia

Fig 05: Linux Bangalore Conference (later FOSS.in)

2001

IT@School by Kerala govt. creates Free Software based IT trainings in 12,000 public schools

2002

The Public Works Department in Kerala moves to FOSS

Kerala, Trivandrum

SMC is formed: the biggest language computing developer community in India

Byju Muthukadan

Swathanthra Malayalam Computing (SMC) has been involved in the Malayalam translation of GNOME KDE, and Mozilla projects like Firefox.

2005

NRCFOSS

NRCFOSS set up by GoI to popularize FOSS in India

The National Resource Centre for Free/Open Source Software (NRCFOSS) was the first initiative by the GoI towards increasing the acceptance of FOSS at a national level.

Kerala, Trivandrum

The 4th International GPL v3 conference takes place

Kovid Goyal creates Calibre an e-book management system

2007

The Electronics Corporation of Tamil Nadu migrates to OpenSUSE

BOSS Linux is released in four editions

Best viewed as 2 page spread

2008

The Kerala State Electricity Board moved to a FOSS platform called ORUMA

Fig 06: KSEB moves to ORUMA

2009

ICFOSS is set up by Kerala Govt. to promote FOSS usage

Conceptualised to popularize FOSS for universal use; consolidating the early FOSS work done in Kerala; and networking with different nations, communities and governments to collaboratively promote FOSS.

2010

The Software Freedom Law Centre sets up it's India base

SFLC.in brings together lawyers, policy analysts and technologists to fight for digital rights, protect the freedom of the software and reports on the state of the Indian internet, and also has a productive legal arm.

2011

All courts in India directed to switch to Ubuntu 10.04

The Supreme Court of India directed all courts across the nation to switch over to Ubuntu 10.04. The apex court also gave all the courts customised Ubuntu Linux DVD for installation.

2013

The GoI drafts the framework for adoption of OSS in e-Governance systems

FSF India responds to the draft framework with feedback to replace OSS with FLOSS, among other concerns

2014

Kerala Legislative assembly moves to GNU/Linux

2015

The framework for adoption of OSS is released

2018

FOSS businesses grow in India

India becomes a fertile ground for businesses using FOSS technologies. Businesses like ERPNext, Zerodha, Chatwoot, Hasura leading their space with FOSS based products, and ventures like Hasura receiving large scale funding and support.

2008

A FOSS Enterprise Resource Planning tool is created by Rushabh Mehta

India says no to OOXML as an open standard

The Bureau of Indian Standards (BIS), said the format was neither compatible nor interoperable with other formats such as the Open Document Format (ODF), the existing ISO standard for document interchange developed by the Free and Open Source Community.

Chapter 02

Our Approach

The objective of this study was to begin chronicling the FOSS ecosystem in India and to map the actors within this ecosystem. After which through interviews with different stakeholders, we identified key challenges faced in driving both contribution and adoption of FOSS in India.

The report is a clarion call for various stakeholders to come together and harness the Indian FOSS ecosystem as an essential step for nation building in terms of economic, technology and talent growth.

2.1 Interviews

We created a list of interviewees keeping in mind the need for equal representation from the different stakeholder categories.

We conducted around 50 semi structured interviews to draw out and document insights from each respondent on the key challenges face by the FOSS ecosystem and their various suggestions to address these challenges.

We also conducted some round table learning circles with many different stakeholder contributors.

2.2 Reading Circles

We started a reading circle to get through the many texts chronicling different histories. We split the books, papers, and articles amongst the team members and documented condensed versions, for the team to read and discuss and get more insights.

2.3 Limitations & Conflict of Interest

While designing this study, we tried to correct for biases in selection specifically for gender. However, despite our best efforts the report is still largely made up of cis-male points of view. This is indicative of biases prevalent in this ecosystem which goes far beyond gender.

The opinions expressed in the paper are the author's own opinions and do not condone the personal views of the individuals mentioned in the report.

While we have made every attempt to ensure that the information contained in this report is from reliable sources, if there are any corrections or modifications to make, please write to us at: **info@civicdatalab.in.**

FOSS tools used in the report

1. Jitsi [88] for our interviews
2. BigBlueButton [89] for our learning circles
3. SpaceDeck [90] for our brainstorming sessions
4. For the images in the report, we used the Open Source image library- *Humaaans by Pablo Stanley* [91], which we then modified to create more Indian versions of the characters.

88 "Jitsi", Accessed Oct 20 2020, https://jitsi.org/

89 "BigBlueButton", Accessed Oct 20 2020, https://bigbluebutton.org/

90 "Work Together, Visually." Spacedeck Open, accessed October 21, 2020, https://spacedeck.com/.

91 "Mix-&-match illustrations of people with a design library", humaaaans, accessed November 5 2020, https://www.humaaans.com/

FOSS & Communities

Regional & National level FOSS intrest groups across India

Eg:

- *Free Software Foundation*
- *FOSS@Amritra*
- *PyLadies Delhi*

FOSS Groups

Individuals volunteering time to contribute to the ecosystem and mobilising community

Eg:

- *Aruna Sankaranarayanan*
- *Balasubramanian D*
- *Cherry G Mathews*
- *Kamal Velan*

Volunteers

Help in grassroot adoption of FOSS by recommending policy and governance frameworks and funding and promoting FOSS initiatives

Eg:

- *Centre for Internet and Society*
- *FOSS United Foundation*
- *eGovernments Foundation*
- *IT for Change*
- *Mozilla Foundation*
- *Software Freedom Law Centre*

Non- Profit Organisation

Chapter 04

FOSS & Communities

4.1 Landscape

In the beginning, there was the hacker ethic [92]. Steven Levy in his book *Hackers: The heroes of the computer revolution* put down the principles as such:

A. Access to computers, and anything which might teach you something about the way the world works, should be unlimited and total. Always yield to the Hands-on Imperative!

B. All information should be free.Mistrust authority : promote decentralization.

C. Hackers should be judged by their hacking, not bogus criteria such as degrees, age, race or position. You can create art and beauty on a computer.

D. Computers can change your life for the better.

From 1950 to the early 80s the idea that software code which was neither fixed nor tangible could be protected under copyright did not exist. This changed in 1980, when the copyright law was extended to computer programs.

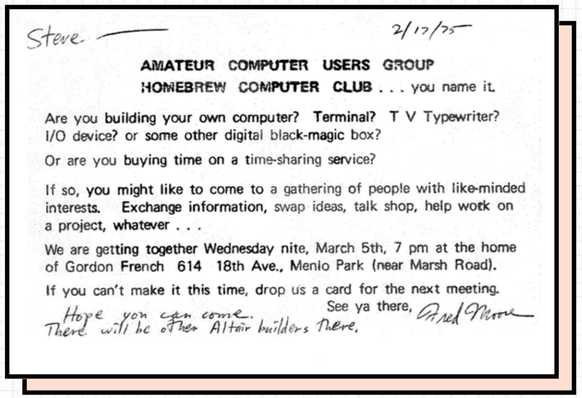
Starting in the 1950's and 60s, students & drop-outs from the MIT AI Lab, which was at that time lead by Marvin Minsky, started tinkering, exploring on these huge cumbersome machines, that they had at their disposal which required great effort to make even the smallest computation [This research was largely funded by the Department of Défense and ARPA]. They formed communities such as the *Tech Model Railroad Club* and the *Midnight Computer Wiring Society*.

The second wave of hackers was from the 1950s to the 60s as computers spread across America and with the creation of the ARPAnet (the precursor to the internet), so did the hacker ethic first within other Universities such as

[92] Steven Levy, Hackers: Heroes of the Computer Revolution (Harmondsworth: Penguin Books, 2001). ISBN 0-385-19195-2

Stanford AI Lab and Carnegie Mellon, and then within commercial Research centres such as AT&T & Xerox.

And finally, the third wave was in Northern California. Where they were trying to build computers they could modify and program at home. For Eg: *People's Computer Company* and *MITS* which created the Altair 8800 a computer kit with about 256 bytes of memory and cost US$397.



Steve — 2/17/75

AMATEUR COMPUTER USERS GROUP
HOMEBREW COMPUTER CLUB . . . you name it.

Are you building your own computer? Terminal? T V Typewriter? I/O device? or some other digital black-magic box?

Or are you buying time on a time-sharing service?

If so, you might like to come to a gathering of people with like-minded interests. Exchange information, swap ideas, talk shop, help work on a project, whatever . . .

We are getting together Wednesday nite, March 5th, 7 pm at the home of Gordon French 614 18th Ave., Menlo Park (near Marsh Road).

If you can't make it this time, drop us a card for the next meeting.

Hope you can come. See ya there, Fred Moore
There will be other Altair builders there.

The *Homebrew Computer Club* was formed and met for the first time in 1975 in a garage in Silicon Valley. This club quickly grew to the hundreds and included legendary figures such as Lee Felsenstein, Steve Dompier, Steve Wozniak, Steve Jobs, and Bill Gates, that laid the foundation for the entire personal computer industry of today. Two things happened in the early 80s which changed the course of the IT industry for the next few decades: The accessibility to computer hardware reached critical mass around 1980, and a legal decision altered copyright law to cover binaries in 1983 (Apple vs. Franklin) [93]. Around this time (in 1984), a young physics student named Richard M Stallman who was studying at Harvard was also hacking at the now dwindling MIT AI lab with many of the younger hackers moving on to get paying jobs and settling down. His witnessing of these changes in his formative years would shape his world view. In response, he developed the GNU Operating System [94] founded on the principles of Free Software thus setting in motion the wheels of the Free and Open Source Software movements that we know.

The FOSS movement would go on to take over the world in a few decades partly due to co-option of FOSS by big businesses that ran on the internet like Google [95], Facebook [96], Amazon [97], Netflix [98] et cetera.

Today, the motivations might range from a personal need such as fixing a few specific bugs that's bothering them, to engaging [99] with FOSS projects to hone their coding skills. Some are motivated by a larger belief in the ideology of FOSS and others by pure fun [100].

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[93] Jan L Nussbaum, "Apple Computer, Inc. v. Franklin ComputerCorporation Puts the Byte Back into Copyright Protection for Computer Programs," Golden Gate University Law Review 14, no. 2 (1984): pp. 281-308, https://doi.org/http://digitalcommons.law.ggu.edu/ggulrev/vol14/iss2/3.

[94] "The GNU Operating System and the Free Software Movement," [GNU head] , accessed October 21, 2020, https://www.gnu.org/.

[95] "Google," GitHub, accessed October 21, 2020, https://github.com/google/.

[96] "Facebook," GitHub, accessed October 21, 2020, https://github.com/facebook.

[97] "Amazon," GitHub, accessed October 21, 2020, https://github.com/amzn

[98] "Netflix, Inc.," GitHub, accessed October 21, 2020, https://github.com/netflix.

[99] Josh Lerner and Jean Tirole, "Some Simple Economics of Open Source," The Journal of Industrial Economics 50, no. 2 (2003): pp. 197-234, https://doi.org/10.1111/1467-6451.00174.

[100] Karim R Lakhani and Robert G Wolf, "Why Hackers Do What They Do: Understanding Motivation and Effort in Free/Open Source Software Projects," Perspectives on Free and Open Source Software (MIT Press), 2005. https://ocw.mit.edu/courses/sloan-school-of-management/15-352-managing-innovation-emerging-trends-spring-2005/readings/lakhaniwolf.pdf

3.1.1 History of FOSS Communities in India

Freedom must be understood as a product of unique cultural histories and within this context the idea of "Freedom" in India is influenced by the Indian struggle for independence, statehood and socialism.

As Jasmine Folz states in her 2018 thesis, *An ethnographic study on the FOSS ecosystem* in India [101] - *Freedom must be understood as a product of unique cultural histories and within this context the idea of "Freedom" in India is influenced by the Indian struggle for independence, statehood and socialism.*

On asking members of FOSS communities why they joined the community, their responses were of two kinds: :

1. They were influenced by the call for freedom as heard from the speeches of Stallman on his various visits to India, seeing the community as a means to rid one of inequalities of society.
2. It was new and seemed interesting from the traditional route of learning subjects in college, here one got an opportunity to tinker and build on their own, widening their own learning circle.

FOSS set its roots in India relatively early in the global FOSS timeline. In the 80s in India, all government agencies were mandated to use UNIX-the precursor to Linux and many academic institutions were already using TeX-an academic typesetting system.

With Linux entering the fray in 1991, the move to Linux was an easy one especially for most universities. As more Linux enthusiasts came out of these institutions and its popularity grew, Linux User Groups (LUGs) were being formed in almost all major cities with a growing Linux India mailing list through which the volunteers communicated. The testament to the sustenance of these groups are the many individuals in their early 20s that we interviewed who had been introduced to Linux and FOSS through these user groups.

[101] Jasmine m Folz, "Free and Open Source Software in India: Mobilising Technology for the National Good" (dissertation, 2019). https://www.research.manchester.ac.uk/portal/en/theses/free-and-open-source-software-in-india-mobilising-technology-for-the-national-good(41c31286-4476-4f8e-9fcd-3c3034a5d450).html

Until the late nineties, the internet was still, largely, a privilege for government institutions but that started changing as Internet Service Providers became more accessible.

Another large initiator into FOSS was the emergence of the PCQuest magazine, a FOSS evangelizing magazine [102], which would give away Linux CD's in the magazine, and the FOSS.in conference in the 90's and by the early 2000's there were a lot of FOSS conferences [103] that were nationally and internationally attended by many.

This move also popularized Red Hat [an American FOSS products & support company] in India and in 2000, it opened an Indian Office. Red Hat has been one of the organizations instrumental in localization of Linux for different languages, and popularizing the use of Linux within government and Indian enterprises [104].

Throughout the 2000's, the different user groups were evangelizing and promoting the use of FOSS at the grassroots in Indian states. Organizations such as Software Freedom Law Centre's (SFLC) [105] India chapter took on the role of defending the FOSS community from legal challenges, organizations like the Centre for Internet and Society (CIS) [106] and IT for Change [107] helped evangelize the use of FOSS.

The Landscape Shifts

From the late 2000's, globally, FOSS communities started rallying around popular FOSS projects [Python [108], Rust [109], TensorFlow [110]]. GitHub, the closed source version control tool became the place where this community resided and socialised. According to the GitHub Octoverse study, in 2019, there were 40m+ developers on GitHub with 10 million new users annually [111].

FOSS was taking over the world with its ubiquity, larger corporations were now appropriating FOSS technologies (For Eg: IBM acquired Red Hat [112], Microsoft acquired GitHub [113]).

102 Home Page, PCQuest, accessed October 21, 2020, https://www.pcquest.com/.

103 Leslie D'Monte, "Atul Chitnis-Champion of Open Source in India," mint, June 4, 2013, https://www.livemint.com/Industry/XAxZ8cLSg1XKLP5ck4mNTO/Atul-Chitnischampion-of-open-source-in-India.html.

104 "The World's Open Source Leader," Red Hat - We make open source technologies for the enterprise, accessed October 21, 2020, https://www.redhat.com/en.

105 "Software Freedom Law Center, India," Software Freedom Law Center, India, accessed October 21, 2020, https://sflc.in/.

106 "Homepage" Centre for Internet & Society, accessed October 21, 2020, https://cis-india.org/.

107 "IT for Change," Home, accessed October 21, 2020, http://www.itforchange.net/.

108 "Our Community," Python.org, accessed October 20, 2020, https://www.python.org/community/.

109 Abhiram Ravikumar, "Rust – A Growing Community in India," Mozilla India Blog, 2016, https://blog.mozillaindia.org/1721.

110 "Welcome to TensorFlow's Global Community," TensorFlow, accessed October 21, 2020, https://www.tensorflow.org/community.

111 "The State of the Octoverse," The State of the Octoverse, accessed October 20, 2020, https://octoverse.github.com/.

112 "IBM Closes Landmark Acquisition of Red Hat for $34 Billion; Defines Open, Hybrid Cloud Future," IBM News Room, accessed October 21, 2020, https://newsroom.ibm.com/2019-07-09-IBM-Closes-Landmark-Acquisition-of-Red-Hat-for-34-Billion-Defines-Open-Hybrid-Cloud-Future.

113 "Microsoft Acquires GitHub," Stories, accessed October 21, 2020, https://news.microsoft.com/announcement/microsoft-acquires-github/.

And within India, a similar shift was noted. As Indian FOSS communities started coming up around different popular FOSS projects (Eg: TensorFlow, Rust), the idea of a larger politically minded FOSS community that evangelizes and promotes FOSS was being replaced by smaller communities that were more interested in building and maintaining software without as much emphasis on ideologies.

In the early 2000's there were almost no FOSS projects to come out of India (with the notable exception of Calibre, an ebook software). This trend has reversed in the last decade, and in 2018, there were many projects originating within India (Hasura [114], Hoppscotch [115], Chatwoot[116]) which also have a community around them.

> Earlier linux and open source weren't different, the Venn diagram was 100% overlapping. Today you don't have to only be a Linux nerd, you can be a nerd of anything else
>
> *Arun Raghavan*
>
> *(a FOSS enthusiast and a Gstreamer programmer)*

Members of the Indian FOSS community do not have one single identity. They have plenty, they go by activist, hacktivist, coder, engineer, evangelist, journalist, student, professor, government bureaucrat, and entrepreneur, to name a few. But this may also cause a slight dilution of the community's voice.

Gstreamer, a library for handling multimedia components was used by the LIGO team for data processing when detecting gravitational waves [117]

[114] "Instant GraphQL APIs for Your Data: Join Data across Databases, GraphQL & REST Services to Build Powerful Modern Applications," Hasura, accessed October 21, 2020, https://hasura.io/.

[115] "Hoppscotch," Hoppscotch, accessed October 21, 2020, https://hoppscotch.io/.

[116] Homepage," , accessed October 21, 2020, https://www.chatwoot.com/.

3.2 The Anatomy of the new FOSS community

The shape of the FOSS movements and communities are gossamer in nature and have been changing with time. Free and Open Source Software and by extension FOSS communities are by definition distributed and they come in different shapes, sizes and colours. The members of these communities have different roles, as shown here:

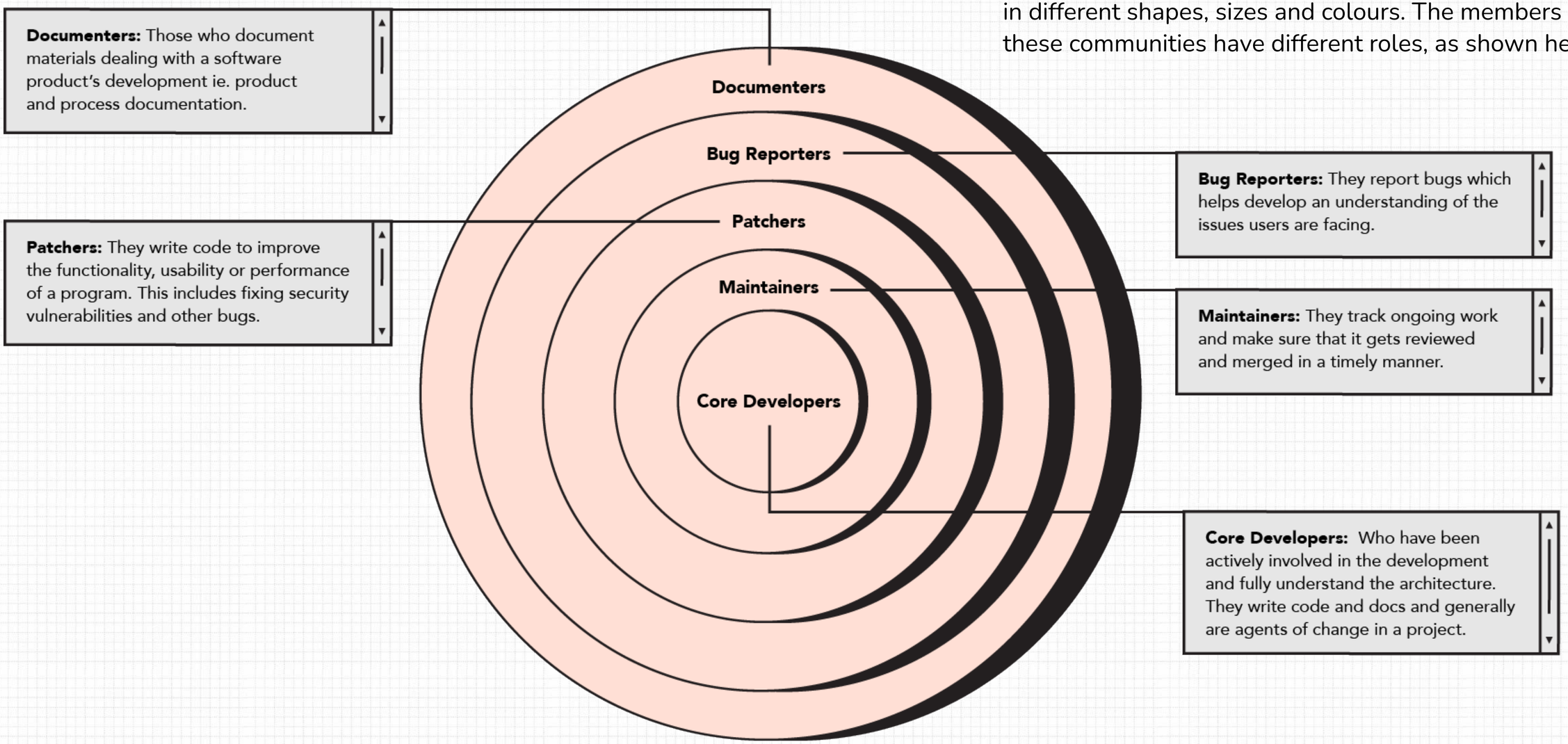


Figure 8: The various stakeholders within a community

However there are many different kinds of FOSS communities. We have elucidated a few categories for communities below with examples but this is by no means an exhaustive list and is changing with time.

Figure 9: The types of FOSS communities

3.2.1 They can be categorised based on their raison d'être

Single Project Communities

Communities around specific projects such as R [118], Rust [119], Python [120], Julia [121], TensorFlow [122], ERPNext [123], HasuraGraph QL [124] etc. Sometimes they become big enough to form foundations which exist to provide a mechanism to bring funds from the software's users, including both individuals and companies, to its developers.

Eg:
NetBSD Foundation [125], Python Software Foundation [126], Django Project Foundation [127], Blender Foundation [128], OpenStreetMaps Foundation [129].

Depending on the origins of these projects and communities they can be further be divided into

The brainchild of a single person or few people

Communities could be the brainchild of one person or a few people tinkering and creating a product/project and then a community around it

Eg:
Rich Hickey created the Clojure programming language over two years and largely without external funding or support [130].

ERPNext[131] was created by Rushabh Mehta and would go on to become quite a successful open source project to come out of India.

Julia [132], a programming language created by Jeff Bezanson, Stefan Karpinski, Viral B. Shah, and Alan Edelman would go on to have a large academic community.

IndLinux [133], a linux distribution that supports a variety of Indian languages was created by a few enthusiasts trying to improve its reach.

117 GstLAL < Computing/DASWG < LIGOWiki, accessed October 21, 2020, https://wiki.ligo.org/Computing/ DASWG/GstLAL.

118 "The R Project for Statistical Computing," R, accessed October 20, 2020, https://www.r-project.org/.

119 "Rust," Rust Programming Language, accessed October 21, 2020, https://www.rust-lang.org/.

120 Python. Accessed Nov 05, 2020, https://www.python.org/

121 JuliaLang. Accessed Nov 05, 2020, https://julialang.org/

122 "Welcome to TensorFlow's Global Community," TensorFlow, accessed October 21, 2020, https://www.tensorflow.org/community.

123 Erpnext.com, "Open Source Cloud ERP," ERPNext, accessed October 20, 2020, https://erpnext.com/.

124 "Instant GraphQL APIs for Your Data: Join Data across Databases, GraphQL & REST Services to Build Powerful Modern Applications," Hasura, accessed October 21, 2020, https://hasura.io/.

125 The NetBSD Foundation, Inc., accessed October 21, 2020, https://www.netbsd.org/foundation/.

126 Python Software Foundation. Accessed November 05, 2020, https://www.python.org/psf-landing/

127 "About the Django Software Foundation", Django Software Foundation, Accessed November 05, 2020, https://www.djangoproject.com/foundation/

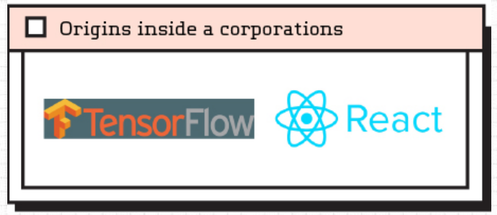
128 "Blender Foundation", Blender Foundation, Accessed Nov 05, 2020, https://www.blender.org/foundation/

129 "OpenStreetMap Foundation", OSMF, Accessed Nov 05, 2020, https://wiki.osmfoundation.org/wiki/Main_Page

130 "Clojure," Clojure, accessed October 21, 2020, https://clojure.org/.

131 Erpnext.com, "Open Source Cloud ERP," ERPNext, accessed October 20, 2020, https://erpnext.com/.

132 JuliaLang. Accessed Nov 05, 2020, https://julialang.org/



Origins inside a corporation

Projects can be born inside a corporation with a healthy community outside raising issues, fixing bugs, and sometimes helping maintain them

Eg:
TensorFlow [134] and React [135]

Origins inside academia

Projects can be born inside Universities and Research Institutions usually to solve academic problems

Eg:
R created by Ross Ihaka and Robert Gentleman from the University of Auckland.

Jupyter notebooks [136] created within UC Berkeley

Python [137] created by Guido Van Rossum at Centrum Wiskunde and Informatica.

[133] "The IndLinux Project," The IndLinux Project, accessed October 21, 2020, https://indlinux.org/.a

[134] "Welcome to TensorFlow's Global Community," TensorFlow, accessed October 21, 2020, https://www.tensorflow.org/community.

[135] "React – A JavaScript Library for Building User Interfaces," – A JavaScript library for building user interfaces, accessed October 21, 2020, https://reactjs.org/.

[136] Jupyter Notebooks. Accessed Nov 05 2020, https://jupyter.org/

Multi-Projects/Domain Specific Communities

Communities around multiple projects.

Domain Specific

These can be communities around specific project domains or disciplines

Eg:
Open Bioinformatics Foundation [138],
Open Source Geospatial Foundation [139],
Kuali Foundation [140] for architectural solutions.

Umbrella Organizations

Communities that host or support many projects.

Eg:
Linux Foundation [141]

Software Freedom Conservancy which hosts around 40 projects [142]

Apache Software Foundation which hosts about 200 Apache Projects [143].

137 Python. Accessed Nov 05, 2020, https://www.python.org/

138 Kushinauwu, "About the OBF," OBF Open Bioinformatics Foundation, accessed October 21, 2020, https://www.open-bio.org/.

139 "Homepage," OSGeo, accessed July 20, 2020, https://www.osgeo.org/.

140 Kuali Foundation. Accessed Nov 05, 2020, https://kuali.org/

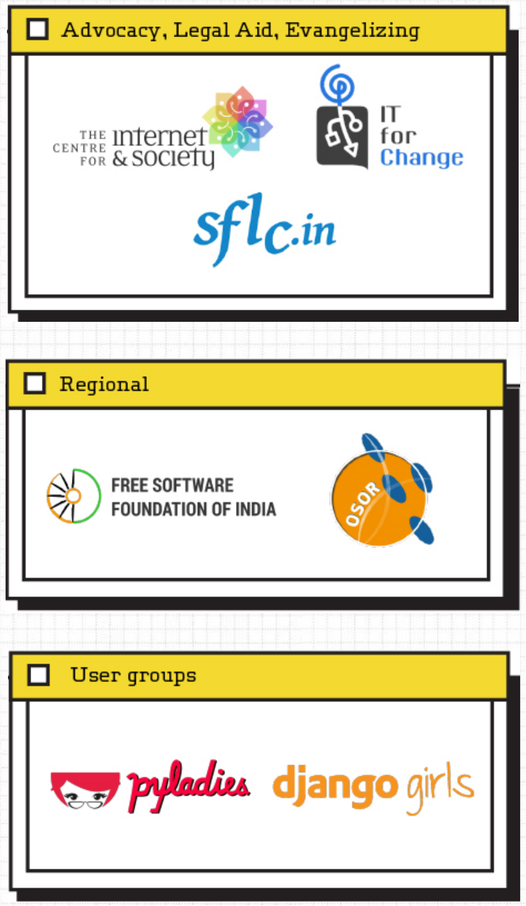
141 Linux Foundation. Accessed Nov 05, 2020, https://www.linuxfoundation.org/

142 Software Freedom Conservancy, accessed Nov 05, 2020, https://sfconservancy.org/

143 "Welcome to The Apache Software Foundation!,"

Alternatives Reasons

Communities could form around reasons such as advocacy, legal aid, financial aid, technical aid, governance, and inclusivity.



Advocacy, Legal Aid, Evangelizing

Eg:
SFLC India [144], IT for Change [145], CIS [146] which have worked hard to promote and support FOSS - legally, technically, and financially.

Regional

Communities could form around regional identities/problems/solutions.

Eg:
Free Software Foundation India [147], Open Source Observatory and Repository in European Union [148], Free Software Movement - Tamil Nadu, Karnataka.

User groups

Communities could form around reasons for inclusivity in underrepresented groups

Eg:
PyLadies [149], Django Girls [150].

The Apache Software Foundation, accessed October 21, 2020, https://www.apache.org/.

144 "Software Freedom Law Center, India," Software Freedom Law Center, India, accessed October 21, 2020, https://sflc.in/.

145 "IT for Change," Home, accessed October 21, 2020, http://www.itforchange.net/.

146 "IFAT and ITF - Locking Down the Impact of Covid-19," Centre for Internet & Society, accessed October 21, 2020, https://cis-india.org/.

147 "Free Software Foundation of India," Free Software Foundation India, accessed October 21, 2020, https://fsf.org.in/.

148 "Homepage," OSGeo, July 20, 2020, https://www.osgeo.org/.

149 "Welcome!," PyLadies, accessed October 21, 2020, https://pyladies.com/.

150 "Django Girls Is a One-Day Workshop about

3.2.2 FOSS communities are also governed through different kinds of models

These governance models exist mainly to

1. Guarantee health and survival of the community. This means that they find efficient ways to integrate contributions and contributors to the existing project and also find ways to sustain irrespective of contributions [151].

2. Create a community of contributors and collaborators.

The three most popular kinds of governance models ones are:

- **The Benevolent Dictator Model**
- **Apache Software Foundation Governance Model**
- **Debian Governance Model**

The Benevolent Dictator Model [152]
Where project founders retain the final say in disputes or arguments within the community, Eg: Clojure[153] & Linux.

Apache Software Foundation Governance Model [154]
A corporation style governance model,where the members elect a Board of Directors which sets corporate policy and appoints officers who execute this corporate policy; and the Board appoints various Project Management Committees which run the various Apache software projects.

Debian Governance Model [155]
There is also the more consensual, democratically run Debian Governance Model, which elects a leader from within the community with various officers handling administrative and technical roles the group also comes with their own Debian constitution.

Programming in Python and Django for Women," Django Girls, accessed October 21, 2020, https://djangogirls.org/.

