WOMEN IN OPEN SOURCE SOFTWARE INNOVATION PROCESS: WHERE ARE THEY?

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ABSTRACT

The Open Source Software (OSS) Innovation process is no more a foreign face in the software development community as it is increasingly being used as a platform for modern software innovation both in the commercial and software research community. Although the concept of freedom is mostly prominent with the OSS innovation process, less than 2% of the contributors are women in this male-dominated area. Minorities, including women, are often ignored in its process. This paper presents the case of lack of participation from women in the OSS innovation process. Lack of participation and contributions from women in OSS innovation creates an imbalanced population in the OSS-based knowledge demography and an unbalanced proportion of gender distribution. Based on a comprehensive review, this paper aims to suggest a Constructivist-Technofeminist-OSS Innovation Process framework for understanding female contributions in OSS innovation, not only from a singular point of technical view, but also from social constructivist and feminist perspectives.

Keywords: Open source software, technofeminist, SCOT, female developers.

INTRODUCTION

Open Source Software (OSS) is different from proprietary software in terms of its freely accessible source code that makes it possible to share, study, modify and customize it. OSS is developed using Open Source (OS) methodology which is strikingly different from the traditional and modern Software Engineering (SE) practices that consists of a set of principles and practices

that are based on the contribution of geographically distributed contributors via the internet (Gacek, & Arief, 2004; Stallman, 2007). The concept of OS is very simple in that when all computer programmers are allowed to work freely on the source code of a program, the increasing transparency of the project allows for collaborative development to correct errors and enable adaptation to different hardware platforms and needs. "Freedom" (in terms of liberty, not price) for the developers has in fact built up OSS movement that is well-known today for its high degree of reliability and portability (Wang & Chen, 2005).

OSS can be considered as a technology that complies with the concept of innovation. Innovation concerns something fresh, be it an idea, practice or thing perceived as new by an individual that can be used to foster economic growth and development (Ratnasingam, 2009). Duggan (1996) defined innovation as "the successful exploitation of new ideas". This definition is very broad but still correspond to the innovation theory by Schumpeter as stated in Wang and Chen (2005) that relies on the commercialization of every single new combination that is based on these four characteristics (a) the application of new materials and components, (b) the introduction of new processes, (c) the opening of new markets or (d) the introduction of new organizational forms. However, innovation in the OSS community differs significantly from the founder of innovation theory definition in terms of the relation of innovation with commercialization since it is not often that OSS is commercialized as compared to proprietary software (Wang & Chen, 2005).

OSS is a collective work of contributors who are associated with communities that they join to produce OSS. Contributors in OSS can be anybody regardless of age, gender, race, culture and formal qualifications such as formal education level. In spite of fewer obstacles to be part of the OSS innovation process, male contributors are still outnumbered female contributors in a shocking great gap of more than 98% (Ghosh, Glott, Krieger, & Robles, 2002; Nafus, Leach, & Krieger, 2006). A recent study in Australia showed an almost similar trend where only 7.3% are female contributors (Waugh Partners, 2008). This phenomenon has shown that women are still under-represented in OSS development thus demonstrat a phenomenon of social dynamics that is throughly male-dominated world where women do not play a role in OSS innovation (Lin, 2005; Nafus, Leach, & Krieger et al., 2006).

The trend of male domination in the OSS innovation process reflects that the same issues regarding gender in the software industry seems to be duplicated. Under-representation, discrimination and prejudices, sexism and 'glass ceilings' are among the long-term existing problems regarding women and software industry where in order to obtain the same respect as men, women

have to work harder than the opposite sex (Lin, 2005). The gender issues in OSS innovation might be more complex than what it seems, as female contributors often experience hybrid discrimination, both from the male-dominated OSS community and the socio-cultural patriarchy (Lin, 2005). This is true when women are unconsciously driven out of OSS communities, usually by the unconscious sexism of well-intentioned men (Lin, 2006; McPherson, 2009). The incidents of sexism are not purposely meant to be done but some of the actions are actually sexist towards women without them realising it.

