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Open source software contributors' motivations in a community of practice

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University of Tennessee

To the Graduate Council:

I am submitting herewith a dissertation written by Hoda Baytiyeh entitled "Open source software contributors' motivations in a community of practice." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Education.

Jay Pfaffman, Major Professor

We have read this dissertation and recommend its acceptance:

Accepted for the Council:

Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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Open Source Software: Contributors' Motivations in a Community of Practice

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Abstract

The success of open source software is gaining more attention from software users as well as educators. A variety of open source Software exists for different operating systems (Windows, Macintosh, and Linux) for users in many languages contributed and maintained primarily by volunteers. To learn more about what drives them to devote their time and expertise to creating, debugging, and supporting these widely-used applications, an online survey with Likert-scaled items measuring different types of motivations was distributed to contributors to Mozilla, Moodle, OpenOffice, Koha, and Limesurvey. The survey included comments that were used to check the validity of the Likert-scaled items and open-ended questions that allowed respondents to express their reasons for participating in these open source communities. The Likert-scaled items showed that the open source contributors (n=110, 38 paid and 72 volunteers) are motivated primarily by intrinsic desire: altruism, creation, and learning. Receiving payment for their work did not significantly impact reasons for contributing to OSS projects. The comments and open-ended questions validated the findings and indicated that building a "Utopian" community—the desire to help for the greater good worldwide—is one of the most important motivators. Also, the freedom to create free software and share a pool of knowledge with those from inside and outside the community is a main reason why contributors join and remain members of open source communities. The conclusion suggests using the community of open source software as an example of collaboration not only in the online learning but also for participation in classrooms.

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CHAPTER I

Introduction

Free Open Source Software (F/OSS) has its roots near the beginning of computing when researchers had to share software source code[1] because commercial software was not available (Moon & Sproull, 2002). Open Source Software is free and comes with the source code needed to adapt it to users' needs. To those accustomed to paying for software, it is surprising to learn that volunteers produce high quality software that allows anyone not only to use but also to read, modify, and redistribute the source code (von Hippel & von Krogh, 2003). So, why do people volunteer their time and expertise to create free software? The OSS communities are communities of practice performing specific activities to build and maintain these remarkable resources.

Programming Communities of Practice

Communities of practice are defined as "groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis" (Wenger, McDermott, and Snyder, 2002, p.4). These people don't necessarily work together everyday, but they meet or interact together to share information, insight, and advice. They accumulate knowledge and become informally bound by the value of the shared learning.

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[1] Source code (commonly just source or code) is any sequence of statements or files written in some human-readable computer programming language. Source code allows the programmer to communicate with the computer using a reserved number of instructions.

Communities of practice may take diverse forms (Wenger, McDermott, & Snyder, 2002). These communities differ based on the members who participate and the situation that leads to their existence. Communities of practice can be:

- small or large when the number of members plays a role in the type of the community. Also, they can have different structures if they are subdivided by geographic region or topic.
- long-lived or short-lived, because the development of such communities takes time. Some of them exist over centuries, such as the communities of tailors and carpenters, but others are short-lived such as COBOL programmers.
- co-located or globally distributed, based on the mode of interaction, face-to-face, e-mail, or phone. Also, how many times they interact varies. Some meet regularly or once a week while others meet once a year.
- homogeneous or heterogeneous, depending upon whether all members in the community come from similar or different disciplines or if they have similar or different functions.
- inside and across boundaries if the community exists entirely within a unit or stretches across boundaries.
- spontaneous or intentional, depending upon whether the community started without any intervention from members or it was developed for specific needed qualifications.
- unrecognized or institutionalized, depending upon whether the community is incorporated into an official structure of an organization or invisible with no one aware of the value of such a union.

Regardless of the various styles of communities of practice, they all share a basic structural model including three essential elements: the *domain* of knowledge which enables members to recognize the importance of the community and inspires them to participate, the *community* which creates strong relationships among members based on mutual respect and the willingness to share ideas and experience, and the *practice* which constitutes a set of tools, terms, and documents shared by the members.

Regardless of their form, communities of practice exist everywhere. Some of them are at work or at school; others are in our hobbies or at a place of worship. Recent advances in networking technology enable worldwide communication that support social interaction, cooperation, and collaboration for learning and knowledge building (Friedman, 2005). The progress in the available technology has fostered the development of numerous communities impossible before. Joining a public online community and being committed to participation incorporates formal knowledge integrated with informal practice. One model of the available online communities is the Open Source projects community. Developing and maintaining software encompasses several tasks besides programming where learning is a process of engagement in a community of practice. There are many roles in a F/OSS community that members can choose. Some people design icons; others translate the programs to other languages; some work on coding; others work on the testing procedure and debugging; some write the documentation; still others provide support and training.

So, what are the motivations of these volunteers who provide free time and effort to join and remain members in such communities? This study investigates contributors' motivations in a community of practice.

Need for the Study

Among the relevant issues associated with open source development, the voluntary participation is one of the most significant and debated questions (Strasser, 2001; Kock, 2005). Software industry executives and managers try to recognize the incentives behind contributing in F/OSS. Although, studies have focused on the implications of the volunteer phenomenon in the management field (Krogh & von Hippel, 2003; Mustonen, 2005; Yildirim, 2006; Riehle, 2007), few research studies have attempted to answer this question using psychological methods. Exploring the incentives of volunteers in F/OSS development is an important concern not only for technological innovation in industries, but also for the academic theories in learning. Currently, few interpretations using psychological theories exist regarding contributors' involvement in the F/OSS community. Investigating who is contributing to the Free Open Source software and what motivates people to join as well as to remain members in the F/OSS communities will contribute to the knowledge base of online communities as well as the potential presence of communities of practice that surround computer-mediated-communication. The findings will help educators to use the open source communities as a prototype in their academic practice.

Statement of the Problem

Lave and Wenger (1991) defined a community of practice as a group of people who engage in a shared activity where the social interaction is a critical component of learning. Therefore, learning is engaging in the activity, context, and culture in which it occurs. In other words, individuals learn as they participate by interacting with the community, tools, and the situation. The membership is defined by participation and commitment rather than expertise and mastery. A community of practice defines itself based on three dimensions: (1) what it is about – the joint enterprise that is continually renegotiated by its members, (2) how it functions – the mutual engagement that connects members together into a social entity, and (3) what capability it has produced – the shared repertoire of communal resources such as routines, artifacts, and vocabulary that members have developed over time (Wenger, 1998). Although there have been considerable attempts to describe and explain open source participation, at the time of this research, few rigorous empirical studies have focused on the practice of involvement in open source communities. This study was intended to fill a gap in the literature by exploring the voluntary contribution phenomenon in F/OSS.

Purpose of the Study

The main purpose of this research was to understand why people join F/OSS communities and become active members willing to contribute to and collaborate on projects for free. The study focused on contributors' beliefs as well as their perceptions about their involvement in such communities. This study examined F/OSS contributors from the theoretical perspectives of several motivational theories and models. Such a

study affords scholars new insights into the importance of social interaction and in turn can be systematically utilized to improve adult learning in different educational settings.

Research Questions

The increased interest in open source projects raises important questions related to the development process completed by individuals who are willing to share their knowledge as well to volunteer their time and effort. The study examined the following main questions regarding open source participation:

1. Who is contributing to the open source projects?
2. Why do participants join the open source community?
3. What are the motives for those members to contribute, help, and remain involved in such activities?

Significance of the Study

Several reasons may drive people who choose to be active members in an open source community. Because learning is central to a community of practice, studying such communities can afford us insights into the socially embedded nature of learning that can in turn be employed to enhance learning in various educational contexts. This study questioned the motivational essence behind joining and staying involved in a community of volunteers using psychological theories. The findings offered some insights into the use of multiple approaches for participation. This study has important significance related to both the extent and impact of the collaborative environment on the Open Source Software movement that surrounds the new technologies. The findings clarified why members join and remain members in these collaborative communities. Also, the study

showed the social and psychological aspects that exist behind computer-mediated-communication used to create and maintain remarkable applications. The study explained how the open source communities represent a community of practice and consequently can be used as a prototype to foster a new style of teaching and learning in the academic environment. Classrooms are small communities where the three essential elements of a community of practice can be implemented by creating a *domain*, a *community*, and a *practice*.

Delimitations of the Study

Creswell (2003) suggested using delimitations to narrow a study's scope. The main delimitation of this study is its focus on only a few open source software projects: the Mozilla internet suite, the OpenOffice productivity suite, the Moodle course management system, the Koha integrated library system, and the LimeSurvey survey application. An additional delimitation of this study was targeting only participants who have specific roles in these communities, such as developers, projects owners, and translators.

Limitations of the Study

One limitation could be the use of an online survey. The survey poses specific questions about factors that affect participation in open source projects and includes exploratory questions about the importance of different motivational aspects. Another limitation was whether the survey's response rate was acceptable because of the uncertainty of the population size.

Summary

In summary, this study offered a rigorous analysis of several issues related to open source developers' motivations and performance. Participants in five open source applications were targeted to understand their motives to join and remain members in the F/OSS community. Taken together; the different software projects under study will make a significant contribution to the emerging literature that surrounds the participation in F/OSS projects and the implications of such phenomenon on the field of education.

CHAPTER II

Review of Literature

Introduction

This chapter includes a review of literature related to the purpose of the study, which is to explore the incentives behind the volunteer participation and contribution in the Free Open Source Software (F/OSS). Before exploring the available studies related to motivation in open source development projects, a history of F/OSS will be summarized, followed by an introduction about the three open source software that will be studied in this research (Moodle course management system, OpenOffice suite application, Mozilla internet suite, Koha integrated library system, and Limesurvey tool to develop and maintain surveys).

History of Free Open Source Software

F/OSS has its roots from near the beginning of computing and is typically free while providing users with source code that is usually shared via the internet and can be adjusted for users' own needs (opensource.org). In the 1960's, while using computers for their work, researchers had to share software code because commercial software was not available (Moon & Sproull, 2002). Later, when commercial software became accessible, F/OSS became a convenient alternative since it allowed users – most of whom were programmers – to have access to the source code. Thus, users were able to adapt and improve the program according to their personal needs. In late 1970s, UC Berkeley began creating its own version of UNIX, BSD (Berkeley Software Distribution) following AT&T's commercializing of UNIX. In the 1980s, Stallman (1994) claimed that computer

programs should be a public good. He called for Free Software, and established the Free Software Foundation. Soon after, the Free Software Foundation created the "General Public License" (GPL), a license that guarantees users the availability of the source code for all future enhancements of all published software under the license (e.g., Linux Kernel). In the 1990s, the FreeBSD 1.0 was released including networking, virtual memory, and task switching. Subsequently, the Apache group built the Apache Web server which became the dominant HTTP server. Afterward, Netscape released the source code to its Mozilla web application suite. Also, IBM, Oracle, and other major software companies have ported their products to Linux. In the late 1990's, the number of Linux users was estimated at 7.5 million (Gonzalez Barahona, Heras Quiros, & Bollinger, 1999; Comerford, 1999; Seltzer, 1999; Hars & Ou, 2002). It is since then that the idea of F/OSS has gained more and more attention from developers and users.

Impact of Open Source Software

The advent of Free Open Source software (F/OSS) has significantly impacted the software ecosystem. F/OSS can be a specific approach to software development, a business strategy, or a lifestyle. There are two types of open source software: community open source and commercial open source.

Community open sources are owned by a broad community of volunteers who determine which contributions are accepted in the source code as is the case with the Apache Web server. On the other hand, commercial open sources are owned by a company that maintains the copyright and determines what source code to implement as is the case with the MySQL database. While the company employs and pays software's

developers, commercial open source are available for free to users. How do they make their money? Usually, by providing support services or selling proprietary software enhancements.

Open source implementation is not limited to software companies such as Hewlett Packard, IBM, Intel, Novell, and Oracle (Cohen, 2005), but also expands to reach different business companies such as EBay that provides open source for some features of the application (Bostrom, 2005). Koening, Guptill, & McNee (2005) predicted in their recent market study that open source technologies will penetrate all types of business applications, database management systems, desktop productivity, and else.

Moreover, the open source movement has contributed automated library-systems. Addressing the need for commercial support options for open source library automation systems, some of the staffs supporting Koha (the first open source automated system, developed in 1999) started Liblime in 2005. This company provides a variety of services to the support of Koha and other library-related open source software. Also, the PINES consortium of 252 public libraries in Georgia has migrated from Unicorn to Evergreen. Evergreen is a new open source integrated library system created by a team of developers funded by the state Library Agency of Georgia (Breeding, 2007).

The latest example comes from the French paramilitary force in February 2008 which decided to switch from Microsoft Windows to the free Linux operating system (AFP, 2008). During the year 2008, 5000 to 8000 desktop computers switched to Ubuntu and it is planned that over the next four years 12,000 to 15,000 desktops will have Ubuntu, so that every desktop uses the Linux operating system by 2013-2014. The

French Police provided several reasons for this move; to diversify suppliers, to reduce the force's reliance on one company, to give the gendarmerie (Police) more complete conrol of the operating system, and to decrease cost. The move away from licensed products will save the gendarmerie about ten million dollars a year. The gendarmerie, with its 100,000 employees, is the biggest administration to shift to open sourcing for its operating system but it is not the first in France. In fact, the National Assembly adopted Ubuntu for its 1,200 PCs in 2007(AFP, 2008).

Reasons for Contribution to Open Source Software

Observers of open source phenomenon question the rationale behind contributors' motives for sharing their work. Contributors offer code, reveal proprietary information, and help others to solve their technical problems. Involvement in such projects implies providing time and effort for free. However, all volunteers in F/OSS are adults who have decided to join F/OSS communities. For instance, the SourceForge.net repository of OSS projects, on its own, hosts 86,873 OSS projects with 910,899 registered contributors (Bitzer, Schrettl, & Schröder, 2007). Social researchers have explored theories of motivations and distinguished between the intrinsic and extrinsic motivation. In the following, adults' motivational theories with their application to the F/OSS developers are reviewed.

Intrinsic and Extrinsic Motivation

A plethora of definitions exist for motivation. However, most of these definitions fall into two broad categories: physiological definitions and psychological definitions.

For the purpose of this research study, the focus will be on the psychological aspects of motivation.

As defined by most psychologists, motivation may describe the following processes: arousing a specific behavior, giving direction or purpose to a specific behavior, maintaining a specific behavior, or leading to choose a particular behavior (Wlodkowski, 1982, 1989). Within all the established theories, scholars distinguish between the concepts of intrinsic and extrinsic motivation. Intrinsic motivation refers to a learner's internal desire to perform a task for no definite reward other than personal satisfaction. On the other hand, when the learner is motivated by incentives external to his/her interest and satisfaction, the factors will be called extrinsic motivators.