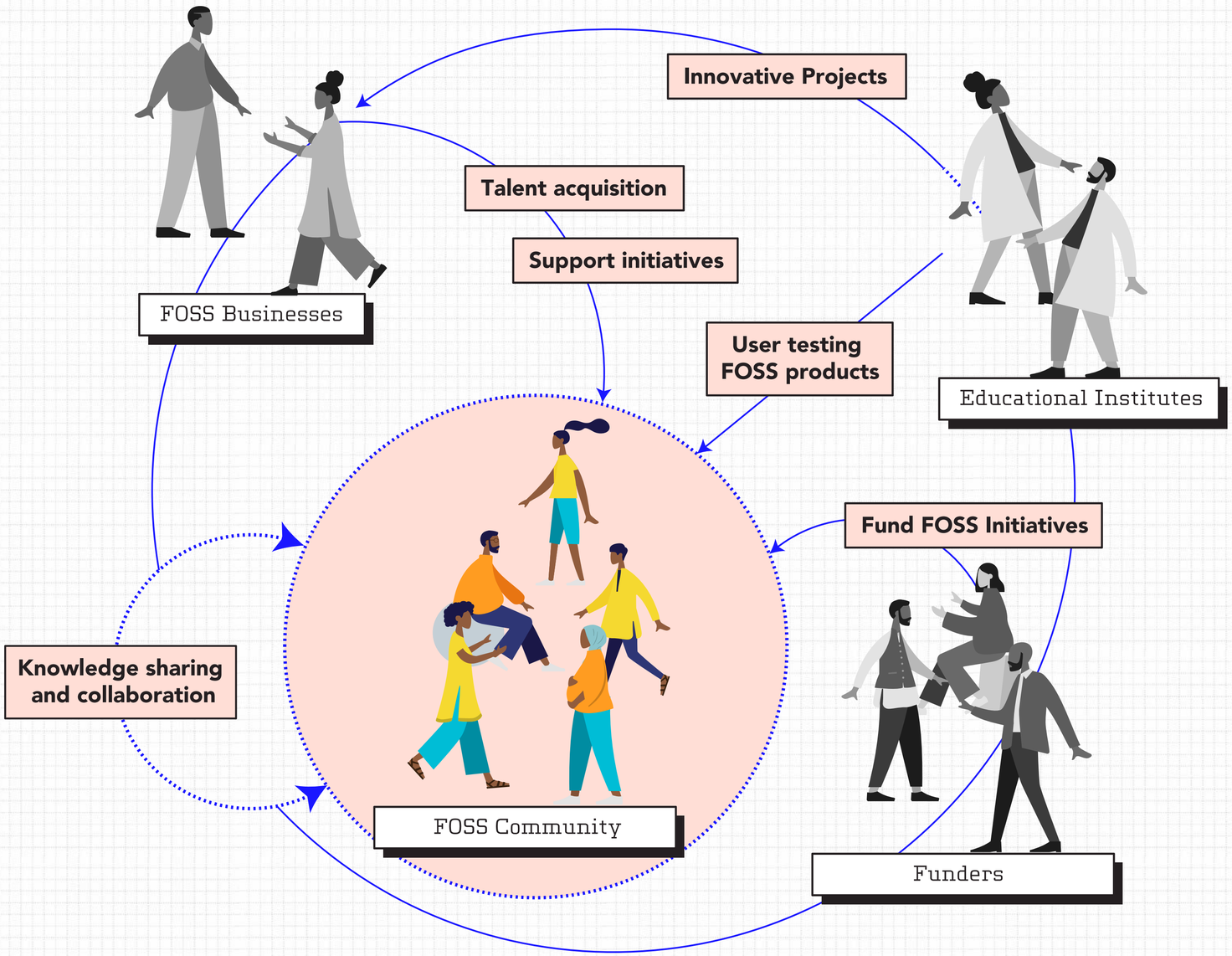
151 Damian A. Tamburri et al., "Discovering Community Patterns in Open-Source: a Systematic Approach and Its Evaluation," Empirical Software Engineering 24, no. 3 (2018): pp. 1369-1417. https://doi.org/10.1007/s10664-018-9659-9.

152 "OSS Watch," OSS Watch, accessed October 22, 2020, http://oss-watch.ac.uk/resources/benevolentdictatorgovernancemodel.

153 Rich Hickey, "Open Source Is Not About You," Gist, accessed October 21, 2020, https://gist.github.com/richhickey/1563cddea1002958f96e7ba9519972d9.

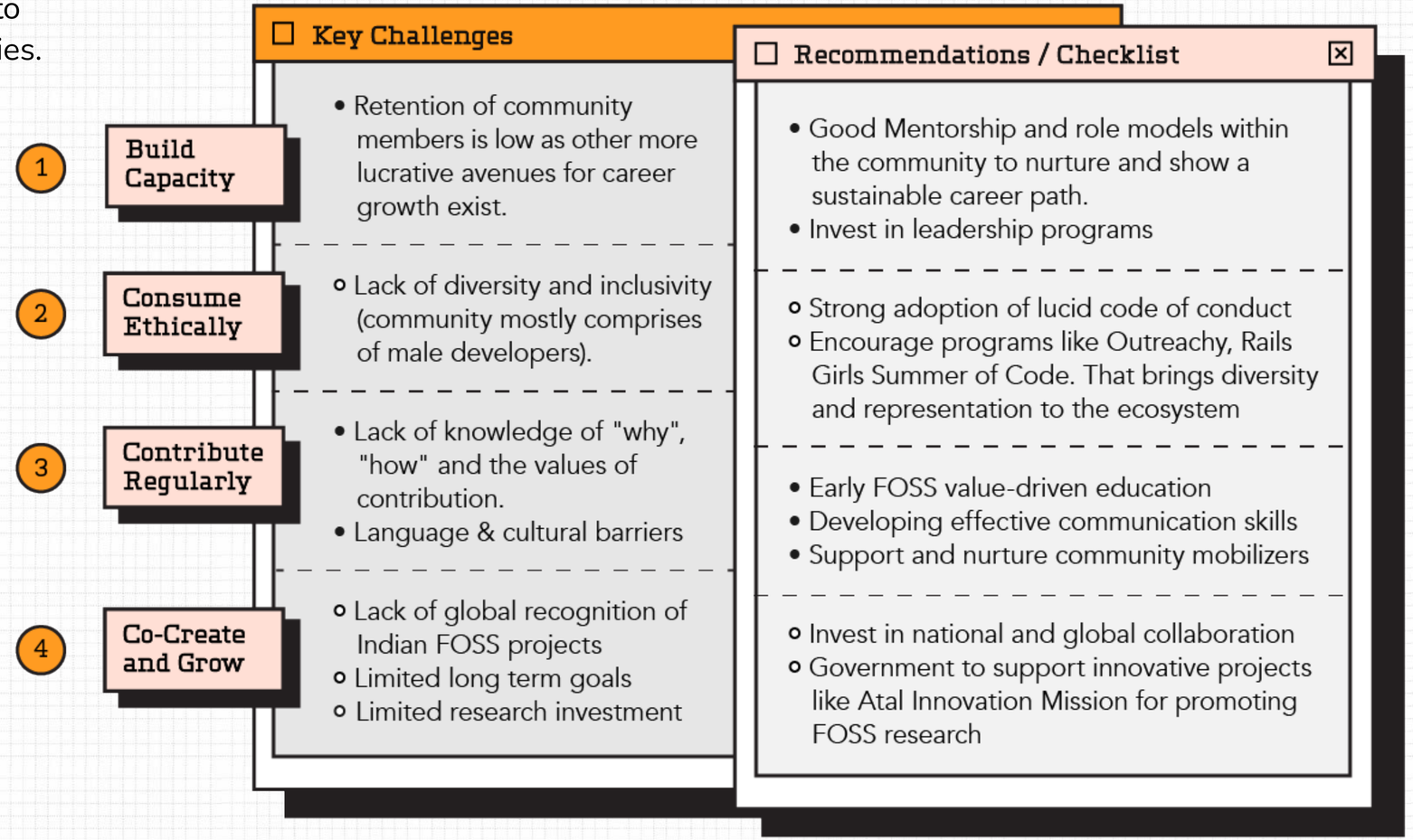
154 "Apache Governance Overview," The Apache Software Foundation, accessed October 21, 2020. https://www.apache.org/foundation/governance/.

FOSS &
Communities



Key Challenges & Recommendations

Based on our conversations with different community members we have written down some common challenges and recommendations to sustain and thrive FOSS communities.



3.3.1 Capacity

FOSS Communities struggle with retention of young volunteers:

A career with high monetary returns in FOSS related products and services is still a distant dream in a country like India, where an engineering degree is considered a pathway to a safe and secure economic future. What most local FOSS groups and communities have difficulty with retention.

Though most FOSS groups like FSM TN, Karnataka get a steady stream of students very few stay longer than a few years and even fewer transition to becoming mentors.

Organisations like amritaFm seem to have been fairly successful, some local FOSS groups are also exploring and incubating co-ops as a way of sustainable growth. ICFOSS in Kerala seemed most systematic and successful with their Student Outreach, Ambassadors or Internship programmes.

A lack of guidance or mentorship to direct young FOSS enthusiasts towards a sustainable career path in the FOSS ecosystem:

"A community works through people using technology, as people work through software using hardware[156].

The most common challenge mentioned during our interviews with the community was the lack of awareness/guidance for the younger members in the community around the history, ideals and reasons for FOSS adoption and contribution.

This could be due to lack of documentation, especially in an Indian context. Another common reason mentioned during the interviews was the burnout experienced by community

155 "OSS Watch," OSS Watch, accessed October 21, 2020, http://oss-watch.ac.uk/resources/debianleader.

156 "What Are Socio-Technical Systems?," The Interaction Design Foundation, accessed October 22, 2020, https://www.

mobilisers (a few of the members we spoke to were either on a sabbatical or had completely disassociated themselves from the community)

Multiple skills such as designing, coding and presentation and speaking are all necessary to get support from the community and should in turn be directed and nurtured [157].

3.3.2 Ethical Consumption

Cultural restrictions and insensitivity from male peers and community mobilizers who organise FOSS events and meets.

This seems to be a large reason for women, people of colour, parents, non-technical contributors, gay, lesbian, transgender, and other underrepresented communities to not contribute to the ecosystem.

Talking about the challenges faced by women, Ramya Ramya Raghupathy (an Outreachy [158] mentor, and a contributor to HOTOSM [159]) also mentioned that there was a hesitation largely due to cultural reasons to participate in communities and programs that had a male majority.

A few other women within the community also mentioned being part of a FOSS community meant travelling to various events, some going late into the night which is a privilege for many girls in India.

There was also a wide cultural gap faced by many individuals as most international groups were largely made up of cis-white men.

There also seems to be an inbuilt hierarchy with the developer at the head of the chain.
Other skill sets such as research, UI/UX design, graphical & research methodologies, non-technical writing and documentation need to be recognised as value adding skills which enrich a community. The projects without this miss out on perspectives and experiences that

HOTOSM has been instrumental in mapping disaster stricken areas such as Nepal during the earthquakes [160]

interaction-design.org/literature/topics/socio-technical-systems?order_by=popularity.

157 Rahul De', "Open Source Software in the Global South," The International Encyclopedia of Digital Communication and Society, November 2015, pp. 1-9, https://doi.org/10.1002/9781118767771.wbiedcs024.

158 "Internships Supporting Diversity in Tech," Outreachy, accessed October 20, 2020, https://www.outreachy.org/.

159 "Humanitarian OpenStreetMap Team: Home," Humanitarian OpenStreetMap Team | Home, accessed October 22, 2020, https://www.hotosm.org/.

can drive innovation for a better world.

There are some ways around it, for example: Google's Season of Docs, which provides a framework for technical writers and open source projects to work together towards the common goal of improving an open source project's documentation [161].

Free and Open Source software have had a strong historical focus on developers, sometimes at the cost of user experience.

FOSS alternatives to expensive proprietary software like Microsoft Office and Adobe Illustrator do exist. However, most of them are not preferred to their proprietary alternatives even though they are free because of lack of usability. Involving Human-Computer Interaction (HCI) experts or similar professional figures have resulted in a limited success or failed attempts, because these experts are either ignored by developers or find a hard time mediating user needs and developers' interests [162]

OSS is great for builders, bad for buyers. Getting a great end-to-end customer experience on an OSS product is hard

Sanjay Purohit

(Chief Curator of Societal Platforms)

3.3.3 Contribution

Lack of knowledge around how to contribute to the community coupled with cultural restrictions, that need drastic change in our mindset.

Individually, Indians [from within the country and outside] are contributing to FOSS projects regularly. We have the third largest number of developers on GitHub [164] but as pointed out by Cherry Mathews,a FOSS community mobiliser and previously a core contributor to NetBSD, individual-Indian contribution is difficult to track.

Societal Platform is a not-for-profit which works with open digital ecosystems [163]

NetBSD is a small FOSS Operating System and used in the International Space Station, in your USB drive, clocks et cetera [165]

[160] Nepal Earthquake, accessed October 22, 2020, https://hotosm.github.io/tracing-guides/guide/Nepal.html.

[161] "Introduction | Season of Docs | Google Developers," Google (Google), accessed October 22, 2020, https://developers.google.com/season-of-docs/docs.

[162] Paula m bach and michael twidale, "Lucky Seven: How Can the Crowd Help Design?" https://doi.org/10.1.1.377.9930.

[163] "A Greater Good Beckons When We Collaborate.," Societal Platform, October 1, 2020, https://societalplatform.org/.

[164] "The State of the Octoverse," The State of the Octoverse, accessed October 20, 2020, https://octoverse.github.com/.

However, the question that needs to be addressed is: Is India considered a strategic FOSS contributor or largely a consumer?

India is still largely a consumer. This is slowly changing. There are many homegrown FOSS products (Eg: Hasura [166], Chatwoot [167], Bagisto [168]) that have come up in the last few years, but compared to the population of India or the Information Technology workforce of India, these numbers are still minimal.

There is a need to innately understand the value addition of contributing to the FOSS ecosystem (both for the individual and the community).

There is a need to cultivate the ability to solve problems or build the confidence and capability to contribute and grow an idea within an ecosystem. This is a multi-layered and global problem.

3.3.4 Co-create

There is a lack of innovative, globally recognised Indian FOSS projects. This can be attributed to short-sightedness and a lack of appetite for research.

Globally recognized Indian FOSS projects like the Julia programming language (which is run out of India, and the US) are few in number. Many FOSS projects (backed by foundations or corporations) add value and growth to the ecosystem and continually find inherent value in it, be it finding talent or improving their offering and testing.

165 Research carried out using NetBSD, accessed October 22, 2020, https://www.netbsd.org/gallery/research.html.

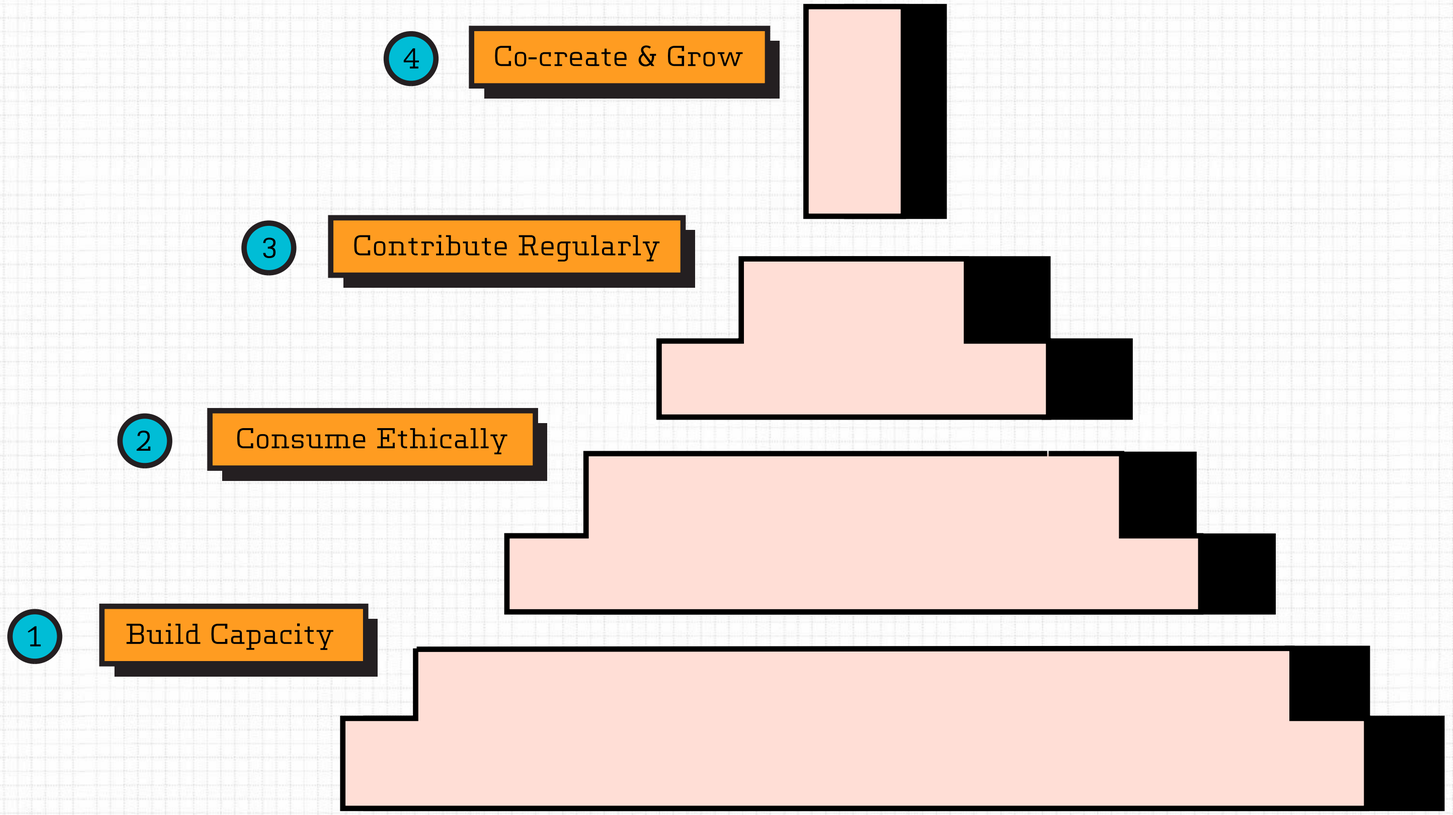
166 "Instant GraphQL APIs for Your Data: Join Data across Databases, GraphQL & REST Services to Build Powerful Modern Applications," Hasura, accessed October 21, 2020, https://hasura.io/.

167 "Provide Exceptional Customer Support Over," ..., accessed October 20, 2020, https://www.chatwoot.com/.

168 "Laravel ECommerce," Bagisto, accessed October 22, 2020, https://bagisto.com/en/.

3.4 Recommendations

The challenges faced by FOSS communities are diverse and multilayered and require us to look at the solutions from various lenses. While the list is not comprehensive one can start by building capacity by following mindful practices like Code of Conduct and onboarding a more diverse and engaged population to build a more involved community with the right mentorship and leadership.



3.4.1 Capacity

Retain students with leadership capabilities in the community through leadership programs

- Leadership in FOSS is very different from that within proprietary led systems. The innate benefit of building know-how's and of exercising the creator muscle needs to be taught along with inculcating the values of FOSS observed Kamal Velan from the Free Software Foundation, Tamil Nadu.
- Socio-technical incentives and meritocratic principles tend to favour the rise of charismatic and trustworthy individuals to occupy more central roles.
- Therefore there is a need to employ and train aspiring mentors and leaders by designing Fellowships or sponsor Leadership programs. A training module for FOSS leaders in India could be created in conjunction with business schools in India.

Succession Planning

Succession Planning [169], a program formulated by Vicky Brasseur [170] or the University of Brandeis's Open Source Program [171] which offers micro-courses, graduate level credits and sponsored certification would be a great way to incentivise, retain, and prevent burnouts.

[169] Vicky Brasseur, "For Project Safety Back up Your People, Not Just Your Data," Opensource.com, August 2018, https://opensource.com/article/18/4/passing-baton-succession-planning-foss-leadership.

[170] "VM (Vicky) Brasseur," VM (Vicky) Brasseur, accessed October 22, 2020, https://www.vmbrasseur.com/.

[171] "An Open Source Education Program That Suits Your Availability and Learning Style," The Brandeis GPS blog, April 21, 2020, https://blogs.brandeis.edu/gps/2020/04/21/an-open-source-education-program-that-suits-your-availability-and-learning-style/.

3.4.1 Capacity

There is a need for good, dedicated mentorship

- A person or organization, who is rooted and is empathetic to the challenges unique to India but has their pulse on the global situation would be best suited to lead, challenge and channelise young minds to seek more innovative solutions.

- Leaders who give diverse voices equal opportunity are nearly twice as likely as others to increase value-driven insights, and individuals within a “speak up” culture are 3.5 times as likely to contribute their full innovative potential. [172]

Mitchell Baker

Mitchell Baker was instrumental in opening the source code of Netscape, which eventually gave birth to firefox, and is now the chairperson of the Mozilla Foundation.

Baker helped define a functional model that took into account the diverse ideas, needs, and opinions of the community, before making strategic decisions and afterward, in executing projects. In addition, she designed process frameworks and maintained the financial viability of the projects. [173]

[172] Melinda Marshall, Sylvia Ann Hewlett, and Laura Sherbin, “How Diversity Can Drive Innovation,” Harvard Business Review, August 1, 2014, https://hbr.org/2013/12/how-diversity-can-drive-innovation.

[173] “Mitchell Baker - Visionaries on Innovation,” The Henry Ford, accessed October 22, 2020. https://www.thehenryford.org/explore/stories-of-innovation/visionaries/mitchell-baker/.

3.4.2 Consume

There is a need to learn, empathize, innovate, and take action.

- Groups such as the PyLadies [174] and Rails Girls Summer of Code [175] create inclusive spaces for women to participate in.
- Many communities are also creating codes of conduct alongside marginalized and underrepresented groups, which are then religiously implemented.
- These seem like good starting points and there is a need for continuous sensitisation to make this more commonplace.

Krishnakanth Mane

Krishnakanth Mane, a FOSS advocate and programmer who works on GnuKhata and Orca Screen Reader is on a mission to empower rural India and differently abled communities through FOSS-based ICT interventions [176].

Mozilla's Code of Conduct

These guidelines aim to support a community where all people should feel safe to participate, introduce new ideas and inspire others. The Mozilla Project welcomes contributions from everyone who shares their goals and wants to contribute in a healthy and constructive manner within the community [177].

[174] "Welcome!," PyLadies, accessed October 21, 2020 https://pyladies.com/.

[175] RailsGirlsSoC, "Rails Girls Summer of Code," Rails Girls Summer of Code, accessed October 22, 2020 https://railsgirlssummerofcode.org/.

[176] Abishek Prakash, "We Can Make A Better World With Free Software: Krishnakant Mane", Aug 2017, https://itsfoss.com/interview-krishnakant-mane/.

[177] "Community Participation Guidelines," Mozilla, accessed October 22, 2020, https://www.mozilla.org/en-US/about/governance/policies/participation/.

Outreachy[178]

Even as demand for programmers has been exploding with time, women's representation in this field has not been moving at the same pace.This phenomenon is not new or surprising or regional. There have been many studies looking at the inherent sexism in the field of Information Technology [179,180].

In 2015, Rohini Lakshane wrote a blog titled "The trouble with being a woman in FOSS" which encapsulates all the misogyny and lack of respect that women face regularly in the community [181].

Joseph Reagle also argues in a paper titled "Free as in Sexist [182]" that the innate features of the FOSS movement (along with other aspects such as lack of different perspectives, lack of role models, off-putting language, and lack of time) contribute to the gender gap in the ecosystem. That is, the geek/hacker stereotype can be unappealing. Open communities are especially susceptible to difficult people, and the ideas of freedom and openness can be used to dismiss concerns and rationalize the gender gap as a matter of preference and choice. Some of the most influential members of this ecosystem including Linus Torvalds [183], Richard Stallman [184], and Eric S Raymond [185]. With role models like these, the ecosystem has not been an easy place for underrepresented groups to thrive.

One of the programs that actively try to counter this is Outreachy. It started off as an Outreach Program for Women in FOSS and has now expanded to include many under represented groups.

It is a remote internship program that was started by the Software Freedom Conservancy (formerly Gnome Foundation) promoting diversity and opportunities to people who face under-representation in technology. The GNOME Project, one of the projects on which the interns work, noted several signs that the program has improved its recruitment and retention of women contributors.

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178 "Internships Supporting Diversity in Tech," Outreachy, accessed October 20, 2020, https://www.outreachy.org/.

179 Victoria Martinez De La Cruz and Carlos Ivan Chesnevar, "Encouraging Women Participation in Free AndOpen Source Software Organizations:The GNOME OPW Initiative," Jornadas Argentinas De Software Libre 1850-2857 (2013). http://42jaiio.sadio.org.ar/proceedings/simposios/Trabajos/JSL/08.pdf

180 "Women in Computer Science," ComputerScience.org (ComputerScience.org, October 22, 2019), https://www.computerscience.org/resources/women-in-computer-science/.

181 Rohini Lakshane, "The Trouble with Being a Woman in FOSS," Medium (Deep Dives, July 11, 2016), https://deepdives.in/the-trouble-with-being-a-woman-in-foss-75181981bfdd.

182 Joseph Reagle, "View of 'Free as in Sexist?" Free Culture and the Gender Gap: First Monday," View of "Free as in sexist?" Free culture and the gender gap | First Monday, accessed October 22, 2020, https://journals.uic.edu/ojs/index.php/fm/article/view/4291/3381.

183 Noam Cohen and Mark O'Connell, "After Years of Abusive E-Mails, the Creator of Linux Steps Aside," The New Yorker, accessed October 22, 2020, https://www.newyorker.com/science/elements/after-years-of-abusive-e-mails-the-creator-of-linux-steps-aside.

184 Steven Levy, "Richard Stallman's Disgrace," Daring Fireball, September 27, 2019, https://daringfireball.net/2019/09/richard_stallmans_disgrace.

185 Jesse Singal, "Is This Crazy Anti-Feminist Rumor the Platonic Ideal of the Men's-Rights Internet?," Intelligencer (Intelligencer, November 4, 2015), https://nymag.com/intelligencer/2015/11/this-the-perfect-insane-anti-feminist-rumor.html.

3.4.3 Contribution

There is a need for motivated driven individuals who can work with different communities and bring out the best in them for the larger ecosystem.

- The gap in effective contribution back from the community is largely because of a lack of deeper understanding of FOSS values and not knowing how best to contribute.
- There is a need to bridge this gap through early education, inculcation of values, and inspired mentorship. Developing communication skills would also come in handy.
- In a country like India, language is a huge barrier to contribution. Introduction of Indic computing, which helps the user code in Indian scripts would definitely help reach a larger audience. For Eg: Swathanthra Malayalam Computing attempts to do just that [186].
- Contribution by the community is also heavily dependent on highly motivated and driven individual/s (the community mobilisers), who run the risk of burnouts or have ideological differences as initiatives grow. There is a need to support young FOSS leaders, via scholarships, fellowships or grants

Open Leadership Framework[187]

The aim of the Open Leadership Framework put forth by Mozilla is to establish an adaptable set of open leadership principles, practices, and skills that people can use for personal and professional development as part of an open community or project.

COSA Community Leaders 2020[188]

The Clinic for Open Source Arts (COSA) has a Community Leaders Program for 2020. Built with a goal to empower people to build new communities or step into existing ones with the tools and skills to guide those communities. It is focused on training leaders for the communities surrounding open source creative tools, emphasizing accessibility, inclusiveness, education, contribution, and also sustainability.

186 "Swathanthra Malayalam Computing," Swathanthra Malayalam Computing, accessed October 22, 2020, https://smc.org.in/.

187 "Open Leadership Framework," Open Leadership Map Framework : Open Leadership Framework, accessed October 22, 2020, https://mozilla.github.io/open-leadership-framework/framework/.

188 "COSA Community Leaders Program," COSA Community Leaders 2020, accessed October 22, 2020, https://opensourcearts.github.io/COSA_CL_2020/.

3.4.4 Co-create

And lastly, the need for innovation in India is multi-layered and stems from awareness (in schools and colleges), to mentorship (post-college) and then to sustainability (big corporations preferred over smaller FOSS companies).

- ICFOSS, an autonomous organization set up by the Kerala Government has some comprehensive programs around capacity building for different stakeholders from students to government officials [189].
- It also conducts R & D and technology development programs to lead the search and incubation of innovative FOSS projects.
- While global product-based leadership can be seen in community led projects such as CKAN [190] developed by the Open Knowledge foundation [191]. It is a popular data platform used by governments across the globe. Apache Superset [192], a tool developed by Airbnb [193] and later contributed to by the Apache community [194] has become the most sought-after data visualisation tool in the recent past.

FOSS United Foundation[195]

A not-for-profit foundation set up by the founders of ERPNext and Zerodha.

They plan to tackle the disproportionately low number of quality FOSS projects coming out of India given a thriving industry compared to the explosion of projects that has happened globally over the last decade by

- Promoting the spirit of hacking, tinkering, and writing code, not only for profit, but for fun.
- To build quality free software for public good.
- To build quality free software that specifically empowers people with tools to run their livelihoods and power the economy.

189 "Home," ICFOSS, accessed October 20, 2020 https://icfoss.in/.

190 "Ckan," ckan, accessed October 22, 2020 https://ckan.org/.

191 "Open Knowledge Foundation," Home, accessed October 22, 2020, https://okfn.org/.

192 "Welcome," Welcome, accessed October 22, 2020, https://superset.apache.org/.

193 "Superset," Airbnb Engineering & Data Science, accessed October 22, 2020 https://airbnb.io/projects/superset/.

194 "Apache Community Development - Apache Community Development - Welcome," accessed October 22, 2020, https://community.apache.org/.

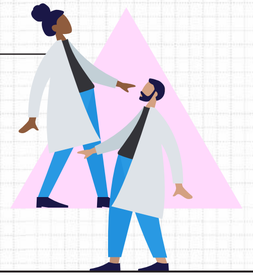
195 "FOSS United Foundation," FOSS United, accessed October 22, 2020, https://fossunited.org/.

3.5 Way Forward

One of the primary challenges to the FOSS ecosystem are small silo-ed FOSS communities without a unified voice. One of the ways in which FOSS communities can begin thriving is to correct for these challenges early on.

This happens through early stage introduction to these technologies and values in a classroom setting. The education sector is fertile ground to enable an organic cycle of FOSS usage and equally important value adoption, to inculcate larger ideas of contribution back to the community.

FOSS & Education

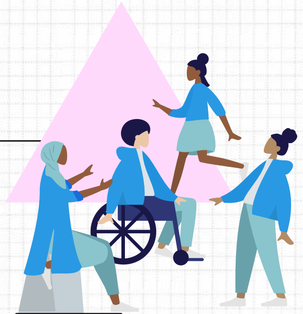


Higher Education & Research Institutues

Research & educational institutes, independant, public or private entities working to harness FOSS in academia

Eg:

- *Bhabha Atomic Research Centre*
- *Tata Institute of Fundamental Research*
- *IIT Bombay*

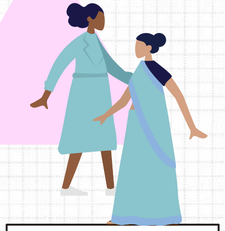


Schools

Institutes imparting education and FOSS literacy to K - 12 children

Eg:

- *Govt. Schools in Assam*
- *Govt. Schools in Kerala*



Online Education

Online platforms imparting education and FOSS literacy

Eg:

- *Khan Academy*
- *Spoken Tutorial*

Chapter 04

FOSS & Education

4.1 Landscape

4.1.1 Role of Education

Educational institutes can play a crucial role as facilitators for the FOSS ecosystem, while also reaping the benefits from adoption. The use of FOSS technologies in classrooms can help increase awareness, create public demand for FOSS based products, and help develop the right FOSS led workforce for the future.

These institutes can also act as the primary medium to embrace and advocate FOSS values, while also encouraging contributions back to the community [196]. Beyond the movement, these steps also boast huge benefits for the institutes including lower costs, reliability, performance and security. A study from 2009 estimates that the tangible savings from using FOSS in schools across India were roughly about Rs.8254 crores [197], these numbers might probably be a lot higher now. This was in addition to building long-term capacity and sustainability.

4.1.2 FOSS in Education

The education ecosystem in India suffers from systemic challenges around access, affordability, dropouts, and outcomes. Free and Open Source Software (FOSS) can act as an enabler to help overcome them. In 2009, The Right of Children to Free and Compulsory Education Act (RTE) [198] was passed which envisions a future with 100% school enrolment for children between the age of 6 to 14 years. In the decade since this act, the proportion of enrolled children has increased by around 19%.

196 "Can India Ever Be a Global FOSS Hub," Linux For You, September 2010. https://www.mindtree.com/sites/default/files/2017-10/306%20mindtree-thought-posts-can-india-ever-become-a-global-foss-hub_0.pdf

197 Rahul De', Lewin Siwamalai, and Ravi A Rao, "Economic Impact of Free and Open SourceSoftware Usage in Government," June 2015. https://sflc.in/sites/default/files/wp-content/uploads/2016/06/ICFOSS_economic-impact-freev3.pdf

198 Right To Education, accessed October 22, 2020, http://righttoeducation.in/know-your-rte/about.

Even after these positive developments, concerns remain about post-primary dropout rates, equal access to quality education, affordability, and learning outcomes [199].