Though there are many studies being carried out in OSS, only a few found that gender biasness in OSS is problematic while most of the research focuses on the process and structure of OSS related to organizations and management (Lin, 2005). Many researchers of OSS innovation have neglected the diversity of the members, and presume a stereotyped male-dominated 'hacker's community' in most of the OSS studies where the issues of gender inequality are often ignored (Lin, 2005). When it comes to producing the software that meets the requirements of society, the inclusion of both male and female developers is needed because software is gendered in both design and use (Lin, 2004; Wajcman, 2006). The shaping and construction of software innovation might be biased without inclusion of both genders the in OSS community. The absence of female developers in fact, disadvantages OSS since women are also the end users of the OSS, and unless women are involved in its development, the OSS will not be liberating enough.

GENDER ISSUES IN SOFTWARE INDUSTRY

The issues about female under representation in the software industry have been continuously acknowledged by academic literature (Hodgkinson, 2000; Ilavarasan, 2006; Klawe, Whitney, & Simard, 2009). The under-representation issue is the effect of the low numbers of females entering CS or IT related higher education (Binkerd & Moore, 2002). This is true when the software industry recruits their staff from engineering, computer science (CS) and SE stream graduates (Binkerd & Moore, 2002). Most literature associate the relationship between low numbers of females entering CS and information technology (IT) programmes with the subjects seen as "masculine" (Lagesen, 2008) and women's claims that IT education is uninteresting, difficult and time consuming (Weinberger, 2004).

Another factor that hinders women from participating in the software industry is the assumption that IT work involves long working hours and is not conducive to family life when they have to balance formal work and house

chores (Crump, Logan, & McIlroy, 2007). The lack of prominent female role models for young women in IT is another factor that does not motivate females to enter the software industry (Ilavarasan, 2006; Lin, 2005). The other issues regarding gender in the software industry is the issue of 'glass ceiling' still existing in IT organizations and resulting in a lesser number of women in high hierarchy levels in IT organizations (Ilavarasan, 2006). In order to obtain the same acknowledgement as men in the workplace, women have to put in extra effort than men. The issue of discrimination between men and women is another discouraging factor for women to be in the software industry. For instance, Klawe, Whitney, & Simard, (2009) reported that women with the same qualification of a CS degree earned less than $2k than men in the United States (US) and only 5% of women made it in the top leadership in the technology industry.

However, the trend of women entering computing and technology-related tertiary education is showing positive increments in the US, India and in some Asian countries (Klawe et al., 2009). Although it is showing an increase of women in 'masculine' tertiary education, the percentage is still considerably low (Klawe et al., 2009). A perplexing scenario in Malaysia shows a unique case where in tertiary education related to computer science, women make up half of the class population (Lagesen, 2008; Othman & Latih, 2006). This scenario shows that not all women agree that computer science is masculine and reject the 'geek culture'. However it is not only about solely achieving equal representation but the fact that much work has yet to be done in terms of gender biasness in the computing industry (Klawe et al., 2009) like the factors mentioned previously.

GENDER IN THE ENGINE ROOM

The issue regarding gender is not merely about the gap and percentage of females and males using computers, Information and Communication Technology (ICT) and other Information Systems (IS), but also about the issue of women as part of the development team and being there in the 'engine room' (Powell, Hunsinger, & Medlin, 2010). Since computer science and software development is seen as a masculine field, where women are under-represented and almost excluded, the results of the analysis on how gendered perceptions and values influence the technological design as well as the usage of the (Moore et al., 2008; Wajcman 2010, 2004; Faulkner 2001; Cockburn & Ormrod, 1993).

The under-representation of women in the engine room or software development therefore reflects a lack of input from women as serious, as without them male

perspectives will continue to dominate the way in which the technologies are developed and used, and, as Wajcman (2004) writes, "unless women are in the engine rooms of technological production, we cannot get our hands on the levers of power" (p.111). The imbalanced domination of both sexes is among the social factors that must be studied, especially the way technology reflects gender divisions and inequalities. The issue is not only men's domination of technology, but also the way gender is embedded in technology itself (Wajcman, 2010).

Most of the existing gender and technology literature have tended to concentrate on gender and technology in the workforce but there are only limited studies with regard to exploring how technological designs, especially IT, might differ depending on the gender of the designer and users (Rosser, 2005). The fact that women have practically no voice in the development of major technological innovations that affect our lives is a detriment of the technological industry and society as a whole (Wajcman, 2000). Exclusion of women in the technological production and creation will increasingly translate to social exclusion as Wajcman (2004) highlights in her book, the under-representation of women in the science and technology area profoundly affects how the world is made.

