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Free and Open Source Software in developing contexts

From open in principle to open in the consequences

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Abstract

Purpose – Originating in the USA and Northern Europe, Free and Open Source Software (FOSS) found on the internet its fertile environment. In more recent years, FOSS is becoming an increasingly important element in strategies for development and implementation of information and communication technologies also in developing countries. Mainstream research on FOSS has catered to the underlying principles or freedom, open organizational forms, and on its economical aspects. The purpose of this paper is to shed new light on the actual consequences of FOSS, often left in the background.

Design/methodology/approach – The paper examines where FOSS principles' assumptions are likely to be more evident: in contexts of developing countries, which are geographically and organizationally far from the original environment of FOSS. A mixed methodology characterizes this work: quantitative and qualitative methods bring readers' attention to unusual empirical settings and downplayed organizational processes of information technology (IT) implementation and adoption.

Findings – The consequences of FOSS on IT implementation and actual use are ambivalent. It is argued that FOSS adoption does not happen spontaneously, neither by decree, and that the relevance of open technologies as public goods remains in the different role of local actual technical and organizational capabilities, and environment conditions.

Originality/value – Such a focus complements existing studies on the economical relevance of FOSS, which are not the focus of this paper.

Keywords Internet, Public domain software, Communication technologies, Africa, India

Paper type Research paper

> I think that if the developing country is serious about not just seeing ICT as a cost center, but as a requirement for national development, the real advantage of open source ends up being able to build up your own knowledge base. And that is not cheap in itself – you'll likely pay as much for that as you'd pay for a proprietary software solution. The difference being that with the proprietary solution, you'll never catch up, and you'll have to pay forever, without ever learning anything yourself (Linus Torvalds in Weerawarana and Weeratunge (2004)).

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Introduction

The introduction of information and communication technologies (ICT) is expected to change processes and management in organizations, where (not the least in developing contexts) organizational procedures and decision making tend to be top-down. On the other hand, the actual processes of adoption of ICT are not linear due to the variety of contexts with multiple rationalities (Avgerou, 2002; Chilundo and Aanestad, 2004). Although Free and Open Source Software (FOSS) development and implementation has been thoroughly explored over the last decade, the relevant literature is confined to the adoption of licenses and explicit and tacit norms developed by FOSS communities, and mostly in economically developed countries. Common assumptions about FOSS dynamics emphasize the spontaneity of open and distributed development and adoption. More prominently, assumptions like dispersed and mobilizable ICT capabilities are not usually available in developing contexts, the perceived reliability of FOSS is not universal, reliability in "the crowd" cannot be taken-for-granted, copyright and other FOSS-related rules may be not present, or not enforced.

This paper explores the constraints to development, use, further development and further use of FOSS in South Africa (SA) and in Kerala, India. In SA, FOSS does not appear to be widely used. In "Why South Africans don't FLOSS?" Johnston and Seymour (2005) attempted to identify the factors that influence and limit the usage and intended usage of FOSS within SA. They examined private and public sectors, and found that South African small medium enterprises (SMEs) are often in favor of purchasing proprietary software rather than using FOSS. Strategically, the SA government has expressed strong intentions to use FOSS since 2001, given its focus on local skills development, foreign exchange exposure and national security. On a practical level, limited FOSS usage was found within the SA government (Johnston and Seymour, 2005).

In Kerala, the government puts much emphasis on FOSS. We use this case as an example of understanding FOSS from the local viewpoint. On the Government of Kerala – Department of Information Technology's (2007) side, we note FOSS-related emphatic expectations for emancipation in the "knowledge society." On the other, we explore actual development and implementation of a FOSS-based health information system (HIS) promoted by an international action-research network, locally supported by the government. Both South African and the Indian states considered have clear public policies to support FOSS, our cases show how FOSS adoption does not happen spontaneously, neither by decree.

Technology, organization, and environment

Dedrick and West's (2003) adaption of the technology-organization-environment (TOE) framework to address FOSS adoption is used as a framework. TOE framework identifies three dimensions along which an organization functions that influence its ability to adopt technology and affects the process by which it accepts and implements technological innovation (Zhu *et al.*, 2003). The TOE framework is a method for ascertaining the features that form technology adoption. The three groups of contextual factors as shown in Figure 1 influence an organizations intent to adopt an innovation, and affect its assimilation process and eventually its impacts on organizational performance (Zhu *et al.*, 2003).

