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Research-in-Progress

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Abstract

Participant turnover in open source software development is a critical problem. Using Schneider's (1987) Attraction Selection and Attrition Framework and the notion of Person-Organization fit, we hypothesize about the relationship between a participant's fit with an open source project and turnover. Specifically we predict that value fit, needs-supplies fit and demands-abilities fit between a participant and a particular project will have a negative association with participant turnover and that the role of the participant in the project acts a moderator. An empirical study is designed to examine the hypotheses using a combination of survey and archival data. Since for-profit companies are increasingly leveraging open source software development, implications of our findings will be useful for project managers seeking to retain talented contributors in the absence of financial compensation.

Keywords: Open Source Software, Turnover, Attraction Selection and Attrition, P-O Fit

Introduction

Participant turnover in Open source software (OSS) projects is a non-trivial issue because of the frequency with which it occurs and its negative impact on project performance. Turnover is specified as voluntary job termination (Sheridan 1985) or more simply as an employee leaving a current job (Fields et al. 2005). Robles and Gonzales-Barahona (2006) analyzed the evolution of some OSS projects (e.g., GIMP, Mozilla) over 7 years and found that these projects suffered from yearly turnover in core development teams and had to rely heavily on regeneration. Similar results on turnover were reported by von Krogh et al. (2003) in their analysis of the Freenet project.

Turnover is a critical problem in software development projects because it can lead to schedule overruns (Collofello et al. 1998) and regenerating teams is a complicated issue (Reel 1999). Regeneration is challenging in OSS development because of the "contribution barrier" where newcomers face difficulty in acclimatizing themselves with the complex architecture of the project (Crowston et al. 2004; von Krogh et al. 2003). Once participants overcome this contribution barrier, it is in the best interest of the project to retain them. Therefore, there is intense competition for participants among OSS projects (Ahokas and Laurila 2004; Krishnamurthy 2005).

In this paper we use the concept of Person-Organization (P-O) fit to understand OSS turnover. P-O fit is broadly defined as the compatibility between an individual and the work environment along relevant dimensions. In studies of traditional organizations, the existence of good fit typically results in positive outcomes (Kristof 1996), such as

improved work performance, weakened intention to quit and less turnover (Kristof-Brown et al. 2005; Bretz and Judge 1994). We seek to answer the following research question: How does an OSS participant's P-O fit influence the participant's tendency to leave the project?

Understanding how P-O fit affects OSS project turnover is important because the OSS context differs from traditional organizations in important ways (Raymond 1999). First, a participant has more freedom to leave an OSS project than a traditional organization because s/he is unlikely to have a binding contract that requires him/her to stay for a particular length of time. A conventional organization often erects considerable barriers to acting on experiences of misfit and the consequences of turnover may be severe (Kristof-Brown et al. 2005). Second, traditional employment may over-emphasize the fit between an organization's pay and employee's desire for financial compensation and render other dimensions of fit less important for predicting turnover.

To summarize, in the OSS context where the participant enjoys a relatively high level of freedom to join or leave projects, P-O fit beyond financial considerations may be closely related to turnover intention. Understanding how a participant selects a project may help an OSS project manager to attract, select and retain (i.e., prevent turnover) the right kind of participant. It is especially important to understand why a participant continues to contribute to a project in light of the fact that most OSS projects are abandoned (Choi et al. 2010).

This work contributes to both the OSS literature and the P-O fit literature. We move the OSS literature from examining why participants contribute in OSS development in general to understanding how an OSS participant chooses a specific project to remain active in. We also contribute to the OSS literature by examining the important issue of turnover. We extend the P-O fit literature beyond traditional contexts by examining how fit influences an OSS project. Further, we contribute to P-O fit literature by extending the notion of Needs-Supplies fit. To make these contributions, we follow the suggestion of Crowston and Fagnot (2008) and draw on Schneider's (1987) Attraction-Selection-Attrition (ASA) framework.

This paper begins by presenting literature review to highlight the gap in OSS research that the P-O Fit perspective can fill. We then develop the notion of P-O fit in the OSS project context and outline a set of exploratory hypotheses and present our research model. This is followed by the methodology section where we outline an empirical plan to conduct the study and the type of findings we anticipate presenting at ICIS in December, 2010. Finally we conclude with a discussion of the potential implications of this work for IS research and practice and its limitations.

Literature Review

There are important unanswered questions about factors affecting participants' choices to remain active in one OSS project and not another. A majority of OSS research concerns itself with a participant's motivations to contribute to OSS development (Hertel et al. 2003; Hars and Ou 2002). The antecedents of contribution include a participant's desire to use the software application and a desire to learn (Hertel et al. 2003; Hars and Ou 2002). A second stream of research has focused on why participants become long-term contributors to an OSS project. Long-term contributors are distinguished as being hobbyists, learning oriented and/or seeking to develop an identity (Fang and Neufeld 2009; Shah 2006). While this literature offers a rich foundation, it provides little explanations for why a participant would leave a project.