Moreover, individuals' competence and self-determination are related to emotions and enjoyment. The intrinsic motivation is performing an activity for its innate satisfaction rather than a consequential recompense (Ryan & Deci, 2000). Hence, having fun in exercising an activity is the main idea of intrinsic motivation. However, certain circumstances can have a negative impact on task performances that are initially intrinsically based (Deci, Koestner, & Ryan, 1999). Many argue that, extrinsic rewards reduce intrinsic pleasures in performing activities, where a "hidden cost of reward" could arise and therefore the intrinsic aspect can be destroyed.

Frey (1997) argued that identifying the effect of extrinsic and intrinsic motivations on task performance is not systematically simple. Individuals may enjoy performing any activity while they are paid.

Also, Lindenberg (2001) has proposed the need of a new conceptualization for the relationship between the extrinsic and intrinsic motivation while separating the intrinsic motivation into two components: enjoyment and obligation to the community. He assumed that people possess a diversity of objectives while achieving their activities. A frame is created around the main objective with the related compatible objectives. After the main objective is achieved, the other goals still remain in the person's background intentions. For example, a pianist may have an objective of making money while having fun and enjoying his performance. Lindenberg (2001) argues that individuals may socialize within specific norms of a group, and consequently create a frame of action. Therefore, an individual could have an extrinsic incentive (e.g., monetary rewards) as a main objective along with an intrinsic incentive (e.g., self-enjoyment) as a related objective and vice versa. Individuals can have the two types of motivations that balance one another for a single activity.

Motivations to Participate in F/OSS Projects

In *The Cathedral and the Bazaar*, Raymond (1999) distinguished between two different styles of development. The first is the open source software development which is comparable to a bazaar, where anyone has the right to join and contribute. The other style is the commercial software development, which is similar to a hierarchical cathedral style. Raymond argued that the bazaar style creates a democratic atmosphere where contributors can discuss the best solutions for the source code efficiently since every developer is a user. Berzoukov (1999) subsequently criticized Raymond's postulations,

by claiming that OSS communities are driven by competitive motives of reputation with commercial software companies.

Linus Torvalds (1998), who published the source code of the Linux Kernel, claimed that one of his main personal motives was the "fun to program" and he believed that his co-developers had the same incentive. Conversely, he declared that the success of Linux is related to the reputation and status that might provide the developers with career opportunities prospects (Torvalds & Diamond, 2001).

Lakhani and Wolf (2005) found that although financial incentives are important for contributors, work enjoyment is a key intrinsic motivation. A web-based survey was administered to 684 software developers in 287 F/OSS projects. The majority of respondents were experienced professionals working in IT-related jobs, with approximately 40 percent being paid to participate in the F/OSS project. The authors concluded that external motivational factors are the main incentives of participants. Intellectual stimulation deriving from writing code, and improving programming skills were high motivators for participation in the F/OSS projects. On the other hand, the authors found that enjoyment – how participants feel while performing an activity – is the strongest motivational aspect. As a whole, the researchers showed that intrinsic motivation is the responsible for such devotion. Creativity to improve programming skills and enjoyment were revealed to be the main factors that stimulate contributors' work for free.

Other researchers have showed that contributors' objectives are to reveal their technical capabilities to obtain better job opportunities for future prospects (Lerner &

Triole, 2000). In another study, the same researchers found that the main incentives behind the volunteer participation are for extrinsic benefits (Lerner & Tirole, 2002).

Also, Riehle (2007) claimed that software developers strive to become contributors in open source projects to acquire more recognition, independence, and therefore to guarantee better future as well as better careers.

With all the above suggestions from different applied studies to the F/OSS, the researchers' explanations fall into one or more of the following motivational related theories: learning, flow, creativity, community commitment, and profit.

Learning Motivation

Dewey (1915) argued that humans possess an innate desire to learn. People could be attracted by new software applications or games because they will have an opportunity for learning the latest innovation. However, the excitement for learning might diminish once the real meaning and objective of the novel activity were discovered. In the case of F/OSS, some people might be interested in learning about new techniques of computer-related technology. Some applications require acquisition and learning about tools and features along with their correspondent advantages and disadvantages. Learning about tools might provide satisfaction that makes the process more engaging. Another type of learning that could occur in F/OSS contribution is to discover the strategies and methods involved in the process of participation. For instance, each F/OSS community has its own guidelines for contribution that encompasses a set of regulations.

Knowles (1980) defined "Andragogy" assuming that adults are self-directed. He posited that adults use their accumulation of experience from the "growing reservoir",

have their own social role, and tend to be more problem-centered than subject-centered. Later, Knowles (1984) included two more assumptions regarding adults' internal motivations and their needs to identify what to learn. He claimed that the most potent adults' motivations are internal rather than external because adults need to identify the reasons behind their learning. Within the above assumptions, Knowles stressed the importance of adults' independence in the diagnosis of their own needs, the implementation of their experience, and the evaluation of their knowledge.

Furthermore, Knowles (1980) showed adults are highly pragmatic learners. In fact, most of adults are goal oriented and need instruction that can be immediately applied to their life or job-related. They want instruction that gives them the ability to apply in their daily life (Wlodkowski, 1989). They may engage in learning situations to meet a goal, and to achieve competence. Wentzel (1994) suggested that social competencies affect academic achievement. Also, adults could be motivated to learn because of their need to grow, to become more than they are (Knowles, 1980).

In addition, Ponton (1999) suggested that autonomy represents a subset of self-directedness, and defined an autonomous learner as one who is able independently to exercise learning activities. Moreover, the exhibition of personal initiative, resourcefulness, and persistence were the three factors for autonomous learning assumed by Ponton and Carr (2000). A later study was conducted to measure the relationship between learners' resourcefulness and persistence (K. Ponton, Derrick, & Carr, 2005). The factors included in learners' resourcefulness were the anticipation of future rewards, the priority of learning over non-learning, and the ability to resolve learning problems.

On the other hand, learner's persistence factors included goal directedness, self-regulation, and volition. The study revealed that adults' persistence in autonomous learning is correlated to the anticipation of future rewards. However, the choice of learning activities with respect to both time and value could play a major role.

Similarly related to the previous factor is the desire to participate in competitions. The excitement of competing may attract people to activities that otherwise provide little immediate gratification. F/OSS contributors might see the open source related projects as an opportunity to compete with others with the objective of more learning.

Flow Motivation

Csikszentmihalyi (1975), who was one of the first psychologists to study the enjoyment-based motivation, suggested a state of "flow" where enjoyment is maximized. Csikszentmihalyi (1991) established this concept by surveying people periodically (several times daily). He was interested in the activities that people were exercising and to what degree they were engaged in the activity (Csikszentmihalyi & Lefevre, 1989). He proposed that the challenge within the activity is associated with the engagement state and the perceived ability. This state, that he has called "flow", is accompanied with clear goals, feedback, and feeling of control. Also, time was an essential factor because people in a flow state are completely engaged and can lose track of time (Nakamura & Csikszentmihalyi, 2002). The satisfaction will be characterized with an intense focus and concentration, an integration of action and awareness, self-confidence in abilities, and the satisfaction of the activity itself (Nakamura & Csikszentmihalyi, 2003). A flow state can arise when the challenge of the task matches the person's skills. Hence, people who

contribute to open source might be seeking to a flow state when they decide to participate to specific projects. Software programmers demonstrate the presence of a flow state when they participate in F/OSS (Torvalds & Diamond, 2001).

Creativity Motivation

Another aspect of enjoyment is the sense of creativity in task achievement (Amabile, 1996). Amabile suggests that creativity consists of two main components. The first component is related to a heuristic task that has no identifiable solution. The other component is associated with a new and suitable solution to a specific task. Amabile has linked the creativity with an objective assessment done by expert observers and a subjective self-assessment to understand the impact of the creative production.

Also, constructionism, or "learning by making", helps people to acquire skills through personal creation and innovation. In fact, people learn better when they construct a public artifact (Harel & Papert, 1991). Constructionism asserts that learning is particularly effective when constructing something for others to experience. This can be anything from an internet posting, to more complex artifacts, such as developing a software package. In the case of F/OSS, contributors create new patches and participate with new ideas for improving the software under construction. Also, the act of creation itself might provide satisfaction through the process itself: from the initial stages to the completion of the project in order to witness the end of the course of action.

Contributors to F/OSS may exercise their autonomy in the software design by expressing themselves and personalizing methods. Project- and design-based pedagogies

are based on the similar assumption which is that balancing the need for self-expression is one's self-efficacy (Kolodner, Crismond, Fasse, Gray, & Holbrook, 2003).

Social Motivation

One of the intrinsic motivation factors acknowledged by Lindenberg (2001) is the obligation to the community. He proposed that people socialize when they work and interact consistently within the norms of a group. Maslow's (1987) theory of human motivation is based on a hierarchy of needs. At the third level of his triangle hierarchy are the belongingness and love needs, such as work group, family, affection, and relationships. The needs can be attained not only by joining and belonging to the group but also by residing a member of the community. In fact, the belongingness is an essential concept to motivation in education (Weiner, 1990; Ames, 1992). Such motivation is intrinsic; it emanates from the person. Although social factors are recognized by motivation research, they are not given the same importance as in education and cognitive research (Brown, Collins, & Duguid, 1989; Cobb, 1994). Therefore, social factors might affect motivation just as they affect learning.

Moreover, Ryan and Deci (2000) consider that the desire to belong to a group is a primary reason behind performing social motivated behaviors. Most activities are not entirely intrinsically driven. In fact, the intrinsically motivated activities become increasingly reduced by social demands and roles that require individuals to be responsible for extrinsically motivated tasks. Relatedness, competence, and autonomy are the fundamental human needs that fall under the self-determination theory (Deci, Vallerand, Pelletier, & Ryan, 1991; Ryan & Deci, 2000).

Kasser and Ryan (1993, 1996) showed that the connection to the community correlates with the mental well-being. One way to experience relatedness is to share one's work (or performance) with others. For example, Anderson, Manoogian, and Reznick (1976) showed that part of children's motivation to draw is to share their drawings. Children's motivation was reduced when the experimenter showed no interest in the children's drawings and avoided verbal or eye contact. One explanation for this result is that without a means to share their work, the drawing activity loses some of its value. Hence, members in F/OSS community might be interested in helping others to appreciate the contribution in order to expand the group or to share their knowledge. As such, through a study for users' assistance into the Apache system community, Lakhani and von Hippel (2003) demonstrated that users' motivation to participate is the willingness to share information and solutions. Most users provide help since they know the solution to the problem posed and providing the proper answer can be identified and transmitted at low cost. Therefore, the Apache users' community believes that its information has no proprietary value. The F/OSS programmers share a strong sense of community identification and commitment to the group norms.

Closely related to the group commitment, four aspects can trigger users' motivations to contribute for free (Kollock, 1999):

a. Augmentation of one's reputation.
b. Expectation of reciprocity.
c. Sense of efficacy that could have effect on the environment.
d. Commitment to the group.

Kollock's analysis for users' incentives added a significant aspect. The expectation of reciprocity which is grounded in most communities' beliefs and values: someone helped me before, I am helping someone now, and I expect that this person will help someone else later. It is like a closed circle of people connected to each others, where everyone feels rewarded by keeping the community alive, active, and strong.

Also, contributors have different identities within the community which provide them with more confidence and recognition. For instance, the hacker identity is an honor identity within the F/OSS community. Hackers solve programming problems and share code while having fun (Raymond, 1999; Stallman, 1999).

In such communities, a consensus is established between all members without any contract, since values and ethics are predominating. The defining characteristics of communities of practice are mutual engagement of the members encompassing a shared repertoire of common resources including "routines, words, tools, ways of doing things, stories, gestures, symbols, genres, actions, or concepts that the community has produced or adopted in the course of its existence, and which have become part of its practice" (Wenger, 1998, p. 83).

Other possible social motivation factors might include the desire to be liked by others and to have a means to stimulate conversation within the community of F/OSS.

Extrinsic Motivation

Lerner and Tirole (2000) showed that there is a link between the different perspectives for contributors' motivations. They consider that through their contributions,

participants acquire an immediate payoff and a delayed payoff characterized in the following way:

a. The immediate payoff is the current benefit minus the current cost. Thus, the immediate payoff subsists in the own use of the developed product.
b. The current benefit is the use and need for the task development.
c. The current cost is the time invested for this improvement depending on how much the contributors enjoy the task.
d. The delayed payoff is the potential future rewards in terms of recognition and reputation.

Such motivation includes identification and integration in the activity where the benefits are the final goals. The interpretations given by von Hippel and von Krogh (2003) for the potential incentives are similar to the suggestions of Lerner and Tirole. They proposed that contributors in F/OSS are motivated for private needs (e.g., need for code) and collective needs (e.g., revelation requirements).

Another potential profit-extrinsic motivation factor for F/OSS contributors is the job prospects for programmers who have reputations in the field. Software companies looking for a particular skill in the labor market can trace qualified programmers within F/OSS communities. Also, contributors improve their programming skills through their active peer review (Wayner, 2000; Moody, 2001). Most often, software users and contributors suggest modifications and improvement of the code (G. von Krogh, Spaeth, & Lakhani, 2003). Clearly, the interaction between peers and the feedback given by

outsiders enhance not only the quality of the code but also the programming expertise of the contributors.

Another immediate benefit related to F/OSS programmers is the direct use of the product. Von Hippel (1988) proposes that participants have strong incentives to create solutions to their particular needs. Overall, users have been shown to be the source of innovations in scientific instruments (Riggs & Von Hippel, 1994), industrial products (Urban & Von Hippel, 1998), sports equipment (Franke & Shah, 2003), and library information systems (Morrison, Roberts, & von Hippel, 2000).

Likewise, one's social stature within the F/OSS community can be related to the performance in the group's activity. These extrinsic rewards may drive not only a desire to perform but also a desire to increase the social stature. Another possible motivator for participation in F/OSS is the desire to be better than others. The desire to demonstrate or possess some superior skill may itself be part of what attracts people to contribute to F/OSS related activities.

Altruism Motivation

Altruism is widely regarded as being associated with positive norm and – following the Theory of Reasoned Action (Ajzen & Fishbein, 1980) – should have a positive influence on the level of participation in open source projects. Programmers may identify themselves as members of the open-source community and align their goals with those of the community. They may treat other members of the community as kin and thus be willing to do something that is beneficial for them as well for themselves. Altruistic behavior of this type is called “kin-selection altruism” by social psychological

researchers (Hoffman, 1981). Programmers with this variant of intrinsic motivation will be motivated to participate in open-source projects and help their kinship partners. As other altruistic behaviors, altruism might be an important drive that motivates the open source programmers to participate in open source projects.

Current Findings on Motivations in F/OSS Development

Few have applied rigorous psychology methods to F/OSS development. An exception is few significant studies focusing on contributors' motivations in F/OSS projects explained in the following.

Hars and Ou (2002) examined the motivational factors of 79 participants in 41 F/OSS projects. Of the total number of participants, 27% were Linux developers. The study revealed that 16% of the contributors were remunerated and they spent 38% of their time working on the projects. Developers rated eight motivational factors on a seven Likert scale (*Strongly Agree/Strongly Disagree*). The following results show the percentages of respondents who ranked high or very high on each of the eight motivation categories:

a. Human capital: 88.3%

b. Self-determination: 79.7%

c. Peer recognition: 43.0%

d. Personal need: 38.5%

e. Self-marketing: 36.7%

f. Community identification: 27.8%

g. Altruism: 16.5%

h. Selling products: 13.9%

The preliminary analysis with correlation coefficients showed that external factors are more significant than the internal ones. However, the authors did not conduct any regression analysis to examine interdependencies between the variables.