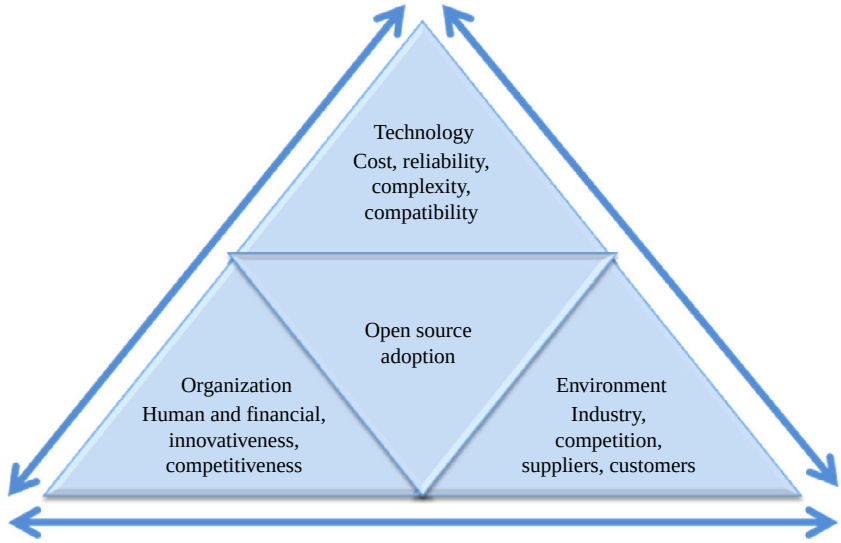

Figure 1.
TOE framework

The technology dimension refers to the internal and external technologies existing within an organization, as well as those available to the organization. Major factors include costs, perceived reliability, complexity, and compatibility with existing technologies and skills (Zhu *et al.*, 2003; Dedrick and West, 2003).

The organizational dimension refers to the perception of an organization with regards to technological innovativeness (Dedrick and West, 2003). Factors include human and financial resources and innovativeness of the organization. The competitive position of the organization, the role and intensity of information technology (IT) in the organization are additional factors. A high level of IT intensity is proportional to open source adoption (Kwan and West, 2004).

The environmental context refers to the arena in which the organization operates and conducts its activities (Zhu *et al.*, 2003). An organization is influenced by the industry it operates in and by its competitors. Factors include industrial rivalry, relations with customers and suppliers (Zhu *et al.*, 2003). Here, we expand this concept including all the aspects which affect FOSS adoption also by non-for-profit organizations.

Free and Open Source Software in South Africa

Johnston and Seymour (2005) attempted to identify the factors that influence and limit the usage and intended usage of FOSS within SA. Organizations in both the private and public sectors were examined ranging from large listed companies to small non-government organizations (NGOs). Research has shown that of the TOE technological factors, cost (though important) is not the main reason for adopting FOSS in SA. The main reasons identified were performance, stability, and control (Mosoval *et al.*, 2006).

Since 2001, the SA Government strategically expressed strong intentions to use FOSS, given its focus on local skills development, foreign exchange exposure, national security, and dependency, thus shaping the TOE environment context. The SA

Government adopted policy recommendations regarding FOSS in 2003 (Policy on Free and Open Source Software use for South African Government, 2006). But on the TOE organizational level, limited FOSS usage was found within government (Johnston and Seymour, 2005). Political influences and risks associated with the scale and complexity of large government organizations nullify their FOSS strategic usage intent. Decision makers cited the need to leverage off their existing skill base and infrastructure, political pressure to eliminate additional risk by not going through unchartered territory, as reasons for remaining tied to proprietary software (Johnston and Seymour, 2005). There are few perceived incentives to move to FOSS.

Two research approaches were used, the first was done using a survey instrument, and over 1,700 questionnaires were received from SMEs, and NGOs. A qualitative approach was then adopted, using in-depth interviews with users and providers of both the proprietary and FOSS software (Johnston and Seymour, 2005). Decision makers who had either recently gone through the decision to implement or not to implement FOSS, or were considering implementing FOSS were interviewed. Three organizational groups were selected, public, large private corporate enterprises, and SMEs. It was found that South African SMEs are often in favor of purchasing proprietary software rather than using FOSS, as they seek immediate resolution of technological issues, brand equity is important (tried and tested), and they fear the risk of unknown. Most SMEs and NGOs are not fully aware of all the options open to them regarding software (specifically FOSS), few have clear ICT goals, and many do not see the benefits of ICT (Johnston and Seymour, 2005). Organizations size (or lack thereof) can create barriers to FOSS adoption for SMEs, as some of the benefits of FOSS can only be realized by developing internal expertise which may not be feasible for smaller firms (Nepelski and Swaminathan, 2007).