More recently, the government released The National Education Policy (NEP) 2020 [200] which extended its scope to children aged 3–18 years. It also seeks to address the above challenges through harnessing technology.

The policy suggests setting up an autonomous body, National Education Technology Forum (NETF) in order to facilitate decision making on the use of technology. There are also recommendations around using open, interoperable and evolvable digital infrastructures so as to make solutions more sustainable.

FOSS can plan an important role in this ecosystem to ensure equitable, affordable & sustainable access.

Numerous policies and programmes have been introduced to adopt ICT in the Indian education ecosystem. A FOSS led approach towards implementing these can help further the scale of adoption. There have been numerous FOSS products [201] and initiatives [202] at the national level, with the GoI also releasing an Open Source Software Policy [203].

Within education however:

- There is a centrally sponsored scheme created to leverage the potential of ICT; National Mission on Education through Information and Communication Technology (NMEICT) which has several programmes under it [204].

- There is also the the Centre for Development and Advanced Computing (C-DAC) that has developed various e-learning solutions [205] for content management support, evaluation and assessment, and virtual classroom collaboration.

[199] Sanchayan Bhattacharjee, "Ten Years of RTE Act: Revisiting Achievements and Examining Gaps," ORF, August 8, 2019, https://www.orfonline.org/research/ten-years-of-rte-act-revisiting-achievements-and-examining-gaps-54066/.

[200] MoHRD, "National Education Policy 2020," accessed October 2020, https://www.mhrd.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf.

[201] "FOSS Products: Ministry of Electronics and Information Technology, Government of India," FOSS Products | Ministry of Electronics and Information Technology, Government of India, accessed October 22, 2020, https://www.meity.gov.in/content/foss-products.

[202] "Major FOSS Initiatives: Ministry of Electronics and Information Technology, Government of India," Major FOSS Initiatives | Ministry of Electronics and Information Technology, Government of India, accessed October 22, 2020, https://www.meity.gov.in/content/major-foss-initiatives.

[203] "Guidelines," egovstandards, accessed October 22, 2020, http://egovstandards.gov.in/guidelines-0. "National Mission on Education through Information and Communication Technology," NMEICT, accessed October 22, 2020, https://nmeict.ac.in/.

[204] "National Mission on Education through Information and Communication Technology," NMEICT, accessed October 22, 2020, https://nmeict.ac.in/.

[205] "DAC E-Learning," C, accessed October 22, 2020, https://www.cdac.in/index.aspx?id=st_el_elearning.

Additionally, in 2020-21, the Budget for the Department of Higher Education has allocated Rs.444 Crores towards Digital India e-Learning [206]. This, while being about 18% less than the previous year's revised estimate, can still be employed towards further adoption of FOSS technologies in education through schemes like NMEICT.

4.1.3 Coding and FOSS

The demand for coding skills among young learners has increased drastically. In and out of school coding programmes, Ed-Tech and massive open online courses (MOOCs) can play an important role in propagating FOSS technologies and principles.

Coding helps inculcate curiosity. It pushes students to question, observe, analyse, and record everything around, which breaks the old pattern of classroom education which is a restrictive, one-way exchange of knowledge.

One of the prominent reforms announced in the NEP is the initiation of classes on coding for students from class 6 onwards [207]. For Eg: Scratch [208], a block-based visual programming language for young learners which was developed by the MIT Media Lab [209], has now been translated into 70+ languages and is accessed by over 50 million users around the world [210].

According to a report by RedSeer and Omidyar Network India, the number of ed-tech users in the K-12 and post-K-12 segment in India has doubled in one year from 45 million in 2019 to 90 million in 2020 [211]. Even as students move higher within academia, most tools used are FOSS based technologies.

Therefore, these pathways, both in and out of schools, can act as a major enablers of training in FOSS technologies while also communicating the values and benefits of adoption.

Tools like Tensorflow, Keras, Python, and R are being increasingly used in very specialized research

Rahul De

Professor at IIM-Bangalore, author of many papers on the economic impact of FOSS in India

206 "Union Budget (2020-21) - Department of Higher Education," Datasets - Open Budgets India, accessed October 22, 2020, https://openbudgetsindia.org/dataset/department-of-higher-education-2020-21-budget.

207 Anurag Gupta and Rajeev Tiwari, "New Education Policy 2020: Integration of Coding and Analytical Thinking from the Schooling Level," Hindustan Times, August 13, 2020, https://www.hindustantimes.com/education/new-education-policy-2020-integration-of-coding-and-analytical-thinking-from-the-schooling-level/story-G0ihYK8LitcMXmxbwBBd6L.html.

208 "Imagine, Program, Share," Scratch, accessed October 22, 2020, https://scratch.mit.edu/.

209 "News + Updates," MIT Media Lab, accessed October 22, 2020, https://www.media.mit.edu/.

210 "Imagine, Program, Share," Scratch, accessed October 22, 2020, https://scratch.mit.edu/statistics/.

211 Anil Kumar, "EdTech In India: An Omidyar Network India & RedSeer Report," RedSeer, April 2020, https://redseer.com/reports/edtech-in-india-an-omidyar-network-india-redseer-report-2019-20/.

Julia

The JuliaCon 2020 just ended recently, and most intriguing for a software conference, it was filled with academicians and researchers. There were presentations on everything from fluid dynamics to brain imaging to language processing. Despite this variety, the presentations had a deep sense of community around a shared attitude that seems to have been influenced by the free software movement [212,213].

Julia is a fast, interoperable programming language well suited to numerical analysis and Computational Science. It was designed by Viral B. Shah, Jeff Bezanson, Stefan Karpinski, and Alan Edelman in 2009 [214].

Its interoperability meant that all these scientists were discovering new ways to collaborate and incorporate each other's code and use them in new and unforeseen ways.

Julia is currently being used by the Federal Reserve Bank of New York to make models of the United States Economy. It is being used by the Climate modelling alliance to create a next generation global climate model [215]. It is also being used by NASA and INPE (Brazilian equivalent of NASA) for space mission planning and satellite simulation [216].

[212] "Conference Agenda," Agenda | JuliaCon 2020, accessed October 22, 2020 https://live.juliacon.org/agenda/2020-07-31.

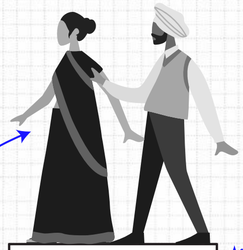
[213] Lee Philips, "The Unreasonable Effectiveness of the Julia Programming Language," Ars Technica, October 9, 2020, https://arstechnica.com/science/2020/10/the-unreasonable-effectiveness-of-the-julia-programming-language/.

[214] Stefan Karpinski and Jeff Bezanson, "Why We Created Julia," The Julia Programming Language, February 2012, https://julialang.org/blog/2012/02/why-we-created-julia/.

[215] "New York Federal Reserve Bank," Julia Computing, accessed October 22, 2020 https://juliacomputing.com/case-studies/ny-fed/.

[216] Circuitscape, "Circuitscape/Circuitscape.jl," GitHub, accessed October 22, 2020 https://github.com/Circuitscape/Circuitscape.jl.

FOSS & Education



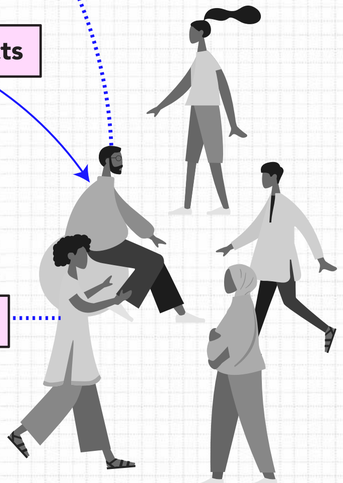
Governments

Evangelize & support use of FOSS in education

Collaborate on FOSS Tools

Support FOSS Adoption

Contribute to community projects

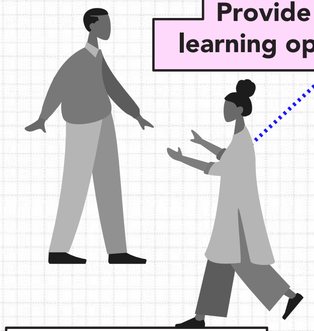


Mentor children

FOSS Community

Educational Institutes

Provide project learning opportunities

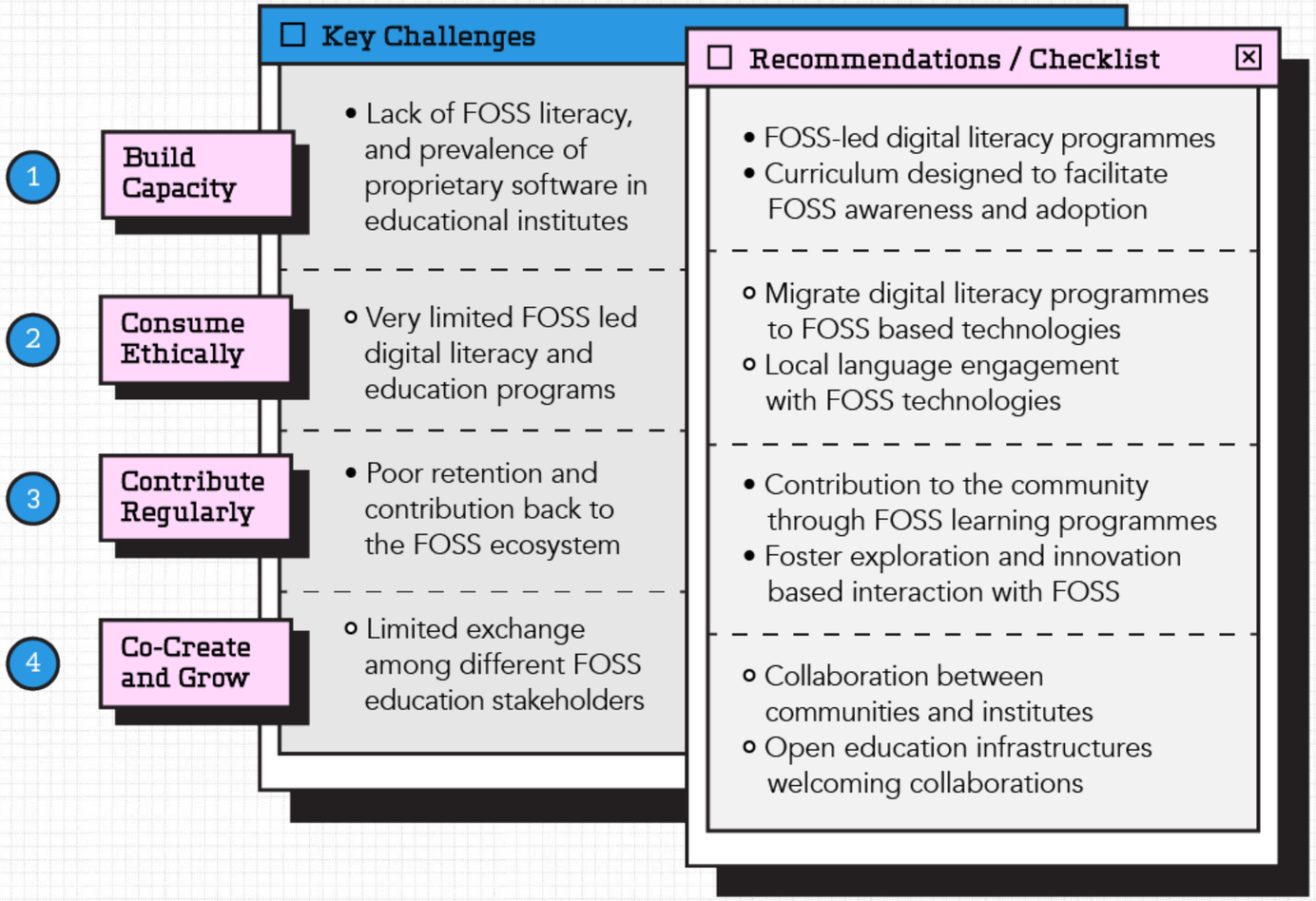


Talent acquisition

FOSS Businesses

Key Challenges & Recommendations

The education sector is already a vast space with its own challenges and complexities and needs further research to understand the landscape better. FOSS has an integral role to play in the journey of the sector to ensure equitable access to knowledge through diverse sources while ensuring sustainable adoption.



4.2.1 Capacity

The primary challenge in building a FOSS led education ecosystem in India is the literacy [217] to adopt such technologies.

There is a need for augmenting Information and Communication Technology (ICT) and FOSS capacity in educational institutes before FOSS assisted education can be implemented.

A big barrier for FOSS adoption in the education ecosystem is the limited knowledge around FOSS technologies and use. According to a study from 2017, almost 95% of India's technology graduates cannot write a working program.

In the Indian education setup, technological interventions are not felt as a critical need. A lot of the time, these interventions are considered inferior to the traditional teaching methods. Capacity building for FOSS technologies is required before the advantages and benefits can be realised.

ICT curriculum across educational institutes mostly use proprietary software for education.

With educators and students not exposed to the ideas and usage of FOSS from an early stage education, it becomes difficult to change these habits at a later stage. In many cases, the syllabus explicitly specifies proprietary software brand names (such as MSWord, MSExcel) instead of using generic terms like documents, spreadsheet, giving

[217] Kannan Moudgalya, "Campaign for IT Literacy through FOSS and Spoken Tutorials," Proceedings of the 13th Python in Science Conference, 2014 https://doi.org/10.25080/majora-14bd3278-009.

teachers and students no freedom to choose the software that meets their needs.

A few initiatives like the IT@School Project in Kerala [218] have been taken to formalize FOSS based curriculums, but the same have not been realised and adopted to their full potential in the state and across the country. This carries through to universities as well.

Our university system of affiliating colleges gives too much importance to university syllabi

Kannan Moudgalya

Professor at IIT Bombay and creator of FOSSEE

Inclusion of more non-denominational statements would allow for greater FOSS uptake. For example while there are various homegrown FOSS teaching tools such as BigBlueButton[219], Chatshalla [220] or Classmeet [221], they are not being taken up by schools and colleges.

4.2.2 Consume

Institutes face major challenges during the planning and implementation of programmes to adopt and sustain FOSS Led education [222].

Competing demand for resources in educational institutes hinders adoption of FOSS technologies. Even though the benefits of FOSS (economical or otherwise) are very well documented [223], they have not been realised to the same capacity.

Adoption of FOSS based programs faces numerous challenges from the planning phase (eg: infrastructure, budget) to implementation (eg: lack of manpower, resistance to change). With educational environments being particularly resource deprived, various integral functions take priority.

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[218] Biju Prabhakar and Arun M, "IT@ SCHOOL AND FREE SOFTWARE IN EDUCATION: THE KERALA MODEL," Information, Society, and Development, 2007. https://www.researchgate.net/publication/330030587_Campaign_for_IT_literacy_through_FOSS_and_Spoken_Tutorials

[219] "Open Source Web Conferencing," BigBlueButton, accessed October 22, 2020, https://bigbluebutton.org/.

[220] "Home," Chatshala.com, May 15, 2020 https://www.chatshala.com.

[221] "ClassMeet," ClassMeet, accessed October 22, 2020, https://classmeet.chiguru.tech/.

[222] Briju Thankachan and David Richard Moore, "Challenges of Implementing Free and Open Source Software (FOSS): Evidence from the Indian Educational Setting," The International Review of Research in Open and Distributed Learning 18, no. 6 (2017), https://doi.org/10.19173/irrodl.v18i6.2781.

[223] "FOSS Education," FOSS Education - Wikibooks, open books for an open world, accessed October 22, 2020, https://en.wikibooks.org/wiki/FOSS_Education.

One way to enable FOSS adoption at scale is access to laptops with these technologies needs to be made available at an early age.

Kannan Moudgalya

Professor at IIT-B and creator of FOSSEE [224] and Spoken-Tutorial [225], tools that promote FOSS use amongst students

There is a lack of localized digital literacy curriculum to enable learners to learn in their native languages and support adoption. India faces a challenge that most popular operating systems and applications are available only in English. There is a need for localised content to foster widespread adoption of these technologies.

The localisation of Linux to Indian languages can spark off a revolution that reaches down to the grassroots levels of the country [226].

Venkatesh Hariharan

FOSS advocate and India representative or the Open Invention Network

4.2.3 Contribute

India faces a key challenge of retention and continuous contribution back to the FOSS ecosystem due to lack of value communication from an early age.

FOSS learning in institutes lacks a contribution pipeline for young learners to foster the habit of collaboration. There is a big gap between number of learner and contributors with the ecosystem. There are more one-time contributors and short term involvement from individuals in search of better employment opportunities.FOSS learning programmes do not always have community contribution avenues attached to the modules.

There is a need to communicate the values and principles of FOSS, fostering a collaborative culture While some young learners are accessing FOSS technologies

224 "POSTER," FOSSEE, accessed October 20, 2020 https://fossee.in/.

225 "Spoken Tutorial Project, IIT Bombay," Home, accessed October 20, 2020, https://spoken-tutorial.org/.

226 "Why Linux Makes Sense for India," SlashDot, accessed October 22, 2020, https://mailman.apnic.net/mailing-lists/s-asia-it//archive/2000/01/msg00031.html.

during in and out of school learning programmes, the values and benefits of the same are not always communicated. FOSS is primarily treated as a learning tool to gain better opportunities and not always a space to collaborate and innovate, which are at the core of the movement.

4.2.4 Co-create

The FOSS education ecosystem is scattered in silos with limited exchange between different stakeholders to create and expand together.

Limited opportunities for collaboration between the community, businesses, and educational institutions. Most FOSS learning programmes are limited to learning new tools and technologies. Challenges around digital literacy and local language learning would hugely benefit from community level engagement and solutions. There is limited exposure in terms of partnerships with the community to collaboratively develop or with businesses to enable real world training scenarios.

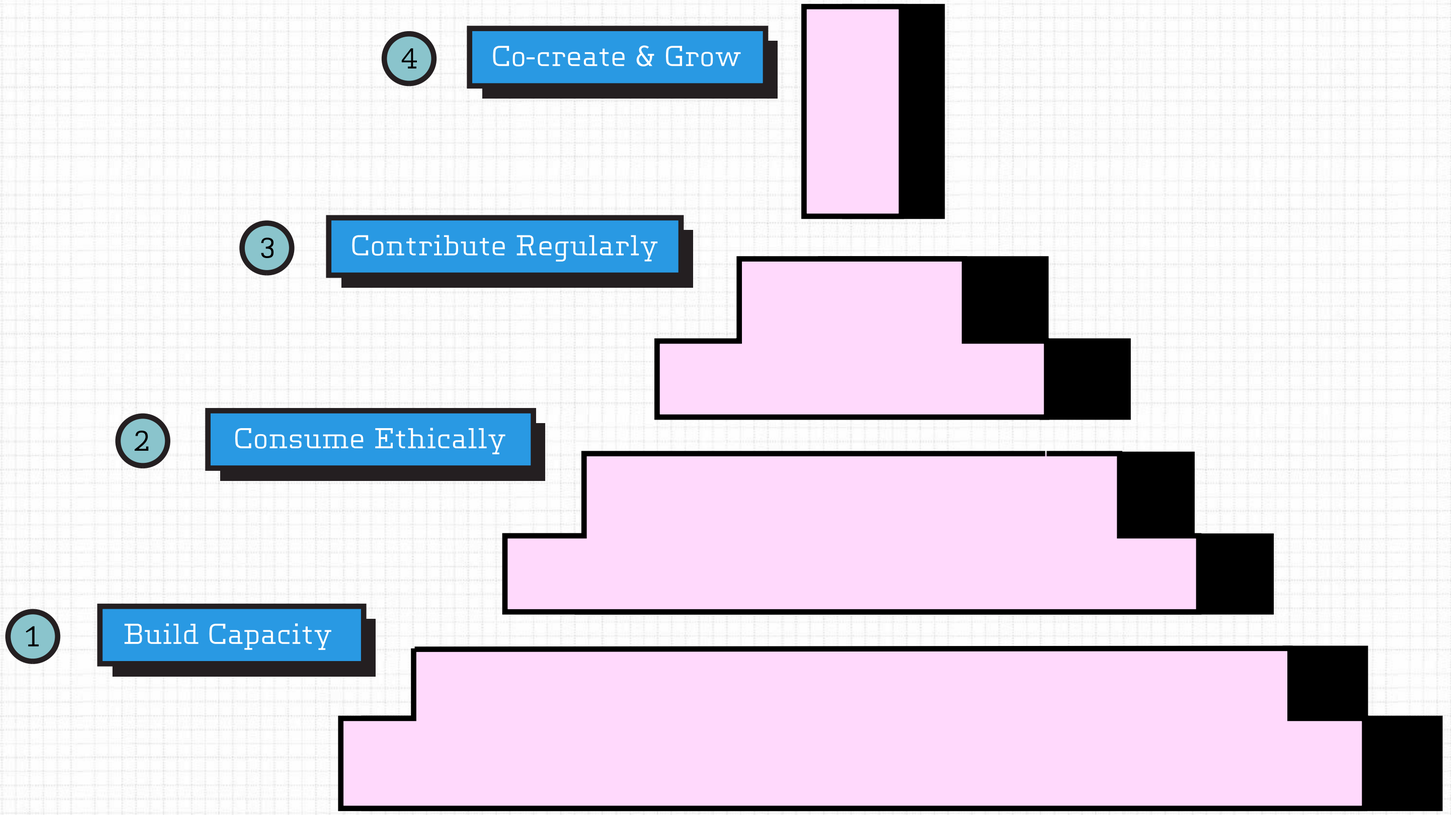
Even after taking huge leaps, the overall adoption of FOSS technologies across the Indian education ecosystem has been fairly inconsistent.
The government FOSS expansion programmes have not seen the lateral adoption envisioned. Schemes like NMEICT[227] mention the adoption of FOSS but encouraging widespread adoption of FOSS led-ICT is not the central theme of the programme.

Additionally, many of the government initiatives employing FOSS technologies don't always provide their source code in the open for further development and contribution.

[227] "National Mission on Education through Information and Communication Technology," NMEICT, accessed October 22, 2020, https://nmeict.ac.in/.

4.3 Recommendations

The challenges of FOSS in education, as stated above, are fairly multifaceted requiring interventions through various levels and inlets to help sustain growth and adoption of the movement in the sector. While the list of challenges and recommendations stated is not comprehensive by any means, it is meant to act as a useful scale to measure the progress against and take strategic steps to move forward.



4.3.1 Capacity

4.3.1a Digital Literacy

Building digital literacy programs to empower educators and learners alike to adopt FOSS technologies as a classroom tool.

- Advocacy campaigns need to enlighten stakeholders towards ICT and FOSS led education while communicating values and benefits.
- There should be emphasis on participation and activity, while upgrading the skills and knowledge of the educator.
- One must ensure FOSS literacy before FOSS enabled literacy in educational institutes.
- In colleges, just like there is the National Service Scheme as an extracurricular activities, FOSS should also be encouraged.

A single resource cannot work across multiple classrooms,contextualisation to local needs is required to build the capacity of teachers

Yogesh K S
IT for Change [228]

FOSS & Education

IT@School Project [229]

The IT@School is a project under the Directorate of Public Instruction of the Government of Kerala, India. This project integrates ICT to improve conventional teaching and learning systems.

IT@School is one of the largest deployments of FOSS-based ICT education in the world. The main activities of the project are capacity building, infrastructure development, content development, and e-governance.

The project impacts 6 million students and 200,000 teachers every year. The school teacher community in Kerala was key in promoting and adopting FOSS in schools in the IT@School project in the state.

228 "IT for Change," Home, accessed October 21, 2020, http://www.itforchange.net/.

229 Biju Prabhakar and Arun M, "IT@ SCHOOL AND FREE SOFTWARE IN EDUCATION: THE KERALA MODEL," Information, Society, and Development, 2007.

IT for Change

written by ***Gurumurthy Kasinathan***
Founder and Director of IT for Change

School education is a very important site for FOSS adoption, as young learners learn about FOSS philosophies as well as become familiar with FOSS applications/tools. This will help in the promotion of FOSS in society. Proprietary vendors like to make sure only their products are used in education, as these become default for users. Microsoft Windows and Microsoft Office is a good example of this.

From 2002, Kerala has been using FOSS in its government school system. This is discussed in 4.1 However, other states did not follow this and remained with Microsoft Windows/Office based school education programs. Kerala was seen as the odd person out.

In 2011, IT for Change, keeping Kerala as a beacon, began a program to implement FOSS in Karnataka Govt school system and by 2015; around 20,000 high school teachers (50% of total strength) were trained on FOSS applications including educational applications (like Geogebra, Phet, Marble, Audacity, Recordmydesktop etc). The Karnataka education department continued this program and has trained all high school teachers on FOSS. In 2015, IT for Change initiated similar programs in Telangana, Andhra Pradesh and Assam and trained teachers as master trainers to continue FOSS use in schools.

This process of pushing FOSS in Indian education has seen participation of many individuals and institutions, including Nagarjuna (FSF/ HBSC), Anivar Aravind, Venky Hariharan, Swecha/ FSMI, IT for Change, under the umbrella called 'FOSSCOM' (FOSS Community). This group also worked on policy and program advocacy with national and state governments. The group wrote to state governments of Maharashtra, Rajasthan, Assam and Tamil Nadu to protest against choice of proprietary OS in the school programs and in case of Tamil Nadu, this decision was reversed to include FOSS OS.

In 2012, the NCERT issued the 'National Policy on ICT for School Education', this specifically recommends FOSS. In 2013, NCERT released

the National ICT Curriculum, which avoids mentioning any product names and instead proposes a variety of areas for applications (which would require/favour use of FOSS). The NROER was launched by NCERT in 2013 as a repository for Open Content. Prof Rajaram Sharma, then Joint Director NCERT and Head of CIET (Central Institute of Education Technology), played a key role in driving these initiatives of NCERT. Since NCERT is the curriculum making / shaping body in India, this promotion of FOSS in school education played a big role in persuading state governments.

With these developments, the use of FOSS in Indian school education system has gone mainstream and now education departments prefer to use FOSS as default in their school programs. This is a complete change from pre 2011 where FOSS was looked at with suspicion. For instance, when TISS launched the CLIx program across 4 states in 2017, FOSS was their choice for software deployment. Large scale deployment in schools (India has more than a million schools) will greatly support FOSS implementation across the country

4.3.1b FOSS Curriculum

A FOSS led curriculum needs to be created and adopted in schools to facilitate awareness and adoption around FOSS from an early age.

- We need a syllabus that integrates usage of FOSS applications, teaching material for the educators, and technical support to implement programmes.
- Institutes like the National Council of Educational Research and Training (NCERT) [230] should ensure that there is a FOSS curriculum for primary and secondary education in the country.

Computer Masti [231]

Computer Masti programmes address the gap towards FOSS in education by defining a syllabus based on FOSS to build computer fluency. They also prepare teaching material for FOSS in primary schools. Teacher training is also conducted with a specific focus on FOSS. The programme addresses basic concepts and social aspects of computer and FOSS usage.

[230] "NCERT," NCERT, accessed October 22, 2020 https://ncert.nic.in/.

[231] "A Comprehensive Computer Science Curriculum Solution Created by Computer Science Professors at IIT Bombay in Collaboration with Next Education," Computer Masti | Computer Science textbooks for schools, accessed October 22, 2020, https://computermasti.in/.

4.3.2 Consume

4.3.2a Migration

Migrate existing digital literacy missions and programmes at the national level and institute level to FOSS based technologies.

- There is a unique opportunity among businesses, communities, government departments to support educational institutions that want to move away from proprietary technologies and adopt FOSS solutions as a means of education. This needs to be capitalized.
- There needs to be stronger support, resources, and opportunities to educational institutions to incentivize and adopt FOSS technologies

FOSSEE [232]

The FOSSEE programmes assists educational institutes to adopt and migrate to FOSS based labs.

FOSSEE, is a project funded by the National Mission on Education through ICT, Ministry of Education (Formerly MHRD), Government of India.

The project at IIT Bombay aims to promote the use of Free/Libre and Open Source Software (F/LOSS) among other institutes and individuals. It encourages the use of F/LOSS by ensuring commercial software is replaced by equivalent F/LOSS tools, and helps develop new F/LOSS tools and upgrade existing tools to meet requirements in academia and research.

FOSSEE conducts activities such as Lab Migration to migrate existing labs at educational institutes to equivalent open source software.

[232] "POSTER," FOSSEE, accessed October 20, 2020, https://fossee.in/.

4.3.2b Local Language

Local language engagement with FOSS technologies would drastically increase the interest and motivation to adopt a new framework.

- We need to localize the digital literacy curriculum to enable learners to learn and contribute in their native languages
- We also need to collaborate with the community to ensure localisation and widespread adoption of such technologies

Spoken Tutorial [233]

Spoken Tutorial is an open digital learning library of FOSS resources in 22 Indian languages.

Spoken Tutorial is a project funded by the National Mission on Education through ICT, MHRD, Government of India, to promote IT literacy for education and employment.

Ten-minute-long spoken tutorials (ST) are created for self-learning, dubbed into all Indian languages and can be used offline. Both ST and the software trained by them are available free of cost to everyone in a large variety of subjects.

About 36,000 college labs use ST in their official curriculum. More than 60 lakh students and college teachers have been trained using this methodology during the past 7-8 years. The resource is available for other countries, who can dub the ST in their languages and train their students with the approach extendable to other skills training.

[233] "Spoken Tutorial Project, IIT Bombay," Home, accessed October 20, 2020, https://spoken-tutorial.org/.

4.3.3 Contribute

4.3.3a Community Initiatives

Existing in- and out- of school education infrastructure should communicate FOSS values and enable contribution back to community.

- Governments should enable communities to create value-based learning and community contribution programmes on existing platforms such as the National Programme on Technology Enhanced Learning (NPTEL) [234] for students in educational institutes.

- Ed-Tech platforms can inculcate FOSS history and value along with technical skills in the curriculum through coding platforms for kids like WhiteHatJr [235] with community project programs.

FOSSEE [236]

FOSSEE encourages the use of FOSS contributions from existing students.

FOSSEE (Free/Libre and Open Source Software for Education), a project funded by National Mission on Education through ICT, MHRD, Government of India, promotes the use of F/LOSS tools to improve the quality of education in our country.

It aims to reduce dependency on proprietary software in educational institutions. The programme also has text book companions to help individuals pick up practical FOSS skills. These companions are developed in collaboration with the existing students who contribute having acquired skills through the programme.

[234] "Nptel, Online Courses and Certification, Learn for Free," Nptel, online courses and certification, Learn for free, accessed October 22, 2020, https://nptel.ac.in/.

[235] "Live Online Coding for Kids: WhiteHat Jr.," accessed October 22, 2020, https://www.whitehatjr.com/.

[236] "POSTER," FOSSEE, accessed October 20, 2020, https://fossee.in/.

Creation of innovation labs in educational institutions to foster play and exploration based interaction with FOSS technologies.

The curricula should not be restricted by the formal education framework and should be more focused on learning-by-doing and learning with others. The Gnowledge Lab [237] for example stresses on designing and developing discourse based constructionist learning environments for students mainly in STEM. There needs to be more exploration, discussion and creation among young students using FOSS technologies for the needs of the local community and to foster innovation.

Gnowledge Lab is a Research & Development lab by Homi Bhabha Centre for Science Education (HBSCE) and Tata Institute of Fundamental Research (TIFR) in Mumbai. It has various collaborative FOSS tools for STEM education

Atal Tinkering Labs [238]

Atal Innovation Mission embeds innovation-based learning through Atal Tinkering Labs.

Atal Innovation Mission (AIM) is Government of India's flagship initiative to promote a culture of innovation and entrepreneurship in the country.

Atal Tinkering Labs (ATL), a program of the AIM is directed towards creating a problem solving mindset across schools in India. In order to foster inventiveness among students, ATL can conduct different activities ranging from regional and national level competitions, exhibitions, workshops on problem solving, designing and fabrication of products, lecture series at periodic intervals.

[237] "Resources," Gnowledge Lab, accessed October 22, 2020, https://www.gnowledge.org/projects/resources.html.

[238] "AIM. TO INNOVATE.," AIM, accessed October 22, 2020, https://aim.gov.in/.

4.3.4 Co-create

4.3.4a Cross Collaborations

Programmes to identify, promote and grow existing FOSS collaboration between communities, businesses and educational institutes.