Yet, feminist thinking has little impact on the world of Information Systems (IS) even if it is one of the major vectors in contemporary social theory (Adam, 2002). It is important to note that feminist research on the actual design, development and implementation of IS has decreased from its zenith in the late 1980s and 1990s when a number of considerably high-profile projects were reported, that contribute to the few reports in the literature of such projects (Adam, 2002). While there seems to be just as much concern in gender and information and communication technology in the literature (Adam, 2002; Rosser, 2005), the empirical research projects in IS with gender-equity inspiration seems to have all but disappeared (Adam, 2002) with the lack of citations in major IS publications that imply the feminist-inspired gender and IS projects were ignored by the IS mainstream. One of the reasons is the assumption of feminist writing on gender being only confined to 'women's issues' and is therefore not of interest to everyone.

GENDER ISSUES IN OSS INNOVATION

The OSS innovation process while in many ways is more open and democratic in comparison with proprietary software development, it still has some of the problems encountered in the field of computing in general. The diversity of

members in OSS innovation reflects a range of social contexts. It is not only the part they play in the community, but also the social context embedded within each of the developers. There are issues on biasness and inequality towards gender in OSS and other minorities such as different ethnic groups and contributors who are not involved in coding such as business and marketing people, and also users (McPherson, 2009). It reflects that the strong programming culture in OSS development and implementation seems to be enjoyed only by hackers that are capable of manipulating technologies, thus creating an imbalanced population of OSS-based knowledge. Amanda McPherson stated, "all too often, open source is viewed as an "old boy's club," and not just in regard to gender. At many events, business people, marketing folks, or users who don't code aren't made to feel especially welcome."(p.38)

The statement shows that the gender issues in OSS might be more complex than what it seems, as female contributors often experience hybrid discrimination, both from the OSS world that is dominated by male contributors and also from socio-cultural patriarchy (Lin, 2006). The strong programming culture in OSS innovation somehow hinders women participation in its innovation where women are more likely to contribute in writing documentation and reporting bugs. These non-programming activities are equally important to writing code as OSS cannot become widespread since software is not ready to use just as it is written. Yet, programming skills and knowledge are not the only contributions a person needs to be involved in OSS innovation. Bug reporting, writing documentation, translating and localising, improving graphics or even promoting people to use OSS are also crucial for the OSS innovation process since software alone is not straight away ready to use as it is written. The heterogeneity of reasons in contributing to OSS development related to the human aspect reflects that diversity of people consequently causes essential differences within the OSS community as a whole (Ghosh et al., 2002) thus influencing the construction of OSS innovation.

Among the factors that hinder women participation in the OSS innovation process are that they are actively or unconsciously excluded rather than passively disinterested to join because of unconscious sexism or hostility towards women in the community by men (Nafus, Leach & Krieger, 2006). The inflammatory talk in the community that is accepted in most of the OSS communities as a key means of building reputation is off-putting for women and worsens the confidence levels in joining the process, especially with lower levels of computing experience (Lin, 2005; Nafus et al., 2006; Powell, Hunsinger & Medlin, 2010). For the newcomers it can be offensive and discouraging from involving further in the OSS process.

Apart from communication discrimination, the developer's documentation unconsciously reflects prejudices with the use of 'he' rather than 'he or she' or 'they'. It might not be the intention of the developers but it still portrays a non-welcoming environment for women when coupled with inflammatory talk in the community (Lin, 2005; Powell et al., 2010). This is true with some of the OSS conference themes that is a discouragement for women to be a part of, for example for the 2010 FOSS.my conference in Malaysia, the theme was 'It's time to make a difference. I am looking at the man in the mirror'. When women become part of the community either they are treated like an alien, or assumed to be male (online context) or receive a high amount of attention because of their gender which somehow decreases the feeling of being accepted as a community member rather than the 'female gender identity' (Lin, 2005; Nafus et al., 2006).

The "hacker" ethics also relies on a strong programming culture that involves long hours of coding activities which usually situates itself outside the 'mainstream' sociality. This makes it very difficult for women to volunteer in a committed situation owing to the fact that women have less spare time in comparison with men as they need to attend to housework chores (Lin, 2005). As a successful OSS project requires volunteers to commit to it progressively but without much spare time and energy from women to contribute makes it difficult for them to succeed in OSS projects. The place and title of a contributor in the OSS process are earned through how much they have contributed, and time commitment is not on the women's side. Figure 1 shows that there are distinct roles in OSS communities played by contributors such as developers, leaders and users in an onion-shaped hierarchy (Crowston & Howison, 2006). In order to be in the midst of the onion, they have to contribute actively in the project.