In a survey of key issues for chief information officers of listed companies in SA (Johnston *et al.*, 2007), FOSS did not feature at all. Surprisingly, people development and skills development were also not listed as key issues, this in a developing country with a skills shortage and given the government's focus on skills development. Harris (2008) reported that the shortage of ICT skills could threaten business growth in SA. The number of positions advertised in the South African *Sunday Times* requiring ICT skills rose from 238 in the first quarter of 2007 to 3,485 in the last quarter of 2007.

If software procurement was predominantly cost driven (technology) or driven by skills development (organizational), FOSS would be the first choice for many organizations, but this is not the case (Mosoval *et al.*, 2006). Insights for the possible explanations to this low adoption rate might be obtained from the environmental problems faced by developing countries while adopting FOSS.

In essence, these major problems are not technical or organizational, but mostly political or environmental (TOE). The concept of "free software" is not easily understood by people (including politicians) and it requires some explanations before advantages are apparent (Aiyer, 2004). Political influences and risks associated with the scale and complexity of large government organizations nullify their FOSS strategic usage intent. Governments and organizations in developing countries remain tied to proprietary software largely due to a conservative approach to risk. Organizations in developing countries find it less risky to stick to proprietary products as opposed to building/customizing FOSS applications (Camara and Fonseca, 2007). Organizations with an intricate ICT environment steer away from additional risk or complexities. "It is

not the type of software *per se* that they are concerned about, but rather the availability and quality of service" (Johnston and Seymour, 2005, p. 444). These organizations prefer to spread their risk and adopt a hybrid of both FOSS and proprietary systems (Johnston and Seymour, 2005).

TOE environmental or political issues are also perceived through the increasing pressures from rich countries to avoid FOSS and to adopt short-term solutions that favor proprietary software (Aiyer, 2004). For instance, computers employing proprietary software are promoted in schools and universities. Students familiarize themselves to specific, familiar, proprietary software applications and are later converted into future target customers for the software companies. Their lack of knowledge of FOSS applications is then a means for software companies to maximize future returns for themselves, rather than maximizing returns for the local society by producing citizens highly skilled in all forms of software applications (Aiyer, 2004).

Another TOE environmental issue regarding the adoption of FOSS applications in developing countries pertains to the unwillingness of governments and companies to modernize legacy applications (Rossi, 2004). Legacy applications have been implemented over a long period of time and IT managers are often unwilling to accept the risk associated with modernizing these applications (a TOE organizational factor). The compatibility issue is the extent to which new technology can co-exist with existing technology such as legacy systems. In turn, programmers are also reluctant to undergo training to use new FOSS tools. As a result, FOSS use grew at the fringes of public and private companies within developing countries, whose core applications remained based on proprietary software (Feller and Fitzgerald, 2002; Rossi, 2004). The perceived risks which have been identified need to be assessed by each organization, and strategies need to be developed to reduce or manage the risks.

James and van Belle (2008) reported on four broad factors governing the sustainability of FOSS migrations in a developing country context. The four broad factors were financial, education, organizational maturity, and cultural sustainability. These four factors can be linked to the TOE factors, with financial falling into the TOE technology factor, education and cultural fall into the TOE organizational factor, while organizational maturity falls largely into the TOE environment factor. Financial factors included cost reduction; understanding the total cost of ownership, identifying hidden costs, and providing incentives to employees (James and van Belle, 2008). Cost was not a main issue for most organizations in SA (Mosoval *et al.*, 2006). Mosoval *et al.* (2006) found that the most critical factors influencing decisions in favor of FOSS in South African organizations were performance, stability, and access control (i.e. organizational maturity factors). Educational factors included the organizational education culture and policies as well as employee training. Cultural factors included the employees' perception of job security; their educational backgrounds, and their perception of change (James and van Belle, 2008). Most organizations in developing countries have an unadventurous approach to change (Camara and Fonseca, 2007). Organizational maturity has several dimensions, maturity in terms of applications, vendors and development communities, maturity of organizations processes, and maturity of the in-house information systems (IS) department (James and van Belle, 2008).