- There needs to be more focus on introducing students to FOSS development alongside communities working in specific focus areas. For Eg: QikPik [239] (an Indian retail store) organized a Open Source Monsoon hackathon [240] where communities and organizations working on FOSS projects volunteered as mentors for college students as they solved issues for FOSS projects.
- Institutes need to provide community oriented capstone projects for FOSS tools and training programmes.
- Students should work with experienced mentors from programs such as GSoC and Outreachy to learn more about about FOSS development practices [241,242].

239 "Qikpik Technologies Private Limited Information", The Economic Times, accessed October 22, 2020, https://economictimes.indiatimes.com/company/qikpik-technologies-private-limited-/U72200TG2014PTC096714.

240 "QikPik Monsoon Opensource Hackathon," QikPik, accessed October 22, 2020, https://qikpik.store/hackathon/.

241 "GSoC," Google Summer of Code Archive (Google), accessed October 22, 2020, https://summerofcode.withgoogle.com/archive/.

242 "Internships Supporting Diversity in Tech," Outreachy, accessed October 20, 2020, https://www.outreachy.org/.

Ensuring open educational resources and technologies are employed in educational institutes across the country.

- There is a need for FOSS education content management system, hosting open educational resources around FOSS technologies for wider access.

- Open sourcing educational platforms incubated by the government with enhancements and expansion led by the community. For Eg:, the Gnowledge Lab, an R & D platform created in collaboration with Bhabha Atomic Research Centre (BARC) and Tata Institute for Fundamental Research (TIFR) [243], focuses on the structure and dynamics of knowledge networks. They develop, design and distribute many FOSS learning tools (CUBE [244], MakerSpace [245]) under copyleft licenses.

- Extending platforms like DIKSHA [246] and Project Sunbird [247] to work with the FOSS community and educators to develop tools and resources for FOSS education.

Khan Academy [248]

Khan Academy offers open educational content and an open source platform.

Khan Academy offers practice exercises, instructional videos, and a personalized learning dashboard that empower learners to study at their own pace in and outside of the classroom.

Khan academy tackles math, science, computing, history, art, history, economics, and more, including K-14 and test preparation (SAT, Praxis, LSAT) content. All of Khan Academy's content is available as Open Education Resources (OERs) and the platform's source code is available as open source repositories.

[243] "Resources," Gnowledge Lab, accessed October 22, 2020, https://www.gnowledge.org/projects/resources.html.

[244] "Collaboratively Understanding Biology Education," Gnowledge Lab, accessed October 22, 2020, https://www.gnowledge.org/projects/cube.html.

[245] "MakerSpace," Gnowledge Lab, accessed October 22, 2020, https://www.gnowledge.org/projects/makerspace.html.

[246] "Homepage"Diksha, accessed Oct 22 2020, https://diksha.gov.in/

[247] "Project Sunbird," GitHub, accessed October 22, 2020, https://github.com/project-sunbird.

[248] "Free Online Courses, Lessons & Practice," Khan Academy (Khan Academy), accessed October 22, 2020, https://www.khanacademy.org/.

4.4 Way Forward

Appropriate FOSS literacy efforts along the key pillars of capacity building, ethical consumption, contribution and co-creation will definitely play a critical role in the mass adoption of these technologies.

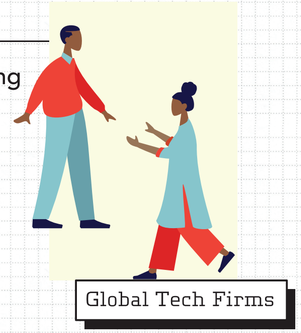
This inturn should increase market demand as well as create a potential workforce that is FOSS literate and capable. This will be crucial for Indian businesses to move from a consumer to a producer mindset within the FOSS ecosystem.

FOSS & Business

Global tech firms having an Indian FOSS presence

Eg:

- *Amazon*
- *Google*
- *GitHub*
- *Red Hat*
- *Tata Consultancy Service*
- *Thoughtworks*
- *Wipro*



Global Tech Firms

Individuals contracted to work on FOSS projects

Eg:

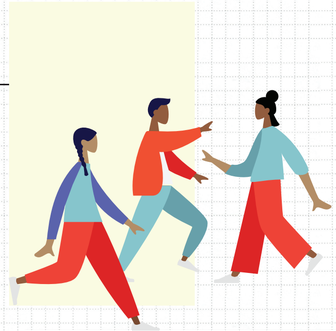
- *Arun Raghavan*
- *Nirbheek Chauhan*
- *Steven Deobold*
- *Vaishali Thakkar*

Consultants

Start ups implementing FOSS based solutions in India

Eg:

- *Ashnik*
- *Bagisto*
- *Coopon*
- *Dhiway*
- *Frappe Technologies*
- *Hasura*



Micro, Small & Medium Enterprises

Organisations that allocates capital for FOSS with the expectation of a future financial return or to gain an advantage

Eg:

- *OSS Capital*
- *Strive VC*
- *3One4 Capital*

Investors

Chapter 05

FOSS & Businesses

> Open source became a movement — a mentality. Suddenly infrastructure software was nearly free. We paid 10% of the normal costs for the software and that money was for software support. A 90% disruption in cost spawns innovation.
>
> *Mark Suster*

5.1 Landscape

5.1.a Adoption and use of FOSS by businesses

The following key factors led to adoption of FOSS by businesses:

Rise of the LAMP Stack

The following key factors led to adoption of FOSS by businesses:

The year was 1995, Linux was already developed and three key elements that would push FOSS into the limelight were being created in three different parts of the world.

The database MySQL was being developed by a Swedish company, the Apache HTTP server was being created in the University of Illinois and PHP was initially developed by a Canadian developer. The four elements together would later be called the LAMP stack (Linux/ instead of UNIX, Apache, MySQL or PostgreSQL/instead of Oracle and PHP) [249]. The LAMP stack was already in practice by the time it was given a name in 2000. It would go on to compete with and win against huge commercial products from players as large as Microsoft [250] and Apple [251] with rather modest marketing.

It would go on to be the Web Service Stack of choice while building websites and applications and large companies would soon start offering their resources to develop these platforms over time [252].

Formation of the Open Source Initiative

In 1998, the Open Source Initiative(OSI)was created by Bruce Perens and Eric S Raymond [253]. The OSI adopted the definition of Open

[249] "LAMP Stack Explained: Master the Basics and Get Started Quickly," LAMP stack explained: Master the basics and get started quickly, accessed October 22, 2020, https://www.ibm.com/cloud/learn/lamp-stack-explained.

[250] Jithu Daniel, "The Complete Microsoft Technology Stack For Businesses," ClaySys Technologies, December 3, 2019, https://www.claysys.com/blog/microsoft-technology-stack/.

[251] "Apple - Apple Tech Stack," StackShare, accessed October 22, 2020, https://stackshare.io/apple/apple.

[252] Ernie Smith , "LAMP Stack History: It's Everywhere, But Developers Hate It," Tedium, accessed October 22, 2020, https://tedium.co/2019/10/01/lamp-stack-php-mysql-apache-history/.

[253] "History of the OSI," History of the OSI | Open Source Initiative, accessed October 22, 2020 https://opensource.org/history.

Dump the moralizing and confrontational attitude that had been associated with ‘free software’ and instead promote open source ideas on pragmatic, business-case grounds [256].

Michael Tiemann
OSI founding member

If a multi-billion-dollar company hires a kernel developer or funds a web framework, they will almost certainly weigh in on that project’s trajectory but at least the project’s community can still remain outside the company’s walls.

Steven Deobald
FOSS contributor

Source from the Debian Free Software Movement [254].The OSI was created to in the words of the founding member Michael Tiemann [255]

Growth of contributions from Internet based businesses

While the progenitors to the internet (ARPANet and WorldWideWeb) were created in the late 1980’s and early 1990’s, the true digital revolution began around 2004 (a.k.a Web 2.0) with more responsive web design to focus substantially upon allowing users to interact and collaborate with each other [257,258].

This is the era of internet based companies where the main business model is advertising and the overarching aim is to make everyone live their lives on the internet. These are built on top of FOSS technology stacks and had a lot of vested interest in bettering these FOSS technologies. And so, web-based tech firms (such as Google [259], Netflix [260], Amazon [261], Facebook [262]) started contributing to FOSS in terms of manpower and funds. Now, even though most of these projects have contributions primarily from developers employed within the parent corporation, there is still a vibrant community outside.

Cloud computing

Cloud computing is the on-demand availability of computer resources (especially storage and computing power) without direct active management by the user, engaged by the customer over the internet.

In 2006, Amazon created a subsidiary called Amazon Web Services, that would provide on-demand cloud computing platforms. Later, Google and Microsoft would follow.

This particular innovation would spark off the start-up boom as initial investment was suddenly negligible. However, this new innovation comes with it’s own kind of vendor lock-in possibilities [263]

254 Bruce Perens, “Debian’s ‘Social Contract’ with the Free Software Community,” Debian’s “Social Contract” with the Free Software Community, 1997 https://lists.debian.org/debian-announce/1997/msg00017.html.

255 “Michael Tiemann’s Home Page,” Home page for Michael Tiemann, accessed October 22, 2020 https://people.redhat.com/tiemann/.

256 “History of the OSI,” History of the OSI | Open Source Initiative, accessed October 22, 2020 https://opensource.org/history.

257 “The Invention of the Internet,” History.com (A&E Television Networks, July 30, 2010), https://www.history.com/topics/inventions/invention-of-the-internet.

258 Grant Blank and Bianca C. Reisdorf, “The Participatory Web,” Information, Communication & Society 15, no. 4 (2012): pp. 537-554 https://doi.org/10.1080/1369118x.2012.665935.

259 “Google,” GitHub, accessed October 21, 2020 https://github.com/google/.

260 “Netflix Open Source,” Netflix Open Source Software Center, accessed October 20, 2020 https://netflix.github.io/.

261 “Amazon,” GitHub, accessed October 21, 2020 https://github.com/amzn.

262 “Facebook,” GitHub, accessed October 21, 2020 https://github.com/facebook.

263 Mark Suster, “Understanding Changes in the Software & Venture Capital Industries,” Medium (Both Sides of the Table, April 14, 2016), https://bothsidesofthetable.com/understanding-changes-in-the-software-venture-capital-industries-b69a7e3a1ec7.

5.1.b. The Rise of commercial FOSS business models

The popularity of the FOSS movement has resulted in new business models emerging to accommodate for the non- traditional ideas about economies, collaboration, and business.

Large scale adoption of FOSS by enterprises was possible because of the commercial support and services provided by companies like Red Hat.

Today, FOSS is being used in mission critical applications like stock exchanges, payment networks, e-commerce platforms and others. With the recent rise of Software as a Service businesses, subscription models are the norm, but in the early days this was not common.

In the 1990s, proprietary software was sold in the form of licenses, while development and implementation services formed the commercial model around FOSS. FOSS has been pushing for the creation of new kinds of business models to accommodate its non-traditional ideals of collaboration and freedom [264].

Around the early 2000's, new business models arose that started offering support (Service Level Agreements) and services (training, consulting, workshops) to those companies, individuals, and governments who wanted to adopt FOSS (For example: Red Hat, Canonical) [265,266].

This was taken a step further by dual-licensing models where an identical product is released with two licenses - a restrictive and permissive license (For Eg: MySQL)[267].

The creation of subscription models, stable enterprise editions, and building an ecosystem of software

[264] "The ReSolve Initiative," Omidyar Network India, accessed October 22, 2020, https://www.omidyarnetwork.in/the-resolve-initiative.

[265] "The World's Open Source Leader," Red Hat - We make open source technologies for the enterprise, accessed October 21, 2020, https://www.redhat.com/en.

[266] "Canonical," Publisher of Ubuntu, accessed October 22, 2020, https://canonical.com/.

[267] MySQL, accessed October 22, 2020, https://www.mysql.com/.

and hardware vendors around FOSS gave enterprises the confidence to deploy FOSS. This helped FOSS move from the edge of the enterprise (where it was deployed in non-critical applications) to the core of the enterprise.

Over the past decade there have been many commercial FOSS companies emerging which produce and distribute FOSS products.The timeline for the emergence of the different kinds of FOSS business models is illustrated below.

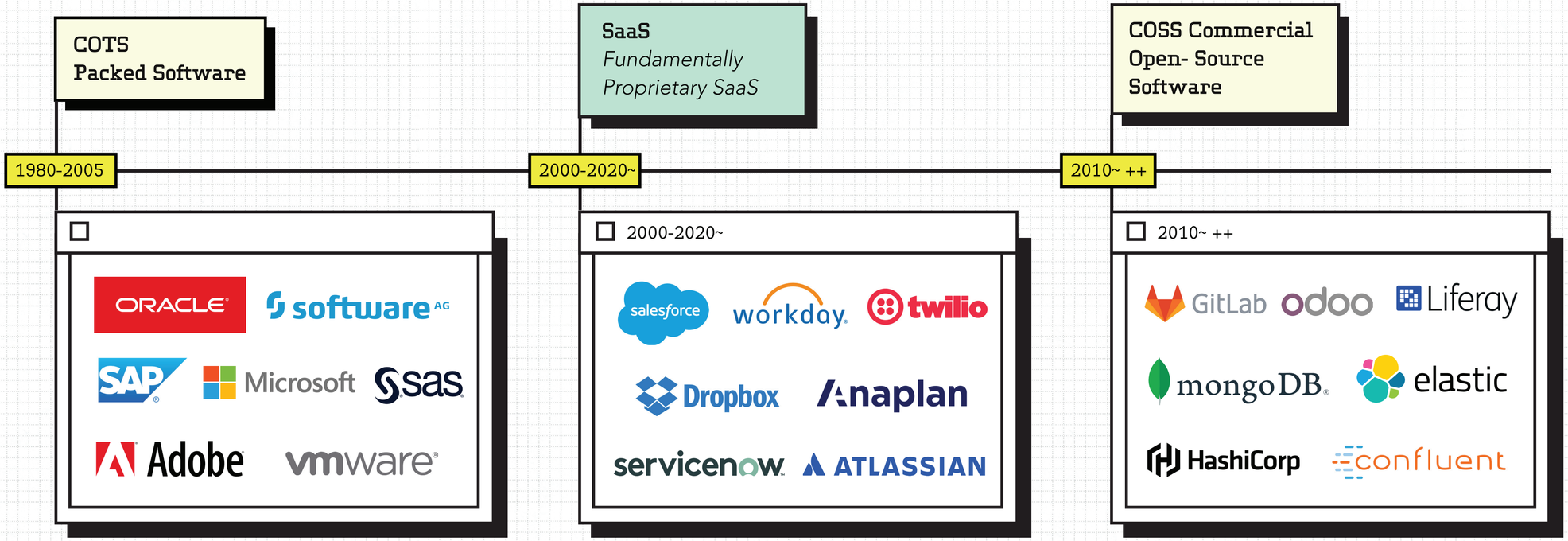


Figure 10: Different Eras of software business (image from COSS media) [268]

[268] Joseph Jacks,"For an Open Future", Coss Media, Mar 2020. https://coss.media/for-an-open-future/

The acceptance of FOSS business models meant that there was growing pragmatism about how to sustain FOSS. Quality of FOSS products are improving every day and, in many domains, they are reaching the quality of a proprietary product. This kind of acceptance is a huge opportunity for FOSS entrepreneurs.

Rushabh Mehta
Creator of ERPNext

There are FOSS business models that can solve the challenge of how to make money providing software that is by definition licensed free of charge. Monetizing methods include:

Advertising

Advertising as in the case of Mozilla where most of its revenue came from Google search being advertised on the Firefox browser, this also proved to be their downfall as Google went on to build Chrome which has now taken such a large piece of market share. This recently led them to lay off around 25% of it's workforce [269]. Similarly AdBlock plus, the open source Ad blocking service gets paid by Google to whitelist advertisements [270].

Open Core

Open Core was the business model that stemmed directly from dual-licensing. The usual difference between the two is that Open Core models usually have a community facing version and an enterprise version usually, the core FOSS product is available in open and then there are a set of differentiating features that almost all customers need that are closed off. These features are usually for collaboration, management and security. (For Eg: Confluent based on the Open source streaming platform Kafka, it offers a managed solution[271].)

Software-as-a-service

The customers can access the software over the internet along with a FOSS deployment. So there are plug and play and versions or do-it-yourself ones of the software. You usually sell subscriptions for this model. Eg: WordPress.com. WordPress is an open source content management system (CMS) that has to be hosted on a web server, whereas WordPress.com is a privately held hosting service that runs using the WordPress CMS. This service makes it easier for customers to publish blogs or websites without having to deal with the intricacies of installing the WordPress CMS or locating and configuring web hosting.

269 Abishek Prakash, "What does Mozilla firing 25% of it's work mean", It's FOSS, Aug 2020 https://itsfoss.com/mozilla-struggle/

270 Julia Greenberg, Adblockers are making money off Ads (and tracking too), Wired, Feb 2016. https://www.wired.com/2016/03/heres-how-that-adblocker-youre-using-makes-money/

271 ""Confluent" The complete soluntion for cloud native event streaming. Dec 21, 2020. https://www.confluent.io/.

Its success earned Automattic, the company behind it, a valuation of over $1 billion[272]. There are also Open Core-as-a-service versions of this. Eg: HasuraGraphQl[273], Cassandra-as-a-Service [274].

Open Source Consultants

There are many instances of individual developers or boutique consultants (core contributors or maintainers of specific projects) that work with customers on specialized FOSS projects. For Eg: Nilenso, an employee owned cooperative that works with Clojure [275], Centricular works with GStreamer [276].

Gift Economy

This includes donations, crowdfunding campaigns which fund individual developers and maintainers. Eg: Github Sponsors [277], Patreon [278],Kickstarter [279] where the community that depends on the FOSS projects can choose to fund individuals for their work. Large scale FOSS projects are almost never sustained completely on this.

Ancillary business models

Open Collective helps projects collect and spend the money transparently, there are usually complicated logistics around funding FOSS projects which it helps deal with [280]. Tidelift on the other helps manage your FOSS project and works with large projects and independent maintainers [281].

A useful indicator to measure growth and future potential of FOSS related businesses is the volume of private capital flowing into the space.

As of mid-2020, there are at least 50 commercial OSS based companies that have raised more than 100 million USD as VC funds [282]. Rahul De (Professor at IIM-Bangalore and author of several papers on the economic impact of FOSS in India) also stresses, this is just the beginning, as the entire emerging wave of digital transformation tools that are going to disrupt technology and innovation in the near future are also almost entirely built on FOSS-blockchain [283], containers [284], IoT software [285], embedded OS [286].

[272] Lora Kolodny, "Automattic Valued at $1.16 Billion, Says It Doesn't Need IPO," The Wall Street Journal (Dow Jones & Company, May 5, 2014) https://www.wsj.com/articles/BL-VCDB-14502.

[273] "Instant GraphQL APIs for Your Data: Join Data across Databases, GraphQL & REST Services to Build Powerful Modern Applications," Hasura, accessed October 21, 2020 https://hasura.io/.

[274] "Cloud Data Management: DBaaS," Datastax, accessed October 22, 2020 https://www.datastax.com/products/datastax-astra.

[275] "Nilenso Software," Nilenso Software, accessed October 22, 2020, https://nilenso.com/.

[276] "Centricular," Centricular • GStreamer, Multimedia and Graphics Expertise • Open Source, accessed October 22, 2020, https://www.centricular.com/.

[277] "GitHub Sponsors," GitHub, accessed October 22, 2020 https://github.com/sponsors.

[278] "Patreon," Patreon, accessed October 22, 2020 https://www.patreon.com/.

[279] Kickstarter, accessed October 22, 2020 https://www.kickstarter.com/.

[280] "Open Collective," Open Collective - Make your community sustainable. Collect and spend money transparently., accessed October 22, 2020 https://opencollective.com/.

[281] Tidelift, "Managed Open Source Software - the Tidelift Subscription," Tidelift, accessed October 20, 2020 https://www.tidelift.com/subscription/tidelift-tour.

[282] "COSSI: $100M+ Revenue Commercial Open-Source Software (COSS) Company Index," Google Sheets (Google), accessed October 22, 2020, https://docs.google.com/spreadsheets/d/17nKMpi_Dh5slCqzLSFBoWMxNvWiwt2R-t4e_l7LPLhU/edit.

[283] "The Great Chain of Being Sure about Things," The Economist (The Economist Newspaper, 2015), https://www.economist.com/briefing/2015/10/31/the-great-chain-of-being-sure-about-things.

[284] "What Is a Container?," Docker, accessed October 22, 2020, https://www.docker.com/resources/what-container.

[285] Margaret Rouse, "What Is IoT (Internet of Things) and How Does It Work?," IoT Agenda (TechTarget, February 11, 2020), https://internetofthingsagenda.techtarget.com/definition/Internet-of-Things-IoT.

[286] Steve Heath, "Embedded Systems Design," Embedded Systems Design - 2nd Edition (Elsevier, October 30, 2002), https://www.elsevier.com/books/embedded-systems-design/heath/978-0-7506-5546-0.

5.1.c New and emerging areas of corporate contribution to FOSS ecosystem

Other than commercial FOSS businesses, there are other ways in which corporations can contribute to FOSS. A few examples of this kind of contribution are detailed below.

Corporate Contributions

Large corporations can choose to contribute to already existing FOSS projects through manpower or money. For example: There is in-house sponsorship of FOSS projects inside Google and IBM where they have many developers working on specific FOSS projects. Facebook also hired a lot of maintainers of Mercurial to keep working on the same projects [287].

Mercurial is a distributed versioning software alternative to Git that is used largely by Facebook

Corporate Creators

There have been plenty of FOSS Projects or libraries that begin inside corporations and have a community supporting it from outside the walls. For Eg: TensorFlow, Android, Go, and Flutter were created inside Google [288] and React Native was created within Facebook [289].

TensorFlow has been used by NASA for orbit classification and object clustering of asteroids [290] and by Netflix to recommend TV shows to you and your family [291]

Companies that Promote FOSS

There are some companies that release proprietary software that support FOSS projects. For Eg: Github (now owned by Microsoft) is a proprietary software that hosts a platform for software and development and versioning using Git [292]. Other examples include Atlassian[293] (a proprietary project management software that is given for free to FOSS projects) and Discord (a proprietary instant messaging application that is free for FOSS projects) [294].

[287] Durham Goode, Rain, "Scaling Mercurial at Facebook," Facebook Engineering, June 24, 2020, https://engineering.fb.com/core-data/scaling-mercurial-at-facebook/.

[288] "Open Source by the Numbers at Google," Google Open Source Blog, accessed October 20, 2020, https://opensource.googleblog.com/2020/08/open-source-by-numbers-at-google.html.

[289] "Open Source Projects by Facebook," Projects, accessed October 23, 2020, https://opensource.facebook.com/projects.

[290] Jacob Manning, "TensorFlow Lite Is Going to Space," Medium (TensorFlow, March 7, 2019), https://medium.com/tensorflow/tensorflow-lite-is-going-to-space-897b3c84cfeb.

[291] Prem Kumar, "TensorFlow for Netflix Movie Recommendation - Using Deep Learning," Medium (Towards Data Science, June 22, 2020), https://towardsdatascience.com/tensorflow-for-recommendation-model-deep-learning-d9d4e826ea0b.

[292] "Where the World Builds Software," GitHub, accessed October 23, 2020, https://github.com/.

[293] Atlassian, "Software Development and Collaboration Tools," Atlassian, accessed October 23, 2020, https://www.atlassian.com/.

[294] "Open Source Projects," Discord, accessed October 23, 2020, https://discord.com/open-source.

5.1.d In an Indian context

India does not view itself as a stakeholder in this technology and this drives their priorities for contributing back to FOSS. Fundamentally India's tech economy is project resourcing not tech resourcing

Anonymous
Drives opensource at a large cloud computing firm

The Global landscape is quite different from India. While every large Indian tech firm is a consumer of FOSS, there is very little contribution to FOSS from Indian businesses.

India is a large consumer of Free and Open Source Software. The Gartner study (2008) reported that 85% of enterprises in Asia Pacific (N=274) are using FOSS.

The most powerful examples of FOSS use in India come through mobile phone Operating Systems that are all in the open (Android, KaiOS, and Tizen). More than 95% of the phones in India use FOSS in the Operating Systems of their mobile phones.

This has made the mobile phone a lot more accessible to the general population (around 5 million people had access to a phone in early 2000s to about a billion now) [295] with a 34% decline in the prices of the phones between 2010 to 2019.

Other prominent examples of FOSS use come from the National Stock Exchange and the Bombay Stock Exchange, all of which run on Red Hat's distribution of Linux.

Insurance companies like LIC and New India Assurance Company also migrated to Linux, with savings of about $8.75 million and $16.7 million, respectively[296].

However, according to the same Gartner study more than 69% of companies surveyed had no formal policy for evaluating and cataloguing FOSS usage [297]. This is largely because historically, when technology became a viable industry in India, the big tech players (Wipro [298], TCS [299]) looked at the opportunity of being involved in

[295] Vaibhav Asher "Number of Smartphone Users in India 2015-2022," Statista, October 16, 2020, https://www.statista.com/statistics/467163/forecast-of-smartphone-users-in-india/.

[296] Rahul De', Lewin Siwamalai, and Ravi A Rao, "Economic Impact of Free and Open SourceSoftware Usage in Government," June 2015.

[297] David Meyer, "Gartner: 85 Percent of Companies Using Open Source," CNET (CNET, November 17, 2008), https://www.cnet.com/news/gartner-85-percent-of-companies-using-open-source/.

[298] "Open Source Applications & Architecture Solution Company," Wipro, accessed October 23, 2020, https://www.wipro.com/en-US/open-source/.

[299] "IT Consulting Services & Business Solutions: Tata Consultancy Services (TCS)," IT Consulting Services & Business Solutions | Tata Consultancy Services (TCS), accessed October 23, 2020, https://www.tcs.com/.

the larger ecosystem very differently from the rest of the world, like selling services as opposed to technology creation.

This way of thought has also dictated the investment being funneled into innovation or FOSS which has always been low *from within the industry*.

However, it is likely that India will catch up to the rest of the world. FOSS consumption across all Indian businesses already exists, it is yet to translate to contribution, acknowledgement or innovation.

A Chief Technical Officer from a major services company had this to say about the reasons for reduced contribution to FOSS.

a. Lack of strategy

b. Lack of knowledge and capacity around FOSS values and its advantages

c. Lack of knowledge around licenses

d. Lack of incentive

While the government does have a FOSS policy, its execution is non-existent, making sure its procurement procedures are not friendly for FOSS companies to participate.

5.1.e Indian FOSS Contributions

Indian subsidiaries of larger multinational companies (Dell [300], Red Hat [301], IBM [302], Thoughtworks [303]) have been contributing to FOSS in alignment with their global strategy.

The first large FOSS company to enter India was Red Hat, an American company that sells the Red Hat distribution of Linux.

Red Hat did a lot for the promotion of FOSS early in India and even set up a team that took on the task of localizing Linux to Indian languages. Recently, Red Hat was bought by IBM in 2018 [304]. The Indian offices of IBM research have also been active contributors to Indian FOSS [305].

Thoughtworks India, which was set up around 2001, has also been a large contributor to FOSS and has created and maintained lots of active thriving projects. More recently, Flipkart, one of India's largest shopping retail stores created some FOSS projects and repositories [306], while MindTree, a Bangalore software services company announced that it was a member of Hyperledger, an open source collaborative effort created to advance cross-industry blockchain technologies [307].

The recent ballooning of the Asian tech industry especially in China is also leveraging the Indian FOSS ecosystem. Alibaba and Tencent are amongst the top 10 FOSS contributing organizations in the world [308,309], and the Indian subsidiaries of these different Asian companies have also been prioritizing FOSS as a part of their strategy.

There are other ancillary organizations, HasGeek, a veteran FOSS company, primarily works on the model of

300 "Open Source at Dell," opensource. dell, accessed October 23, 2020, https://opensource.dell.com/.

301 "The World's Open Source Leader," Red Hat - We make open source technologies for the enterprise, accessed October 21, 2020, https://www.redhat.com/en.

302 "Open Source at IBM," IBM Developer, accessed October 23, 2020, https://www.ibm.com/opensource/.

303 "Open Source," ThoughtWorks, accessed October 23, 2020, https://www.thoughtworks.com/open-source.

304 "IBM Closes Landmark Acquisition of Red Hat for $34 Billion; Defines Open, Hybrid Cloud Future," IBM News Room, accessed October 21, 2020, https://newsroom.ibm.com/2019-07-09-IBM-Closes-Landmark-Acquisition-of-Red-Hat-for-34-Billion-Defines-Open-Hybrid-Cloud-Future.

305 "IBM Research," GitHub, accessed October 23, 2020 https://github.com/IBMResearch.

306 "Flipkart," GitHub, accessed October 23, 2020 https://github.com/Flipkart.

307 Longjam Dineshwori, "Mindtree Joins Hyperledger to Accelerate Blockchain Development," Open Source For You, July 31, 2019, https://www.opensourceforu.com/2019/07/mindtree-joins-hyperledger-community-to-accelerate-blockchain-development/.

308 "Alibaba," GitHub, accessed October 23, 2020 https://github.com/alibaba.

309 "Tencent," GitHub, accessed October 23, 2020 https://github.com/Tencent.

310 "Hasgeek," Hasgeek, accessed October 23, 2020 https://hasgeek.com/.

connecting different FOSS enthusiasts/groups, organizing events and promoting FOSS [310].

However, In India most contributions from companies towards FOSS comes in the form of sponsorships and funds to conferences (For example: TCS and Infosys have been known to regularly sponsor Drupal conferences [311]).

Other companies like QikPik have been sponsoring FOSS hackathons for college students [312] to work on and learn how to contribute to FOSS projects.

Over the last 2-3 years, FOSS businesses and projects from India have grown many fold. There are a few FOSS projects that have sprouted along with FOSS businesses such as Calibre [313], Frappe Technologies [314] that built ERPNext, Zerodha [315] (a financial service company, which has released some FOSS repositories), Bagisto (an ecommerce platform) [316] and, Hasura (a GraphQL engine on Postgres) [317]. Former Former Red Hatters have also started companies like Ashnik [318], Unotech [319], Vinca Cybertech [320] that are built around FOSS services. Some of them are now moving up the value chain to focus on building FOSS products, while others like Dhiway are primarily open source product companies [321]. Hasura recently received 25 Million$ in investment[322] which also signals that investors are ready for FOSS entrepreneurs.

While there has been increased use of FOSS within the sector, it still suffers from reduced contribution, sparse knowledge and support toward FOSS businesses and a divide between the community and businesses.

311 "TATA Consultancy Services," Drupal.org, October 22, 2020, https://www.drupal.org/tata-consultancy-services.

312 "QikPik Monsoon Open Source Hackathon," QikPik, accessed October 22, 2020, https://qikpik.store/hackathon/.

313 "Calibre E-Book Management," calibre, accessed October 20, 2020, https://calibre-ebook.com/.

314 "Excellent Open Source Products and Services," Frappe, accessed October 20, 2020, https://frappe.io/.

315 "Online Stock Trading at Lowest Prices from India's Biggest Stock Broker," Zerodha, accessed October 23, 2020 https://zerodha.com/.

316 "Laravel ECommerce," Bagisto, accessed October 22, 2020 https://bagisto.com/en/.

317 "Instant GraphQL APIs for Your Data: Join Data across Databases, GraphQL & REST Services to Build Powerful Modern Applications," Hasura, accessed October 21, 2020 https://hasura.io/.

318 "Enterprise Open Source Industry Survey 2020: The Covid-19 Impact," Ashnik, accessed October 23, 2020https://www.ashnik.com/.