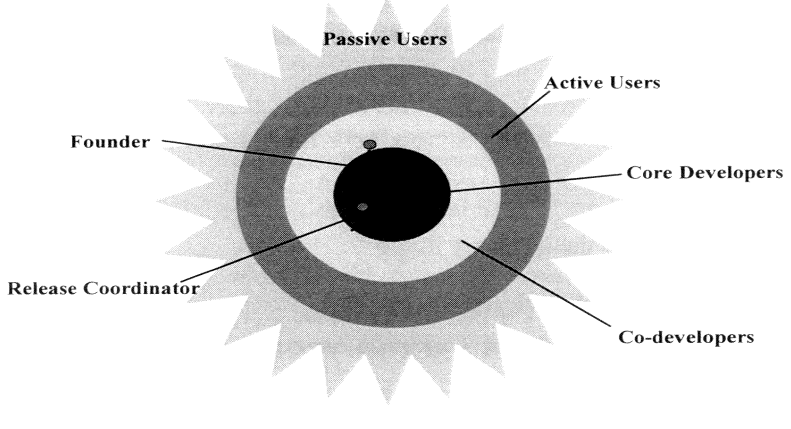

Figure 1. Onion-shaped OSS community (Crowston & Howison, 2006).

In order to encourage women to participate in OSS innovation, several OSS communities specialized for women are formed. Some examples of OSS communities for women are LinuxcChix, Debian Women, Women's Information Technology Transfer (WTT) and in Malaysia, FossChix and several others. The communities are formed because of the realization by some women and minorities who want to foster an innovation environment that is not only friendly to women but also to various minorities in society (Lin, 2006). These groups are not for the intention of separating male and female contributors but more as a welcoming platform for women and the minority to be part of the OSS movement without being prejudiced of their gender identity. The community provides mutual help amongst women participants in the OSS innovation process that can also maintain a number of women who will promote the OSS use and include a feminist approach of design and usage of OSS. It is not to the extent of separating the genders, or narrowing the gender argument down to a fight between men and women, but about all majority and minority, the powerful and the powerless classes (Lin, 2006). Perplexingly, women participation in computer science tertiary education is increasing, especially in Malaysia (Lagesen, 2008; Othman & Latih, 2006) but their participation in OSS innovation is still extremely low. This raises an interesting point to ponder upon.

Thus, not only the reasons behind the scarce numbers of female developers in OSS development should be investigated but also to find out 'what', 'why' and 'how' women play their role in contributing to OSS innovation. This will help to prepare the OSS community to be a more welcome environment that can attract women to participate in its development.

On the other hand, adding up the numbers of female involvement in OSS is not really helpful, but the diversity that comes along actually helps keep the OSS community strong and healthy since the strategy is that the increment in female involvement will lead to an increment in other kinds of diversity in OSS innovation (Malmrose, 2009). Furthermore, there is the strong need to discover better alternatives to promote both female and male developers to join forces with each other in OSS development. This issue is important in order not to fail in terms of meeting the needs of the society as well as not to neglect the context of the software usage.

OSS INNOVATION AS A SOCIO-TECHNICAL PROCESS

Collaborative work at the heart of the OSS innovation project as it depends on the various contributions from various types of actors. Actors in OSS

innovation projects can be maintainers of the projects, core developers, casual contributors, bug reporters, patch submitters and end-users participating in its development (Lin, 2004; Crowston & Howison, 2006). Unlike the traditional ways of software development that have predefined phases like planning, design, development and testing, OSS development does not have a clear cut of the phases in its innovation process. OSS innovation in its community is an active socio-technical process which is influenced by various factors, namely the social and technical aspects (Lin, 2004) since it is based on the contributions from various actors from various backgrounds, culture, gender, and skill. OSS demonstrates a unique combination of private and collective aspects of innovation and knowledge and represents a bizarre collaborative effort that depends on the skill of the contributors and adheres to certain philosophies (Wang & Chen, 2005).

Since OSS is a technology that relies on society's contribution of collaborative work, it is undeniable that gender differences will also influence the shaping and the design process of technological change, which in turn, configures gender relations (Wajcman, 2010). Consequently, the lack of women's viewpoints in the OSS innovation process shows the great influence of men's input in its development where women's perspectives on software design and usage are not accounted for since diversity in developers can lead to better technologies.