Despite the large majority of respondents to a survey describing themselves as users of FOSS, only 5 percent answered the questionnaire from a FOSS system

(Linux in all cases), the rest responded from proprietary software (Mosoval *et al.*, 2006). This seems to be a recurring theme, individuals support the idea of FOSS, but are not prepared to move from familiar proprietary environments. Until individual users (as opposed to corporate) can successfully be weaned away from proprietary software, FOSS will remain as it is often considered, even by its staunchest proponents; software for hackers (Mosoval *et al.*, 2006).

Summing up, the TOE environment dimension (like perceived risks associated with the scale and complexity of FOSS adoptions in large organizations) nullifies FOSS strategic usage intent. Through the need to leverage off their existing skill base and infrastructure, and the political pressure to eliminate additional risk by not going through unchartered territory, also government remains tied to proprietary software.

Looking at FOSS from the implementation side

This case from Kerala explores further FOSS in its consequences. More precisely, FOSS principles and expectations – expressed by official documents – are confronted with the actual consequences of choosing FOSS on the ground of implementation. To mark the difference between "open in principle" vs "open in the consequences," complementary vignettes from India show how FOSS relies on assumptions whose absence generate unexpected side-effects.

A crucial challenge for FOSS in developing contexts concerns the establishment of functioning and sustainable implementations in organizations. This paragraph locates our view closer to FOSS adopters, as implementation dynamic is under-estimated in the common approach to ICT for development (Avgerou, 2007). Given the novelty of organizational forms required and implied by FOSS, the local elaboration and eventual consolidation of FOSS-based implementations cannot take place without going through a trial and error heuristic. Because of this, it is relevant to relate the expectations surrounding and legitimizing FOSS, with the politics and practice of implementation.

Empirically, the present case relies on the activities of an international network devoted to development and implementation of reporting software for aggregated data from primary health care facilities in developing countries. The program on health information (PHI) systems started in SA in the mid-1990s to support the restructuring of the post apartheid health system. PHI software and approach were subsequently introduced in several other African and Asian countries. PHI is now an "assemblage" (Lanzara, 2008) of a variety of actors and partnerships involving universities, public health authorities, non-governmental organizations, donors, international organizations, and consultants. PHI has significant links both at the global level (participating in a broad and heterogeneous network of organizations like universities and research centers, international donors, ministries of different countries) and local levels (where systems are piloted and implemented, capacity building is carried out, requirements for further developments are collected).

Over several years of activity, PHI developed a standard approach for HIS roll-out within health care systems:

(1) initial contacts with health care authorities;

(2) situational analysis and assessment of HIS;

(3) participatory customization of HIS;

(4) start of a pilot implementation;
(5) training; and
(6) scaling up of HIS and aiming at institutionalization.

This pattern of activity inscribes the participatory principles and experiences of PHI. As in most of other places of implementation, PHI followed those stages in Kerala, as well. Prominent characteristics of the project introduce its relations with FOSS, and frame the empirical data presented here. Participatory design and action research – in line with the Scandinavian tradition – provided guiding principles of activities. PHI relies explicitly on participatory design as an action-research approach to understand and empower peripheral levels of public health care systems. A key issue was to inscribe health personnel's practices into customized IS, which would be based on the information actually needed.

Regarding the technological dimension of the TOE framework, software developed by PHI has always been FOSS, but it was initially based on a proprietary platform, which was well-established by the mid-1990s. A few years later, the diffusion of the internet and related technologies made this solution seem outdated. As the project evolved, it became apparent that the tools required for the continuous updating and customization of the software also had to be freely available. So, a purely FOSS version's development was started, also with the intention of making it both web-based and platform independent. Some underlying concerns about the switch were spelled out in the following message between PHI coordinators:

> Mon, 23 Aug 2004 11:36:37 +0200
> Hi,
> Just two generic comments to this discussion:
> 1 A fundamental challenge with the DHIS is that it MUST be able to address the needs and information infrastructures of different developing countries (at least), which IN PRACTICE vary far more than the information infrastructure in any single country (and in general vary more than the current information infrastructure in rich countries). In practice this means for instance that it should:
>
> – Run on any "platform" from a standalone PC to a thin-client based WAN (whether internet or intra-net based).
> – Be able to communicate with other DHIS instances using any standard medium (diskettes, low bandwidth dial-ups, broadband connections). These will often have to be mixed in any specific environment – if the network goes down, you need to use diskettes, etc.
>
> Even if we don't cater for ALL such scenarios in the version beta version, it must be catered for in the system analysis.
> 2 Be careful about limiting your 'systems thinking' to what is currently addressed by AccessMD. There are some obvious extensions of this that we have already done development work for or at least have been discussing extensively in South Africa:
>
> – Staff and patient based surveys (Client Satisfaction Survey, Waiting time survey).
> – Human resource Development (HRD module).
> – Patient-based data for specific purposes (Special Patient Data module, etc.).
> – Web based reporting and data mining (web pivot reporter, web portal).
> – GIS.
> – Management modelling (Equity Gauge).
>
> I also know there's been significant development work done in, e.g. Ethiopia and India to cater for additional needs (disease surveillance, etc.).