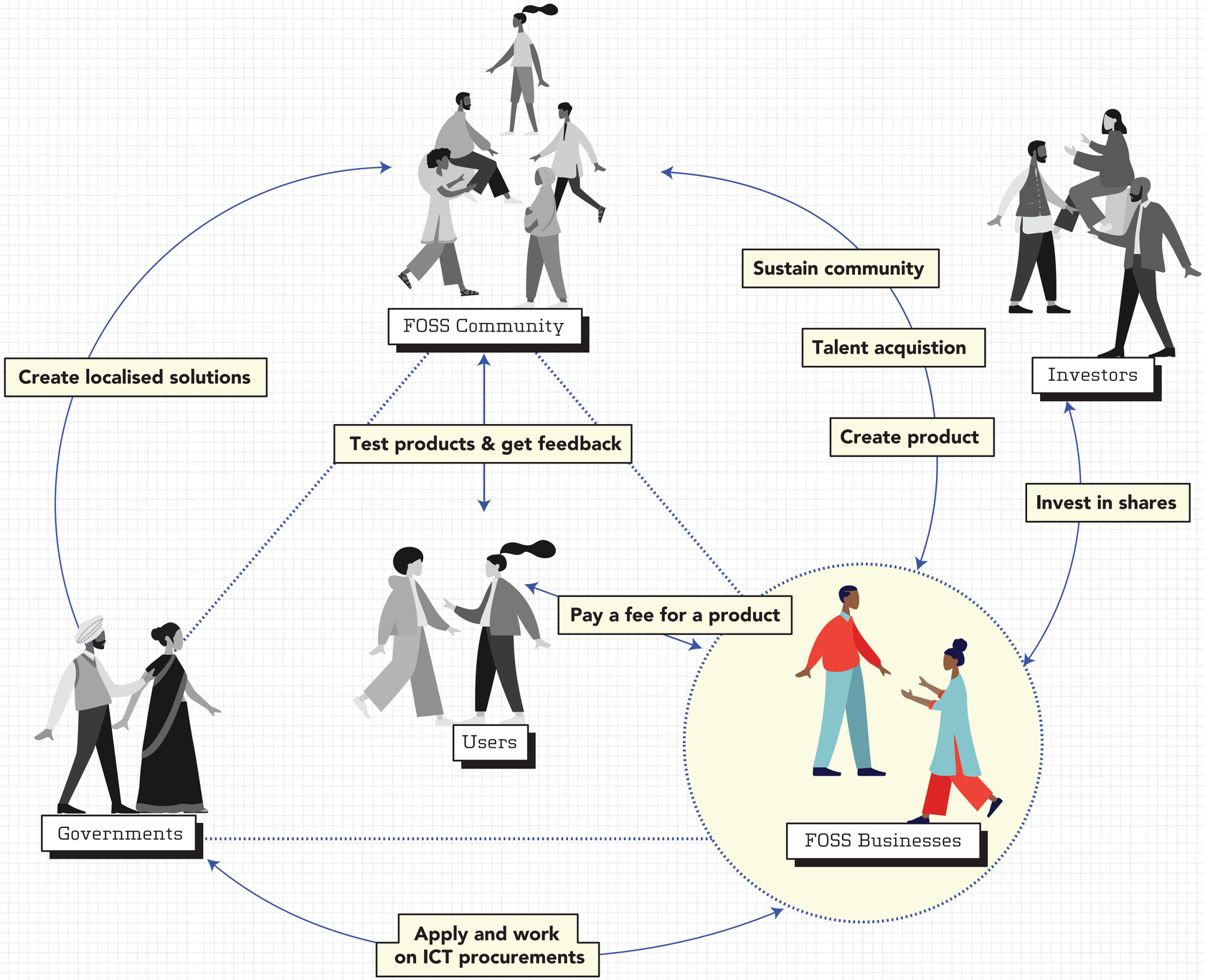
319 "Enterprise Identity Access & IT Service Management," Unotech, October 12, 2020, https://unotechsoft.com/.

320 Vinca Cyber, accessed October 23, 2020 https://www.vincacyber.com/.

321 "Build Trust Ecosystems Connected to Real World Events," Dhiway, accessed October 23, 2020 https://dhiway.com/.

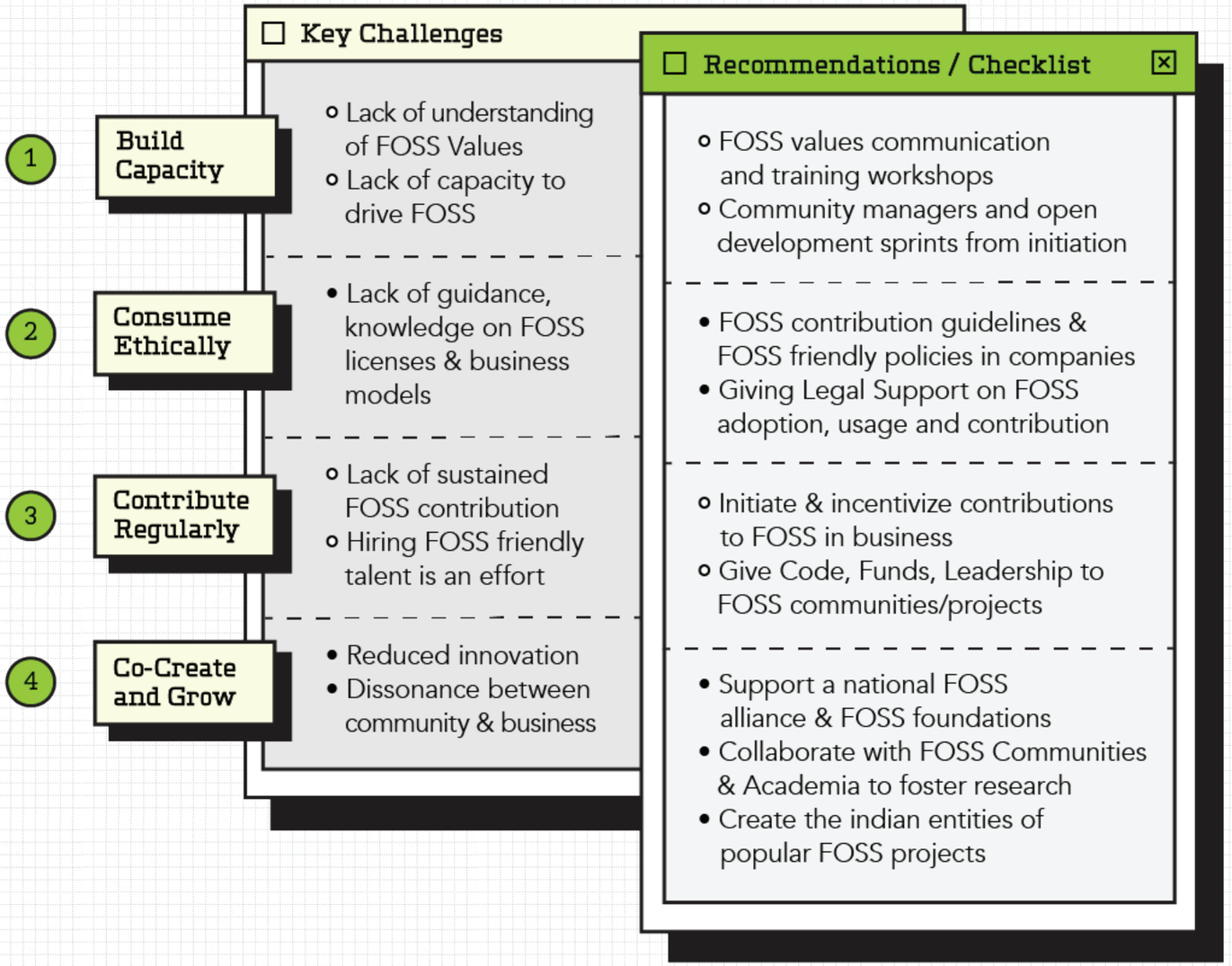
322 Press Trust of India, "[Funding Alert] Developer Tools Startup Hasura Raises $25M in Series B Round from Lightspeed, Others," YourStory.com, September 9, 2020), https://yourstory.com/2020/09/funding-alert-startup-hasura-series-b-lightspeed.

FOSS & Business



Key Challenges & Recommendations

Based on our conversations with individuals from different sizes and shapes of business (Micro, Small, Medium, and large -services and product companies), we have written down some common challenges in sustaining a FOSS business.



5.2 Key Challenges

We are not able to communicate the value that we bring in as a country to the FOSS World and do not take assertive steps or play a definitive role.

Anonymous
Drives opensource at a large cloud computing firm

5.2.1 Capacity

- For Indian Businesses, while there is widespread consumption of FOSS across all kinds of businesses, there is a lack of communication about the value of FOSS and the need to contribute to FOSS. This leads to a dearth of talent and code. According to Venkatesh Hariharan (an avid FOSS advocate and India representative for Open Invention Network) this is the first thing that needs to be addressed for all actors within the sector.
- Larger businesses are usually software agnostic with no strong preferences for COTS or FOSS. Smaller businesses, because of more systemic issues with respect to knowledge around FOSS (that has been briefly touched upon in the previous section), tend not to look to FOSS as a viable business option. For Eg: companies like Infosys [323] and Tata Consulting Services [324] offer Open Solutions and adoption as a part of their array of services, which of course means a large portion of the developers are definitely being trained to work with FOSS, however, public facing repositories and contributions on GitHub are negligible.

Many members of the community have noted that since 2012, the visible energy of the FOSS movement toward evangelizing seems to have dampened. This energy dampening, they say, could be due to the appropriation of FOSS technology by larger corporations or by FOSS going mainstream which has created a disconnect between the traditional FOSS movement and big businesses.

5.2.2 Ethical Consumption

Richard Stallman founded the Free Software Movement on the belief that it was unethical to deny users

[323] Infosys Limited, "Open Source," Infosys, accessed October 23, 2020, https://www.infosys.com/services/open-source.html.

[324] "IT Consulting Services & Business Solutions: Tata Consultancy Services (TCS)," IT Consulting Services & Business Solutions | Tata Consultancy Services (TCS), accessed October 23, 2020, https://www.tcs.com/.

the freedom to run, copy, distribute, study, change and improve the software [325]. Stallman said that,

---

With these freedoms, the users (both individually and collectively) control the program and what it does for them. When users don't control the program, we call it a "nonfree" or "proprietary" program. The nonfree program controls the users, and the developer controls the program; this makes the program an instrument of unjust power

Richard Stallman
Founder of the Free Software Movement

In a statement that is eerily applicable to current debates around social networks, Stallman says,

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Even when proprietary software isn't downright malicious, its developers have an incentive to make it addictive, controlling and manipulative. You can say, as does the author of that article, that the developers have an ethical obligation not to do that, but generally they follow their interests. If you want this not to happen, make sure the program is controlled by its users.

Richard Stallman
Founder of the Free Software Movement

It is to Stallman's enduring credit that the ethical principles of the Free Software movement, and its codification into the four freedoms of Free Software licenses, resulted in a revolution in software development and use. While Stallman's ideas were gaining ground, a group of individuals crystallized around Netscape's release of code that went into the famous Netscape browser. In early 1998, Christine Peterson coined the term 'open source' as a business friendly term that is different from the philosophically and politically focused label 'free software.' This was followed by Bruce Perens and Eric S.Raymond, who set up the Open Source Initiative (OSI).

[325] "What is Free Software", GNU head, Free Software Foundation , accessed October 23, 2020, https://www.gnu.org/philosophy/free-sw.html.

Though there are differences in the ‘Free Software’ and ‘Open Source’ philosophies, it is indisputable that these two communities have created a huge amount of public goods. Ethical consumption of this code would mean that software users respect the licenses that come with the respective FOSS programs, and contribute back to the community, wherever possible.

5.2.3 Contribution

While adoption of FOSS in businesses has ramped up since the early 2000s, in terms of large-scale collaboration and innovation with FOSS, India paints a different picture.

According to an analysis from 2016, India figured quite highly in the number of pushes to Github [326], and this figure is further substantiated in the Octoverse study from Github [327]. We also represent the second largest developer base on StackOverflow with 13% monthly visits [328] so there is definitely the user base from India. However, we are still far behind when it comes to creation and especially when it comes to FOSS project creation from Indian businesses.

However, given the size of our IT sector and population [329], we do not figure highly when it comes to projects initiated from within the country [330]. This becomes even more apparent when we look at the most popular projects on GitHub and there are just a couple Indian companies that figure in the top 1000 [331].

Big businesses (primarily large Software as a Service companies) outside of India have been taking the helm of contributing to projects, creating projects in the public for developers to critique, adopt, build, and better their software.

In 2019, almost 70% of all fortune 50 companies have contributed to different repositories in GitHub and by 2019 most of the top 10 projects with the most numbers of contributors and

[326] Felipe Hoffa, “What Countries Have More Open Source Developers per Capita than the US?,” Medium, September 14, 2016, https://medium.com/@hoffa/github-top-countries-201608-13f642493773.

[327] “The State of the Octoverse,” The State of the Octoverse, accessed October 20, 2020, https://octoverse.github.com/.

[328] “Stack Overflow Developer Survey 2020,” Stack Overflow, accessed October 23, 2020, https://insights.stackoverflow.com/survey/2020.

[329] Patrick Thibodeau, “India to Overtake U.S. on Number of Developers by 2017,” Computerworld, July 10, 2013,, https://www.computerworld.com/article/2483690/india-to-overtake-u-s--on-number-of-developers-by-2017.html.

[330] Mombach Thaís, Valente Marco, Chen Cuiting . ”Open Source development around the world: A comparative study”, Arxiv 2018, https://arxiv.org/pdf/1805.01342.pdf

[331] “Gitstar Ranking,” Gitstar Ranking - Top GitHub users and repositories, accessed October 23, 2020 https://gitstar-ranking.com/.

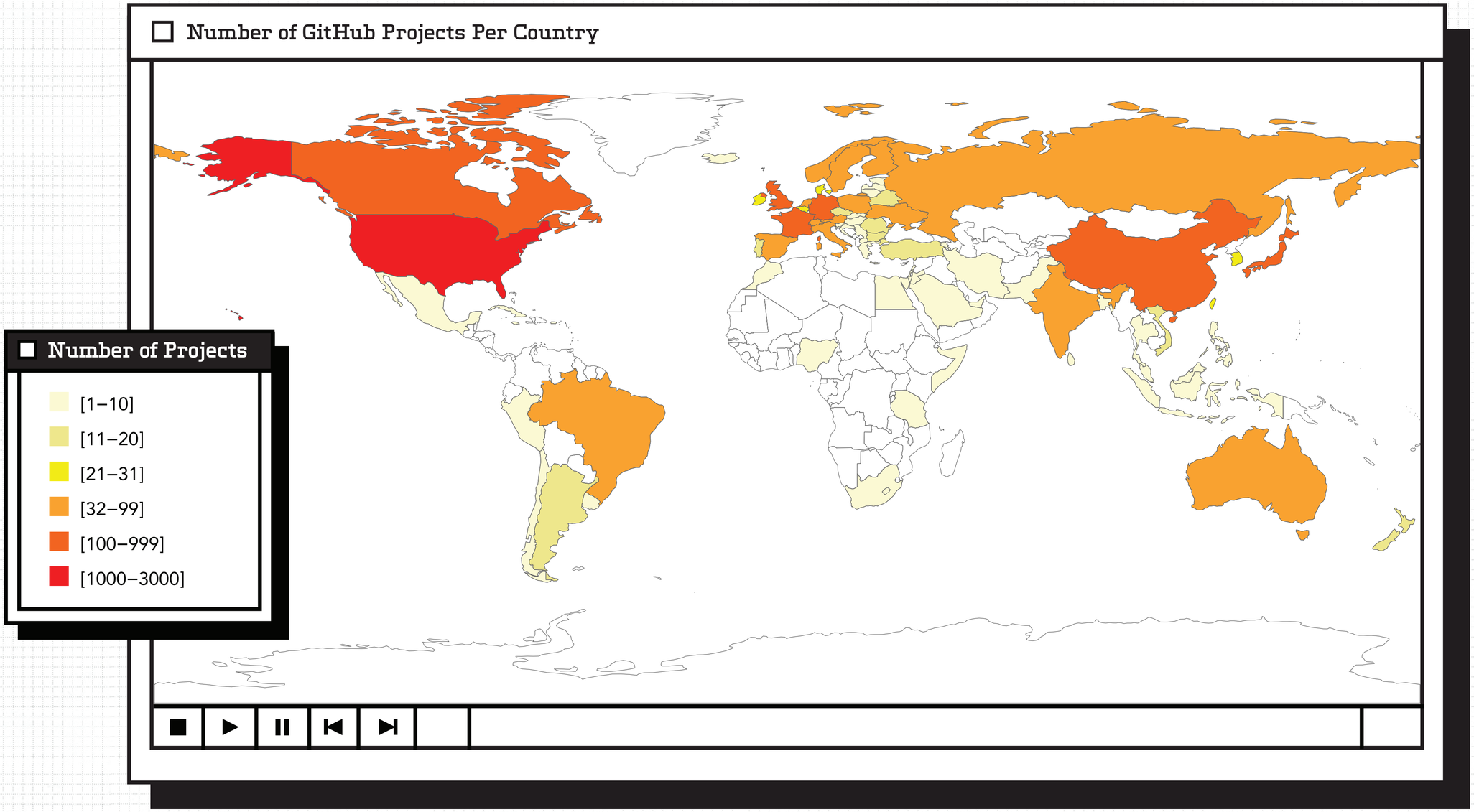


Figure 11: Number of GitHub Projects Per Country as on year 2018[330]

Some of the Indians MSMEs who built services businesses around FOSS are now climbing the value chain and building FOSS products. If this trend accelerates, we will see more FOSS code and products emerge out of India.

Venkatesh Hariharan
India representative of the Open Invention Network

activity are those created by big businesses [332].

The barrier to entry for FOSS contribution is quite high. There is a certain degree of privilege associated with FOSS contributions especially because a large portion of this contribution is volunteer driven, at least in the beginning, until you get good enough to get paid for it. This means contributors need to have the time and resources to be able to contribute outside of their daily jobs.

Unlike Indian FOSS communities that evangelize FOSS ethics, big businesses do not emphasise on the values associated with adoption of FOSS. So even though younger developers are definitely using FOSS, the culture of giving back may not be getting transferred.

Most Indian big tech players, especially IT enabled Service (ITeS) companies, are still quite agnostic about keeping their underlying code open especially with regards to their key services and offerings.

As mentioned by a CTO from a large services company in India while comparing FOSS and COTS to buildings

Our job is that of an architect/ contractor to build the best house for our client, not say use yellow bricks only

Anonymous
CTO, Major services company

5.2.4 Co-Creation

This lack of FOSS contribution is visible through reduced innovation in Indian businesses. Only 1% of India's GDP is being invested in innovation. A large part of this comes from the lack of an ecosystem to nourish this innovation. India has been ranked at about 43rd.

This lack of FOSS contribution is visible through reduced innovation in Indian businesses. Only 1% of India's GDP is being invested in innovation [333].

[332] "The State of the Octoverse," The State of the Octoverse, accessed October 20, 2020, https://octoverse.github.com/.

[333] Ragini Bhuyan, "Three Charts That Show Why India Lags in Innovation," mint, January 27, 2016, https://www.livemint.com/Politics/YakNmdFyeTMDuMb6u28udL/Three-charts-that-show-why-India-lags-in-innovation.html.

One needs an actual piece of code or software around which communities, volunteers, other businesses, governments, can gravitate. This in India is still quite small, while it is improving.

Rushabh Mehta
Creator of ERPNext

Improving the quality of community participation in code will lead to better reputation within the FOSS community and better quality of code that these organizations put out.

Jaydeep and Sai Krishna
Thoughtworks

The service-based economy churns out students who are focused on career-based learning with more job opportunities but not necessarily innovating through first principles.

A specific challenge within an Indian context that keeps surfacing is the dissonance between businesses and the community.

Outside of India, communities are growing larger and more of them are churning out more useful FOSS projects that become the backbone for others to build on top of. These projects are largely developer-facing and in this space the pace of innovation vhas been stellar.

While there are more companies monetizing from FOSS projects now in India, especially among small and medium sized businesses, there is a huge gap in transitioning from being an active part of the community to building a successful business around FOSS in India.

The actual number of FOSS projects coming out of India is still quite low

It is because most entrepreneurs focused on FOSS have very limited support and mentorship options available in terms of legal compliances, financial sustainability, procurement opportunities, et cetera.

Creating a community around a FOSS project so that there is more collaboration is also a challenge in the current ecosystem. Without community managers and constant effort from the part of the creator during the initiation of these projects which includes open developers sprints and popularizing projects at conferences and other events. For Eg: MOSIP which puts its code out in the open has trouble initiating community participation [334]. Similarly, repositories from Flipkart[335], Wipro [336] have the same trouble initiating community contributions.

MOSIP, an FOSS platform for foundational ID's (built by IIIT-Bangalore)

[334] "An Open Source Platform on Which National Foundational IDs Are Built," MOSIP, accessed October 23, 2020, https://www.mosip.io/.

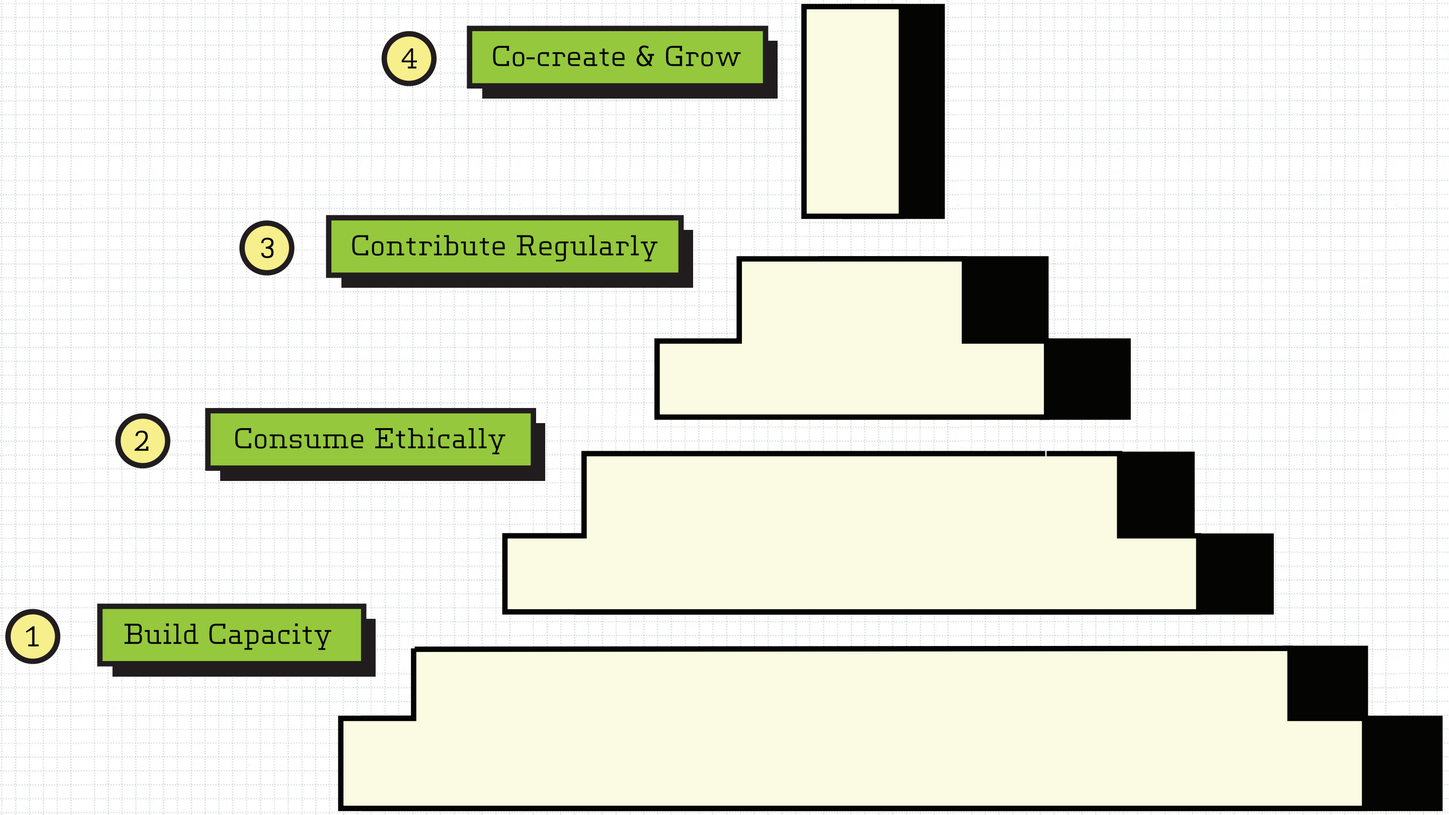
[335] "Flipkart," GitHub, accessed October 23, 2020 https://github.com/Flipkart.

[336] "Open Source Applications & Architecture Solution Company," Wipro, accessed October 23, 2020 https://www.wipro.com/en-US/open-source/.

5.3 Recommendations

With core technologies like Big Data, AI, distributed ledgers, Internet of Things, mobile operating systems being built as FOSS, businesses have to move from opportunistic, ad-hoc adoption of FOSS to more strategic and thoughtful adoption.

This requires understanding the collaborative development model of FOSS, rules of engagement with the FOSS community, understanding FOSS licenses, FOSS business models and the factors that drive leadership in FOSS development.



5.3.1 Capacity Building

- Regular communication of FOSS values as well as training on FOSS licenses and guidelines to CXO's, managers, and individual contributors.

The Management should first buy into the idea of contributing to FOSS which usually tends to trickle down. After this community guidance could be used to learn how, what, and where to contribute to FOSS.

FOSS is the new normal. The collaborative innovation model of FOSS enables rapid innovation that is difficult for proprietary software vendors to match, which is why FOSS dominates emerging technologies like Big Data and AI. Any form of industry leadership now requires an understanding of FOSS development models. Therefore, we should inculcate the FOSS culture in industry, academia and government.

Venkatesh Hariharan
India representative of the Open Invention Network

ICT@ innovation in Africa [337]

Created by Free Software and Open Source Foundation in Africa to foster & support micro, small and medium-sized enterprises (MSME) in the field of Free and Open Source Software through regional networking and strengthening of consulting capacities of ICT associations and training institutions.

[337] "Ict@Innovation: Free Your IT Business in Africa/4-4," Ict@innovation: Free your IT Business in Africa/4-4 - Wikibooks, open books for an open world, accessed October 23, 2020, https://en.wikibooks.org/wiki/Ict@innovation:_Free_your_IT_Business_in_Africa/4-4.

- The creation of Indian entities (subsidiaries) of larger FOSS projects and communities would also aid capacity building.

- Businesses that are “open” to FOSS should have, at the time of initiation of their project, a community manager and create an open developer sprint.

- Indian start-ups have a unique business opportunity to help customers migrate from proprietary closed-source software to mature FOSS alternatives and provide dedicated support. Therefore, we must support MSMEs and Start-ups in the field of Free and Open Source Software through Information and Communications technology foundations and institution led capacity building.

The most thing missing is a support system for FOSS creators. The “magic” that FOSS delivers to the various “consumers” - public / private / state is primary due to the code while other stakeholders help in amplification of the effort. Today with online platforms, it has become much easier to get your work discovered by various users.

Rushabh Mehta
Creator of ERPNext

Red Hat was one of the first Commercial Open Source Software (COSS) companies to operate in India. The 3A model that was adopted in the early days of Red Hat - the Awareness, Appreciation and Adoption funnel. The idea was that if 100 people are aware of FOSS, 10 might appreciate it and one might adopt it. Therefore, in the early days of FOSS, a lot of effort was put into FOSS awareness.

[338] “The World’s Open Source Leader,” Red Hat - We make open source technologies for the enterprise, accessed October 21, 2020, https://www.redhat.com/en.

5.3.2 Creation of FOSS Friendly Policies, Guidelines:

Drafting strong FOSS friendly policies would incentivize contributors from within these companies to contribute to FOSS projects.

- Companies that use open source software need to create company-wide policies to ensure that all staff is informed of how to use open source (especially in products). An open source policy exists to maximize the impact and benefit of using open source, and to ensure that any technical, legal or business risks resulting from that usage are properly mitigated.

- While many companies including those within India have FOSS policies, these policies can fall on a spectrum of very defensive policies (minimize risk) to FOSS friendly policies (maximize impact).

- Many companies do not have FOSS friendly policies and guidelines. This is largely due to lack of knowledge around copyrights and licenses. There is also a hesitation to pick up FOSS as there is the very real possibility of misuse of FOSS until a court intervenes.

- For ethical consumption of FOSS and in order to protect creators, The Software Freedom Law Centre and the Free Software Foundation have put together the “principles of community oriented GPL enforcement” as well as some comprehensive tutorials around this subject [339,340]. There are indian chapters of these organizations to provide consulting and guidance around these subjects. The supply exists, but more awareness and demand among user companies is necessary [341].

FOSS Friendly Policies[342]

Some companies like Zalando, Google, Verizon have FOSS contribution guidelines for their employees.

[339] “Copyleft and the GNU General Public License: A Comprehensive Tutorial and Guide,” copyleft.org, September 26, 2018, https://copyleft.org/guide/.

[340] Publications - Software Freedom Law Center, accessed October 23, 2020, https://www.softwarefreedom.org/

[341] “Software Freedom Law Center, India,” Software Freedom Law Center, India, accessed October 21, 2020 https://sflc.in/.

[342] Todogroup, “Todogroup/Policies,” GitHub, accessed October 23, 2020, https://github.com/todogroup/policies.

5.3.3 Promotion of FOSS

Once a strong basis with FOSS knowledge and policies are in place, companies can then begin promotion of FOSS.

- Indian companies should start encouraging and promoting their employees to start working on FOSS projects. FOSS is a meritocracy and learning to put out code in the open and get it critiqued and improved would largely improve the quality of employees in these organizations. This also does the added work of advertising its open source contributions so as to attract better developers like in the case of Netflix [343] and Paypal [344].

Thoughtworks

As Jaydeep, Angshuman and Sai Krishna from Thoughtworks mentioned, Thoughtworks for example spends a substantial amount of employee power and time working towards FOSS initiatives and publishing their code in the open. These could be internal tooling that they make open, projects that employees take up of their own interest that are encouraged or as a part of their consultancy.

A few Eg are:

Bahmni
A hospital management application for low resource settings [345].

Appium Test Distribution (ATD)
A tool that tests an application in different Operating Systems [346].

Swecha
A program that looks for free software resources for teaching children [347].

[343] "Netflix Open Source," Netflix Open Source Software Center, accessed October 20, 2020, https://netflix.github.io/.

[344] "Open Source at PayPal," Open Source at PayPal, accessed October 23, 2020, https://paypal.github.io/

[345] "Hospital system for low resource settings,"Bahmni, accessed October 23, 2020, https://www.bahmni.org/

[346] "Appium Test Distribution", Github, accessed October 23, 2020, https://github.com/AppiumTestDistribution

[347] Sujan Mehra, Naga, "Bridging the digital divide in underprivileged communities.", thoughtworks Blogs, Nov 26 2014. https://www.thoughtworks.com/insights/blog/bridging-digital-divide-underprivileged-communities

- Companies should also give back in the form of finances and structure (either conferences, hackathons, grants, and funds under their banners).

  More big tech giants within India taking similar initiatives would be a step in the right direction towards a larger change from consumer to producer.

  Github also hosts a huge list of beginner friendly projects for contributions which could be a great way for young individuals starting up to improve their FOSS skills [350]

OS.20 conference [348]

The India OS.20 conference organized by Frappe Technologies.

In January 2020, Frappe Technologies, a small FOSS product company, had a small conference called India OS with members from the community, businesses and policy makers to come and talk about FOSS tech.

Its motto was a throwback to FOSS.in:
"Talk is Cheap, Show me the Code:
A True Spirited Open Source Conference"

InClojure [349]

A Clojure conference that is organized in India every year. It is largely volunteer driven (mostly from within the sponsoring companies) and sponsored by a few companies including Helpshift and Nilenso.

[348] "Why IndiaOS," IndiaOS, accessed October 20, 2020 https://indiaos.in/why-indiaos.

[349] "IN/Clojure is India's annual Clojure and ClojureScript conference, and Asia's first", In/Clojure2020, accessed October 20, 2020, https://inclojure.org/

[350] "MunGell/Awesome for Beginners", GitHub, accessed October 20, 2020, https://github.com/MunGell/awesome-for-beginners

5.3.4 Co-Creation of FOSS Projects with the Community

Finally, once companies are more capable, it will be possible to co-create and sustain FOSS projects with the community.

It is imperative to reiterate the importance of having a strong foundation before engaging in this co-creation and collaboration. This can be shaped in many different ways.

Jaydeep, Sai Krishna and Angshuman from ThoughtWorks [351] mention that the main skill that is necessary while starting a FOSS project inside companies is a product mindset.

It is not just about the developer. Business analysts, product owners, documenters, designers are all imperative to a project succeeding. This is more often than not ignored.

Jaydeep and Sai Krishna
Thoughtworks

It would also require standardizing community engagement processes & guidelines and it takes substantial effort from within the company to drive community engagement, one would need to go talk at conferences and events and popularize the project and respond to the community regularly.