UNDERSTANDING WOMEN'S CONTRIBUTIONS IN OSS INNOVATION

In order to understand the contributions from women in the OSS innovation process, this study will apply the Social Construction of Technology Theory (SCOT) by Pinch & Bijker (1984), the Feminist theory (Cockburn & Ormrod, 1993), the Technofeminism theory (Wajcman, 2004), and the Technology Use concept (Crowston, Wei, Howison, & Wiggins, 2008). Taking the stand that the OSS innovation process is a socio-technical process, the SCOT theory will serve as the guiding theory for the OSS process that involves diverse types of social groups. The Feminist and Technofeminism theories will be applied with particular attention to female contributors in OSS that help shape and assign meanings to its products (Mahmod Yusof & Dahalin, 2010a, 2010b). Since OSS projects are carried out using online discussions through mailing lists, Internet Relay Chats (IRC), forums and other types of computer-mediated technology, technology use concepts will provide guidelines along with SCOT and the feminist theory for this study.

SOCIAL CONSTRUCTIVIST VIEW

The Social Construction of Technology (SCOT) theory is a social constructivist's view that sees the developmental process of a technological artifact described as multidirectional views of technological development in contrast to the linear models that follow pre-specified steps used explicitly in many innovation studies, and implicitly in many of the history of technology studies (Pinch & Bijker, 1984). SCOT believes existing technologies will shape future technologies and decisions made in the past will shape future technological evolution. SCOT consists of four main concepts in its approach: (1) relevant social groups (RSGs); (2) interpretive flexibility; (3) technological frame, and (4) closure and/or stabilization (Bijker, 1995).

The RSGs concept emphasize that the members need to be using and sharing the same set of meanings on a certain technological artifact in order to be considered 'relevant'. The RSGs can be institutions and/or organizations of groups of individuals that assign similar meanings to a particular technological artifact. A problem is defined as such only when there is a RSG for which it makes up a problem. Interpretive flexibility means not just how people interpret or assign meanings to an artifact flexibly, but flexibility exists in how the artifacts are designed. It shows there are also other possible ways in designing an artifact rather than just one possible or one best way. The concept of closure and stabilization emerges when interpretive flexibility decreases that shows the meanings given to an artifact are becoming more stable and less vague. Closure is believed to have happened when one interpretation of the artifact emerges as dominant over others as a result of consensus from the process of social negotiation between RSGs (inter-groups). Finally, the artifact becomes grounded and stabilizes around the dominant interpretation.

A technological frame is the concept of sharing similar interpretations of an artifact within RSGs. This is crucial since if it does not exist, there will be no RSG and future interactions. This concept suggests that each member of the RSGs has similar interpretations and assigns the same meaning towards an artifact. It constrains the interaction in an RSG by providing its members with appropriate resources, tools and structures that lead to meaning attribution and constitution of an artifact.

SCOT shows better articulation and is methodologically more robust than other neighboring theories such as the Social Shaping of Technology (SST) and the Actor-Network Theory (ANT) since it breaks down the technology development and changes processes. It helps in giving guidelines that are heuristically constructive in analyzing and describing the development of a technology (Pinch, & Bijker, 1984).

FEMINIST APPROACH

The SCOT methodology has difficulties in explaining the influence of broader social structures and why some actors are excluded or marginalized and why some actors (namely gender) and outcomes may be absent (Wajcman, 2000; Williams & Edge, 1996) thus leading to the representation of technology as sharply gendered (Wajcman, 2000).

To amend this problem, Wajcman (2004) introduces technofeminism. It emphasizes the need to investigate the gendering of new technologies to assess critically how technologies are shaped in ways detrimental to women. Technofeminism relies on feminist political practices in combination with feminist research to change sociotechnical networks to include more women in technology development. It recognizes the 'mutual shaping' of technology, whereby *gender relations* influence the development of technology as technology too has the ability to affect (positively and negatively) gender relations. Gender relations show the particular power dynamics which are embodied in the conceptualization of differences and sameness, or inequalities or assumed equalities between men and women (Cockburn & Ormrod, 1993; Gillard, Howcroft, Mitev, & Richardson, 2008). *Gender identities* (Cockburn & Ormrod, 1993) are needed to explain how we go as regards to being men and women in the OSS innovation process. It captures the notion of "socio-technical" in technology development that social and technological elements are mutually constituting and hence the co-production of gender and technology (Faulkner, 2000) based on the politics of gender relations. Therefore, the technofeminist approach to technology studies suggests that a technology development and use cannot be understood without reference to gender and vice-versa.