Ghosh, Glott, Kreiger, and Robles (2002) investigated the potential incentives of users and developers of F/OSS projects for the European Commission. Using snowball sampling, the authors collected 2,774 participants. The study revealed that almost 70% of participants had agreed that the potent motivational factor was "to learn and develop new skills" and almost 65% of them had revealed that the essential incentive was "to share knowledge and skills with others". A broad grouping of all responses generated four types of participants within the sample:

a. Social reasons aspects: 53.2%

b. Career and monetary aspects: 31.4%

c. Political aspects: 12.7%

d. Personal needs aspects: 2.6%

No regression analysis was conducted to examine any relationship between the revealed variables.

Lakhani and von Hippel (2003) explored the organization of support tasks in the case of Apache web server software, and showed that participants are motivated by providing service for free to others. The authors examined data of long-term participation from Usenet posting patterns for a 4-year period (1996 to 1999). Also, data were collected through questionnaire from people who posted or answered questions during

the 4.5 months from 1 October 1999 to 15 February 2000. The findings revealed that the support functions in the Apache community are valuable. Moreover, 98% of the effort expended by information providers returns as direct learning benefits to those providers. Apache support providers reported gaining a direct benefit from investing in support because they learn valuable information relevant to the management and upgrading of their own website. The findings revealed that the actual answering of questions took up only 2% of information provider's time. Also, the providers reported that they invest only l–5 minutes per question answered. Thus, information providers were able to answer at a low cost because they only posted information they already knew.

Hertel, Niedner, and Hermann (2003) studied the motives of 141 contributors to the Linux kernel using an internet-based questionnaire. Of the 141 participants, 69 were Linux developers and 72 were observers subscribed to the Linux kernel mail list. The study revealed that developers dedicated 18.4 hours/week on development. Also, developers rated the following seven motivations aspects on an order of importance scale (1 as being very unimportant and 5 as being very important):

a. Hedonistic motives (e.g., enjoyment of programming tasks) : 4.7
b. Pragmatic motives (e.g., software improvement, career enhancement): 4.3
c. Social/Political motives(e.g., software freedom): 4.1
d. Developer identification: 4.0
e. Linux user identification: 3.9
f. Norm-oriented motives (e.g., reaction of family, friends, and others): 3.9
g. Time loss (e.g., time devoted to development): 3.6

In a regression on the hours/week participants spent on Linux-related activities, participants spent more hours on Linux-related activities when they identified with the specific categories such as Linux developer but not as a Linux user. In addition, participants who rated time losses due to Linux development as less important spent more time on Linux-related activities. No other motivational factors had significant effects. However, the pragmatic motives components, such as software improvement and career enhancement, had a significant effect on the willingness to be involved in Linux development in the future. Thus, the higher participants rated personal reward, the more they are willing to remain a member of the community.

Lakhani and Wolf (2005) used a Web-based survey administered to 684 software developers in 287 F/OSS projects. The majority of the participants in the study were skilled and experienced professionals working in IT-related activities development, with approximately 40 percent being paid to participate in F/OSS projects. The study showed that the strongest driver behind the volunteers' incentives was work enjoyment, which is an intrinsic benefit. They argued that contributors enjoyed their feelings of creativity and intellectual stimulation while working on open source projects, thus refuting the theory that participants are motivated for extrinsic benefits (e.g., better jobs, career advancement) was refuted. In contrast, the enjoyment-based intrinsic motivation, specifically how creative a person feels when working on the project, was the most prominent incentive. Moreover, the results revealed that the intellectual stimulation of code writing and improving programming skills are the most important motivators for project contribution.

Roberts, Hann, and Slaughter (2006) evaluated the relationships between the motivations, participation, and performance of the Apache projects developers. The results show that past-performance rankings enhance developers' subsequent status motivations. Two extrinsic motivations were conceptualized: use-value that measures the extent to which solving bugs, or problems, or adding needed features is important to developers in motivating their participation, and status motivation that measures the motivating potential of status. The archival data collected from a longitudinal field study (four years) of software developers. A targeted survey was used with a 30% response rate leading to 325 participants. The results revealed that developers' motivations are related. Being paid to contribute to Apache projects is positively related to developers' motivations but negatively related to their use-value motivations. Also, the external rewards did not decrease the intrinsic motivation; instead the status motivations enlarged the intrinsic motivations. Moreover, participation is affected by different motivations. Developers who are paid for participation have above average contribution levels, while developers who possess use-value motivations have below-average contribution levels. Therefore, contribution levels are not significantly impacted by intrinsic motivations. On the other hand, the level of contribution impacts the performance rankings.

Wu, Gerlach, & Young (2007) explored the OSS developers' intentions to pursue their involvement in future project development. The authors analyzed the motivations of F/OSS developers to identify the significant determinants of developers' intention in F/OSS related activities. The authors collected data from a field survey of 148 participants of current OSS projects working in three communities: SourceFourge.net,

Debian.org, and OpenWebmail.org. The sample consisted of 148 participants where 127 were volunteer developers and 21 were paid employees. The research model for the study was based on expectancy-value theory (EVT). EVT is a cognitive–motivational theory that relates an individual's level of motivation to the expectations and value/valence (positive or negative) held by the individual on reaching a goal Lynd-Stevenson (1999). The model clarified understanding the developers' incentives by measuring both the subjective importance of the motive and confirmation of the outcome expectancy. The results showed that satisfaction with contributing in OSS projects has the strongest influence on OSS participants' willingness to participate in future projects. The developers' motives on enhancing human capital and satisfying personal needs appear as the second position. Moreover, developers acquire some OSS products for a personal or job related use. The findings supported the idea of reciprocity where people receive help and support based on previous contributions. Thus, the indirect help influenced the intention of involvement in future projects through satisfaction. Also, participants believed that contributing to OSS projects development has influence on their career advancement as well as on human capital while obtaining the software applications they need. However, the results showed discrepancies in the developers' satisfaction where 14% rated their experience as not satisfying; 28% rated their experience as not pleasant; 43% rated their experience as not contented; and 51% rated their overall experience as not delighted. Of those surveyed, 41% indicated that participating in open source projects did not make it easier to get a better job; 43% did not experience career advancement;

and 37% had not found participating to be an important part of their job. Conversely, only 10% rated advancing their skills in developing software neutral or less.

Bitzer, Schrettl, and Schröder (2007) demonstrated that traditional signaling payoffs (extrinsic factors) don't explain the involvement of volunteers in their humble and invisible OSS projects and activities. Based on the private-provision-of-public-goods model (Hendricks, Weiss, & Wilson, 1988; Bilodeau & Slivinski, 1996), the authors were able to define the characteristics of OSS providers as well as the time of provision. They relied on the following intrinsic factors in order to generate the model:

a. the need for a particular software solution, i.e. the phenomenon of user-programmers
b. the fun to play, i.e. some form of payoff to master the challenge of a given software problem
c. the desire to give a gift to the programmer community as well the desire of belonging to a community of active OSS programmers, i.e. a gift benefit

The study showed that OSS is provided at maximum speed with no delay. Therefore, these findings are consistent with Hertel, Niedner, and Hermann (2003) and Lakhani and Wolf (2005). They suggest that the key force behind the voluntary involvement of OSS programmers is driven by intrinsic motives which are the most important reason for programmer's enthusiastic commitment to OSS projects.

Members of the F/OSS Communities

Studies of OSS demographics show that the 'average' OSS contributor is about 30 years old and well-educated. Hars and Ou (2002), for instance, revealed that 54 % of the

contributors in their sample were under than 29 years old and 72% possessed college or graduate degree. Similar results were found by Krishnamuturthy (2002), Hertel, Niedner, and Hermann (2003) , and Lakhani and Wolf (2005).

Moreover, the vast majority of open source projects comprise fewer than five members (Hunt & Johnson, 2002; Crowston & Howison, 2004; Krishnamurthy, 2002, 2005). For example, Krishnamurthy (2005) showed that some successful F/OSS projects are designed to be small. By using excerpts from the Frequently Asked Questions (FAQ) in the team's original manifesto, he claimed that the Firefox development team (six members when the study was conducted) discourages people to submit patches. Rather than seeking a large number of developers and interested individuals, the core team provides the code for their programs to the world for free, but does not allow just anyone to participate in the development of the product. Based on public online conversations, Krishnamurthy (2002) provided five theoretical explanations to describe the "closed-door" approach in F/OSS. The first justification is that evaluating potential members is time consuming for the developing team. The next two explanations are based on self-selection based on rigid entry requirements needed for only highly persistent programmers. The fourth argument is related to the fun-driven intrinsic motivation arguments which recommend that extending a group could damage the fun of the activity. The last argument is that complicated projects that are intended for diverse users' capabilities necessitate a small team since they involve input in both technical and user interface areas.

In addition, "core developers" were defined as participants who are identified as being on the core team by the F/OSS project and who have formal decision rights in the project (von Krogh, Spaeth, & Lakhani, 2003) In order to examine the value of peripheral members to the software development effort in a F/OSS community, an analytic tool called "innovation process history" was created by matching 241 concrete software features to 2,402 changes in software source code repository and 20,129 exchanged messages among 798 individuals. The study revealed that peripheral members initiated the development activity in the community, developed the majority of the new features, provided critical solution, and tested information during the development process while core members developed performance-related features. Moreover, the study showed that the interactions between core and periphery members are essential for problem solving and knowledge creation in the community.

Overview of the Targeted Open Source Applications

Moodle

Moodle is a web based Course Management System (CMS) designed around pedagogical principles using the collaborative possibilities of the Internet. The word Moodle was originally an acronym for Modular Object-Oriented Dynamic Learning Environment (http://moodle.org/). It is provided under the GNU Public License and included many features within an e-learning platform such as forums, content management resources, quizzes with different kinds of questions and several activity modules. Moodle is widely used including 330,000 users speaking over 70 languages in

196 countries. Moodle is one of the most user-friendly and flexible open source courseware tools available (Reynolds, 2003).

OpenOffice

Donated by Sun Microsystems, the OpenOffice source code is written in C++ and delivers language neutral and scriptable functionalities. Thus, this architecture allows the use of the suite as separate application or as embedded components in other applications. All documents can be saved in OpenDocument format; the new international standard for office documents (http://www.openoffice.org/). OpenOffice includes five main components: "Writer" word processor, "Impress" tool for creating effective multimedia presentations, "Draw" tool to communicate with graphics and diagrams, "Calc" spreadsheet program, "Base" program to access databases that enables users to manipulate database data.

Mozilla

Mozilla Foundation was created to host Netscape Communicator as open source software. Later, Mozilla suite was released including under the GNU General Public License and is the second most popular browser worldwide as of December 2007 (http://www.mozilla.org/). It includes tabbed browsing, a spell checker, bookmarking, and a search system that uses Google. Thus, anyone can view, modify, redistribute the source code, and it includes more than 2,000 add-ons that can be added by users. Other internet-related applications are developed by Mozilla such as Camino, Bugzilla and SeaMonkey.

Koha

Koha is an Integrated Library System (ILS) and was the first open source ILS. It is distributed under the GNU General Public License (http://www.koha.org). In use worldwide, its development is steered by a growing community of libraries collaborating to achieve their technology goals. Koha's impressive features set continue to evolve and expand to meet the needs of its user base. Koha includes modules for circulation, cataloging, acquisitions, serials, reserves, patron management, branch relationships, and more.

LimeSurvey

LimeSurvey is an open source online survey application written in PHP based on a MySQL database (http://www.limesurvey.org). Limesurvey enables users without coding knowledge to develop, publish and collect responses to surveys. Surveys can include branching, custom preferred layout and design (using a web template system), and can provide basic statistical analysis of survey results. Surveys can be either publicly accessible or be strictly controlled through the use of "once-only" tokens for each survey participant. Additionally results can be anonymous be separation of participants data and result data, even for controlled surveys. LimeSurvey is available in more than 49 languages and dialects. In 2008 LimeSurvey was nominated in the category Best Project in the SourceForge.net Community Choice Awards 2008.

Conclusion

This review of literature supports the need to gather further information related to the participation in F/OSS. The available studies do not provide a clear explanation of the

potent incentives of participants. Also, few studies have rigoursly explained the potential relations and correlations between the different motivational factors related to the incentives of contributors testing different F/OSS projects.

Summary

The chapter offered a review of the available literature related to the purpose of the study. The summarized studies provide a foundation for the base of the present research which is to explore the motives and incentives behind the volunteer participation and contribution to F/OSS. The difference in the revealed findings shows the need for further and deeper studies.

CHAPTER III

Method

The main purpose of this study was to investigate contributors' motivations to join and remain in F/OSS based on motivational theories (intrinsic and extrinsic). The research questions were to explore who is contributing to the F/OSS, why these members participate in the F/OSS communities, and what motivate them to join as well to maintain their membership in the F/OSS communities.

Selection of the Population

The population for this study consists of contributors to different open projects: Moodle, OpenOffice, Mozilla, Koha, and Limesurvey. In November 2008, a survey was sent online to eight different groups of contributors to OSS projects: Moodle developers, Moodle translators, Moodle forum, Mozilla developers, OpenOffice education, OpenOffice developers, Koha developers, and LimeSurvey developers.

Moodle developers were shown on the developers' Webpage with 149 developers http://moodle.org/mod/cvsadmin/view.php. An account was created to post requests for participation on the "talk pages" of the 149 developers. Users' talk pages are a place that someone can leave a message for an individual user. However, 14 of them were set up to reject messages from people who are not listed as contacts, and therefore 135 messages were sent successfully.

Moodle translators email addresses were available online and messages were sent using the author's email account. The webpage showed 159 email addresses. However,

after sending the emails, 14 emails were bounced back and only 145 messages were sent to Moodle translators (http://docs.moodle.org/en/Translation_credits).

Moodle forum is a specific Webpage where anyone who has an account in Moodle can post a thread and members can reply. An invitation to take the survey was posted to the forum at http://moodle.org/mod/forum/view.php?id=6801.

All the other projects possess their own public mailing lists. The author subscribed to the following mailing lists and sent an invitation including the survey link: OpenOffice education at dev@education.openoffice.org, OpenOffice developers at dev@openoffice.org, Mozilla developers at project_owners@mozdev.org, Koha developers at koha-devel@lists.koha.org, Limesurvey developers at limesurvey-developers@lists.sourceforge.net.

Instrumentation

The survey instrument was based on the questionnaires employed in previous studies (Hars & Ou, 2002, Pfaffman & Schwartz, 2003; Wu, Gerlach, & Young, 2007; Baytiyeh & Pfaffman, 2009) related to motivational factors in online communities (See Appendix). The patterns of the instruments fall into three broad categories: demographic characteristics accompanied with general questions, open-ended questions investigating the reasons behind joining the OSS community, and multiple-choice questions inspecting the motivational factors.