This generally means that FOSS needs to seep into the company's strategy. Even without concerning ourselves with how this would improve the world at large, this will greatly improve the quality of the code and the quality of the employees within the company.

- Large tech consultant firms within India could have their benched developers (those not on any projects) contributing to FOSS projects to build software that will be used for internal tooling.

- For profit entities can start projects and invite contribution from the community. For Eg: Google's Kubernetes [352] or TensorFlow [353], or Airbnb's Apache Superset [354] (a data visualization tool), Uber's H3 (a geospatial indexing system) [355], and Facebook's ReactNative [356].

This team at Thoughtworks has worked on various FOSS projects including Bahmni [361], a hospital system for low resource settings

The United States department of defense recently deployed Kubernetes on their F-16 fighter jets

[351] "Open Source," ThoughtWorks, accessed October 23, 2020, https://www.thoughtworks.com/open-source.

[352] "Production Grade Container Orchestration", Kubernetes, accessed October 20, 2020, https://kubernetes.io/

[353] "Welcome to TensorFlow's Global Community," TensorFlow, accessed October 21, 2020 https://www.tensorflow.org/community.

[354] "Superset," Airbnb Engineering & Data Science, accessed October 22, 2020 https://airbnb.io/projects/superset/.

[355] "Uber-Open Source", accessed October 22, 2020 https://uber.github.io/#/

[356] "Learn Once, Write anywhere", React Native, accessed October 22, 2020, https://reactnative.dev/

- Corporate entities [357] could also create and participate in foundations or federations with the express intention of supporting FOSS projects and communities. Eg include: Mozilla foundation [358] and corporation, Apache group and Foundation[359] and FOSS United Foundation [360].

Cooperatives

Alternatively, there are some interesting business models that have arisen, in India and outside, that require some thought.

Cooperatives in India have historically been agricultural. However, in the last few years, cooperatives have been making a place for themselves in the software industry. A large number of Free and Open Source Cooperatives have been emerging around the world.
For Eg:

- OSSICS started in Kerala in 1998 has around 60 members and licenses all its products in GPL.

Other examples of cooperatives that are invested in creating FOSS are Centricular [362], Nilenso [363], Chiguru [364] & Coopon [365].

Steven Deobald, co-founder of Nilenso, a software cooperative based out of Bangalore has given this a lot of thought. He has the following to say about

[357] Miller Susan, "Why the Air Force recently put Kubernetes in an F-16", GCN, Jan 2020, https://gcn.com/articles/2020/01/07/af-kubernetes-f16.aspx

[358] "HomePage" Mozilla Foundation, accessed October 21, 2020, https://foundation.mozilla.org/en/.

[359] "Welcome to The Apache Software Foundation!," The Apache Software Foundation, accessed October 21, 2020, https://www.apache.org/.

[360] "FOSS United Foundation," FOSS United, accessed October 22, 2020, https://fossunited.org/.

[361] "Hospital system for low resource settings,"Bahmni, accessed October 23, 2020, https://www.bahmni.org/

[362] "Centricular," Centricular • GStreamer, Multimedia and Graphics Expertise • Open Source, accessed October 22, 2020, https://www.centricular.com/.

[363] "Nilenso Software," Nilenso Software, accessed October 22, 2020, https://nilenso.com/.

[364] "Chiguru Technologies," Chiguru Technologies, accessed October 20, 2020, https://chiguru.tech/.

[365] "We Are a Science and Technology Workers' Cooperative Working on Making Ethical Technology Available, Accessible and Affordable to the Masses," Coopon Scitech LLP, accessed October 20, 2020, https://cooponscitech.in/.

FOSS and Cooperatives:
There is a small emergent trend, particularly within India, of new software companies structuring themselves as cooperatives. More often than not, these software cooperatives have free (or open source) software as a key component of their business strategy. To understand why, we need to examine exactly what these two concepts intend to achieve, where they intersect, and how they diverge.

Cooperatives take on different political colours the world over and even a quick read of the Wikipedia entry on cooperatives will demonstrate just how unclear some of the ideals become in different socioeconomic contexts [366]. Some co-ops take on shades of socialism while others reject the principles of charity and welfare altogether. What unifies co-ops is their conformance to The Cooperative Identity, and little else [367]. The core operational aspects of this identity are found in the seven Cooperative Principles (formerly Rochdale Principles) [368]. Software co-ops tend to be structured as worker co-ops, where each employee controls one share/vote in the corporation. **Membership, control, and capital are described by the first three**

Cooperative Principles. While the democratic control of worker co-ops defines their structure as a corporation, it is adherence to the remaining four principles which causes co-ops to share ideological space with the free and open source software (FOSS) movements: autonomy, education, cooperation, and community. We can examine how each of these four axes intersects with FOSS.

Unlike coops, encoded FOSS ideals say nothing about these four axes. The Free Software philosophy describes a system of ethics underpinning the user's Four Essential Freedoms which define whether software is Free or not [369]. Open Source values describe an "attitude" and "principles of the open source way" which underpin the Open Source Definition [370]. But none of these ethics or attitudes are directly encoded in the licenses which define FOSS. By their very nature, FOSS licenses do not dictate your behaviour. This is part of the reason why libertarians and communists can both (rightly) see an ally in FOSS; it is a sort of political chameleon. Conversely, cooperative corporations are legally bound to encode certain structures and behaviours into

366 "What is a cooperative?" International Cooperative Alliance, accessed October 22, 2020, https://www.ica.coop/en/cooperatives/what-is-a-cooperative

367 "Cooperative Identity, value, and principles" International Cooperative Alliance, accessed October 22, 2020, https://www.ica.coop/en/cooperatives/cooperative-identity

368 "Cooperative Principles and Values - Revisions", International Cooperative Alliance, accessed October 22, 2020, https://web.archive.org/web/20091029163330/http://www.ica.coop/coop/principles-revisions.html

369 "What is Free Software?", Free Software Foundation, accessed October 22, 2020, https://www.gnu.org/philosophy/free-sw.en.html

370 "The Open Source Way", OpenSource.com, accessed October 22, 2020, https://opensource.com/open-source-way

themselves. As it turns out, these happen to be the structures and behaviours which form the philosophical foundation of FOSS. As such, a cooperative enterprise will naturally gravitate toward FOSS, but not the other way around.

Co-ops seeking **autonomy** (Principle 4) requires that they actively avoid tethering themselves to other people, organizations, or resources which restrict them. Proprietary software is inherently restrictive to the consumer, which is antithetical to a cooperative's autonomy. While the Four Essential Freedoms are essentially a practical description of computer user autonomy, they free the user and bind the software. There is nothing about these freedoms which prevents the user from restricting her own autonomy; a company which uses FOSS software might encumber itself in other ways. It is only in the explicit case (such as in Principle 4) where the requirement of autonomy leads to FOSS, not the inverse.

Co-ops desiring internal **education** (Principle 5) requires that they consume transparent resources which can be learned. Again, the Second Essential Freedom of free software describes this concisely: "The freedom to study how the program works (and change it so it does your computing as you wish)." Proprietary software is opaque and cannot be studied. Furthermore, arbitrary restrictions which prevent modification of software also prevent the members of a coop from experiential learning, a very important aspect of education in software.

Cooperative Principles 4 and 5 are internal and deal more with how coops consume resources and interact with third parties. To maintain autonomy and educate their members, coops will always prefer to consume FOSS if they are aware of it.

Coops engaged in **cooperation with other cooperatives** (Principle 6) will be required to produce resources which are transparent and accessible. Whether at local, national, or international scales, all cooperation relies on effective and frictionless communication. FOSS does not dictate cooperation; some FOSS projects are actively hostile toward external contribution. But cooperative software projects lend themselves

to FOSS licensing. While a FOSS license does not force its users to cooperate (or not), there is no such thing as “cooperative proprietary software” at all Cooperation and proprietary licensing are mutually exclusive.

Last, co-ops demonstrating **concern for community** (Principle 7) will build upon Principle 6. When the seventh principle was added in 1995, it is unlikely the International Co-operative Allianc was thinking of globally-distributed FOSS software teams as an interpretation of the word “community”. Yet, the wording is sufficiently non-specific so as to comfortably permit this interpretation. Principle 6 actively discusses international cooperation, and it is reasonable to parallel “community” at the same global scale. “Concern for the [FOSS] community” then becomes a specific directive: co-ops should cooperate not only with other co-ops, but with other agents in the construction and maintenance of free and open software technologies.

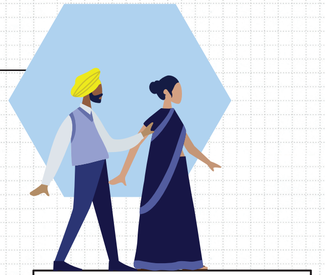
If Cooperative Principles 4 and 5 are internal, Principles 6 and 7 are then external, dealing with how a co-op might produce software. Co-ops should exclusively produce FOSS (arguably, even strictly adhering to a “free software” definition) if they produce software at all.

People are often confused by free and open source software because it does not pick sides. It is written down in contracts: software licenses. These contracts do not state or even imply compatible government policy or corporate structure. It is the job of these contracts to free the users over a future-focused timeline. Cooperatives make a political statement. Worker co-ops, in particular, put control of the corporation in the hands of the employees. In the nineteenth century, employee-owned corporations meant that, within the bounds of the corporation, workers controlled the means of production. In the twenty-first century, the “means of production” are a laptop and an internet connection. 180 years later, software worker coops are not defined by socialist microcosms - as those ideas are barely relevant to the industry. Instead, software worker coops deeply embrace the core principles of cooperatives, which lead them to free and open technologies.

5.4 Way Forward

One of the main challenges to FOSS in businesses is the lack of strategy and incentives around FOSS. One obvious incentive would be if all government software (especially public goods) were to be built on FOSS. This would also be crucial in helping governments gain trust, accountability, and transparency from its citizens. As the Free Software Europe slogan goes “Public Money, Public Code”

FOSS & Government

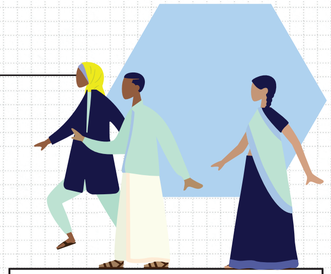


National Governments

Departments & agencies of central government using FOSS for nation wide adoption of ICT initiatives

Eg:

- *Centre for Development of Advanced Computing*
- *Indian Railway Catering & Tourism Corporation*
- *Ministry of Housing & Urban Affairs*
- *Supreme Court of India*



State & Local Governments

Regional government agencies driving grassroots adoption of FOSS led initiatives

Eg:

- *International Centre for Free and Open Source Software*
- *North Eastern Regional Centre of the National Institute of Rural Development*

Chapter 06

FOSS & Government

6.1 Landscape

6.1.1 India's progress on implementing FOSS in E-Governance

FOSS can be considered as a technological extension of democracy itself [371].

It gives users autonomy to access, choose, exchange, collaborate, and participate in software development and adoption. Governments across the globe have shown their commitment to FOSS by making necessary changes to their legislative functioning, policy making and procurement methods [372]. India is no different, various national and state governments have shown their commitment to FOSS by bringing about various FOSS policy changes.

But even after these major policy efforts, both e-governance initiatives and use of FOSS in them, has remained quite constrained across the country. In a recent survey by the United Nations, India ranked 100 out of 193 countries on the E-Government Development Index [373]. Even in Asia, India ranked 29 out of 47 countries, lower than countries like Sri Lanka and Iran.

The report also suggests that India needs to improve its telecommunication infrastructure and the ability of human resources to promote and use ICTs, when compared to other countries in the same socio-economic conditions.

The report also highlights the fact that many countries are rapidly enhancing their public digital goods by leveraging FOSS solutions, open standards and local software communities. One of the many ways in which we can boost India's

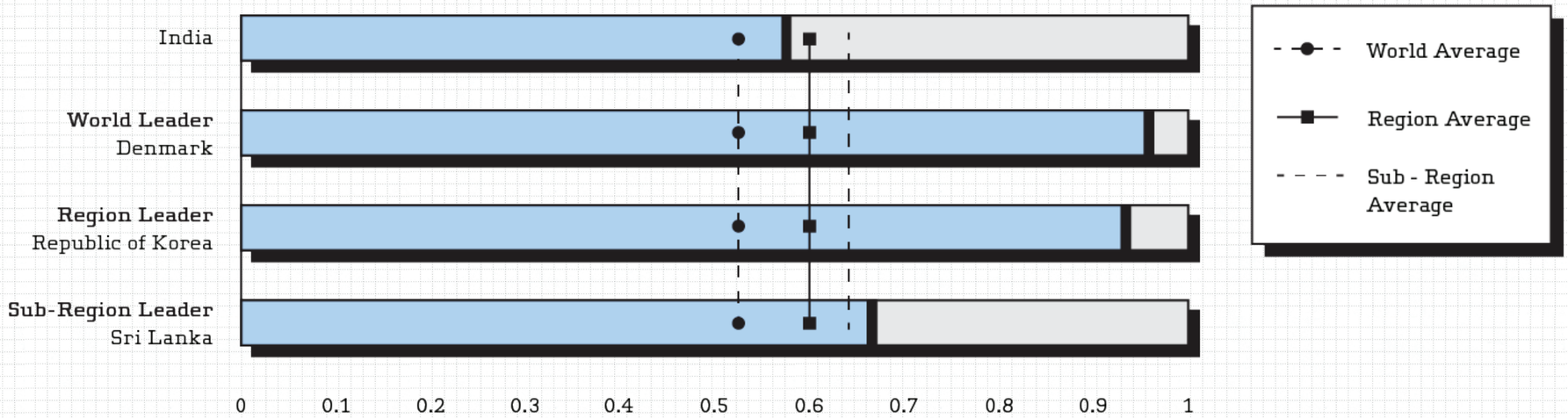
371 Shaw Jeff, "6 Benefits of Using Open Source Software in Government (Industry Perspective)", Government Technology, Feb 1 2016, https://www.govtech.com/opinion/6-Benefits-of-Using-Open-Source-Software-in-Government.html

372 Wong Kenneth, FOSS Government Policy, 2004, ISBN 81-8147-755-3, accessed Oct 20, 2020, http://www.iosn.net/government/foss-government-primer/foss-govt-policy.pdf

373 UN Department of Economic and Social Affairs,"E-Government Survey 2020", https://publicadministration.un.org/egovkb/Portals/egovkb/Documents/un/2020-Survey/2020%20UN%20E-Government%20Survey%20(Full%20Report).pdf

e-government development and participation, is by improving digital literacy and localizing key government platforms.

These will include various national portals, e-services portals and e-participation portals alongside major websites of the related ministries of education, labor, social services, health, finance, environment and more. India has a potential to follow in the footsteps of Europe and Africa, to actively engage FOSS and language communities, to drive robust software reuse, faster deployment and localization at scale.



EGDI Bank	2020	2018	2016	2014	2012	2010
India	100	96	107	118	125	119

Figure 12: India's ranking in UN E-Government Survey 2020

Government of Kerala - A model State championing FOSS in India?

Kerala government has been a pioneer at developing a growing FOSS ecosystem and nurturing it with an apt policy and budgetary support. FOSS made its official entry in the Indian policy landscape, with the Government of Kerala tabling its 2001 Information Technology Policy [374] promoting research and use of FOSS in the state. Later in 2009, the Government of Kerala further strengthened its support by setting up the International Centre for Free and Open Source Software (ICFOSS) [375] which continues to support activities like R&D, startup incubation, capacity building, advocacy, and language computing. Some of the key FOSS initiatives in Kerala are:

- It is the first State to undertake the largest deployment of FOSS in the education sector. This is a part of the ICT-enabled education implemented by Kerala Infrastructure and Technology for Education(KITE) [376]. The state government has instructed all institutions under the General Education Department to strictly use FOSS alone in all teaching and training activities.

- Various state institutions and departments like Kerala State Electricity Board, Kerala Khadi and Village Industries Board, Kerala Public Works Department, and Kerala Legislative Assembly have moved their critical IT operations to FOSS systems [377].

- In 2014, the Kerala government also started ‘Swatantra’, the world’s largest integrated FOSS IT facility in the government sector. It houses an incubation centre and a training space. The initiative is aimed at enhancaing the government’s agenda of promoting democratic access to information with the objective of sustainable economic development [378].

- Some of the relatively new government initiatives coming out of Kerala are Skill Delivery Platform of Kerala (SDPK) [379] and Space Technology Application Dev. ecosystem (STADE) [380].

374 Government of Kerala, “Information Technology Policy 2001”, accessed October 22, 2020,https://web.archive.org/web/20191026032752if_/http://unpan1.un.org/intradoc/groups/public/documents/apcity/unpan002950.pdf

375 “Home,” ICFOSS, accessed October 20, 2020 https://icfoss.in/.

376 “Free and Open Source Software,” KITE, accessed October 23, 2020, https://kite.kerala.gov.in/KITE/index.php/welcome/wedo/1.

377 Special Correspondent, “A Celebration of Software Freedom,” The Hindu (The Hindu, October 9, 2016), https://www.thehindu.com/todays-paper/tp-national/tp-kerala/A-celebration-of-software-freedom/article15307477.ece.

378 TNN, “Chief Minister Launches ‘Swatantra’ IT Facility: Thiruvananthapuram News - Times of India,” The Times of India (TOI, March 1, 2019), https://timesofindia.indiatimes.com/city/thiruvananthapuram/chief-minister-launches-swatantra-it-facility/articleshow/68209046.cms.

379 “Brighten your knowledge, build a better future.” Skill Delivery Platform, Kerala (SDPK), accessed October 23 2020, https://sdpk.kerala.gov.in/

380 Space Technology Application Dev. ecosystem (STADE). Accessed Oct 20 2020 https://spacepark.kerala.gov.in/stade-2/

The Kerala government remains the only state government in the country that continues to make budget allocations (refer Fig. 7.2) for sustaining the FOSS ecosystem. There is however a need to proportionally increase these fiscal commitments as e-governance initiatives further expand in the state. Besides Kerala, other state governments have also begun to proactively adopt FOSS including Tamil Nadu, Uttarakhand, Assam, West Bengal and Haryana[381].

Although these government-led FOSS initiatives have received positive response from the communities, there are still a number of systematic issues that hinders FOSS growth on the ground. In our discussions with government staff from village panchayats in Kerala, various issues related to use of legacy closed source software came up. For example, Information Kerala Mission (IKM) [382] has a variety of software to provide digital services to local governments but most of these services (like Planning and Monitoring, Taxation, Asset Management, and Civil Registration) run only proprietary softwares built for Microsoft Windows XP and Windows 7. Because of this most panchayats and other local government offices are still forced to purchase and run on Windows operating systems instead of FOSS. With decentralized FOSS deployments, we hahve an unique opportunity to help progress our village panchayats in India towards their sustainable digital transformation.

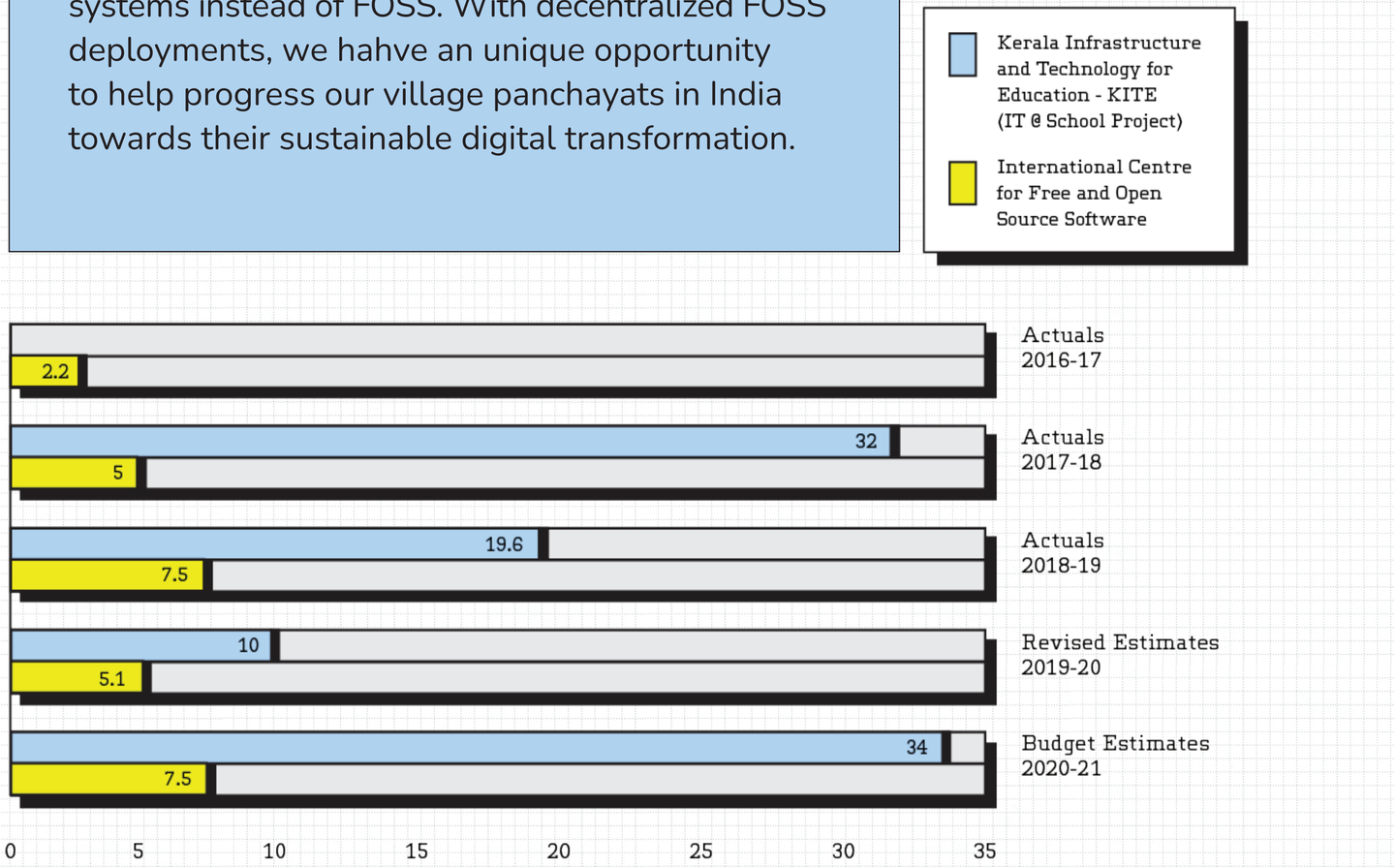


Figure 13: The Government of Kerala budget commitments towards FOSS

[381] GoI DeitY, "Framework ForAdoption of Open Source Software In E-Governance Systems", Apr 2015, Accessed Oct 20 2020, http://egovstandards.gov.in/sites/default/files/Framework%20for%20Adoption%20of%20Open%20Source%20Software%20in%20e-Governance%20Systems.pdf

[382] Information Kerala Mission (IKM), Accessed Oct 20 2020, https://ikm.gov.in

6.1.2 Government of India and FOSS

Even if staff is quite willing to adopt FOSS, the existing legacy closed source software becomes a major hindrance. Government needs to invest in building the new versions for essential digital service software and release them as FOSS for nation-wide adoption and regional customization.

Jaisen Nedumpala,
Secretary at Thamarassery Village Panchayat, Kerala

The Indian government has a promising Open Source Software policy and adoption framework in place. In 2015, Indian Prime Minister Narendra Modi announced Digital India an umbrella programme to make Government services digitally accessible to citizens in all corners of India and to ensure efficiency, transparency and reliability of such services at affordable costs [383].
This was complemented with the announcement of national policy on Adoption of Open Source Software for Government of India, which recommended adoption of Open Source Software (OSS) in all e-Governance systems that were implemented by various Government organizations, as a preferred option over their proprietary counterparts. Along with this policy, GoI also released a detailed Framework for Adoption of Open Source Software in e-Governance Systems.

The framework highlighted the following points:

- The impact of adoption of OSS in Government
- Factors influencing adoption
- Mutual impact of Open Standards and OSS
- Establishing enterprise security with OSS
- Unified software development for all major devices using standards based web browser
- Use of localisation
- Guidelines for public procurement of OSS
- Induction of OSS Solution and ecosystem building for promotion of OSS

Even after having a progressive OSS policy and framework, India is not yet able to engage its vast developer community to co-create open digital assets. The FOSS community welcomed this policy move along

[383] GoI DeitY, "Framework ForAdoption of Open Source Software In E-Governance Systems", Apr 2015, Accessed Oct 20 2020, http://egovstandards.gov.in/sites/default/files/Framework%20for%20Adoption%20of%20Open%20Source%20Software%20in%20e-Governance%20Systems.pdf

with a tinge of healthy skepticism, a feeling that has been compounding each year with no tangible outcome of the policy.

In order to host some of its public software assets, instead of using Github, GoI initiated OpenForge a platform for open collaborative development of e-governance applications. Unfortunately, this effort has not taken off, with close to 7000 users, just odd 50 messages in its forum and not enough meaningful code repositories.

The complex user interface, broken web links and low community engagement of OpenForge, make many people wonder why India didn't join other 60+ countries across the globe to create a decentralized Github pages or use the open-source git-repository management software alternative such as GitLab[385]. These platforms already have a large user base in India.

So far, the Indian government has a mixed record of implementing large IT projects and a shockingly poor record when it comes to open source software. This initiative should not be written off as yet another bureaucratic exercise into nothingness. From my experience in the FOSS industry, I think public money should be used to create public assets [384].

Rushabh Mehta
Creator of ERPNext

ERPNext is an Open Source Enterprise Resource Planning product for businesses, it is being used by Reliance

384 Mehta Rushabh, "Can India break the pattern and do open source right?" Open Source.com, Nov 2014, https://opensource.com/government/14/11/india-government-towards-open-source

385 "Github and Government: Who's using GitHub?", Github, Accessed Oct 20, 2020 https://government.github.com/community/

6.1.3 Indian Judiciary and FOSS

The Judiciary in India has been much more forthcoming in adopting FOSS as compared to our national and state governments.

In 2001, the E-committee of the Supreme Court of India rolled-out guidelines to adopt Ubuntu Linux for the Indian Judiciary [386]. The guidelines also covered the High Courts, District Courts, Family Courts, Labour Courts and Tribunals.

The committee continues to conduct various awareness and training programmes [387] for judicial officers across the country to ensure that the Indian judiciary runs smoothly on FOSS.
One can witness judicial officers and other court staff being quite proficient while using these systems during court trials, as well as managing all the case records and related documentation.

While the country has been releasing favorable policies, there are quite a few challenges when it comes to enactment. We will now go through some of the challenges faced in this ecosystem.

386 eCommittee, Supreme Court of India, "Guidelines for Roll-out and Installation of Ubuntu Linux for Indian Judiciary", accessed Oct 20, 2020, https://main.sci.gov.in/pdf/ecommittee/Guidelines%20for%20Ubuntu%20Linux%20Roll-out%20&%20Installation.pdf

387 eCommittee, Supreme Court Of India, "Change Management for the Judicial Officers - Ubuntu Awareness Cum Training Programme", Accessed Oct 20, 2020, https://main.sci.gov.in/pdf/ecommittee/Guidelines%20for%20Ubuntu%20Linux%20Roll-out%20&%20Installation.pdf

FOSS & Government

Share,re-use & customise FOSS

Governments

Consult & contract to build locally

Fund collaboration with local communities

Give policy suggestions

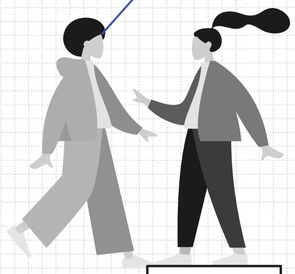
Consume digital services

Procure digital services

Research new digital initiatives

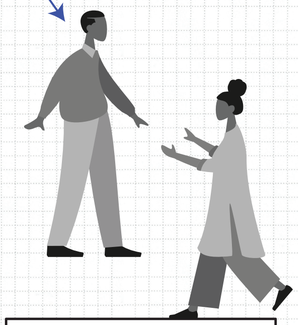
Build capacity

FOSS Community

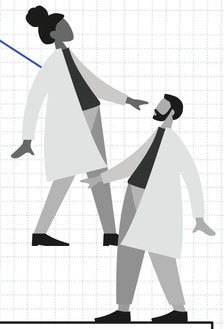


Citizens

Funders & Investors



FOSS Businesses

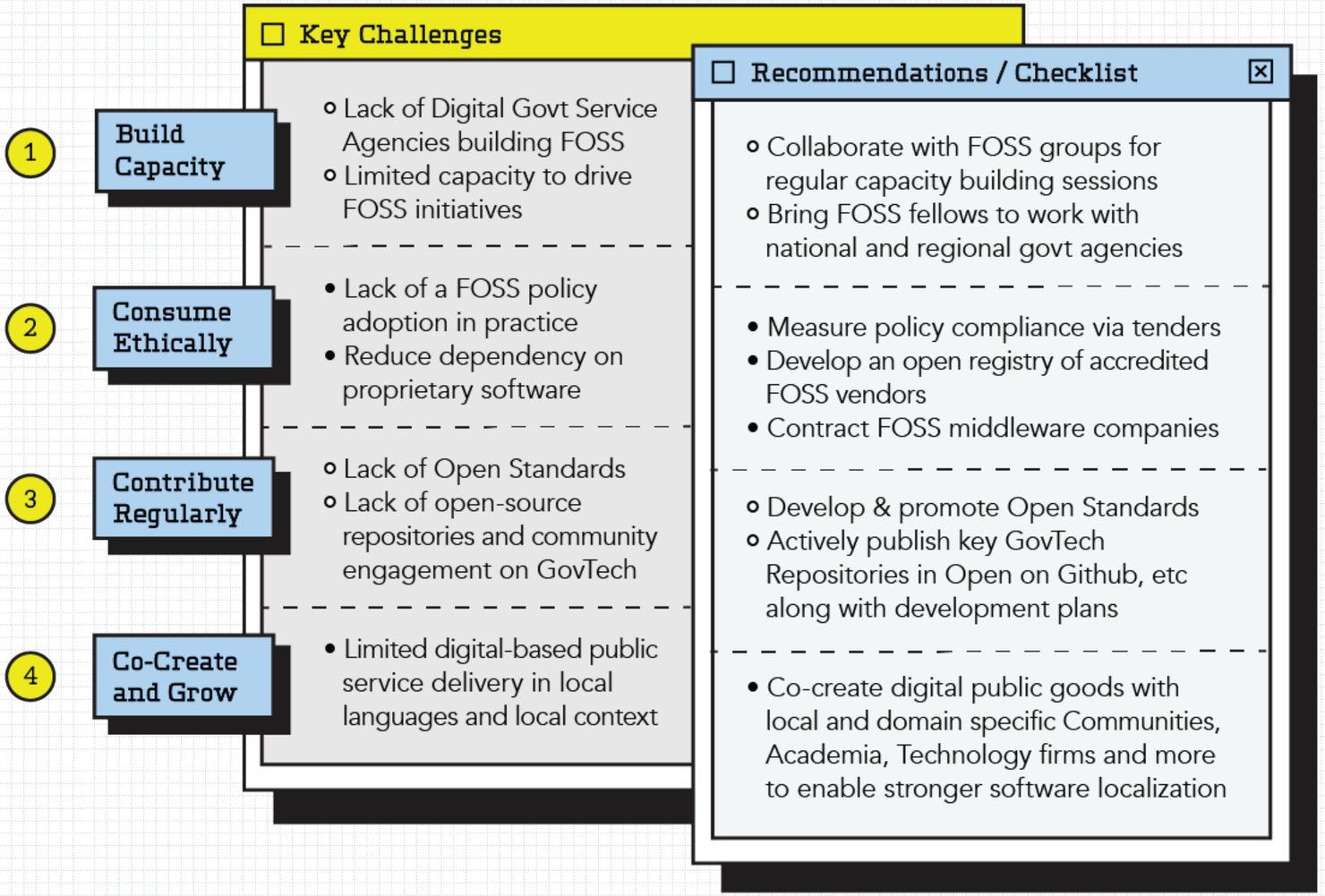


Educational Institutes

Fund organizations that support governments

Key Challenges & Recommendations

Based on our conversations with different stakeholders we have written down some common challenges and recommendations to grow and strengthen the role of FOSS in building our public digital infrastructure.