The following discussions on the conceptual framework of Constructivist-Technofeminist-OSS Innovation (Fig. 2) briefly explain the reasons for choosing the theories and expectations to learn from applying them to OSS innovation.

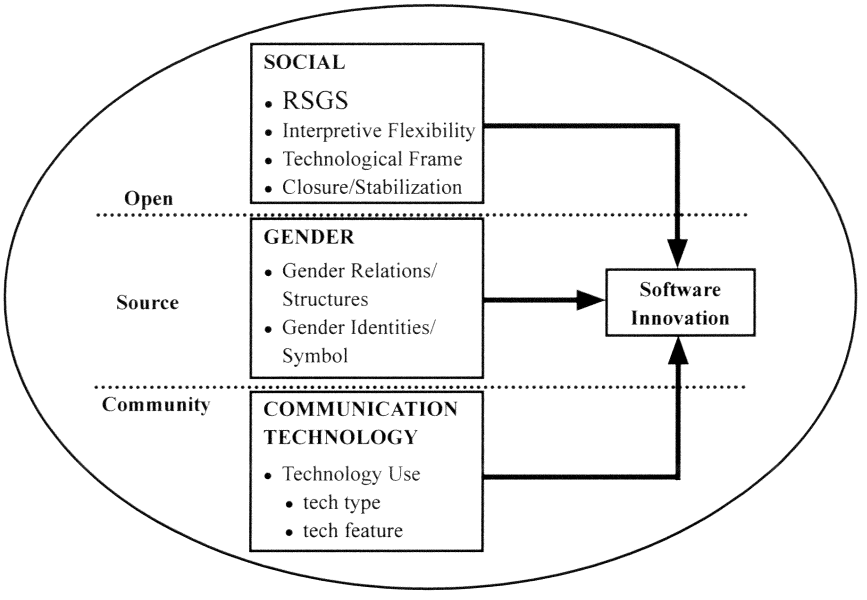

Figure 2. Conceptual framework of Constructivist-Technofeminist-OSS Innovation.

CONCEPTUAL FRAMEWORK

The framework (Fig.2) shows the proposed relationships among the constructs of interest as derived from the theories. The SCOT theory makes up constructivist concepts that are related to *relevant social groups* and contributes *interpretive flexibility*, *closure and stabilization*, and *technological frames*. Since SCOT does not acknowledge technological influences in determining the construction of technology (Pinch & Bijker, 1984), there is a need to incorporate technology use in the framework since the nature of OSS development relies heavily on computer-mediated communication (Crowston, Annabi, Howison, & Masango, 2005; Crowston, Wei, Howison & Wiggins, 2008) and researchers cannot understand technologies at the level or in the way that engineering or physical scientists understand about technologies. No matter how well these researchers understand the content of technology, their understanding may still remain on the outside of the technological content (Williams & Edge, 1996). If social constructivist researchers understand the content of technology such as how a certain technology technologically functions and describe it in the sense of technologically working or non-working, then the research would be an engineering study crossing over the boundary of social constructivism (Williams & Edge, 1996).

The gender relations from Technofeminism and the gender identities from the Feminist theory serve to fulfill the need in investigating the gendering of new technologies to assess critically how technologies are shaped in ways detrimental to women.

CONCLUSION

This paper has demonstrated the issues of what women have faced in software industries and the OSS innovation process. Although OSS is based on volunteerism, women still have little interest in participating in the alien environment because of similar gender issues in the software industry thus limiting the potential contributions toward OSS innovation. It also demonstrated the importance of feminist perspectives incorporated in the OSS innovation process through the social constructivist view since software innovation in OSS communities employs new types of socio-technical practices, development processes, and community networking when compared to proprietary software innovation in industry and differs greatly from traditional modern software engineering practices.

This conceptual framework incorporates the SCOT theory, Crowston et. al's (2008) technology use and variable and feminist approaches which can therefore make an important contribution generally to the Information System and STS research and highlight the need to draw on the theoretical foundations of the OSS innovation discipline. We believe that this study will offer insights on how women play a role in contributing to the construction of software innovation in the OSS through the lens of SCOT Theory with feminist foci.

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