The demographic questions included age, gender, education, current occupation, and months/years of membership in the F/OSS project community. Other questions were

related to the number of weekly hours of participation in project-related activities such as writing code, debugging code, writing documentation, and participating in discussion.

In order to capture the beliefs and perceptions of participants about their memberships, open-ended questions were included in the second section of the survey inquiring the reasons behind joining the community, and if they remain members for the same rationale. Also, participants were asked if they are paid to contribute, if they are members in multiple OSS projects, the role they have inside the community as well as to rate their personal satisfaction for their membership in the online community. Other questions were related to the rewarding aspects of their membership as well as the importance of their participation. These questions served to identify the members of the open source projects and depict the participants' background in terms of experience and commitment to the community.

The third section of the survey focused on the potential motivational factors of the volunteer contribution. This section included 36 statements where participants were asked to rate how important each statement is for their contribution in the open source applications on a scale of 7 (1= very poor, 7=very strong). Six main motivational factors were covered: learning, social, extrinsic, creation, flow, and altruism. Examples and comments' boxes were provided for each statement to check the validity of each of 36 Likert-scaled statements.

Learning

One potential incentive for the open source community membership is the desire to learn. Since adults are able to identify their needs (M. S. Knowles, 1980; Wentzel,

1994), they may engage in learning situations to meet a specific goal (Wlodkowski, 1989). One type of learning that could occur in the contribution process is to discover the strategies and methods involved in the process of participation. Each community has its own guidelines for contribution that encompasses a set of regulations. Thus, the learning-driven aspect was depicted through the following statements: (1) to read about my areas of interest, (2) to learn about dates, places, people, and things, (3) to learn about new tools (4) to learn strategies and methods in the project, (5) to know the little-known stories and facts, and (6) for my personal growth.

Extrinsic

Another potential motivational factor for joining the open source communities is the extrinsic motivation. One immediate benefit related to the open source software is the direct use of the product. Von Hippel (1988) found that participants have strong incentives to create solutions to their particular needs. Also, Lerner and Tirole (2000) showed that through their contributions, participants acquire an immediate payoff and a delayed payoff. The immediate payoff subsists in the own use of the developed product. The delayed payoff is the potential future rewards in terms of recognition and reputation. Likewise, one's social stature within the F/OSS community can be related to the performance in the group's activity. The extrinsic motivational statements included: (1) to increase academic or professional success, (2) to be better than others, (3) to enter competitions with others, (4) to do something that few others know how to do, (5) to gain social stature, and (6) I need this part of the application.

Social

Another incentive for contributing in an open source project might be to socialize with the community. Individuals may contribute because they believe in the community since being a member of a community is one of the fundamental human needs (Maslow, 1987, Deci, Vallerand, Pelletier, & Ryan, 1991; Ryan & Deci, 2000). Having colleagues and friends from all over the world by stimulating conversions and expressing suggestions may be an essential objective. Another social factor is sharing knowledge where the main purpose is the benefit of the whole community by helping others. The social-driven motivational factor was captured through the following statements: (1) to be liked, (2) to share what I know, (3) to belong to a group, (4) to help others appreciate or participate, (5) to use this project to stimulate conversation, and (6) as a commitment to the project community.

Creation

One potential motivational factor is the creation of a public artifact. Constructionism or "learning by making" is the major motivational factor that might help contributors acquiring skills through personal creation and innovation (Harel & Papert, 1991). Members in open source software develop code and debug patches for others to experience. Also, the act of creation itself might provide satisfaction: from the initial stages to the completion of the project in order to witness the end of the course of action. The creation-driven motivational factor was depicted through the following statements: (1) to see the fruits of labor, (2) to adjust or personalize methods, (3) to express myself,

(4) to find or create something new or rare, (5) to nurture or sustain to completion or maturity, and (6) to see my works and achievements.

Flow

Another incentive might be the flow-driven motivational factor. Members might be loosing track of time when they are completely engaged in open source-related activities. Hence, a flow state can arise when the challenge of the task matches the contributors' skills (Nakamura & Csikszentmihalyi, 2003). Being a project owner or translator requires coordinating numerous tasks that need sometimes intense awareness, concentration, and self-confidence in abilities. These responsibilities might be challenging and therefore a flow state might be attained by contributors. The flow-driven motivational factor was rated through the following statements: (1) to feel time change, (2) to feel a sense of control, (3) to overcome new challenges, (4) to do something as an end in itself, (5) to have clear goals and feedback, and (6) for fun and enjoyment.

Altruism

One more incentive might be the altruism-driven motivational factor. The open source community is often described as a gift culture which refers to behavior including acts of altruism and reciprocity. In lieu of tangible rewards, givers receive psychological benefits such as the satisfaction of helping or living up to some commitment (Ross-Ackerman, 1998). Moreover, these rewards such as boosting one's ego, enjoyment, and community identification provide intrinsic motivation to those engaging in OSS development. According to (Ozinga, 1999), altruism is a natural part of human nature and is exhibited in some manner by everyone. Based on this viewpoint, participants make

OSS contributions because they would like to help others by giving something back to those who have given them assistance (Mauss, 1959). In such a gift culture setting, given the abundance of resources, social status is not determined by what one has but by what one gives away, such is the case in the OSS community (Raymond, 1999). The altruism-driven motivational factor was rated through the following statements: (1) working for the greater good, (2) personal belief in open source software, (3) to provide something valuable to others, (4) to improve the quality of free software, (5) to leave a legacy, and (6) to help others.

Data Analysis

After data collection, the data was analyzed differently for each one of the sections included in the survey. The first section of the instrument included demographic questions to identify the participants in the F/OSS communities as well as general questions that helped in learning some details such as the type of activities members do for the projects, their weekly hours of participation, and if they participate in other OSS. Descriptive statistics were conducted to these questions in order to obtain the frequency, mean and standard deviation for each one of the questions included in the first section of the instrument.

The second section of the survey included ten open-ended questions that allow participants to describe what members do for the project, what caused them to join this project and if they keep participate for the same reason. Also, questions were intended to identify if members possess any specific role, if they have issues or concerns related to the projects or their membership in the F/OSS communities and in what ways working on

this project is rewarding for them. These open-ended questions were analyzed inductively using the constant comparative method (Bodgan & Biklen, 2007). The data was coded for patterns and organized into categories that address the goals of joining the open source communities as well as maintaining their membership in these communities.

The third section of the survey included 36 statements that were organized a priori under six categories of motivational theories; Learning, Extrinsic, Social, Creation, Flow, and Altruism. Each one of these theories was reflected through six statements and participants were asked to rate the 36 statements on a seven-point scale.

An exploratory Factor Analysis was applied to the 36 items in order to combine variables that are correlated with one another but largely independent from other subsets of items. To ensure the number of factors to retain, the Scree plot was examined.

Since the scree test is subjective and ambiguous, Horn's (1965) Parallel Analysis strategy was used. Parallel Analysis involves the construction of a number of correlational matrices of random data based on the sample size and the number of the variables of the real data. The average eigenvalues and 95^{th} percentile from the random data were compared to the eigenvalues from the real data. Factors corresponding to actual eigenvalues that were greater than the parallel average random eigenvalues were retained and all the other were discarded.

After ensuring the number of factors to retain, a confirmatory FA was applied to the 36 items to extract the factors and the correspondent items that fall under each factor. Descriptive names were generated for each factor and new variables were computed based on the mean of the items falling under each factor. In order to ensure the validity of

the statements that fall under each one the factors, the comments provided by participants were analyzed inductively to validate the essence of each statement and ascertain that each it belongs to the motivational factor.

A one-way repeated measures ANOVA was conducted to detect the main effects between the located variables. Also, Post Hoc tests were applied to detect any further significance between the motivational factors.

Nonetheless, since all of the previous analysis was conducted for all the 110 participants, an interesting inquiry was to investigate any difference between the paid participants and the strictly volunteers. Therefore, an independent-samples *t* test was conducted for each of the depicted motivational factors comparing the mean score of members who declared that they were paid to contribute to the F/OSS to the mean score of members who did not.

Summary

The chapter described the process of recruiting participants as well as data collection. Also, a detailed explanation of the instrument employed in the study was provided along with the procedure of data analysis.

CHAPTER IV

Results

The research questions of this study were to investigate who is contributing to the open source projects, why participants join the open source community, and what are the motives for those members to contribute, help, and remain involved in such activities. In the following, the results of these questions are presented.

Who is Contributing to the F/OSS?

The first research question was to identify who is participating in the Free Open Source applications. The invitations to take the survey were sent in November 2008. As of December 2008, 104 participants started the survey but only 68 completed all the questions. The invitations were sent one more time using the same email addresses and mailing lists provided above. As of January 2009, additional 59 participants started the survey but it was completed by 42 of them. The final sample was 110 participants who completed the entire questionnaire. Since the majority of the targeted participants belong to online communities using mailing lists, the response rate can't be accurately determined.

However, in order to have an approximation of the existing population, the mailing lists archives were examined for both months November and December 2008. The archives provide a list of messages sent by members along with the date and the author which offer an estimation of the active members at that period of time. Accordingly, the numbers of authors were inspected for Mozilla, Koha, Limesurvey, and OpenOffice public mailing lists (see Table 1). For participants in the Moodle project, the

sample was known, 38 developers and 19 translators completed the survey which implies a response rate of 28% and 13 % respectively. It is important to note that the talk pages and email addresses found on the Moodle webpages and used for the invitation process don't reveal if the members are still active or not.

The survey included general questions collecting participants' demographics such as gender, age, education, and current occupation (see Table 2). The respondents were mostly male (92%), 63% were 18-35 years old, and the majority (83%) had at least Bachelors degrees. These results are consistent with previous studies regarding the gender, average age, and the education level (Hars & Ou, 2002; Krishnamuturthy, 2002; Hertel, Niedner, & Hermann, 2003; Lakhani &Wolf, 2005).

Table 1: Numbers of participants in the first and second contact

	First contact November 2008			**Second contact December 2008**			
Software Application	Archives Members	Survey Not completed	Survey completed	Archives Members	Survey Not completed	Survey completed	**Total completed**
Moodle developers	149	6	25	149	3	13	38
Moodle translators	159	7	12	159	3	7	19
Moodle forum	25	3	4	20	1	3	7
OpenOffice developers	70	9	10	45	4	8	18
OpenOffice education	5	1	2	3	1	1	3
Koha developers	51	6	8	36	4	4	12
Limesurvey developers	22	3	5	15	1	4	9
Mozilla developers	27	1	2	4	0	2	4
Total	508	36	68	431	17	42	110

Table 2: Participants' demographics and their activity in F/OSS projects

		Frequency	Percentage
Gender	Male	101	91.8
	Female	9	8.2
Age	18-25	14	12.7
	26-35	55	50
	36-45	24	21.8
	46-55	11	10
	56-64	2	1.8
	64+	4	3.6
Education Level	High School	4	3.6
	Technical Degree	14	12.7
	Bachelors	43	39.1
	Masters	38	34.5
	Ph.D	11	10
Occupation	Developer	41	37.3
	Consultant	19	17.3
	Student	6	5.5
	Teacher/Professor	25	22.7
	Project Manager	17	15.5
	Retired	2	1.8
Number of years of contribution to the project	<1 year	6	5.5
	1-3 years	61	55.5
	4-6 years	37	33.6
	>6 years	6	5.5
Number of hours /week working on the project	1-2 hours/week	30	27.3
	3-5 hours/week	26	23.6
	6-10 hours/week	16	14.5
	11-20 hours/week	15	13.6
	>20 hours/week	23	20.9
How rewarding is to contribute to the project	I don't know	5	4.5
	Unrewarding	5	4.5
	Not very rewarding	3	2.7
	Sort of rewarding	20	18.2
	Rewarding	40	36.4
	Very rewarding	37	33.6
Paid to participate in the project	Yes	38	34.5
	No	72	65.5
Contributing to other OSS	Yes	47	42.72
	No	63	57.28

The results showed that contributors were mainly developers (37%). Others were teachers/professors (23%), consultants (17%), and project managers (15%) with very few students (6%). Also, 61% of the participants have been involved in F/OSS projects for at least 3 years and over half of them (51%) reported spending 1-5 hours per week working on the F/OSS projects. The majority of respondents (70%) reported that contributing to the project is "rewarding" or "very rewarding."

Moreover, about the third of participants revealed that they were paid to contribute to the F/OSS projects while the majority (66%) was involved as volunteers. Some participants (43%) also contributed to other OSS projects that were not targeted in this study such as Apache, Debian, Drupal, Gentoo, Joomla, Seamonkey, Thunderbird, Ubuntu, and Linux.

The survey inquired about the type of contribution to the F/OSS projects where writing new code appears to be the most time consuming for the contributors to F/OSS projects (see Table 3). In addition, the majority of participants (77%) reported spending an average of three hours/week providing support for users by contributing to newsgroups, mailing list, or message boards. The tasks of coding, commenting/cleaning up code, writing documentation, and providing support were specified in the survey questions. However, the other types of contributions: translation, proofreading documentation, quality assurance, usability testing, designing new modules/features, updating the website, project management, and fund raising/financing the project were provided by participants as other types of tasks (see survey in Appendix).

Table 3: Type of contribution to the F/OSS projects

Type of Activity	Frequency	Percentage	Average hours/week
Debugging code that I wrote	65	59	2
Debugging code that others wrote	60	54	4
Writing new code	66	60	6
Commenting or cleaning up code	40	36	2
Writing documentation	62	56	2
Reading bug reports	72	65	2
Providing support by contributing to newsgroups, mailing lists or message boards	85	77	3
Other			
Translation	22	20	4
Proofreading documentation	20	18	4
Quality assurance	15	14	3
Usability testing	17	15	4
Designing new modules/features	10	9	3
Updating the website	5	4	3
Project management	17	15	3
Fund raising/financing the project	7	6	3

Why People Join the F/OSS?

The second research question was to investigate what motivates people to join the free open source communities. To understand the participants' motivations, the survey included 36 statements related to the potential motivational factors for contributors in the Free Open Source projects. The statements were grouped under six categories: Learning, Extrinsic, Social, Creation, Flow, and Altruism. Each one of the theories was reflected through six statements and participants were asked to rate the statements on a seven-point scale (See Appendix).

Descriptive statistics were calculated to obtain the measures of central tendency as well as the measures of variability of each of the identified items (see Table 4).

The potential motivators were grouped a priori according to the motivational theories that informed them. To see which items are connected, an exploratory Factor Analysis (FA) was employed in order to determine which of the thirty six items formed related subsets.

The objective of FA is to combine into factors variables that are correlated with one another but largely independent of other subsets of items (Thurstone, 1947; Rummel, 1970; Kim & Mueller, 1978; Tabachnick & Fidell, 2007). This method was used as an expedient way to identify a smaller number of constructs (subsets) that represent the Likert-type items.