> Some of the above would be unknown to most of you (and I don't have time now to write up stuff – I'm on holiday!!), but my point is just that you must NOT limit your scope of version 2 to only address monthly routine data.
>
> Finally, also don't forget to consider the issue of multi-language support – as the DHIS grows, ensuring efficient multi-language support mechanisms will be crucial.
>
> Regards

Data from the case of PHI being implemented in India, mainly in Kerala [characterized by uneven adoption of FOSS in spite of FOSS-oriented policies], is presented as a perspective on FOSS from a local stance. The TOE organizational dimension is here presented through excerpts of Kerala Government official documents. They are considered as relevant for this dimension rather than TOE environment because the implementation was completely within the public health care system.

Kerala poses great expectations for FOSS-related emancipation in the "knowledge society" on the side of the public administration. The Government of Kerala – Department of Information Technology (2007) officially writes:

> ICT has opened up the possibility of radically different information exchange patterns by facilitating faster and more efficient dissemination of information. It can play a vital role in sustaining the democratic ethos of the Indian society and ensuring a high level of transparency and accountability in governance [...] The Government has a comprehensive view of ICT as a vehicle for transforming Kerala into a knowledge-based, economically vibrant, democratic and inclusive society. [...] The Government realizes that Free Software presents a unique opportunity in building a truly egalitarian knowledge society. The Government will take all efforts to develop Free Software and Free Knowledge and shall encourage and mandate the appropriate use of Free Software in all ICT initiatives.

In May 2007, the Kerala Health Secretary gave a presentation at the PHI coordinating university, in which the main issues which a HIS can help in improving (from his slides):

- ineffective referral system;
- escalating health expenditure;
- ineffective manpower;
- poor recording, reporting, and documentation; and
- lack of supervision – transfer of institutions to local bodies.

In order to cope with those matters, the expectations from the health care system management's point of view are to streamline information flow towards and from the top administrative level. The expected centralization of information flow contrasts with what PHI advocates and supports: decentralization of action through local use of information. In spite of the substantial divergence of final scopes, reliance on FOSS from both sides facilitated the establishment of cooperation with the state of Kerala, whose positive orientation toward FOSS is clearly expressed by official documents (like the one quoted above). Reference to common principles helped the continuation of collaboration.

Moving on to the TOE environment dimension, we look at the health facilities where software has to be used. The actual situation of implementation had to cope with different set of issues than the ones perceived at the policy-making level. For example, many problems were encountered when installing and using the health data reporting

software in peripheral clinics. Here, computer skills were rare, both with regard to use and maintenance of terminals. The lack of internet connections (and in many cases of continuous electricity supply) did not allow for online access to the HIS from a central server. Installing and maintaining locally all the needed components turned out to be a difficult, and sometimes unmanageable task for health personnel, and the limited number of PHI facilitators could not cope with all the problems in dispersed facilities. Viruses spread through USB memory sticks after each formatting (a previous tentative switching to a FOSS operating system did not achieve satisfactory results), with antivirus updates not easily accessible, and the configuration of the FOSS package proved difficult for most users. The initial solution drew on the possibilities allowed by the FOSS programs and tools that had been used. This allowed the redesign of the whole set of required programs to be run. Bootable CDs with a stripped down version of GNU/Linux as well as the PHI programs, would have allowed the users to solve the above problems of viruses and configurations. Because of concerns about the little RAM available on computers in the clinics, this solution has not really been tried out on large-scale until recently. Another, less "radical" solution has been the development of a single installer, including a "wizard" to guide users through the installation of all programs. The installer reduced the burden of maintaining and updating the tools both on technical and health personnel. Such solutions would have been impossible if the program was not based on FOSS, both technically and also in terms of the distributed organizational ability to create it[1].