6.2.1 Capacity

Limited FOSS Capacity of Indian Government Agencies

Lack of National and State Digital Government Service Agencies building FOSS for India. Most countries across the globe have set up various digital government services agencies in government. A common starting point for many digital transformation programmes in government was the UK's Government Digital Service (GDS) setup in 2011, followed by the start of similar agencies in the USA, Australia, Canada, Singapore, Republic of Korea and more. Although, in India we have government's nodal agencies like the National Informatics Centre (NIC), National Resource Center for Free and Open Source Software (NRCFOSS) and the Center for Development of Advanced Computing (C-DAC), have been implementing FOSS for a while, but one cannot find these repositories online, neither the products nor the documentation, thus restricting anyone else apart from them to use, contribute and implement these various softwares.

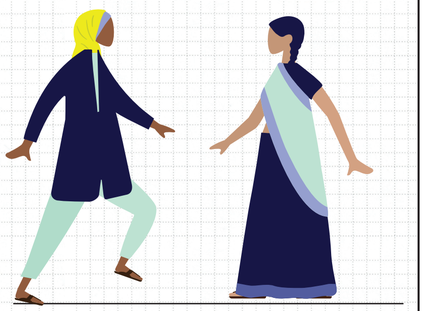
Indian government agencies still lack sufficient capacity to drive FOSS initiatives. There are limited efforts made to educate and train government staff across national, state and local government bodies on FOSS and public-interest technology resources in a timely manner. There is a need to disseminate knowledge on a variety of subjects eg: FOSS principles and merits, software cost estimation, software licensing, assessing switching costs, vendor lock-ins, software ethics, algorithmic accountability, privacy and security, awareness around FOSS alternatives and more. This further constrains most software negotiations where government bureaucrats end up being less competent and experienced than their private sector counterparts.

6.2.2 Consume

Inadequate adoption of FOSS policies in practice

Overcoming dependency of government departments on proprietary software is a big challenge for FOSS. Although we have a number of IT and e-governance policies on national and state-level, most government officers continue to struggle to implement FOSS-first initiatives in their respective departments. Most government departments run their daily operations on a variety of popular proprietary software like WhatsApp, Microsoft Windows, Zoom, Google GSuite, and more without weighing much about data sovereignty, privacy and confidentiality. Further, short term horizons of bureaucrats make them more risk-averse, innovation-averse and they end-up making numerous software related trade-offs. Most "future features" such as ease of customization or switching are given much less weight than "today's features"such as cheap price options [388]. Making a switch from commercial technology in government departments to FOSS will require a strong will, strategic leadership cultural shift and an incentive structure beyond policies.

Mandatory use of FOSS in government is perceived as adversarial by bureaucracy. As per GoI's policy on adoption of Open Source Software (OSS), all government organizations shall endeavour to adopt OSS in all e-Governance applications and systems. However, in certain specialised domains where government organizations need to deploy commercial source software because of absence of OSS solutions meeting essential functional requirements or lack of needed expertise, then in that case government organizations are expected to present sufficient justification. To mitigate such fears, key FOSS stakeholders need to



[388] Rufus Pollock, "Why Open Software Matters for Government & Civic Tech [and how to support it]", July 2016, Accessed Oct 20, 2020, https://rufuspollock.com/open-source-software-and-government/

> Nobody (bureaucrats) would like to take onus and responsibility since you are starting the whole process as an accused [389].
>
> *R Chandrashekhar*
> *Former NASSCOM president and Telecom & IT secretary*

provide strategic FOSS support and build capacity of bureaucrats working to transition to FOSS alternatives.

6.2.3 Collaboration

Lack of collaboration between the Government and FOSS Communities

Most government departments are not able to leverage local communities around its GovTech infrastructure & services thus restricting trust and community participation. Use of proprietary software also restricts various ICT interventions related to public service delivery being timely localized suiting the needs of its target community, thus restricting its reach in last mile adoption.

For example, most FOSS practitioners have been quite vocal about the centralized and closed-source nature of Aadhaar - India's biometric identity database. Indian FOSS communities have raised concerns related to privacy, security and transparency in how biometric data of more than 1.2 billion users [390] is being managed by the government. Moreover, Aadhaar web services are still served in only 13 out of 22 official Indian languages even after cumulative expenditure of more than Rs.12 thousand crores spread over more than 10 years of development [391]. If the Aadhaar code infrastructure was made open source, with upstream community collaborations we could have potentially been able serve its web services in a much broader number of Indian languages and with several localized elements as per the regional needs.

Opening-up the development process and source code of important public digital goods will not only enable trust among citizens but also make these goods much more inclusive, secure and customizable by co-creating with the community.

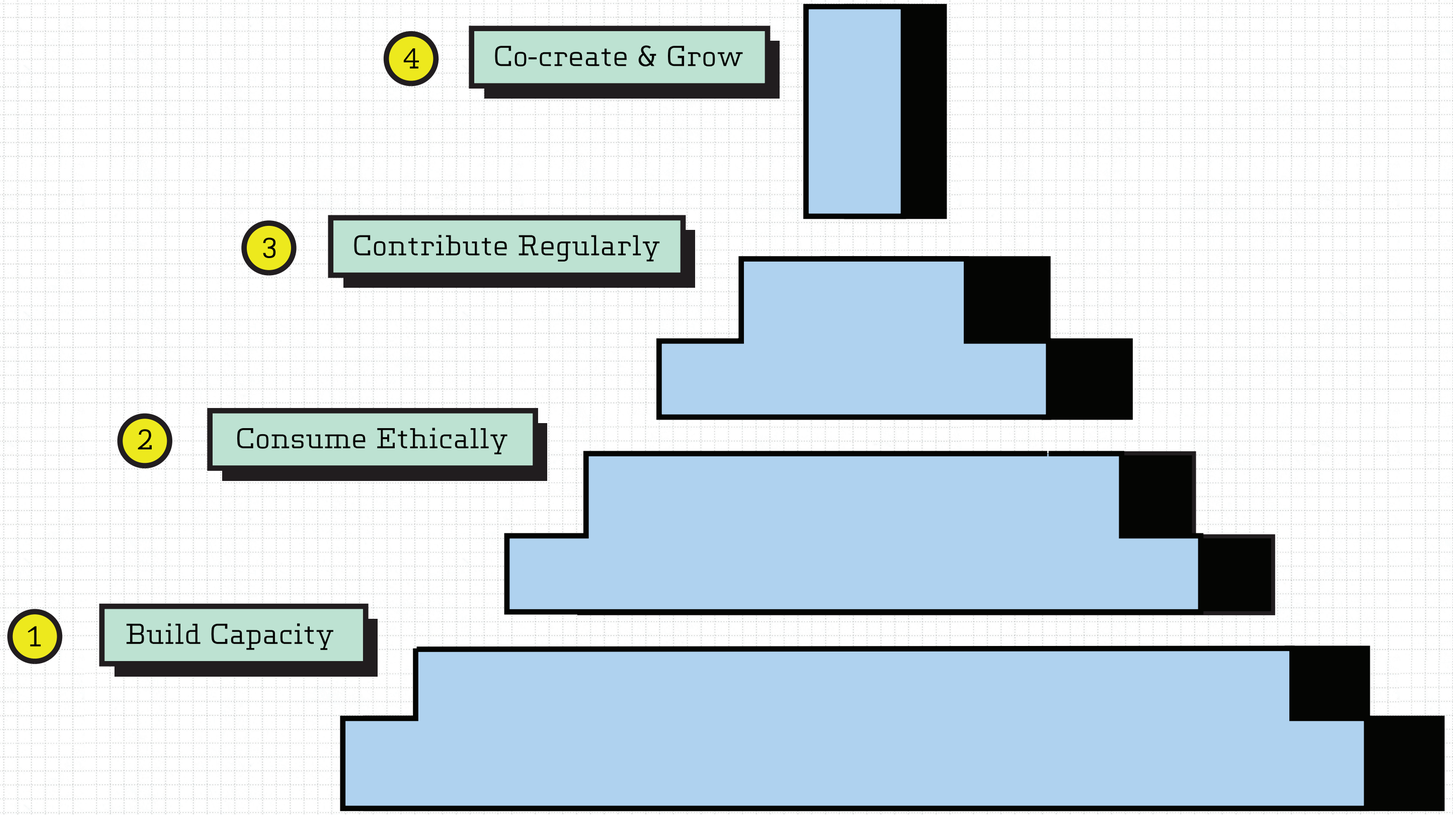
[389] Surabhi Agarwal, "Microsoft uneasy with open-source policy", Business Standard, May 2015, Accessed Oct 20, 2020, https://rufuspollock.com/open-source-software-and-government/

[390] "Aadhaar Dashboard", UIDAI, Accessed August 19, 2020, https://uidai.gov.in/aadhaar_dashboard/index.php

[391] Finance & Accounts, "UIDAI Unique Identification Authority of India", Accessed Oct 20, 2020, https://uidai.gov.in/about-uidai/unique-identification-authority-of-india/finance-accounts.html

6.3 Recommendations

We are witnessing a variety of public digital services being rapidly developed, and an increasing number of beneficiaries are coming online for the first time to avail these services. It is becoming much more critical to adopt FOSS and its values to co-create our public digital infrastructure and make them more replicable, robust and resilient.



6.3.1 Capacity

Build FOSS Capacity of Governments

There is a need to invest on building timely capacity of government officials on FOSS, this can be initiated by following interventions:

- Enable more FOSS groups (Academia, CSOs, Social Enterprise, et cetera) to sign MoUs and conduct regular capacity building workshops on FOSS. We have seen most state governments are interested in doing this.
- Organize “FOSS in Governance” fellowship where host organizations groom and support fellows to be on ground and support state governments’ capacity on FOSS.
- Work regularly with Bureaucrats and Policy Makers to deepen their understanding on FOSS can be used in their respective focus areas.

Urban Local Bodies

Various Urban Local Bodies signing MoUs with eGovernments Foundation to adopt eGov SmartCity eGovernance suite [392].

NIRDPR NERC

The North Eastern Regional Centre of the National Institute of Rural Development(NIRDPR-NERC) conducts regular training programme on “Orientation on Applications of Open Source Software in Rural Development”[393].

[392] “eGov Smart City Suite”, Github, Accessed Oct 20 2020, https://github.com/egovernments/egov-smartcity-suite

[393] NIRDPR, “training programme on Orientation on Applications of OpenSource Software in Rural Development, Mar 2019, Accessed on Oct 20, 2020, http://www.nirdnerc.nic.in/OSS16119.pdf

6.3.2 Setup Robust Policy Frameworks around FOSS

There is a need to develop a strategic FOSS policy adoption framework at Central, State and local tiers of governments. This could be initiated via following interventions:

- Help different departments of the government engage with more middleware companies instead of product development companies, who can give services for dedicated tenures on better FOSS adoption without vendor lock-in and legacy software.

- Improve policy compliance by ensuring government procurements and RFPs are in accordance to e-governance policies to give preference to FOSS and promote publishing of source code by vendors.

- Develop an open registry of accredited software vendors linking their FOSS contributions and other necessary credentials, enabling government procurement agencies to find right partners as per specifications and geography.

Kerala Legislative Assembly

The Kerala Legislative Assembly moved all of their IT operations into GNU/Linux based systems with the assistance of Zyxware Technologies[394]

394 Vinson Kurian, "Kerala Legislature Announces Smooth Transition to Free Software," @businessline (The Hindu BusinessLine, March 12, 2018), https://www.thehindubusinessline.com/news/national/kerala-legislature-announces-smooth-transition-to-free-software/article20821938.ece1.

6.3.3 Consume

Support more FOSS Implementations

Support structures within government departments for financial, technical, legal, institutional, and political support to implement FOSS. We can start bridging it by following interventions:

- India should proactively continue to lead the work on developing Open Standards for various key e-governance functions and sectors.
- Join other countries and move OpenForge to a more community centric platform like Github, building more national and regional community engagement around it.

eGovernance

The eGovernance standards platform which contains frameworks, institutional policies, and digital standards must be kept up to date especially for new and evolving technologies[395].

GitHub

The government agencies from most of the countries in the world including Australia, UK, USA, Europe are all on GitHub [396].

[395] "Notified standards for e-governance applications", e-governance standards, accessed Oct 20, 2020, http://egovstandards.gov.in/notified-standards-0

[396] "Github and Government: Who's using GitHub?", Github, Accessed Oct 20, 2020, https://government.github.com/community/

Work to ensure key building blocks of new and existing GovTech interventions are FOSS first like the use of CKAN [397] in Data.Gov.in, National Data Analytics Platform, state-level and municipal level open data platforms in the country. This will promote low-cost software reuse along with serving the needs of localization for wider reach.

CKAN

The CKAN Association Government working Group [398] which is focused on supporting governments which want to use CKAN for their open data portals on a wide variety of issues from policy to source code. The Australia, Canada, and the USA governments are already a part of this working group.

6.3.4 Contribute & Co-create

Contribute & Co-create for sustainable FOSS

In order to leverage the complete potential of FOSS, governmental ICT actors need to co-create, publish and contribute more on FOSS with their respective domain-specific and local communities.

GOV.UK

The UK Government's Digital Services department launched GOV.UK website with a pull request [399] and at least 13,000 commits from very active communities.

397 CKAN-The open source data portal software, CKAN, Accessed Oct 20, 2020 https://ckan.org/

398 CKAN, "Government Working Group", Accessed Oct 20, 2020, https://ckan.org/about/government-working-group/ "Github and Government: Who's using GitHub?", Github, Accessed Oct 20, 2020, https://government.github.com/community/

399 "alphagov/static", Pull request#94, accessed oct 20, 2020, https://github.com/alphagov/static/pull/94

6.4 Way Forward

If there is one thing that the on-going pandemic has taught us is that, governments need to work together with different stakeholders to resolve larger issues and meet digital demands of our citizens.

There is more need to co-create and innovate to cross this hurdle. One thing that has proven its worth time and again during the various crisis situations in our history is FOSS. So in the final section, we shall look at how FOSS is being leveraged during these troubled times.

Chapter 07

FOSS & Crisis Management

7.1 Landscape

7.1.1 COVID-19 has triggered widespread Global Adoption of FOSS-led initiatives

During crises, FOSS plays a vital role in bringing together key actors from around the world to organize a rapid response. In the wake of a catastrophe, FOSS brings communities together to collect, monitor and manage large scales of heterogeneous data to better understand situations on ground. First identified in December 2019, Coronavirus disease(COVID-19) is an infectious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2).

In the last 12 months, detected cases have zoomed past 65 million, resulting in more than 1.5 million deaths and counting [400].

India is the second most affected country after the United States with more than 10 million cases and 100 thousand deaths [401].

In order to respond to this world-wide health crisis various communities, research institutions, businesses, and government agencies are globally coming together and harnessing FOSS-led co-creation to quickly deploy a variety of digital solutions. We have already witnessed more than 42 thousand public repositories on Github [402], on topics ranging from cases data, interactive maps, listings of essential services, contract tracing apps, and epidemiology models. During these troubled times, we see key actors climbing the FOSS pyramid to co-create impactful solutions quickly. Thus constantly reiterating the integral role FOSS plays during a crisis.

400 "COVID-19 Dashboard by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University (JHU)". ArcGIS. Johns Hopkins University. Accessed October 13 2020, https://gisanddata.maps.arcgis.com/apps/opsdashboard/index.html#/bda7594740fd40299423467b48e9ecf6

401 "Home | Ministry of Health and Family Welfare | GOI". mohfw.gov.in. Accessed October 13 2020 https://www.mohfw.gov.in/

402 Public Code Repositories on Github related to Coronavirus or COVID-19. Github. Accessed October 13 2020. https://github.com/search?q=coronavirus+OR+covid19

7.2 FOSS stakeholders are breaking silos to combat the pandemic

7.2.1 Governments are open-sourcing their COVID-19 efforts

Governments across the globe have rolled-out new digital services and initiatives to inform and engage citizens and other civic actors. In responding to the current health emergency, Governments have put in place new tools such as dedicated COVID-19 information portals, e-services for supply of medical goods, virtual medical appointments, self-diagnosis apps, and e-permits for curfews [403].

Use of FOSS in pandemic response efforts further increases transparency, accountability, reduces costs and risk, and enables faster deployment of tried and tested solutions across the globe[404]. Various countries are working to promptly use FOSS to share information, engage in regional digital cooperation, enable local e-government response and work with citizens groups. They are working to harness innovative FOSS solutions to deploy tracking and tracing apps, e-learning platforms, virtual consultations and more.

> The pandemic has renewed and anchored the role of digital government — both in its conventional delivery of digital services as well as new innovative efforts in managing the crisis
>
> *Liu Zhenmin*
>
> *United Nations Under-Secretary-General for Economic and Social Affairs.*

403 "2020 United Nations E-Government Survey". UN Department of Economic and Social Affairs. Accessed Oct 20 2020, https://www.un.org/development/desa/publications/publication/2020-united-nations-e-government-survey

404 "Building and Reusing Open Source Tools for Government". New America Foundation. Accessed Oct 20 2020, https://www.newamerica.org/digital-impact-governance-initiative/reports/building-and-reusing-open-source-tools-government/

Digital Response to COVID-19

European Union has set up their Digital Response to COVID-19 [405], a large resource database including open source software, open data, websites, and platforms that are useful for public administrations, businesses, and citizens dealing with the ongoing crisis. The response consists of FOSS tools in domains like-contact-tracing apps, chatbots, healthcare services, remote work, data tools and other resources.

Open Call

The Government of Canada has developed Open Call [406]- a living catalogue of free, easy to (re)use tools developed by various global agencies to help governments address some common challenges related to COVID-19. This catalogue includes FOSS initiatives related to exposure notifications, messaging platforms, financial assistance tools, contact tracing apps, self assessment and other information tools.

Digital Response to COVID-19

UNDP Global Centre for Technology, Innovation and Sustainable Development has launched COVID-19 Open-Source Digital Toolkit [407] which consists of FOSS tools in four main areas:

Disease Monitoring: Identifying the spread of COVID-19 in a society

Prevention and Containment: Preventing the spread of the disease and supporting efforts to minimise further spread

Diagnosis: Helping citizens and governments to confirm whether individuals are infected or not

Recovery: Supporting governments and societies recovering from COVID-19

405 "Open source solutions | Joinup". European Union, Accessed Oct 20 2020, https://joinup.ec.europa.eu/collection/digital-response-covid-19/open-source-solutions

406 "Open Call". Government of Canada, Accessed 20 Oct 2020, https://opencall-appelouvert.alpha.canada.ca/#/

407 "Digital Tools for COVID-19", UNDP, Accessed 20 Oct 2020, https://sgtechcentre.undp.org/content/sgtechcentre/en/home/digital-tools-for-covid-19.html

Aarogya Setu

While the Indian government published code of Aarogya Setu in open in an attempt to mitigate privacy concerns and enable public auditing, FOSS communities remain concerned about transparency and participation. In early April, the Government of India launched Aarogya Setu - a contact tracing mobile application which works on Android, iOS and KaiOS. Within weeks of its launch the app had more than 100 million downloads making it one of the most popular apps in the health and wellness category. As part of the MIT Technology Review Covid Tracing Tracker Project [408], the app received just 2 out of 5 stars losing out on key parameters like voluntary use, limitations on data usage, and transparency. The tracker also mentioned that India is the only democracy in the world that is making its contact tracing app mandatory for millions of people. Various internet freedom activists and security experts shared their privacy concerns on data collection, usage and deletion; and demanded to open source the app for public auditing [409].

In order to mitigate these concerns, the government finally decided to publish the code of the Android version of the app on GitHub [410], along with a bug bounty program of Rs.1 Lakh to security experts for identifying and reporting bugs and vulnerabilities. While the app has listed diverse contributors from various government agencies, businesses, and research institutions [411] there are no evident efforts made by the team to engage the FOSS community to actively co-create further development. Many members from the community quoted their dissatisfaction [412], the primary one being limited transparency as the server side code of the app is still not available for review. Moreover, the version on the GitHub repository is a month older than the version of the app available for download [413]. These factors highlight several restrictions FOSS communities face while collaborating with Indian government agencies thus missing an unique opportunity for building robust FOSS-led public infrastructure in the country.

[408] Patrick Howell, O'Neill, Ryan-Mosley, Bobbie Johnson "A flood of coronavirus apps are tracking us. Now it's time to keep track of them", MIT Technology Review, May 7 2020, Accessed Oct 20 2020, https://www.technologyreview.com/2020/05/07/1000961/launching-mittr-covid-tracing-tracker/

[409] Manish Singh, "A security expert says India's contact-tracing app has flaws; New Delhi says they are 'by design'" TechCrunch, May 6 2020, Accessed Oct 20 2020, https://techcrunch.com/2020/05/05/aarogya-setu-app-security-privacy-concerns-india-response/

[410] "nic-delhi/AarogyaSetu_Android: Aarogya Setu Android app native code", NIC Delhi GitHub, Accessed Oct 20 2020, https://github.com/nic-delhi/AarogyaSetu_Android

[411] Aditi Agarwal, "Who made Aarogya Setu? A list.", MediaNama, May 27 2020, Accessed Oct 20, 2020, https://www.medianama.com/2020/05/223-aarogya-setu-contributors/

[412] Neeradh Pandharipandhe, "Aarogya Setu not 'open source' in real sense, claim cybersecurity activists, say server code must be made public", Firstpost, Jun 15 2020, Accessed Oct 20, 2020, https://www.firstpost.com/tech/news-analysis/aarogya-setu-not-open-source-in-real-sense-claim-cybersecurity-activists-say-server-code-must-be-made-public-8480011.html

[413] "Aarogya Setu", Google Play, Accessed Oct 20, 2020, https://play.google.com/store/apps/details?id=nic.goi.aarogyasetu

Local governments and administrative bodies have also come forward to adopt FOSS to engage with citizens and work efficiently in these demanding times. Some notable examples include:

Kerala State Disaster Management Authority in collaboration with a multidisciplinary team of innovators and volunteers launched the CoronaSafe Network[415]- an open-source disaster management platform. It has been instrumental in increasing COVID-19 literacy across the country in 7 Indian languages

Allahabad High Court and Uttarakhand High Court benches have been using a popular virtual conferencing tool - Jitsi Meet during the pandemic [416].

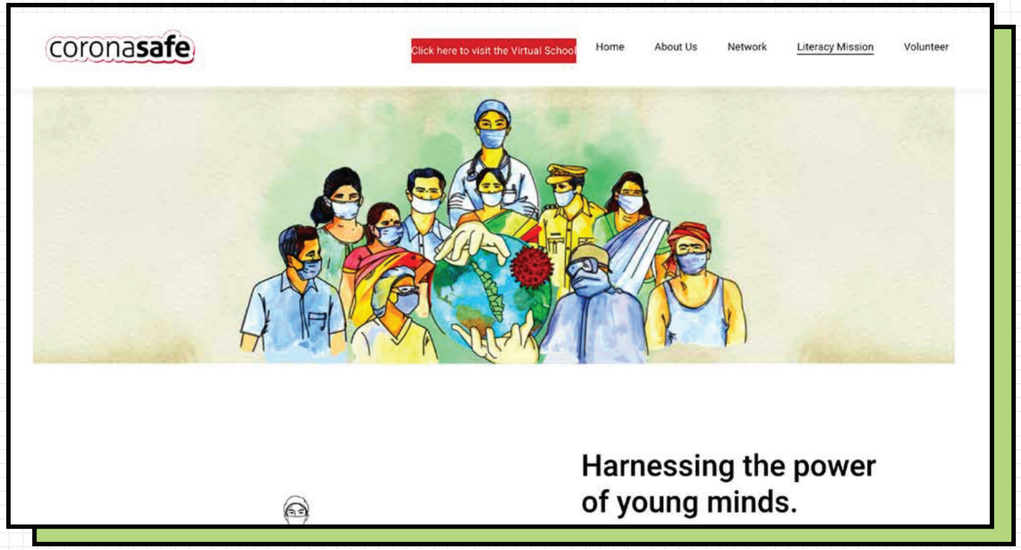


Figure 14: CoronaSafe Network - an open-source disaster management platform increasing corona literacy across the country in 7 Indian languages.

The German Government

The German government has been quite successful in engaging a diverse group of stakeholders (including local communities, research institutes and businesses) in continuous development of Corona-Warn-App [414]. The app helps trace infection chains of SARS-CoV-2 in Germany using decentralized technologies and notifies users if they have been exposed to SARS-CoV-2.

414 "Open-Source Project Corona-Warn-App". The Robert Koch Institute, Germany, Accessed Oct 20, 2020 https://www.coronawarn.app/en/

415 "CoronaSafe Network",The Government of Kerala, Accessed Oct 20, 2020, https://coronasafe.network/

416 "Virtual Courts in India – Weekly Update (6.4.2020 – 11.4.2020)". Khaitan & Co, Accessed Oct 20 2020, https://www.khaitanco.com/covid-19/Virtual-Courts-in-India-Weekly-Update#_ftn13

7.2.2 Tech Businesses are trying to balance recovery and response

> We are not living in a vacuum. The industry has struggled a little bit in the first quarter of 2020 and seems to be stabilizing. Our customers have significantly cut spending, they are much more thoughtful.[417]
>
> *Rishad Premji*
> *Wipro Chairman*

According to a recent survey conducted by NASSCOM, on COVID-19 Impact on Indian Tech Sector [418]- most tech companies in India are facing a short-term demand reduction. From large Indian MNCs to MSMEs, many of them expect 2021 revenues to be negatively impacted with the global slowdown in demand.

The most promising opportunities for recuperation within the sector lies in the digital transformation space by catering to the increasing demand in areas like collaborative workplace technologies, mobility, and cybersecurity. Also, Indian tech companies in health, Ed-Tech, online entertainment and gaming are witnessing tremendous growth. For a well-timed response to these demands, IT firms will require strategic investment in FOSS as these solutions are low-cost, efficient, secure, and easy to deploy compared to their closed-source counterparts.

Various large businesses are signing the Open COVID Pledge[419] around the world to make their patents and copyrights freely available in the fight against the COVID-19 pandemic. Organizations like Amazon, Intel, IBM, Hewlett Packard Enterprise have come on board and published a commitment to make their intellectual property relevant to COVID-19 freely available. The pledge was developed by an international group of researchers, scientists, academics, and lawyers seeking rapid development and deployment of diagnostics.

417 Ayan Pramanik, "Will Indian IT majors see Covid impact like Accenture did? There's one reason why they may not." The Economic Times, Sept 28 2020, Accessed Oct 20, 2020, https://economictimes.indiatimes.com/tech/ites/will-indian-it-majors-see-covid-impact-like-accenture-did-theres-one-reason-why-they-may-not/articleshow/78351280.cms

418 "CEO Pulse Review: Covid-19 Impact on Indian Tech Sector". NASSCOM,Accessed Oct 20 2020, https://nasscom.in/system/files/secure-pdf/NASSCOM_CEO-Pulse-Review-Series-I-vF.pdf

419 "Open COVID Pledge", Open Covid Pledge. Accessed Oct 20 2020, https://opencovidpledge.org/

Functional Genomics Platform

IBM has also published more than 2 million genomic datasets on their Functional Genomics Platform [420], accelerating development of health interventions by studying collective biological activity

IBM

As part of its wider response to COVID-19, IBM has opened up various resources like supercomputing power, virus tracking and an AI assistant. One such effort is to help researchers generate potential new drug candidates for COVID-19. IBM used their novel AI generative frameworks to generate potential molecular candidates that target COVID-19. They created more than 3000 candidate proteins from three target proteins on COVID-19 thus rapidly decreasing the time to drug discovery [421].

Neo4J

Neo4J along with other research organizations have developed CovidGraph [422] - an open source graph database that brings together information on COVID-19 from different sources. CovidGraph has helped institutions like the Canadian government integrate data from multiple departments and facilities.

The power of graph data [distributed via an open source management system] is that it can pull together disparate datasets from medical practitioners, public health officials and other scientific publications into one central view. People can then make connections between all facts. This is useful when looking for future long-term solutions [423].

Jim Webber
Neo4j

420 "Accelerate Discovery", IBM, Accessed Oct 20 2020 https://covid19-mol.mybluemix.net/

421 "IBM Functional Genomics Platform", IBM, Accessed Oct 20 2020, https://s2s-omxware.us-south.containers.appdomain.cloud/landing

422 "Covid-19 Knowledge Graph", CovidGraph.org, Accessed OCt 20 2020, https://covidgraph.org/

423 Dries Buytaert, "The power of open source to fight COVID-19", InfoWorld, Jun 22, 2020, Accessed Oct 20 2020, https://www.infoworld.com/article/3563868/the-power-of-open-source-to-fight-covid-19.html

7.2.3 Digital Ingress, Literacy & the rise of Ed-Tech

The COVID-19 pandemic changed the education landscape of India overnight. Educational institutes were compelled to adopt various digital learning alternatives to sustain timely growth of children.

In a country where only 4.4% of rural and 23.4% of urban households own computers, the challenge becomes even bigger. Moreover, while 42% of urban households have a computer with an internet connection, the same is available to only 14.9% of rural households [424].

These challenges are further aggravated by the physical, psychological and sociological effects of purely online learning [425]. Online learning has further proven to be a considerable challenge for students with disabilities. The National Education Policy 2020, takes notice of the present scenario of education in India, seeks to encourage "carefully designed and appropriately scaled pilot studies to determine how the benefits of online/digital education can be reaped while addressing or mitigating the downsides"[426].

In the same breath, Ed-Tech in India has experienced meteoric rises. From an estimated size of $700 million today, the Ed-Tech market (including higher education and professional skilling courses) is headed for 8x to10x growth in the next 60 months (5-years) [427]. In August 2020, the education technology platform, Byju's, acquired the coding platform, WhiteHat Jr. in a $300 million deal all closed source platforms.

Now more than ever before it is important to think about FOSS and education together. Not as a bystander, but an important piece

[424] Key Indicators of household social consumption of education in India. NSS, Accessed Ot 20 2020, http://mospi.gov.in/sites/default/files/publication_reports/KI_Education_75th_Final.pdf

[425] Protiva Kundu, "'To No One's Surprise, Online Schooling Has Started Taking a Psychological Toll on Students", The Wire, Jul 21 2020, Accessed Oct 20 2020 https://thewire.in/education/online-education-students

[426] MoHRd, "National Education Policy 2020", Accessed Oct 20 2020, https://static.pib.gov.in/WriteReadData/userfiles/NEP_Final_English_0.pdf

[427] Prarthana Bannerjee, "EdTech Market Is Booming In India", Business World, Sept 20 2020 http://www.businessworld.in/article/EdTech-Market-Is-Booming-In-India-/20-09-2020-322696/

Proprietary video conferencing apps such as Zoom often threaten the privacy of users and in such a context, the BigBlueButton application is a unique web conferencing system for official purposes.

K. Anvar Sadath
KITE CEO

of the solving the education puzzle. The pandemic has accelerated the adoption of technology in the classroom, it's critical the FOSS leads the way to ensure equitable access and adoption. There has been a piecemeal approach towards FOSS based Ed-Tech solutions for COVID-19 response. Various organisations have in their individual capacity created solutions to fill gaps, but the large challenges still remain.

The education ecosystem has gone through drastic changes due to the pandemic with the access gap widening further due to uneven adoption of technology. It would require a collective solution to bridge the gap and bring equitable education to each child. FOSS can play a major role in making this journey easier.

Gnowledge Lab

Gnowledge Lab extended ChatShaala, a platform to host STEM-based games mapped to the curriculum for classes K-1 to K-12, including aligned resources for teachers, to include COVID-19 related teaching resources. The complete platform is built using FOSS technologies [429].

KITE

The Kerala Infrastructure and Technology for Education (KITE)[428] customised the free software application called BigBlueButton for online classes and meetings. The facility was extended to all teachers through the Samagra resource portal developed by KITE.

[428] "KITE's customised videoconference system", The Hindu, Apr 17 2020, Accessed Oct 20, 2020, https://www.thehindu.com/news/national/kerala/kites-customised-videoconference-system/article31370388.ece

[429] "Stem Games", Gnowledge, Accessed Oct 20 2020, https://metastudio.org/

7.2.4 Research Institutes around the world are working on FOSS-led research interventions to curb Coronavirus spread

Research Institutes around the world are working on FOSS-led research interventions to curb Coronavirus spread

Academic institutions globally are leading research on COVID-19 covering a diverse set of topics like building epidemiological models, populating diseases databases, developing vaccines, conducting genomic research, and more. The institutions have proactively developed invaluable resources, be it the famous COVID-19 Map developed by Johns Hopkins Coronavirus Resource Center[430] or the vaccine research led by the University of Oxford in partnership with other pharma companies [431]. Most institutes are actively publishing their research in open to enable collaborations, some notable examples are:

CITRIS

The CITRIS (Center for Information Technology Research in the Interest of Society) and the Banatao Institute at University of California has been seed funding a variety of open-source academic collaborations working to create COVID-19 response projects ranging from data analysis platforms to open-source ventilators [432].