Table 4: Mean and Standard deviation of the 36 items

Statement	Mean	Std. Deviation
Learn1:Read about my areas of interest	4.81	1.82
Learn2:Know about dates, places, people, things	3.43	1.83
Learn3:Learn about tools	5.01	1.69
Learn4:Learn strategies and methods in this project	4.93	1.66
Learn5:Know the little-known facts and stories around online communities	3.41	1.85
Learn6:For my personal growth	5.47	1.58
Extrinsic1:Increase academic or professional success	4.78	1.82
Extrinsic2:Be better than others	2.76	1.71
Extrinsic3:Enter competitions with others	2.15	1.47
Extrinsic4:Do something that few others know how to do	3.75	1.96
Extrinsic5:Gain social stature	3.38	1.71
Extrinsic6:I need this part of the application	4.90	2.00
Social1:Be liked	2.78	1.78
Social2:Share what I know	5.27	1.52
Social3:Belong to a group	3.90	1.81
Social4:Help others appreciate or participate	4.52	1.88
Social5:Use this project to stimulate conversation	3.00	1.83
Social6:Commitment to the project community	4.46	1.91
Creation1:See fruits of labor	5.07	1.52
Creation2:Adjust or personalize methods	4.19	1.96
Creation3:Express myself	3.80	1.89
Creation4:Find or create something new or rare	4.74	1.93
Creation5:Nurture or sustain to completion or maturity	4.34	1.71
Creation6:See my work/achievements	4.96	1.73
Flow1:Feel time change	2.95	1.76
Flow2:Feel a sense of control	3.45	1.96
Flow3:Overcome new challenges	4.40	1.84
Flow4:Do something as an end in itself	3.48	1.83
Flow5:Have clear goals and feedback	3.71	1.87
Flow6:Fun/enjoyment	4.65	1.90
Altruism1:Working for the greater good	5.51	1.62
Altruism2:Personal belief in Open Source Software	5.84	1.52
Altruism3:Provide something valuable to others	5.74	1.39
Altruism4:Improve the quality of free software	5.55	1.56
Altruism5:Leave a legacy	4.03	1.94
Altruism6:Help others	5.35	1.50

Exploratory Factor Analysis

The first step to form the potential factors was performed by applying an exploratory FA with principal components extraction, eigenvalues equal or greater than 1.00 (Field, 2005; Ho, 2006). Only factors with eigenvalues of 1 or greater are considered to be significant. An eigenvalue is a ratio between the shared variance and the unique variance explained by a specific factor extracted. An eigenvalue greater than 1 indicates that more common variance than unique variance is explained by that factor.

The absolute loading value was selected to be more than .50 (Stevens, 2002; Field, 2005). Typically, researchers take a loading of an absolute value of more than .3 to be important. However, the significance of a factor loading depends on the sample size. Stevens (2002) recommends that for large samples, small loadings can be statistically significant. For example, a sample of 1000, the loading should be greater than .162. Conversely, for small samples, the loading should be higher. A table of critical values was produced by Stevens (2002) showing the significant loadings. Following the table, for this study with a sample size of 110 participants, the loading should be greater than .50.

An orthogonal varimax rotation was used to maximize the variance of loadings for each factor – within factors, across variables – so that all the factors are uncorrelated with each other (Tabachnick & Fidell, 2007). Therefore, varimax rotation tries to load a small number of variables highly under each factor resulting in more interpretable clusters of factors. The FA yielded to eight factors with eigenvalues greater than 1.00 (see Table 5).

Table 5: Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization

Statements	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6	Factor7	Factor8
Altruism3:Provide something valuable to others	0.803							
Altruism1:Working for the greater good	0.789							
Altruism2:Personal belief in Open Source Software	0.720							
Altruism6:Help others	0.714							
Altruism4:Improve the quality of free software	0.672							
Social4:Help others appreciate or participate	0.521							
Learn1:Read about my areas of interest		0.774						
Learn3:Learn about tools		0.745						
Learn4:Learn strategies and methods in this project		0.669						
Learn2:Know about dates, places, people, things		0.646						
Learn6:Personal growth		0.607						
Learn5:Know the little-known facts and stories around online communities		0.574						
Flow4:Do something as an end in itself			0.823					
Flow1:Feel time change			0.705					
Flow5:Have clear goals and feedback			0.663					
Flow2:Feel a sense of control			0.630					
Flow3:Overcome new challenges			0.604					
Extrinsic3:Enter competitions with others			0.504					
Flow6:Fun/enjoyment			0.503					
Social1:Be liked				0.839				
Extrinsic5:Gain social stature				0.775				
Extrinsic6:I need this part of the application					0.755			
Creation2:Adjust or personalize methods					0.565			
Creation1:See fruits of labor					0.554			
Extrinsic1:Increase academic or professional success						0.784		
Extrinsic4:Do something that few others know how to do						0.503		
Creation6:See my work/achievements							0.710	
Altruism5:Leave a legacy								0.625

Kaiser-Meyer-Olkin (KMO) measure of sampling was equal to .811 which represents the ratio of the squared correlation between variables to the squared partial correlation between variables. This value close to 1 indicates that patterns of correlations are relatively compact and so FA should yield distinct and reliable factors (Kaiser, 1970; Field, 2005).

Also, the Bartlett's test of sphericity which investigates the adequacy of the correlation matrix is significant (<.001). Therefore the hypothesis that the correlation matrix is an identity matrix – the variables are independent – was rejected. And therefore, the results of both KMO measure of sampling and Bartlett's test showed that using FA is appropriate for this study.

Scree-test

Construct definition, measurement, and validity are critical to the behavioral sciences, and determining the number of meaningful factors represented by measures is an important step. Another commonly used method for determining the number of factors to retain is Cattell's (1966) scree test. The test involves an examination of a plot of the eigenvalues for breaks or discontinuities. A scree plot (Figure 1) shows eigenvalue magnitudes on the vertical axis, with number of factors constituting the horizontal axis. The eigenvalues are plotted as circles within the graph, and successive values are connected by a line. Factor extraction should be stopped at the point where there is an "elbow" or leveling of the plot (Cattell & Jaspers, 1967).

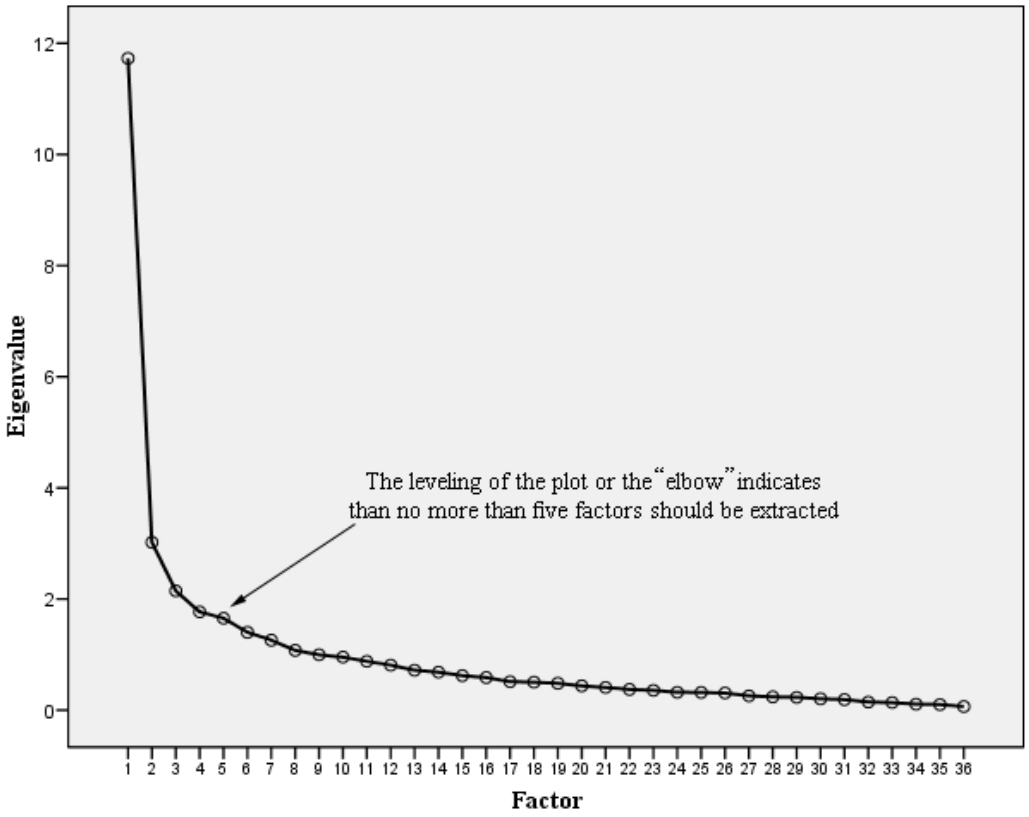

Figure 1: Illustration of the Scree-test for the 36 items

After inspection of the Scree-plot, the line appears to start forming an elbow at the 5th component, which suggests extracting no more than five factors.

Parallel Analysis

Although the Scree test may work well with strong factors, it suffers from subjectivity and ambiguity (O'Connor, 2000; Hayton, Allen, & Scarpello, 2004). Horn (1965) proposed a strategy called Parallel Analysis (PA) that is considered to be one of the most accurate methods for deciding the appropriate number of factors to retain (Zwick & Velicer, 1986; O'Connor, 2000; Hayton, Allen, & Scarpello, 2004). The rationale underlying PA is that nontrivial components from real data with a valid underlying factor structure should have larger eigenvalues than parallel components derived from random data having the same sample size and number of variables (Ford, MacCallum, & Tait, 1986; Lautenschlager, 1989). Thus, PA involves the construction of a number of correlation matrices of random variables based on the same sample size and number of variables in the real data set. The average eigenvalues from the random correlation matrices are then compared to the eigenvalues from the real data correlation matrix, such that the first observed eigenvalue is compared to the first random eigenvalue, the second observed eigenvalue is compared to the second random eigenvalue, and so on. Factors corresponding to actual eigenvalues that are greater than the parallel average random eigenvalues should be retained. Actual eigenvalues less than or equal to the parallel average random eigenvalues are discarded (Glorfeld & . 1995; Horn, 1965; Zwick & Velicer, 1986). Thus, a factor that does not account for more variance than the parallel factor obtained from random numbers would not be retained

because meaningful components extracted from actual data should have larger eigenvalues than parallel eigenvalues.

In this study, the original data set consists of 110 observations for each of 36 variables, so a series of random data matrices of this size (110x36) was generated, and eigenvalues were computed for the correlation matrices for the original data and for each of the random data sets. The eigenvalues derived from the actual data were then compared to the eigenvalues derived from the random data (see Table 6).

In Horn's (1965) original description of this procedure, the mean eigenvalues from the random data served as the comparison baseline. The currently recommended practice is to use the eigenvalues that correspond to the 95th percentile of the distribution of random data eigenvalues (Cota, Longman, Holden, Fekken, & Xinaris, 1993; Glorfeld & . 1995).

Plotting the actual versus randomly generated eigenvalues provided a clear visual comparison of the results. Figure 2 shows a plot of the eigenvalues from the real data along with the mean and 95th percentiles of the eigenvalues for the random data that were generated in the fashion described above. PA supports retaining the five factors whose actual eigenvalues lie above the lines representing the randomly generated eigenvalues. It is important to note that the 95th percentile eigenvalues are very close to the PA mean and therefore, both values appear as one line in the plot (see Figure 2).

Table 6: Real data, Random data, and the 95th percentile of the random data

Real Data Eigenvalue	**Mean PA Eigenvalue**	**95th Percentile Eigenvalue**
11.730	1.721	1.806
3.020	1.629	1.695
2.150	1.561	1.620
1.770	1.504	1.552
1.653	1.422	1.495
1.401	1.420	1.446
1.260	1.36	1.398
1.075	1.318	1.356

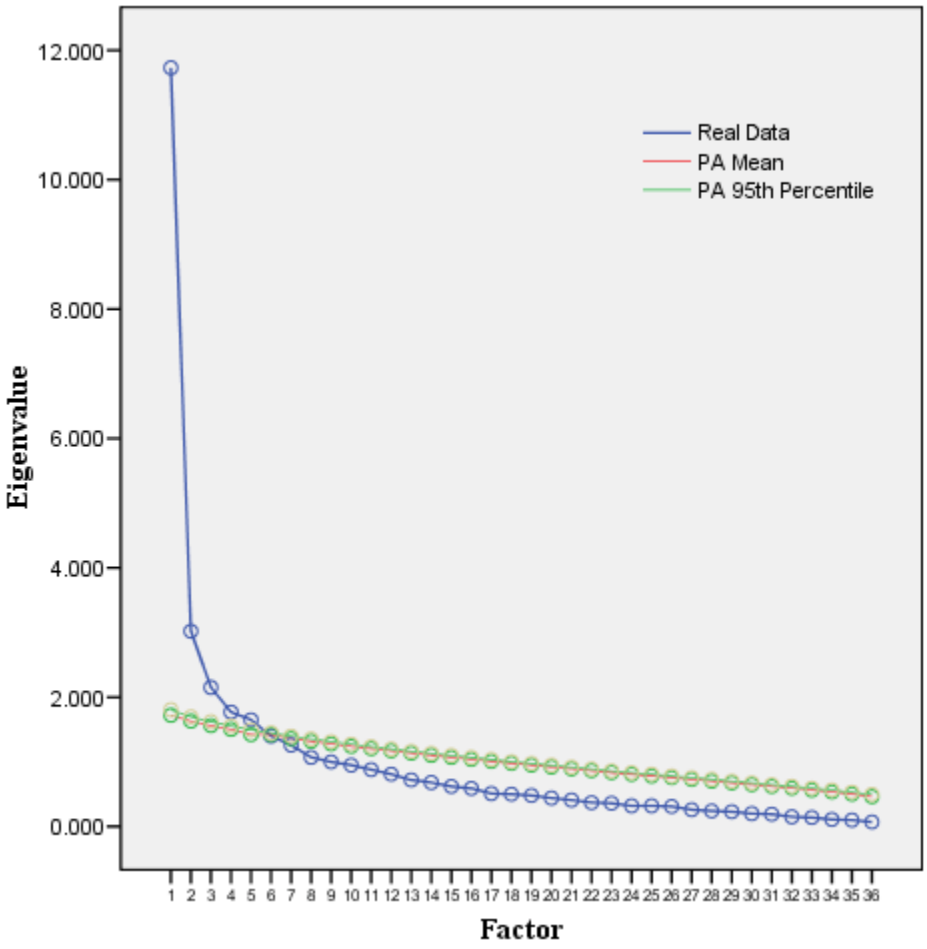

Figure 2: Plot of actual versus randomly generated eigenvalues

Confirmatory Factor Analysis

The last step was to confirm the number of factors to be extracted. A confirmatory FA with the principal component extraction method was re-applied to the 36 items to extract five factors and the correspondent items that fall under each factor. The absolute loading value was selected to be more than .50 (Stevens, 2002; Field, 2005). The rotated varimax extraction of five factors generated 28 items and accounted for 32.58% of the total variance.