A relevant vignette comes from an integration module to be implemented between different applications used by the health care system. One author partly participated, then supervised a masters thesis on the issue. One system was proprietary, the other was the one developed by PHI. As health care officers could not provide the source code to the other system, PHI software developer team had to proceed with a trial and error heuristic to understand how exported data was formatted (this would have provided the basis for integration, Strandli, 2008). Such "reverse engineering" efforts have been resource consuming, and had to be carried out by a graduate student in computer science from the coordinating European university, as the local workers did not have the required skills. Larger scale effects of environment constraints are exemplified by the switch to "pure" FOSS mentioned previously. FOSS tools were chosen to decentralize software development in developing countries, but they ended up in increasing the centralization on the coordinating European university for lack of technical skills availability (outside of Indian IT private companies) in developing countries.

A final example comes from the tentative development of a geographical information system (GIS) in Gujarat, another Indian state in which PHI is involved, the same author participated in such effort. Geo-Info is a quasi government organization with the official mandate to develop GISs and related applications. Cooperation between PHI and Geo-Info was begun, since in abstract terms, it would have had great potential to provide a GIS solution to the state health department. The linkage was pursued through two key strategies. First, a clear separation of the HIS and GIS applications, with PHI and Geo-Info independently responsible of their respective applications. Second, a "loose integration" was made by establishing a module at the database level, where software routines were created so that the routine data being collected through the HIS would be made available in the appropriate format to the GIS

application, which could then use this data and display it on the maps. In spite of these positive premises, the collaboration did not really produce the expected results in terms of actual use. Among the causes, one is of salient interest here: the Geo-Info software code was not available, therefore the software adaptations had to be done internally. In spite of assurance that necessary human resources would have been available, it was not the case. Also, code writers where within different organizations, and no shared practice was established. Here, we see a determinacy of technological and organizational TOE dimensions.

Discussion

Summarizing, the empirical data presented showed the central roles of dimensions that go beyond the narrow focus on legal and economic aspects. Also, and more importantly, we highlight that being "open in principle" does not lead to being "open in the consequences", necessarily. On the basis of the cases presented, choosing FOSS is expected to be desirable both for practical (technological) and political (environmental) reasons: practically, the software can be affected more by the local stakeholders and the globally dispersed "crowd." Politically, the SA and Kerala governments believed that FOSS could be used to enact development in a more consistent fashion to their orientation. But the adoption process proved not to be linear.

Factors affecting the uptake and adoption of FOSS in SA included environmental issues such as "lack of awareness, resistance to change within IT, cost, user-friendly and standardized product, training and skills availability; and after sales service and support" (Johnston and Seymour, 2005, p. 443). FOSS holds the promise of supporting development goals of developing countries. It can accelerate developing countries mastering the technology of software development and enable applications that leverage local knowledge. However, to reach these benefits, information policies need to rely on a thorough understanding both of FOSS (Aiyer, 2004) and of actual environments. The success of ICT in a country is closely related to the national ICT governmental policy (Ehikhamenor, 2002), which is necessary but not sufficient to make FOSS actually used. For instance, governments could intervene and set up suitable public policies. These policies (with incentives) could dictate public funds to support the establishments and long-term maintenance of open source software projects (Camara and Fonseca, 2008). With political support, developing countries can create an Environment in which free software is used to lower costs, to build local skills, to create local businesses and to enable active participation in the global information society based on local strengths. Nevertheless, necessary skills on the ground for implementation (to reach a critical mass of users and "bootstrap" FOSS adoption) cannot be taken for granted.

Lanzara (2008) terms "assemblage":

> [. . .] a plethora of actors like political authorities, technical agencies, bureaucratic organizations, ICT providers, professional service firms, regulatory bodies, software engineering companies, research centers, together with the technical, functional and normative components by which they run their transactions.

An assemblage is shaped by all dimensions of the TOE model. The Kerala case illustrates how FOSS allows assemblages to address and solve problems, which would not have a pure local organizational nor a global technological solution. The assemblage

composed of FOSS programmers from different countries, multinational companies, local SMEs, students from different universities, primary health facilities with their needs, and health system officers among others, is an example of an agency which is globally dispersed but not amorphous, as the term assemblage may suggest.

The assemblage features technical, organizational, and environment characteristics with their specificities, not reducible to a single logic. These constellations are loosely structured and may be evolving and changing. We find this concept useful to account for the mutual interdependence of FOSS, organizations and environment when, both in industrialized and developing contexts, disparate interorganizational arrangements emerge in relation to FOSS.