[430] "COVID-19 Map", Johns Hopkins Coronavirus Resource Center, Accessed Oct 20 2020, https://coronavirus.jhu.edu/map.html

[431] "COVID-19 Vaccine Trials", The University of Oxford, Accessed Oct 20 2020, https://covid19vaccinetrial.co.uk/

The Biozentrum

The Biozentrum at the University of Basel, Switzerland has developed COVID-19 Scenarios,a FOSS computational tool to better understand disease outbreak trajectories and hospital demand [433].

The Allen Institute

The Allen Institute for AI along with other leading research institutes has released CORD-19 (COVID-19 Open Research Dataset) - a collection of FOSS tools and open datasets to find new insights about the novel coronavirus [434].

IISc Bangalore

Indian Institute of Science (IISc) Bangalore has initiated a variety of FOSS projects to boost COVID-19 research in India. One such effort is the open-source City-scale Epidemic Simulator [437] developed by a team of researchers of IISc Bangalore and TIFR Mumbai, to model the spread of COVID-19 in Indian demographics. The tool helps urban planners understand the effectiveness of various social distancing interventions based on demographic distributions and disease spread.

IISc Bangalore

Another initiative at the institute is Project Coswara [435]- a FOSS diagnostic tool for COVID-19 based on the collection and modelling of respiratory, cough and speech sounds. Moreover, IISc has consolidated all the ongoing COVID-19 related projects [436] at the Institute, and created an open call for people with necessary expertise from outside the Institute to collaborate with their research teams.

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[432] "CITRIS COVID-19 Seed Funding: Awarded Projects", CITRIS and the Banatao Institute, University of California, Accessed Oct 20 2020, https://citris-uc.org/citris-covid-19-seed-funding-awarded-projects/

[433] "COVID-19 Scenarios", The Biozentrum, University of Basel, Switzerland, Accessed Oct 20 2020 https://covid19-scenarios.org/

[434] "CORD-19", The Semantic Scholar team at the Allen Institute for AI, Accessed Oct 20 2020 https://www.semanticscholar.org/cord19/about

[435] Project Coswara. IISc, Accessed Oct 20 2020 https://coswara.iisc.ac.in/

[436] "IISc's Response to COVID-19". IISc, Accessed Oct 20 2020, https://covid19.iisc.ac.in/

[437] "City-Scale Epidemic Simulator", IISc and TIFR. Accessed Oct 20 2020

In India, although there are numerous research projects[438] undertaken by academia, we still witness much lesser publication of these efforts as FOSS repositories as compared to their global counterparts.

This to some extent restricts deeper research collaborations, faster reuse and trustworthy provenance to tackle the crisis in the second most affected country in the world.

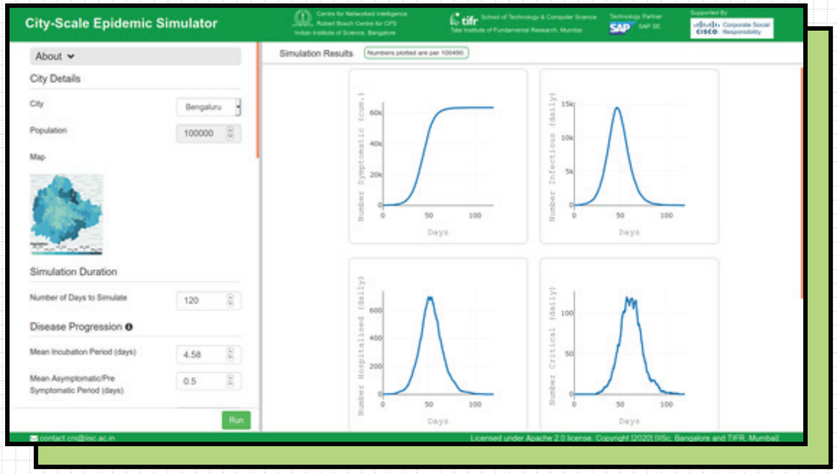


Figure 15: City-Scale Epidemic Simulator developed by a team of researchers of IISc Bangalore and TIFR Mumbai, to model the spread of COVID-19 in Indian demographics.

[438] Ankush Kumar, "How IITs are leading India's fight against Covid-19", TechObserver, Aug 11 2020, Accessed Oct 20, 2020, https://techobserver.in/2020/08/11/how-iits-are-leading-indias-fight-against-covid-19/

7.2.5 FOSS Communities tackling challenging problems related to the pandemic

FOSS communities are on the forefront of tackling the most challenging problems related to the pandemic.

FOSS communities have a unique challenge in front of them: They need to look out for the well-being of contributors during this pandemic as well as align themselves quickly to help curb the crisis by building the right set of tools.

The communities have already managed to create more than 42 thousand public repositories on Github [439] on a diverse set of domains, engaging thousands of contributors across the globe.

These FOSS repositories are now being used by millions of users to get up-to-date COVID-19 related information in their respective geographies.

COVID19 India.org

One of most popular resource of timely information on COVID-19 active cases in India is COVID19India.org [440]- a volunteer-driven crowdsourced effort to track the coronavirus spread in India.

This FOSS initiative engages more than 100 contributors to build an interactive map to show live updates on cases, sourced with the help of more than 55 thousand volunteers collecting data from diverse sources like government websites, daily state health bulletins, local media reports and more. One of the key contributors of the project is Jeremy Philemon, a computer science major splitting his education between the Vellore Institute of Technology in India and Binghamton's Thomas J. Watson School of Engineering

[439] Ankush Kumar, "How IITs are leading India's fight against Covid-19", TechObserver, Aug 11 2020, Accessed Oct 20, 2020, https://techobserver.in/2020/08/11/how-iits-are-leading-indias-fight-against-covid-19/ https://cni-iisc.github.io/epidemic-simulator/

[440] "Coronavirus Outbreak in India", covid19india.org, Accessed Oct 20 2020, https://www.covid19india.org/

Most FOSS communities require timely funding to build and sustain technology projects that can help respond to the COVID-19 pandemic. The cancellations of several in-person community events, further affected the ability of FOSS organizations and projects to seek funding or to promote their work to potential funders and sponsors.

Mozilla

Mozilla initiated COVID-19 Solutions Fund as part of the Mozilla Open Source Support Program (MOSS). This fund was established at the end of March 2020, to offer up to $50,000 each to open source technology projects responding to the COVID-19 pandemic [442]. In a span of three months, the fund supported FOSS initiatives from a variety of domains including - open-source emergency ventilator & face shield designs, modelling tools, electronic medical records platform and ethical supply chains networks.

and Applied Science. He mentions how open-sourcing the website helped to patch bugs in a timely manner and to introduce new features and improvements with the community[441]. The website works in 10 popular Indian languages and attracts millions of users per month.

Figure 16: A snapshot of the COVID19India.org

In such a situation, various philanthropic groups opened small and medium sized funding to help FOSS communities sustain themselves in these difficult times and build digital tools to cater local needs.

441 AB Wire, "Covid-19: US student builds website to track pandemic in India", The American Bazaar, Accessed Oct 20 2020, https://www.americanbazaaronline.com/2020/05/21/covid-19-us-student-builds-website-covid19india-org-track-pandemic-in-india-441214/

442 "MOSS launches COVID-19 Solutions Fund", Mozilla Foundation, Mar 31 2020, Accessed on Oct 20 2020, https://blog.mozilla.org/blog/2020/03/31/moss-launches-covid-19-solutions-fund/

7.3 Way Forward

FOSS is not just crisis proof, it thrives in a crisis. It has been used time and again to overcome troubled times because of its transparent nature.

So, while the road ahead might be unclear, Free and Open Source Software will be used to navigate it.

While this pandemic presents a difficult time for many, I believe Open Source communities have the power to sustain themselves during an economic downturn, and even to grow.

Open Source communities consist of people all around the world who believe in collective progress, building something great together, and helping one another. Open Source communities are not driven by top-line growth - they're driven by a collective purpose, a big heart, and a desire to build good software. These values make Open Source communities both resilient and recharging [443].

Dries Buytaert
Drupal founder and Project Lead

Drupal is an open-source software used to build websites and digital experiences

[443] Dries Buytaert, "Is Open Source recession-proof?", Mar 19 2020, Accessed Oct 20, 2020 https://dri.es/is-open-source-recession-proof

Chapter 08

Conclusion

> A good tool is an invisible tool. By invisible, I mean that the tool does not intrude on your consciousness; you focus on the task, not the tool. Good tools enhance invisibility.
>
> *Mark Weiser*
> *Chief Technology Officer*
> *Xerox PARC* [444]

We are merely at the beginning of this story...

FOSS's main problems also arise from it's ubiquitous and utilitarian nature. Everyone uses it everywhere but the true costs of creating it are not observable because they are globally distributed and largely volunteer driven. Nadia Eqbhal in her report on FOSS likens it to roads and bridges. It makes up most of the software we use and like these roads and bridges, we don't notice it until it is broken[445].

This also means in countries like India that have primarily positioned themselves in the technology space as a provider of human capital resources as opposed to technology, it very rarely figures in the strategy of large Indian businesses. FOSS has been an instrument used differently by different sets of people and at different points of time. It has been a tool for freedom, for power, for inclusion and for collaboration. It is already everywhere, it makes up almost every piece of software we have the privilege of using.

The power of FOSS however, comes from its transparent nature. When you are working with FOSS, you can see it's insides, it is not hiding anything and it can be used by anyone. It truly belongs in the commons.

At the present moment, India has largely placed herself as a consumer of FOSS. But this is changing, and we are now at a crucial nexus to decide when this change is likely to occur and who it will serve.

[444] Mark Weiser, "The World is not a Desktop", Accessed Oct 20, 2020, https://web.archive.org/web/20141109145219/http://www.ubiq.com/hypertext/weiser/ACMInteractions2.html

[445] Nadia Eqbhal, "Roads and Bridges: The Unseen Labour Behind Our Digital Infrastructure" Accessed Oct 20, 2020, https://www.fordfoundation.org/media/2976/roads-and-bridges-the-unseen-labor-behind-our-digital-infrastructure.pdf

The commons is defined as the cultural and natural resources accessible to all members of a society, including natural materials such as air, water, and a habitable earth. [446]

For a FOSS environment to thrive it requires all players to be invested, to work together, to co-create, to criticize, to better. We need to find ways as different stakeholders to work together. We need to make sure individuals who might otherwise have a larger barrier to cross-over are being reached.

446 "About", The Commons Social Change Library, Accessed OCt 20 2020, https://commonslibrary.org/about/

8.1 Initiating a National FOSS Alliance

The creation of an umbrella organization is one means to this end of co-creation.

It could take different shapes: a federation, a cooperative, a consortium. For example: In the early 2000's there was a vibrant & vocal FOSS community that came together every year for the FOSS. in [447] conference which during its time turned out to be one of the largest conferences in Asia.

While the different communities still exist, individuals who can bring them together to collaborate and cooperate with other stakeholders like industry, academia, and government are scarce, especially at the national level.

A national alliance for FOSS could play this role. A few things to consider for the shape of the organization:

8.1.1 Distributed

FOSS is by its definition distributed. You have FOSS projects installed in almost every physical device, that have been created almost entirely by one individual and you have projects created by large corporations with many developers working on it.

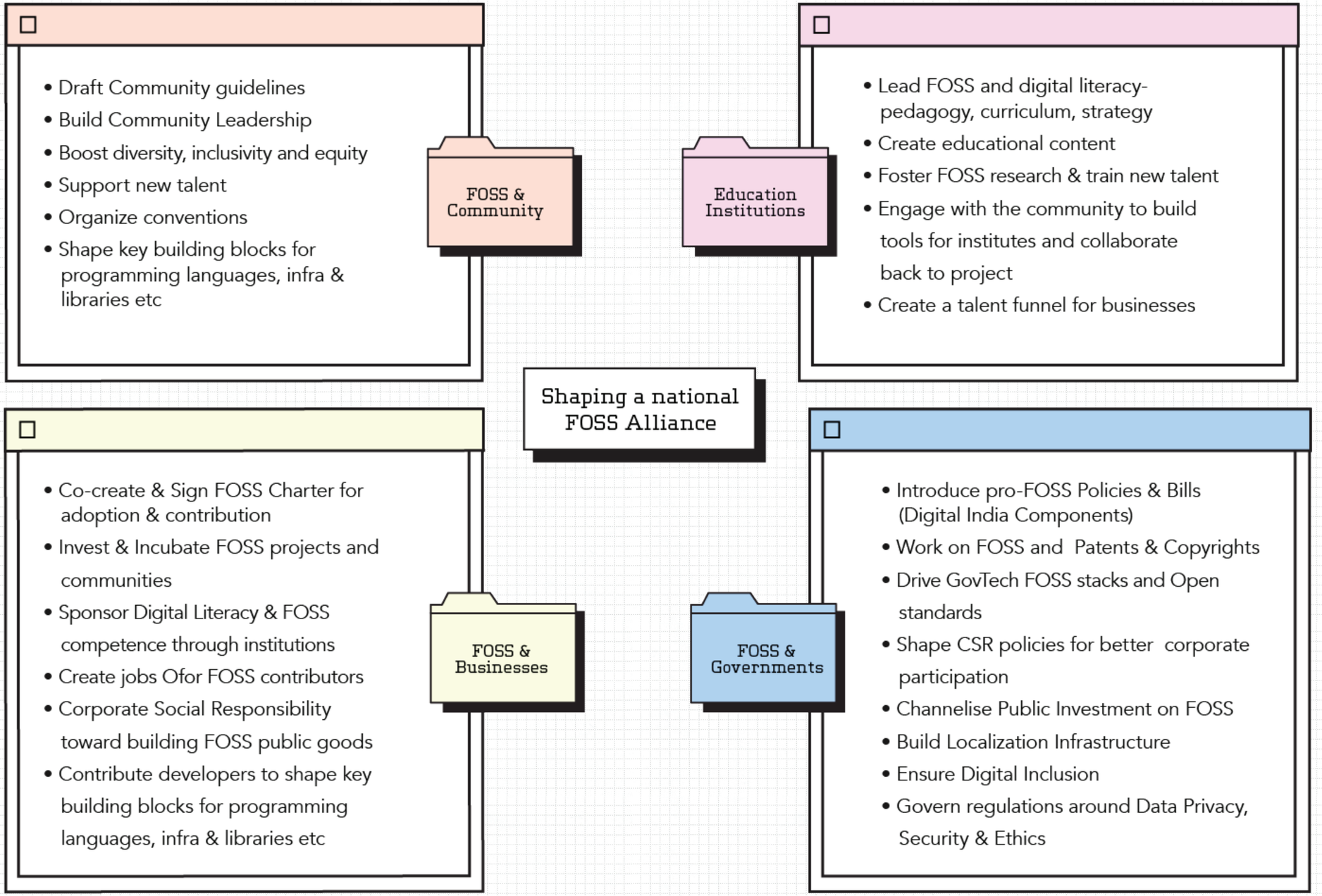
And you have everything in between. So FOSS communities like the projects also come in different shapes and sizes. A FOSS alliance would need to be accommodative of all this difference.

8.1.2 Actors

We envision the following participants in this ecosystem and their roles.

The government, industry and the distributed FOSS communities must "join forces" for India's long-term interests, it requires all players to be invested, to work together, to co-create, to criticize, and to better these products that are in the commons.

[447] Leslie D'Monte, "Atul Chitnis-Champion of Open Source in India," mint, June 4, 2013, https://www.livemint.com/Industry/XAxZ8cLSg1XKLP5ck4mNTO/Atul-Chitnischampion-of-open-source-in-India.html.


FOSS & Community
• Draft Community guidelines
• Build Community Leadership
• Boost diversity, inclusivity and equity
• Support new talent
• Organize conventions
• Shape key building blocks for programming languages, infra & libraries etc
Education Institutions
• Lead FOSS and digital literacy- pedagogy, curriculum, strategy
• Create educational content
• Foster FOSS research & train new talent
• Engage with the community to build tools for institutes and collaborate back to project
• Create a talent funnel for businesses
Shaping a national FOSS Alliance
FOSS & Businesses
• Co-create & Sign FOSS Charter for adoption & contribution
• Invest & Incubate FOSS projects and communities
• Sponsor Digital Literacy & FOSS competence through institutions
• Create jobs Ofor FOSS contributors
• Corporate Social Responsibility toward building FOSS public goods
• Contribute developers to shape key building blocks for programming languages, infra & libraries etc
FOSS & Governments
• Introduce pro-FOSS Policies & Bills (Digital India Components)
• Work on FOSS and Patents & Copyrights
• Drive GovTech FOSS stacks and Open standards
• Shape CSR policies for better corporate participation
• Channelise Public Investment on FOSS
• Build Localization Infrastructure
• Ensure Digital Inclusion
• Govern regulations around Data Privacy, Security & Ethics

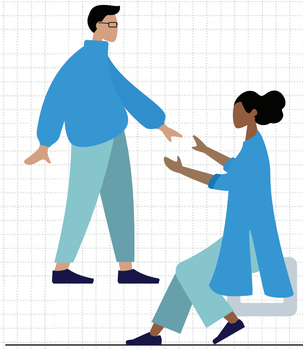
8.2 Where can FOSS be leveraged?

8.2.1 Digital inclusion through Indic language FOSS tools

- FOSS can play a big role in enabling digital inclusion by making the tools for technological innovation accessible in Indian languages. Most operating systems, software programs, and apps are in English- a language spoken by less than 20% percentage of India's population. To address this, many open source groups across the country have built FOSS tools like Indic fonts, dictionaries, translation tools, Indian language user interfaces for GNOME[448] and KDE [449] and other FOSS Operating Systems. These tools provide the basic building blocks for those who want to create Indian language applications which will be accessible to millions of Indians who do not speak English. This will in turn grow the domestic IT market and bridge the digital divide.

- The government can play a huge role by making infrastructural building blocks like dictionaries, parallel corpora (which enable translation from one language to another, and can be very expensive to create), available to the FOSS community. This will enable the community and entrepreneurs to build translation websites, and other services that benefit the people of our country. If we want to ensure parity in computing, such that Indian language users can use ICT technologies with the same ease and comfort that English language users do, FOSS will have to play a huge role.

- FOSS is also easier to customise to more localised needs. For Eg. the



[448] "Gnome", Gnome.org, Accessed Oct 20 2020, https://www.gnome.org/

[449] "Plasma", KDE, Accessed Oct 20 2020, https://kde.org/

creation of FOSS meeting tools more suited to work on feature phones or with 2G internet connections, which are widely used across India. Especially in areas with restricted digital connectivity such as various hilly regions, major Indian Islands and parts of Jammu and Kashmir where most EdTech would still need to run on 2G.

8.2.2 Building Indigenous Technology Capabilities & Technological Independence

- In many industries where innovation used to be driven by hardware, software has taken over. This is true for critical technologies like 5G, 6G, microprocessors, supercomputing, and others. Increasingly the software powering these industries and technologies is FOSS.
- Investing in India's FOSS capabilities in these areas can help us bring down the cost of technology implementation, reduce dependence on technologies supplied by foreign vendors and help Indian companies grow their capabilities.

8.2.3 Building e-government infrastructure in India

- Some of India's largest e-government projects have been built using FOSS. There are several benefits to using FOSS in e-government - ranging from elimination of procurement cycles by using off-the-shelf FOSS software and avoiding the use of expensive proprietary software.

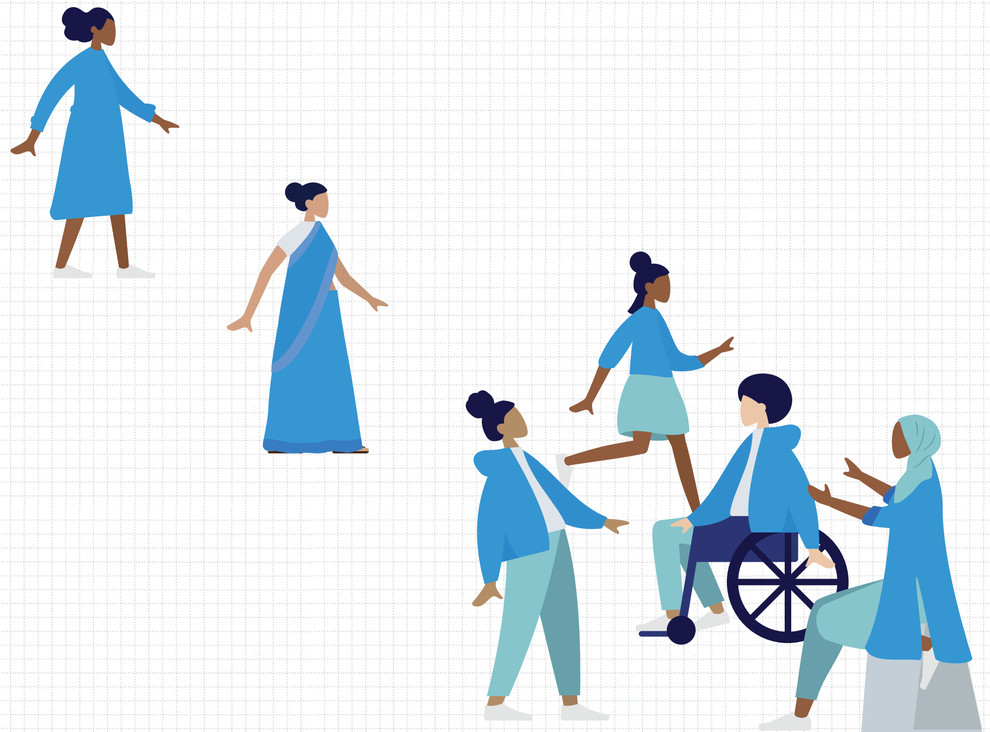
India's Ministry of Electronics and Information Technology (MEITY) has created a progressive policy to encourage the reuse of government applications[450]. If implemented well, this policy can save India crores of rupees that would otherwise be spent in building similar software across government departments. It

[450] MeITY, "Policy on Collaborative Application development by Opening the source code of Applications", Accessed Oct 20, 2020, https://www.mygov.in/group-issue/policy-collaborative-application-development-opening-source-code-applications/

would also help in increasing the success rate of e-gov project implementations.

8.2.4 Reduce barriers to entry

- It is much cheaper to build on top of FOSS and therefore much faster to innovate on top of it. It creates a level playing ground for MSMEs and start-ups. This along with cheaper cloud based hosting services, means that entrepreneurs can enter the market without spending a lot of money. FOSS and cloud levels the playing field for the smaller companies. A growing FOSS ecosystem in India can therefore catalyze a huge growth in various Indian technology companies.



8.3 Closing Thoughts

written by ***Venkatesh Hariharan***
India representative for Open Invention Network

> Software is eating the world.
>
> *Marc Andressen*
> *Venture Capitalist*

In an essay published in the Wall Street Journal in 2001, Venture Capitalist, Marc Andressen, coined the phrase, "Software is eating the world [451]." Andressen explained how software is eating much of the value chain in industries that are seen as part of our physical world.

From financial services to transport, car manufacturing, logistics,entertainment we are seeing software become a dominant part of the value chain.

As supply chains become digital, an increasing percentage of the value is captured by technology intermediaries who use software and data to orchestrate them.

Uber does not own any taxis, AirBnB does not own rooms for rent, but their valuations soared above industry players in the transport and hospitality sectors who owned tangible physical assets like cars and hotels. Their ability to bring suppliers and customers together on a common software platform helped them scale up rapidly, leading to valuations that traditional industry players could not even dream of.

What is true for industries, is also true for technologies. In many industries where innovation used to be driven by hardware, software has taken over. In critical technologies like 5G, 6G, microprocessors and supercomputing, the hardware is becoming a commodity, while the differentiation is being done through software.

Increasingly, the software "eating the world," and powering these industries and technologies is FOSS. Therefore, the significance of FOSS cuts across industries and

[451] Marc Andreessen, "Why Software Is Eating the World", Aug 20 2011, Accessed Oct 20 2020, https://a16z.com/2011/08/20/why-software-is-eating-the-world/

technologies. Identifying sectors that are important to India, and catalysing a FOSS community around these areas will help India attain global technology leadership.

In the early days, software programs written by the FOSS community used to be alternatives to proprietary software. Linux distributions were substitutes for Unix, Open Office for Microsoft Office and so on.

In recent times, we have seen that the collaborative innovation model of FOSS has led to rapid technology development. In emerging areas like big data and analytics, FOSS dominates because the software improved so quickly that proprietary software vendors had no time to react.

Twenty years ago, proprietary software was dominant, while FOSS was a niche player, but this situation has now been reversed. FOSS is the dominant software development model while proprietary software development has become a niche field.

There are socio-economic reasons why India must embrace FOSS. Since FOSS code can be freely used, it insulates India from denial-of-technology regimes that are a growing risk. It helps us control the technology stacks that critical national infrastructure is built upon.

Culturally, the freedom to modify the code, enables us to customize the software to India's needs.

For example, proprietary software vendors were not interested in localizing operating systems and word processing software to Indian languages, which limited the reach of this technology to a small fraction of Indians who speak English.

The Indic Computing community has worked hard to fill this gap by localizing FOSS to Indian languages. Thanks to the work of this community, FOSS software is available in more

than 17 Indian languages. In fact, Indic fonts and dictionaries being used with proprietary software are most likely to be licensed as FOSS. If India becomes serious about preserving our linguistic culture and digital inclusion, FOSS in Indian languages would be the fastest way to enable this.

At the economic level, cost will always be an issue in a developing country like India. FOSS has helped India save billions of dollars, and these savings will only grow with increasing FOSS deployments. India's thriving startup ecosystem is built on the foundations of FOSS, which has reduced the cost of starting up, and unleashed innovation.

The ability to select from a vast library of FOSS building blocks, and create customer facing innovations on top of it, has helped companies get off the ground quickly, and at lower cost.

Most startups would not even exist if they had to first invest in buying proprietary software programs before building their prototypes and proof-of-concept.

Cost is one-half of the equation; the other half is growth. Indian companies will have to master the FOSS skills of collaborative innovation, and community building, if they want to build scalable businesses around FOSS.

A FOSS services businesses like Ashnik now aims to climb the value chain by building FOSS products like Octosum, while companies like Julia Computing, Hasura, Frappe Technologies, Dhiway and others are building FOSS products that have a global reach.

Venture Capital funding is also finding its way to FOSS companies, with Hasura.io raising around $35 million for their product which helps companies build a data layer for modern applications, and Unotech,

an Identity Access Management and IT Service Management company, raising $2 million.

With software becoming integral to all sectors of the economy, FOSS can also help drive India's growth. Innovation around FOSS can help India leverage its vast pool of software talent to attain leadership in many industry sectors globally.

If Silicon Valley innovates for the top one billion of the world's population, India can innovate for the rest of the world. In areas like Public Digital Infrastructure, health, education, finance and others, Indian innovations can go global. Over the next few years, India could become a global hub for FOSS based products and services.

FOSS is important in solving India's immediate problems, but it is also important in shaping India's future. When the noted technologist, Alan Kay, was asked by managers on how to plan future products, he said that, "*The best way to predict the future is to invent it.*"[452]
At a strategic level, India must aggressively leverage FOSS for "*inventing the future.*"

experimentation and innovation around FOSS in the education system, and supporting industry in leveraging FOSS to solve India's problems, we can apply it as a platform for a sustainable future. Government policy support and funding can play a catalytic role in this regard.

However, industry and the FOSS community also need to organize themselves better, and work closely with government and academia to achieve national goals.

This report notes the lack of sustained national level leadership in the Indian FOSS community, and recommends the creation of a national FOSS organization for policy advocacy and capacity building in education and industry. The report also notes the fact

452 "We Cannot Predict the Future, But We Can Invent It – Quote Investigator", Quote Investigator, Accessed Oct 20 2020, https://quoteinvestigator.com/2012/09/27/invent-the-future/

that many strategic e-government projects in India are built on FOSS, and recommends that FOSS be used extensively to eliminate vendor lock-in, reduce procurement delays and project costs, and minimize disruptions due to international political vagaries.

Greater government support for FOSS in e-government could help build a domestic market for FOSS companies, and help Indian FOSS companies build expertise that can be deployed globally.

In education, the examples of Kerala and others demonstrate clear savings by using FOSS. Distributions like Edubuntu have been built with inputs from educators around the world, are easy-to-install and use, and come with several educational software programs bundled with it.

In higher education, FOSS can replace expensive proprietary software. For Eg: Matlab licenses can run into lakhs of rupees, but the FOSS alternative, Scilab is free of cost, and free to modify.

The FOSSEE (Free/Libre and Open Source Software for Engineering Education) project at IIT Bombay promotes the use of FOSS tools to improve the quality of education in our country, and reduce dependency on proprietary software in educational institutions. The project also develops new FOSS tools and upgrades existing tools to meet requirements in both academia and research.

Projects like these should be encouraged and scaled up because, once the software has been created under a FOSS license it can be freely shared. In the long run, this is less expensive than buying licenses to expensive proprietary software, and it also gives students the opportunity to work on improving the software.

Another IIT Bombay project called Spoken Tutorial creates short video tutorials on various subjects, including FOSS programs like Python, that are

then dubbed into multiple languages. The project has conducted more than 100,000 training programs that were attended by 5.8 million students. Interestingly, the project videos are now seeing international interest with some of the videos being dubbed to Arabic, Thai, Spanish and Vienamese languages. Spoken Tutorial is a great example of using technology to scale up FOSS education.

Getting engineering students involved with FOSS projects will also give them practical experience and induct them into the community development process, instead of working on projects which have no reuse value.

Industry can help out by open sourcing their projects, and making these projects friendly to newcomers by classifying the development tasks into easy, intermediate and difficult levels. FOSS in colleges, mentoring programmers in FOSS communities and supporting industry contributions to FOSS, we can help create lucrative FOSS career paths for Indian professionals.

The FOSS initiatives from IIT Bombay have been supported by the Ministry of Human Resource Development, Government of India.

The Indian Government has also approved a slew of policies that are supportive of FOSS in e-government, including an open standards policy that prevents vendors from using proprietary standards to lock government departments into their software, collaborative development policy that encourages government departments to develop code, the FOSS way, and a policy that gives preference for FOSS procurement for e-governance.

In terms of policies, no FOSS evangelist could ask for more from the Indian government. However, these policies remain on papers, and lack focused implementation. If industry and community work with the government to monitor

the implementation of these policies, we can collectively drive better outcomes. While the government has the most amount of resources, in strategic areas like AI and 5G/6G, it could bring multiple stakeholders in industry, academia and the FOSS community to build solutions for India.

India's FOSS community has played a significant role by evangelizing the role of FOSS in industry, academia and government. It has also tackled the digital inclusion challenges by working on localising FOSS to Indian languages.

When users install a Linux distribution, they have the choice of selecting one of 17 Indian languages. Projects like IndLinux.org, Ankur Bangla, Swathanthra Malayalam Computing and others have worked on building foundational tools like Indian language fonts, keyboards, dictionaries and translating the user interfaces for popular FOSS software. Most of these groups are powered by dedicated volunteers and donors, with very little support from industry or government, despite the vital importance of these projects at national and state levels.

Our hope is that this report serves as the starting point for a discussion on how we can take FOSS to the next level in India. There are many areas that need to be delved into deeper, but could not be covered within the ambit and the timelines of this study. We hope that other organizations will step forward to support more research in this area, and document the contribution of the FOSS community and its history, and its potential for India's future.

The fact that software is *"eating the world,"* and value chains are migrating from the physical world to the virtual world, and to FOSS development models, can play to India's strengths in the software sector. However, this requires a recognition that we have to *"seize-the-moment."* This report highlights a clarion call for various stakeholders to come together and harness the Indian FOSS ecosystem, as an essential step for nation building. In conclusion, we would like to say that India has hadvibrant knowledge traditions in mathematics, yoga, astronomy that have enhanced our world.

With the largest base of software developers in the world, we could revive that tradition through FOSS, if industry, academia, government and the FOSS community come together to invent India's future.

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