The sizes of the loadings reflect the extent of relationship between each variable and each factor (see Table 7). A statistical indication of the extent to which each item is correlated with each factor is given by the factor loading. In other words, the higher the factor loading, the more the particular item contributes to the given factor.

Descriptive names were generated for each factor. The survey included specific boxes giving the participants the opportunity to comment on each statement, which served as a means to check the validity of the derived categories. Factor 1, which accounted a variance of (σ^2=11.7%), was labeled Altruism motivator. Factor 2 (σ^2=3.0%), was labeled Learning motivator. Factor 3 (σ^2=2.1%), was labeled Flow motivator. Factor 4 (σ^2=1.7%), was labeled Extrinsic motivator. Factor 5 (σ^2=1.6%), was labeled Creation motivator.

Also, Cronbach's alpha was calculated for each one of the obtained factors showing the altruism motivator with (.851), the learning motivator with (.844), the flow motivator with (.875), the extrinsic motivator with (.785), and the creation motivator with (.706).

Table 7: Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

Statements	Altruism	Learning	Flow	Extrinsic	Creation
Altruism3:Provide something valuable to others	0.797				
Altruism1:Working for the greater good	0.792				
Altruism6:Help others	0.723				
Altruism2:Personal belief in Open Source Software	0.710				
Altruism4:Improve the quality of free software	0.665				
Social4:Help others appreciate or participate	0.512				
Learn1:Read about my areas of interest		0.763			
Learn3:Learn about tools		0.755			
Learn4:Learn strategies and methods in this project		0.686			
Learn6:Personal growth		0.663			
Learn2:Know about dates, places, people, things		0.639			
Learn5:Know the little-known facts and stories around online communities		0.555			
Social2:Share what I know		0.504			
Flow4:Do something as an end in itself			0.786		
Flow1:Feel time change			0.700		
Flow5:Have clear goals and feedback			0.667		
Flow3:Overcome new challenges			0.649		
Flow2:Feel a sense of control			0.628		
Creation4:Find or create something new or rare			0.525		
Extrinsic5:Gain social stature				0.802	
Social1:Be liked				0.793	
Extrinsic2:Be better than others				0.553	
Extrinsic3:Enter competitions with others				0.543	
Extrinsic4:Do something that few others know how to do				0.508	
Creation1:See fruits of labor					0.685
Extrinsic6:I need this part of the application					0.680
Creation2:Adjust or personalize methods					0.552
Creation5:Nurture or sustain to completion or maturity					0.527

Repeated Measures ANOVA

After labeling the factors with descriptive names, five new variables were computed based on the mean of the items falling under each factor. A one-way repeated measures ANOVA was conducted to detect the main effects between the located variables. The results revealed significant differences among the five factor scores, ($F(4, 436) = 99.02$, $p < .001$). The graph (see Figure 3) shows the altruism factor as the most powerful motive for the contributors to participate in the Free Open Source projects with a mean of (M=5.41) on a scale of 7. The creation factor is the second important aspect (M=4.62) along with the learning factor (M=4.61). Finally, the flow and extrinsic factors have the lowest importance with means equal to (M=3.78) and (M=2.96) respectively.

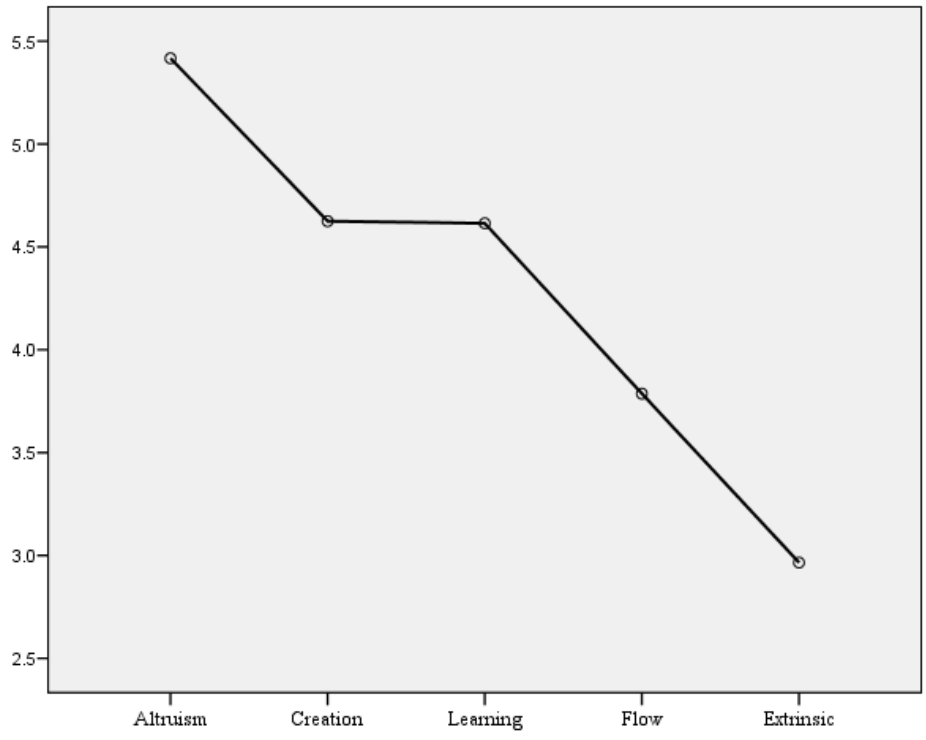

Figure 3: Estimated Marginal Means of Motivation on a scale of "7".

The Post Hoc tests using Bonferroni was conducted to investigate further significance between the five motivational aspects. The altruism motivator was significant with all the other four factors. The creation and learning motivational factors were not significant to one another but they were significant with both the flow and extrinsic motivational aspects at the .05 level.

Paid versus Unpaid Participants

The results shown in figure 3 included all 110 participants. However, some of them were paid to contribute to the F/OSS projects. In order to investigate the motives of participants to contribute to F/OSS, it is important to inquire if there is any difference in the motivational aspects between both groups of participants; the one who are paid and who are contributing for free. Among the 110 contributors who participated in the survey, 38 revealed that they are paid partially or fully to contribute to the project while the remaining 72 were strictly volunteers.

An independent-samples *t*-test was conducted for each of the five motivation factors—Altruism, Learning, Flow, Extrinsic, and Creation—comparing the mean score of subjects who identified themselves as volunteers to the mean score of subjects who did not (see Table 8). No significant difference was found between the paid and the unpaid participants in any of the five motivators (see Figure 4). No Post Hoc tests were conducted since no significance was located for any of the factors between the paid participants and the strictly volunteers members.

Table 8: The five factors compared for unpaid and paid contributors

	Unpaid Contributors		Paid Contributors	
Factor	**Mean**	**Standard Deviation**	**Mean**	**Standard Deviation**
Altruism	5.55	1.16	5.17	1.24
Creation	4.49	1.33	4.88	1.19
Learning	4.64	1.14	4.57	1.36
Flow	3.89	1.5	3.59	1.38
Extrinsic	2.95	1.37	2.99	1.06

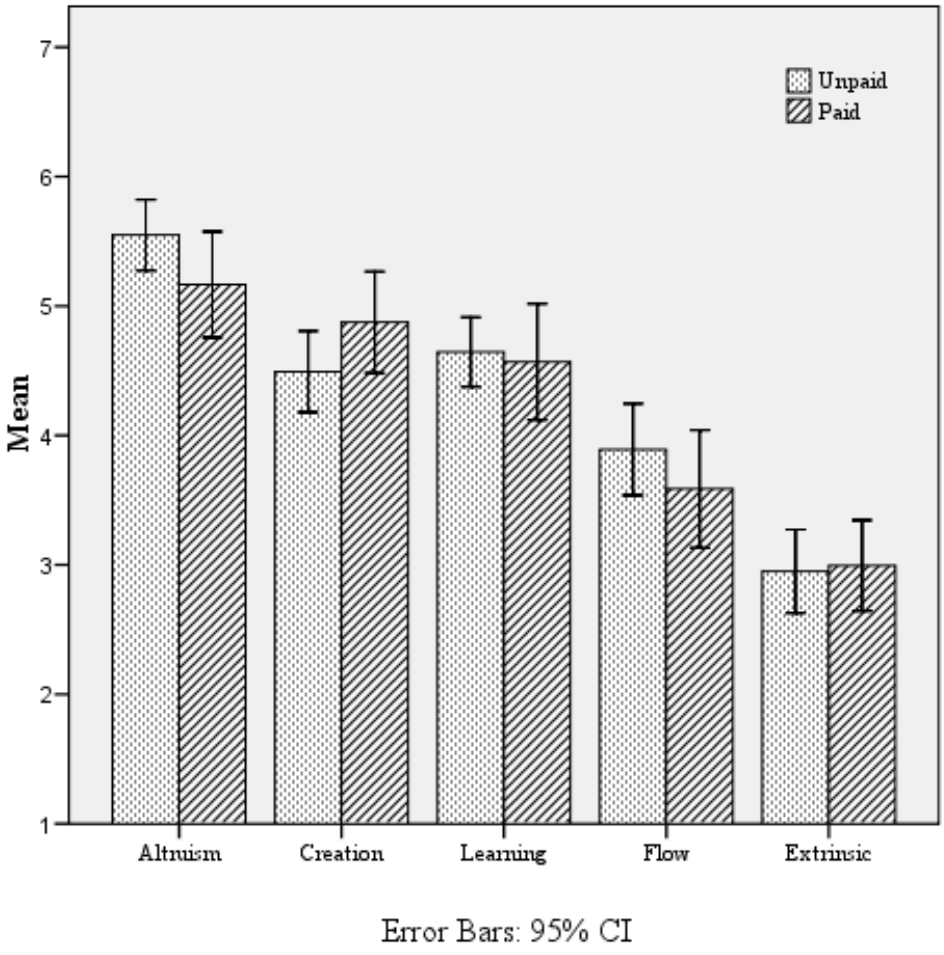

Figure 4: Comparison between the unpaid and the paid participants for the five factors

Why do Members Maintain their Membership in F/OSS?

The purpose of this study was to inquire about the significant aspects of motivation for contributors to F/OSS as well as to investigate the reasons behind joining and remaining members in the F/OSS communities. The third research question was to understand the rationale for participants to maintain their membership in the F/OSS communities. Therefore, along with the multiple-choice questions, the survey included ten open-ended questions that reflect contributors' perceptions about their membership and role inside these communities. The F/OSS communities are formed of groups of contributors who engage in several shared activities; coding, translating, writing documentation, and others. Lave and Wenger (1991) believe that learning is a function of the activity, context, and culture in which it occurs. Also, they assume that participants become more proficient through their practice and that social interaction is a critical component of learning.

To confirm the findings of the motivational indicators and ensure the motivational factors, the open-ended questions were examined. These comments were analyzed inductively using the constant comparative method (Bodgan & Biklen, 2007). The analytic strategy identified issues within the case and look for themes that transcend the context and settings inside online communities. The data was coded for the key points and patterns related to this study's questions about the motivations for contributing to open source software. The themes were organized into categories that address the goals of joining online communities, maintaining the membership, as well as investing time

and effort in F/OSS for a better description and understanding of the open source phenomenon.

Patterns were coded related to the motives of contributors, then refined and revised based on the participants' goals and satisfactions. The evolved themes were: "building a Utopian community", "Commitment to freedom", and "sharing a pool of knowledge." These findings are expanded below using illustrative quotes and examples from the participants' comments.

Building a Utopian Community

Computer mediated communication can obscure race, ethnicity, and social classes. These communities welcome any member and each one has equal opportunities and prospects of roles and positions, since no one distributes the tasks.

When asked whether they had a particular role, the most frequent answer was that participants chose to work on what they believed to be their expertise. For instance, some translate webpages to their native languages, others maintain the websites, some improve accessibilities while others test the modules usability, and so on. As such, some participants stated "No, I don't have a specific role, I am just a team member helping where I can help", and "there are not so many user experience experts in the open source world, so you fill your own niche here." Other participants revealed that they have a role that is widely recognized by other contributors and noted "I'm currently one of the 46 core developers in the moodle project. I think it happened because of my contribution to the community", while another participant declared "I created that role. I volunteered to start a subcommunity site."

Another theme found in the participants' comments and falls under the community belonging is the commitment to give back to the community (Hoffman, 1981). When asked about the reasons behind contributing to the project and remaining as members, the consistent theme was *community support*, or as several participants expressed it "the community spirit". A typical comment was "I used it, needed help, went to the community to get the help. Once I understood more, I contributed back by helping new users coming on board."

These communities recognize everyone's efforts as well as the importance of helping the community, where each member can have somehow a positive impact, and the objective is to do the best for their project and community. Typical comment comes from one participant:

> I hope to see the world change for the better for children in developing countries - see teachers overcoming their barriers is rewarding, see teachers overcome barriers for their students, see students able to learn no matter their circumstances, see students becoming engaged with their learning by helping their teachers to become open to new technologies - very rewarding

Commitment to Freedom

Another motivator theme that was shown as a reason to join and be committed to open source communities was "freedom". The fact that contributors can have the freedom to express themselves to an appreciative audience and have their talents recognized seems to be very rewarding. Contributors have the will to free the world from the private companies and they believe that everyone everywhere should have the right of using the

latest technology. A common pattern found in the participants' answers revealed the *commitment to Free Software ideals and principles*. Some comments were "I'm doing this work for free.... other people can have it free", and "Open Source is one of the world project to provide free software for everyone, I feel better to contribute to all people instead of a few who have big wallets."

In open-source communities, organization and function exist on many levels; the network is not just the Internet, but the people doing the work form a distributed, loosely coupled, peer-to-peer network (Raymond, 1999). This structure provides flavors from various expertises and from all around the world. Participants revealed that they admire the fact of being a member of a free community with no boundaries; they love open source for it being "Open." As such, some comments were "We want to become independent from big software companies that provide bad services for a lot of money", "we like the thought that others will benefit from our development work - especially those who otherwise couldn't afford a system, e.g. charities, libraries in poorer countries, and "working with a worldwide community and seeing your work being used by people all over the world." These comments reflect the importance of having an "Open" community that belongs to everyone and can be reached by anyone worldwide.

Moreover, creative teamwork utterly depends on true communication and is thus very seriously hindered by the presence of power relationships (Raymond, 1999). In OSS, there is no presence of any control that might obstruct the creativity and the communication between members. Members exercise their freedom by contributing to the modules they choose and on their own availability. One participant put it on his own

way “you'll have no pressure on you, so you do only what you want and where you want, you don't have any schedule. Achieving something and you get some sort of reward.”

Sharing a Pool of Knowledge

Developing F/OSS appears to be liberation of one’s intelligence. In contrast to developing software in a context that requires non-disclosure of trade secrets, OSS allows one’s creation to benefit society. A consistent theme expressed by most participants when asked about the reasons behind joining as well as remaining members in these communities was *sharing with the community*. The shared nature of learning and experience happens to be one of the main reasons to be a member of an open source community. Some typical examples from participants were “I enjoyed being able to customize the code and share those customizations with the community”, “now I keep participating because I like helping people with some problems related to the software I wrote and determine how best to share that code with the community”, and “I continue to participate because I enjoy sharing with the community and helping other teachers make effective use of technology for educational purposes.”