Within this frame, the point that this text proposes for discussion is that FOSS plays a role in making organizations becoming more able to "assemble." Besides, their technological and economical relevance, we argue that the relevance of FOSS (and potentially of open technologies, more broadly) is that they facilitate learning to build and sustain relations across globally dispersed settings. For instance, when data flowing from different vertical health programs have to be interconnected, different IS and datasets are brought into contact. New information flows are likely to affect the activities related to those data. So, different organizational settings, with their own specific dynamics and constraints, would interact. The outcome of such interweaving is hardly predictable, as it does not depend entirely on FOSS licenses and the design of the integration efforts.

Conclusion

The TOE framework takes cognisance of the internal and external contexts an organization operates in, and serves as a useful framework when looking at FOSS adoption. As it is unusual in developing contexts to have spontaneous voluntary participation around ICT, FOSS development and adoption need to be designed and carried on in a way that allows local organizations to assemble with others, and to cooperate to indigenize FOSS. Camara and Fonseca (2007) relate modalities of participation to code writing, and software modularity. They propose a two-dimensional model to categorize FOSS projects, with one axis representing shared conceptualization among the people involved, and the other modularization of the software.

A meso-level between global trends and local specificities has to be identified as crucial in situating FOSS for development potentialities. The empirical data presented show that the (formal and informal) constraints which FOSS implies and relies on are fragmented or absent, whereas other environmental aspects can be relevant. So, FOSS indigenization processes cannot be understood and carried out only at the local or global levels: the ability to "assemble" the very different actors is a key for understanding and implementing FOSS. Avgerou (2007) in her critical review of the contemporary literature about IS in developing contexts – addresses three discourses: transfer and diffusion, social embeddedness, and transformation. The latter, rooted into the second, is different from the first as it is conscious of its reductionism. She sketches how the transformational discourse of FOSS is situated between globally accepted emancipatory discourses (Thompson, 2004) on one side, and emphasis on implementations and social embeddedness – strongly advocated by Escobar (1998), on the other. Analytically, FOSS assemblages can be seen as "transformative" as far as

learning balances volatile dynamics and strict procedures. In contexts of multiple accountabilities (Suchman, 2002), we claim that the relevance of FOSS emerges from negotiating alliances, and does not lie in FOSS itself. FOSS facilitates them as far as its openness is allowed by software development processes, and enacted by brokering activities to relate dispersed practices (Gherardi and Nicolini, 2002).

Hustad (2008) who worked on capacity building in PHI India, argues that open standards and technologies – aimed at opening and decentralizing software development – ended up concentrating the burden of software development on the coordinating department of computer sciences, because the skills to write code using state-of-the-art frameworks, respecting application protocol interfaces requirements were not available at low salaries in India and Vietnam. Therefore, FOSS fluidity to inscribe a variety of context-bound socio-technical arrangements (de Laet and Mol, 2000), and avoid path-dependencies and vendors' lock-ins (Weerawarana and Weeratunge, 2004), is not spontaneous. FOSS can be relevant in developing contexts not so much because of open and dispersed participation of an indefinite number of people, but for facilitating dispersed interorganizational relations.

In terms of recommendations, organizations need to be aware that although FOSS is free, using it is not free, there are costs to run it on hardware, people costs, data conversion costs, etc. If software procurement was predominantly cost driven, FOSS would be considered and used by more organizations. Unless FOSS distributors reorient themselves towards a marketing not only of their products, but of open consequences implied by FOSS, it will be impossible for them to compete with multinational proprietary software companies.

FOSS developers also need to address the issue of social production of technology needs, especially for developing nations (Camara and Fonseca, 2007). In essence, many FOSS developers assume that since their products are superior or equivalent to commercial ones, potential users will automatically adopt FOSS. Such is not the case, especially for developing countries, where the user community is conservative, and most users have limited technical knowledge (Camara and Fonseca, 2007). According to Sagasti (2004, p. 85) FOSS developers can guide the implementation of science and technology in developing countries by ensuring that "strategies and policies for establishing an endogenous science and technology base (are) fully incorporate(d) into the design of a comprehensive development strategy for the country." Isolated technology projects have less chance of success or at least being sustainable in the long run.

Note

1. Detailed socio-technical description of the choices and their reasons can be found in Skadsem (2008).

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