Another aspect that falls under the sharing characteristic is *collaboration.* The comments provided by participants revealed that making friends (Maslow, 1987) and cooperating with dedicated people worldwide is rewarding. Some typical comments were “I love the interchange and the cooperation to share code and teaching ideas”, “Getting to work with extremely talented people is important, I learned more while working and in cooperation with other community members”, and “being in touch with ‘GREAT’ people both personally and professionally is rewarding.”

Discussion of the Findings

The data derived from the Likert-scaled questions suggests that participants were mostly motivated by altruistic values. The other aspects that appeared to influence contributors joining the F/OSS were: creation, learning, and flow, whereas the extrinsic aspect was the most poorly rated. To confirm the findings of these motivational indicators and provide check for validity of the Likert-scaled statements grouped under the five categories, an analysis was conducted inductively using the constant comparative method (Bodgan & Biklen, 2007) for the comments provided by participants for each statement. The five categories are expanded below using illustrative quotes and examples from the participants' comments.

Altruism

Contributors to F/OSS spur participation out of sense of altruism (Hoffman, 1981; Mauss, 1959; Ross-Ackerman, 1998). The comments provided for each of the statements validated the categories produced by Factor Analysis. Participants rated the fact *to provide something valuable to others* as the highest component. For instance, as one participant stated, “the fact that anybody can benefit from my efforts, not just a proprietary vendor's customers, is very important.” Lindenberg (2001) shows that obligations can be considered as intrinsic motives and argues that, when people act based on a principle; they do not pursue external rewards. Also, contributors value the F/OSS for the *greater good*. Some comments were “I suppose that Open Source Software contributes to a better world”, “good tools are a benefit to the whole of humanity.” Within the same stream of thoughts, one branch of the obligation hypothesis can be

regarded as ‘reciprocal altruism’ where volunteers who invest their efforts may carry a belief that other programmers investing efforts into related problems will also make the resulting solution publicly available (Hoffman, 1981). Some developers participate in F/OSS as a *personal belief in the Open Source Software* or *to improve the quality of free software*. A typical pattern found in the majority of the comments was “making O/SS a better product” consistent with Richard Stallman’s (1999) vision of OSS as a social movement, promoting computer users’ right to use, study, copy, modify, and redistribute computer programs as part of fundamental democratic principles. For example, one contributor reported:

> I believe in the premise that education and learning should not be restricted simply due to their financial inability to access quality learning information and requisite software necessary for gaining the lifelong skills needed for progressing in today's society. Open Source Software can play a valuable role in providing learners the skills they need to achieve this.

Also, open source programmers *help others* by providing new features and writing programs that have open source codes at their own costs (time, energy, opportunity costs), and therefore belong to this category. Such motives include also the support to one’s community which is a variant of altruism and corresponds to Maslow’s needs for belonging. Some typical comments were “it’s not much of a community if nobody helps each other”, “I know lots of students who need good software but cannot afford the commercial products, so if I can help produce something useful to them, it is worthwhile.”

Creation

The second highest-rated factor is the creation of a publicly sharable artifact. Constructionism, or "learning by making", is shown to be a significant motivational factor that might help contributors acquiring skills through personal creation and innovation (Harel & Papert, 1991). Contributors to F/OSS are developers, translators, or project managers who create new features, modules, or scripts for others to use and experience. Also, the act of *creation* itself might provide satisfaction through the process itself: *to nurture or sustain to completion or maturity*, from the initial stages to the completion of the project in order to witness the end of the course of action. Some participants noted that they "love [to] support someone and hear that solutions are working", and "it feels good to see my code accepted by the project." Also, contributors might be exercising their autonomy through their participation process by creating something new they *need as a part of the application* and *to adjust or personalize*. The comments from participants show the importance of the creation factor through some repeated patterns such as "I like knowing I have made a difference in the application", and "I like being that first one to make this part of the application."

Learning

The learning aspect comes along with the Creation motivator. Since adults are able to identify their needs, they may engage in learning situations to meet a goal and to achieve competence because social competencies might affect their academic achievement (Knowles, 1980; Wlodkowski, 1989; Wentzel, 1994). Another indication of the desire to *learn* is that they rated reading highly. Some comments symbolizing the

learning pattern were such as “staying current is important”, “reading the documentation carefully helps me to learn more about the capabilities of the software”, “learning is key, learning about the product and about the people.”

Other types of learning that could occur during the contribution to the F/OSS projects are *learning about tools* and learning *strategies and methods* involved in the process of participation which might affect both their academic and professional growth. Some participants provided comments such as “I'm still learning new things and I'll never stop”, or “I've learned huge amounts about software development as a result of this project, and involvement in the development of new versions keeps me up to date with current development tools and techniques.”

Learning by *sharing* ideas is another pattern that was frequently found through participants’ comments. People seem to contribute as a means to share what they know. Such aspect is related to the community belonging and one of the fundamental human needs (Maslow, 1987; Deci, Vallerand, Pelletier & Ryan 1991; Ryan & Deci, 2000). Therefore, social factors might affect motivation just as they affect learning. For example, Anderson, Manoogian, and Reznick (1976) showed that children's motivation to work is to share their activity of drawing. Hence, members in the F/OSS projects communities are interested in helping others to appreciate the contribution in order to expand the group or to share their knowledge. Some typical comments showed the occurrence of the *sharing* aspect such as, “Sharing what I know with others is very important to me, and I enjoy realizing there are so many people willing to share their time and expertise”, “I like sharing my knowledge regarding important lifelong skills through

my lessons while providing learners practical knowledge", and "I feel that I am benefiting mankind when I can share knowledge with others."

Flow

The flow-driven motivation comes after the learning factor significance. Flow can arise when the challenge of the task matches the contributors' skills (Nakamura & Csikszentmihalyi, 2003). Contributors to F/OSS considered *doing something as an end in itself* and *having clear goals and feedback* as reasons for their participation in F/OSS. Some common examples from participants' comments were "developing software from analysis to implementation is an application of human problem solving, which itself is akin to breathing", and "I like feedback when it improves the code, feedback from users is always rewarding." Another flow pattern that was found in the comments was *overcoming new challenges*. Some participants expressed that "without a challenge it wouldn't be any fun" "It's always nice finding solutions to problems." Also, *the feeling of time change* appears to be a part of *fun and enjoyment*, as some participants expressed that "it's fun because I don't feel the time…if it was not fun, I would not participate", "it's fun when it works on a very complicated piece of code and I loose track of time."

Extrinsic

Figure 3 shows that the extrinsic factor was not as important as the other aspects. Such findings indicate that having a *social stature, to be better than others,* or possessing powerful qualifications inside the community is not a significant objective for contributors to join F/OSS communities. Obviously, some contributors might have strong extrinsic-driven motivational factors. However, their percentage appears to be very

modest compared with others within the sample. The pattern that was found in the comments showed participants' rejection to the extrinsic statements *feeling better than others*, and *to be liked*. Typical comments provided by contributors were "I usually don't care who's patch gets accepted as long the work gets done, I get more satisfaction from helping others learn", and "even if you write better code, it doesn't make 'you' better than somebody else. This attitude is detrimental to a community of contributors." Also, contributors don't regard *competition with others* or *doing something that few others know how to do* as beneficial to the community. A common found pattern was a denial of competition in their communities. As such, typical comments were "[competition] is not really a good attitude for a collaborative codebase", "Team work is more important and I place project success over personal distinction", and "I don't view this playing field as a competition between individuals but between ideas."

Thirty eight participants were paid to participate in the targeted F/OSS projects. The majority of the paid participants declared that they started working on the projects for free. Their efforts were recognized inside the community, and consequently they were offered a job, such as manager, or consultant. Other participants were students who were paid to work on a project as part of an assistantship. The question that might rise is whether there is any difference of perceptions between the paid and the unpaid contributors. The independent *t*-tests showed no significance between both types of participants across all the factors. Also, the altruistic values remained to be the highest rated factor among the paid contributors. Such outcomes indicate that the external rewards did not impact the contributors' motivations. Although some participants might

have both extrinsic and intrinsic motivators that balance one another for a single activity Linderberg (2001), the findings suggest that contributors to F/OSS are driven primarily by intrinsic motivators.

The Likert-scaled questions suggested that participants were mainly driven by altruistic values, creation objectives, and learning endeavors to contribute to the OSS projects. Moreover, the open ended questions showed that participants maintain their membership in the OSS communities as a means of having a 'Utopian' community, freeing the world from proprietary software, and sharing learning and experience with other members.

The OSS communities resemble to a 'Utopian' community with the recognition that human being have the capacity of self-determination and self-expression (Welton, 2005). The concept of 'Utopia' generally circles around ideas of the good society or the perfect society. Theorists treat Utopia as the motive force of change (Mannheim, 1936) or the obstacle to it (Marx & Engels, 1968). The most useful definition is a broad one where 'Utopia' is understood as the expression of the desire for a better way of living, a place and time where equality and freedom converge to liberate human creativity (Levitas, 2004).

The F/OSS communities welcome anyone on board and members enjoy assisting others especially the newcomers. The guidance offered by members is the essence of a community of practice. Participants spoke about the significant help they have received when they were new in the community and in return, they enjoy helping newcomers. Social interaction was a key to the learning and participants realized that they were not

alone in this journey. Within the community, they can engage in rational discourse and gain confidence in their role within the group. Indeed, the context of the interaction and the communicative infrastructure of the community foster a cooperative spirit among the members.

The characteristics of the OSS communities encompass a variety of skills where members possess personal autonomy that influences their feelings of responsibility. The feedback they get from other members in the community or from users offer them a sense of satisfaction because they feel appreciated for their work. Such experiences not only influence a personal satisfaction but also foster a commitment to the work community.

Moreover, the aspect of the shared learning in the OSS communities provides opportunities for all members to develop their capacities. For Aristotle, human beings' lives become good through the exercising of their capacities. People enter the public sphere where they can live, talk together, and recognize their commonality with others. Members in the community develop and exercise practical knowledge through deliberation within the context of particular problems and action situations (Welton, 2005).

Summary

The chapter included the measures as well as the analysis of the collected data. Also, this chapter discussed the findings of the multiple-choice and open-ended questions.

CHAPTER V

Conclusion

Free open source software has grown to be widely used. A variety of Open Source Software mostly contributed and maintained by volunteers exists for different operating systems in many languages. Free open source communities represent one of the prototypes of non-traditional innovation because they are ‘free’ from any corporate boundaries and ‘open’ to a worldwide community. In order to understand the development of this non-traditional innovation, this study targeted five open source applications by implementing an online survey to answer three research questions: who participate in the F/OSS projects, why do participants join the open source communities, and what are the motives for those members to contribute, help, and remain involved in such activities.

To learn about what drives people to devote their time and expertise to building and maintaining these OSS applications, an online survey with Likert-scaled items measuring different types of motivations were completed by 110 contributors (38 paid and 72 volunteers) to Mozilla, Moodle, OpenOffice, Koha, and Limesurvey. The survey included comments that were used to check the validity of the Likert-scaled items. Also, open-ended questions were provided to allow participants to express reasons in their own words for maintaining their membership in the open source communities. The Likert-scaled items showed that the open source contributors (both paid and volunteers) are largely motivated the intrinsic desires of altruism, creation, and learning. The extrinsic aspect do not seem to explain open source involvement.

The open-ended questions indicated that building a ‘Utopian’ community—the desire to help for the greater worldwide good—is one of the most important motivators for the 110 participants. Also, the commitment to freedom by creating free software and sharing a pool of knowledge from inside and outside the community were the main objectives that contributors have for joining and remaining members in the open source communities.

The OSS communities can be regarded as a ‘Utopian’ community based on egalitarianism because computer-mediated-communication can obscure race, ethnicity, and social classes. Joining a public online community and being committed to participation incorporates formal knowledge integrated with informal practice. Certainly, the advances in networking technology enable worldwide communication to support social interaction, cooperation, and collaboration for learning and knowledge building. These communities are special in that members have equal opportunities and prospects for roles and positions. Contributors seek to build a community that can recognize the importance of teamwork, where each member is welcome and can have somehow a positive impact. The fact that people worldwide use their work suffices as a satisfying reward. A sense of “community spirit” is spread among contributors and the big objective is to provide something useful for the digital generation. The Free Open Source community is a community where individuals are empowered with self confidence based on values. These values are unity as power, knowledge as strength, and cooperation as attitude.

Another important motivator that showed up as explaining participation in OSS projects is the commitment to freedom by liberating people from corporate software packages and creating affordable and high quality computing experiences. The freedom to study how the program works, modify it, redistribute copies, improve it, and release the improvements to the public provides a sense of liberty to contributors. Free, stable, and available software is the dream of the majority of the participants. Also, in F/OSS projects, contributors have the freedom to express themselves to an appreciative audience and have their talents recognized. Raymond (1999), who studied how OSS development works, stated: "I think that the cutting edge of open source software will belong to people who start from individual vision and brilliance, then amplify it through effective construction of voluntary communities of interest (p.23)." As such, there is a difference between being an employee limited by boundaries of private companies and being a member of an OSS community. The former acts on the principles of command and discipline; whereas the latter works on the principle of common understanding. Open communities are not a military parade; the goals are achieved through the effort of many converging wills without coercion. Consequently, the contributors need freedom in practice.

One other motivational aspect that explains why participants maintain their membership in the OSS community is sharing a pool of knowledge. Developing F/OSS is liberation of one's intelligence. In contrast to developing software in a context that requires non-disclosure of trade secrets, OSS allows one's creation to benefit society. The shared nature of learning and experience is one reason to be a member of an open source

community. The acquisition of this intelligence may become a resource, in utopian principle, accessible to people worldwide. Contributors value and enjoy the sharing practice of ideas and experiences while helping each other. Participants believe that interchange and cooperation are essential to increase their knowledge. This type of cooperation facilitates making friends as well as creating the feeling that their work is appreciated and useful worldwide.

Taking together, the Likert-scaled items and the open-ended questions, the most important findings of this study relate to the personal sense of altruism that developers feel vis a vis the Free Open Source Software movement. The work for "the greater good" —the fact that anyone can benefit from their efforts—appeared to be the leading motivator for participants. Through both closed and open-ended survey questions, participants showed a strong connection to the community. The altruism aspect was rated as the highest motivator by both paid and unpaid contributors. Also, the lack of any significant differences between these two groups suggests that payment has not impacted the intrinsic motivations of the paid participants.

Many would be puzzled to know that these participants were driven mostly by altruistic values where they are giving code, information, and expertise away, while also helping outsiders and new arrivals to come on board or to solve F/OSS technical problems. These values though might be the secret of an innovative and strong generation. As one of the participants reported

> I hope to see the world change for the better for children in developing countries – see teachers overcoming their barriers is rewarding, see teachers overcome

barriers for their students, see students able to learn no matter their circumstances, see students becoming engaged with their learning by helping their teachers to become open to new technologies - very rewarding

Participants' comments suggest that participants have a strong desire to help people worldwide, and to ensure that education and learning is available to everyone regardless of financial ability to access quality learning and the software necessary to gain the lifelong skills needed to progress in today's society. OSS contributors consider that the OSS movement can play a valuable role in providing learners the skills they need to attain their learning objectives.

Moreover, the findings suggest that the OSS communities are communities of practice. Communities of practice can exist everywhere, at work, at school, at a place of worship, or in our hobbies. They are a natural part of life regardless of their forms and their objectives. Their existence and survival depends on the voluntary engagement of their members. This engagement is reflected by the amount of belief members have in their community.

The Open Source communities are programming communities of practice that may be large because they are subdivided by topic based on specific applications. These communities may be short-lived or long-lived. We do not have the answer yet. We can assume that they are potentially distributed because the members can be dispersed over the world. Although these members are connected primarily via email and mailing-lists, members share knowledge, not in the form of communication, but the in the existence of the shared practice set of specific situations, problems and solutions. Also, the OSS

communities are heterogeneous because they are composed of members with different backgrounds. In this study, 37% of participants were developers and the remaining was from a variety of backgrounds. This diversity of backgrounds was shown by the fact that 42% of the participants contribute to other OSS projects other than those targeted by this study. This implicates that OSS communities exist both inside and across boundaries. Moreover, the findings showed that the OSS communities are spontaneous. Members came together because they need each other as peers and learning partners. Although OSS communities are not institutionalized, they are recognized, supported, and legitimatized as valuable entities.

Regardless of the form that the OSS communities have, their structure is the fundamental reason for composing programming communities of practice. The three essential elements are strongly present: the *domain,* which was reflected by the need for free and open software for everyone everywhere; the *community,* where members have the willingness to share experience and learning; and *practice,* which is manifested by the set of tools, ideas, and language that members use to communicate.

However, this study has several limitations should be noted. First and foremost, developers were mainly targeted in this study, because they were assumed to be the most interested in developing the OSS. Other contributors might be equally dedicated who instead focus on other aspects of the projects. Second, the number of participants was modest, and a larger sample would have offered more support for the findings. The respondents were only a subset of possible F/OSS communities, so they might not be representative of the general population. Third, the open-ended questions, though useful

for answering the research questions of this study, were not detailed enough to provide a complete understanding of individual contributors' motivations. Multiple interviews may be more appropriate to capture the users' lived experiences since people are not conscious of their motives all the time or they might report some motives but not others, especially when they have multiple motives. Interviews may have confirmed that F/OSS communities represent a community of practice and provided an understanding about members' identity development inside the community. Lastly, participants were members in only a few F/OSS projects; more projects would have provided better representation of F/OSS communities.

I have three recommendations for continuing this research. The main one is to replicate this study by targeting more OSS projects and recruiting more participants. Further investigations of additional F/OSS projects are needed to determine the degree to which the findings presented here are generalizable.

Another recommendation is to identify some participants who have recently started to contribute to free open source projects. A follow-up or a longitudinal study of these participants' identity development inside the community will provide a deeper understanding of F/OSS projects contributions. Tracking these newcomers' perceptions and attitudes through multiple interviews will help in discerning the process of involvement in the F/OSS communities.

My third recommendation is to identify some participants who were members in these F/OSS communities for limited a period of time. Sending surveys or conducting interviews with such ex-members provides insight about weaknesses and downsides these

communities might have and consequently to help researchers understand to what extent the F/OSS community can be called a 'Utopian' community.

Finally, several reasons may drive people who choose to be active members in an open source community. This study used psychological theories to inquire into the motivational essence for joining and staying involved in a community of volunteers using. The findings make a significant contribution to the emerging literature surrounding the issues of motivation behind participation in open source projects while offering some insights into a new approach for participation that could be implemented in the collaborative education field.

Although the study comprises a cognitive dimension to learning, it shows the importance of the shared nature of learning and the need for freedom in practice. The classroom itself could be considered a small community of practice composed of the three essential structural elements: a *domain* where students can learn about a specific topic, a *community* where students and teachers are willing to admit ignorance and share knowledge, and *practice* where everyone comes together to learn through a collaborative approach where knowledge and expertise are shared among teachers and students.

This study demonstrates that altruism and equality are central aspects for the prosperity of the open source movement. It is interesting, though, that some educational systems implement competition in their classrooms hoping to improve learning and foster students' productivity and creativity. These findings suggest that competition doesn't exist in this programming community of practice. As such, one of participants reported

“This is not really a good attitude for a collaborative codebase, team work is more important for me.”

On the other hand, it is important to pay attention to the development process of communities of practice. It may require leadership at multiple levels to address issues of the community progress to foster an effective knowledge system in the *domain* and to connect the people within the *community* to help develop an effective *practice*.

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APPENDIX

Motivations to Contribute to F/OSS

Demographics and General Questions

1. How old are you?

2. Please describe your education.

3. What is your gender?

4. Please choose *only one* of the following:
   - Male
   - Female

5. How long have you been contributing to this project?

6. What is your current occupation?

7. Do or have you contributed to other F/OSS projects? If so, please list them and briefly describe your participation.

8. On average, how many hours do you spend working on this project each week?

9. Please indicate which of the following activities you do for this project and about how much time you spend doing each.
   Please choose all that apply and provide a comment:
   - Debugging code that I wrote
   - Debugging code that others wrote
   - Writing new code
   - Commenting or cleaning up code
   - Writing documentation
   - Reading bug reports
   - Providing support by contributing to newsgroups, mailing lists or message boards
   - Other (please list)
   - Other (please list)
   - Other (please list)
   - Other (please list)

10. What caused you to start contributing to this project?

11. Do you keep participating for the same reason? If not, please explain.

12. Are you paid to participate in this project? If so, please explain (e.g., by whom, how big a part of your job this project is).

13. How rewarding is it to contribute to this project?
    Please choose *only one* of the following:
    - I don't know
    - Unrewarding
    - Not very rewarding
    - Sort of rewarding
    - Rewarding
    - Very rewarding

14. In what ways is working on this project rewarding?

15. Of the things that motivate you to contribute to this project, which one is the most important for you?

16. Please describe what you do for this project.

17. Please describe how you first contributed to this project.

18. Are you in a specific role that is widely recognized by other contributors to this project? How did that happen?

19. What do you do to encourage others to participate in this project?

20. What do you do to encourage people to take on additional tasks?

21. What are some issues and concerns that you have about this project?

Motivational Factors

For the following, please indicate how important each of these statements is for your continued work on this project. In the comments section, please provide your own example or comment to help me know what the item means to you.

22. To read about my areas of interest
    My Example: One reason I like contributing to the Linux kernel is that it allows me to keep learning new things about Ethernet hardware.

    1 2 3 4 5 6 7
    Unimportant o o o o o o o Very important
    Comments

23. To learn about dates, places, people, things.
    My example: I like knowing details about the Linux kernel like which file each networking function is defined in and who maintains each network driver.
    1 2 3 4 5 6 7
    Unimportant o o o o o o o Very important
    Comments

24. To learn about new tools
    My example: Working on Linux has allowed me to learn different tools for managing source code management.
    1 2 3 4 5 6 7
    Unimportant o o o o o o o Very important
    Comments

25. To learn strategies and methods in this project
    My example: Working with Linux helps me learn how to write code that others can understand and modify.
    1 2 3 4 5 6 7
    Unimportant o o o o o o o Very important
    Comments

26. To know the little-known stories and facts
    My example: I enjoy knowing the infrastructure of Linux and the history of the various forks that the networking code has gone through to get to the current version.
    1 2 3 4 5 6 7
    Unimportant o o o o o o o Very important
    Comments

27. For my personal growth
    My example: Contributing to the Linux kernel allows me to grow as a programmer and member of the team that develops it.
    1 2 3 4 5 6 7
    Unimportant o o o o o o o Very important
    Comments

28. To increase academic or professional success
    My example: Part of why I contribute to the kernel is that it provides evidence of my programming skills for potential future employers.
    1 2 3 4 5 6 7
    Unimportant o o o o o o o Very important
    Comments

29. To be better than others
    My example: I like it when my Linux patches are accepted instead of those of other programmers.
    1 2 3 4 5 6 7
    Unimportant o o o o o o o Very important
    Comments

30. To enter competitions with others
    My example: I try to get my patches submitted quickly and try to see that I have more lines of code in the official kernel than others.
    1 2 3 4 5 6 7
    Unimportant o o o o o o o Very important
    Comments

31. To do something that few others know how to do
    My example: I like contributing to Linux because not many people know how to write device drivers.
    1 2 3 4 5 6 7
    Unimportant o o o o o o o Very important
    Comments

32. To gain social stature
    My example: I like contributing to Linux because it increases my respect in the kernel development community.
    1 2 3 4 5 6 7
    Unimportant o o o o o o o Very important
    Comments

33. I need this part of the application
    My example: I contribute to Linux when my clients need particular bugs fixed.
    1 2 3 4 5 6 7
    Unimportant o o o o o o o Very important
    Comments

34. To be liked
    My example: People like me better because I contribute to the Linux project.
    1 2 3 4 5 6 7
    Unimportant o o o o o o o Very important
    Comments

35. To share what I know
    My example: I like working on Linux because it gives me a chance to share my programming techniques with others.
    1 2 3 4 5 6 7
    Unimportant o o o o o o o Very important
    Comments

36. To belong to a group
    My example: Part of why I contribute to the kernel is that I like to be a part of a group of kernel developers.
    1 2 3 4 5 6 7
    Unimportant o o o o o o o Very important
    Comments

37. To help others appreciate or participate
    My example: I like to help help the new contributors to the kernel learning how to make their code fit in with the standards and conventions we use.
    1 2 3 4 5 6 7
    Unimportant o o o o o o o Very important
    Comments

38. To use this project to stimulate conversation
    My example: When people learn that I am a kernel developer, they are often interested in talking about it.
    1 2 3 4 5 6 7
    Unimportant o o o o o o o Very important
    Comments

39. As a commitment to the project community
    My example: One of the things that sustains my work on the kernel is my commitment to seeing it continue to improve.
    1 2 3 4 5 6 7
    Unimportant o o o o o o o Very important
    Comments

40. To see the fruits of labor
    My example: Seeing a formerly buggy driver that I have debugged pass stress tests is very satisfying.
    1 2 3 4 5 6 7
    Unimportant o o o o o o o Very important
    Comments

41. To adjust or personalize methods
    My example: One of the things I like about Linux is that I can configure it to fit my specific needs.
    1 2 3 4 5 6 7
    Unimportant o o o o o o o Very important
    Comments

42. To express myself
    My example: Contributing to Linux gives me an opportunity to express my ideas by improving an existing component in the project.
    1 2 3 4 5 6 7
    Unimportant o o o o o o o Very important
    Comments

43. To find or create something new or rare
    My example: I take great satisfaction in contributing to drivers for cutting edge hardware.
    1 2 3 4 5 6 7
    Unimportant o o o o o o o Very important
    Comments

44. To nurture or sustain to completion or maturity
    My example: I work on coding for a new driver until it is completely bug-free.
    1 2 3 4 5 6 7
    Unimportant o o o o o o o Very important
    Comments

45. To see my work and achievements
    My example: I like knowing that others are benefitting from code that I wrote.
    1 2 3 4 5 6 7
    Unimportant o o o o o o o Very important
    Comments

46. To feel time change
    My example: It is sometimes surprising to realize that I've spent 8 hours working on a problem when it seems like I just started.
    1 2 3 4 5 6 7
    Unimportant o o o o o o o Very important
    Comments

47. To feel a sense of control
    My example: I like working on Linux because I am who decides what I will work on next.
    1 2 3 4 5 6 7
    Unimportant o o o o o o o Very important
    Comments

48. To overcome new challenges
    My example: At first I looked to find small bugs, but now I'm working at writing code for new devices from scratch.
    1 2 3 4 5 6 7
    Unimportant o o o o o o o Very important
    Comments

49. To do something as an end in itself
    My example: Though coding does result in a tangible product, for me the act of writing code itself is what I value.
    1 2 3 4 5 6 7
    Unimportant o o o o o o o Very important
    Comments

50. To have clear goals and feedback
    My example: I like programming because I can always find a new bug to work on and I can tell when it's fixed.
    1 2 3 4 5 6 7
    Unimportant o o o o o o o Very important
    Comments

51. For fun and enjoyment
    My example: When I'm bored it's fun to look at the bug reports and start writing code to fix it.
    1 2 3 4 5 6 7
    Unimportant o o o o o o o Very important
    Comments

52. Working for the greater good
    My example: I contribute to the kernel so that everyone can enjoy a more stable operating system.
    1 2 3 4 5 6 7
    Unimportant o o o o o o o Very important
    Comments

53. Personal belief in Open Source Software
    My example: I work on the kernel to support the Open Source Software movement.
    1 2 3 4 5 6 7
    Unimportant o o o o o o o Very important
    Comments

54. To provide something valuable to others
    My example: I work on the the Linux kernel to help make computing more affordable all over the world.
    1 2 3 4 5 6 7
    Unimportant o o o o o o o Very important
    Comments

55. To improve the quality of free software
    My example: I contribute to Linux so that everyone has free access to high quality software.
    1 2 3 4 5 6 7
    Unimportant o o o o o o o Very important
    Comments

56. To leave a legacy
    My example: Working on Linux allows me to leave the world in a better place.
    1 2 3 4 5 6 7
    Unimportant o o o o o o o Very important
    Comments

57. To help others
    My example: I like to assist others by answering questions to the newsgroups.
    1 2 3 4 5 6 7
    Unimportant o o o o o o o Very important
    Comments

58. Finally, I plan to use this data to help design instruction and future studies.
    One concern with collecting data on the web is that I cannot tell to what extent people have answered accurately or whether they got tired and clicked randomly.
    If you retook this survey, would your responses be similar?
    Please choose *only one* of the following:
    - Not a chance
    - I doubt it
    - May be
    - Probably
    - Definitely

59. If there is something that you think important for me to know about why you contribute to this OSS project, please include it here. Often the questions that I forgot to ask are the most important.

    Submit your survey.

    Thank you for completing this survey.

VITA

Hoda Baytiyeh was born in Lebanon. Having a diploma in Computer Engineering from France, she was admitted in Fall 2006 to the Ph.D. program in the Instructional Technology Department at the University of Tennessee.

Part of her assignments as a graduate assistant was to teach “Integrating Technology in Classrooms”; a senior course offered for pre-service and in-service teachers at the College of Education. The other part was to conduct research to improve techniques that make learning more accessible and enjoyable.

Her research interests involve improving techniques that make learning more accessible and enjoyable and her research agenda focuses on the following areas: effectiveness of Multimedia in teaching and learning, ubiquitous computing, and online learning communities’ motivations.

Her research will be a continuation to her agenda as well as any other topic that might contribute to improve learning using technology.