Moreover, we know little about how project characteristics, in conjunction with contributor characteristics, influence turnover decisions. An OSS project can take many forms in that it can use a variety of licenses, interact to varying degrees with corporate sponsors, and require varying skills (Stewart et al. 2006; von Krogh et al. 2003). Different project characteristics may appeal to participants in different ways.

The notion of fit has been used to study individual behavior, beginning with Lewin (1935) who claimed that behavioral outcome is a function of person and environment, $B = f (P, E)$. The study of OSS motivations behind OSS participation in general represents only the P element of the equation. If the participant is not motivated to contribute, i.e. if P is absent then the $f (P, E)$ part is also absent. On the other hand, we can also envision the case where P is present but E is not; i.e. the case where the participant is motivated but the project environment is not right for him/her, in which case $f (P, E)$ is still missing. Since OSS projects differ on many accounts such as license choice, application type etc. (Choi et al. 2010) each project will have a different E associated with it and therefore the perception of $f (P, E)$ should be treated differently for each participant across projects. Therefore, we argue that what the previous OSS literature has achieved so far can be improved through the use of the P-O fit.

Dimensions of Person-Organization (P-O) Fit

Fit with an organization may be conceptualized in a variety of ways. Muchinsky and Monahan (1987) proposed two distinctions to clarify the multiple conceptualizations: supplementary fit and complementary fit. Supplementary fit occurs when a person "supplements, embellishes, or possesses characteristics which are similar to other individuals in an environment" (pp. 269). The most frequently used operationalization of supplementary fit is the congruence between organization and individual values. Particularly, value fit is present if there is similarity between the values, norms and goals of a person and those of an organization (Kristof 1996).

Complementary fit occurs when a person's characteristics "make whole" the environment or add to it what is missing. There are two main sub-categories of complementary fit: needs-supplies fit exists when the organization satisfies an individual's needs, whereas demands-abilities fit exists when the individual has the abilities to meet the organizational demands (Kristof 1996). Organizations supply financial, physical and psychological resources as well as task-related, interpersonal and growth opportunities demanded by the employees. When the organizational supplies meet employees' demands, needs-supplies fit is achieved. On the other hand, organizations demand knowledge, skills, abilities and effort from the employees. Demands-abilities fit is achieved when the employees meet the organizational demands.

We further differentiate between psychological and pragmatic components of the needs-supplies fit. This distinction is necessitated by the diverse participant need satisfaction sought and allows us to capture the differences in participants motivated by psychological needs such as enjoyment (Shah 2006) and feelings of competence (Hars and Ou 2002), and those driven by pragmatic needs such as learning, personal use of software, and financial compensation (Hars and Ou 2002). This fit typology is summarized in Table 1.

Table 1. Fit Constructs		
Fit Type	Sub-Fit Type	Content Dimension
Value		License restrictiveness and market sponsorship (Stewart et al. 2006); forking norms and named credit policy norms (Stewart and Gosain 2006); and reciprocation (Shah 2006).
Demands-Abilities		Knowledge, skills, abilities and effort (Kristof 1996).
Needs-Supplies	Psychological Needs Fit	Enjoyment/fun in programming and peer recognition (Shah 2006); feeling of competence (Hars et al. 2002).
	Pragmatic Needs Fit	Learning, personal use of software, self marketing and financial compensation (Hars et al. 2002).

The concept of P-O fit plays a particularly important role in Schneider's Attraction-Selection-Attrition (ASA) framework (Schneider 1987), which explains patterns of turnover. ASA builds on the premise that similar people are attracted to and selected by organizations whose goals are similar to their own, and people who do not fit will tend to leave. Although ASA model suggests that attraction and selection will screen out people with low fit on average, it does not rule out the fact that mistakes will be made in both the attraction and selection phases. To quote Schneider (1987), "So, while people may be attracted to a place, they may make errors, and finding they do not fit, they will leave". Hence, P-O fit provides an explanation as to why people may be attracted to, selected by and leave organizations (Kristof 1996).

Selection, in particular, is a critical process for maximizing P-O fit. Traditionally, recruitment, job interviews, and hiring procedures are usually designed to maximize probability of identifying employees that fit with the organization (Karren and Graves 1994). OSS projects may also employ selection strategies, especially when it comes to the decision to grant Concurrent Versions System (CVS) access to participants. Newcomers often have to demonstrate technical expertise and some level of understanding of project expectations in order to obtain CVS access (von Krogh et al. 2003). In our model we consider the impact of the OSS selection practices on the relationship between P-O fit and turnover.

In the following section, we develop a set of hypotheses about the relationship between P-O fit dimensions and turnover, and how CVS access as a result of OSS selection process can alter this relationship.

Hypothesis Development

Individual values within an organization are relatively enduring beliefs that a specific mode of conduct or end-state is preferable to its opposite (Chatman 1991; Rokeach 1973). When personal values and priorities match the values and priorities of a particular organization, an individual is happier and more likely to maintain an association with that organization. In the context of OSS, such a choice of mode of conduct or end-state can be reflected in the project members' shared values regarding the license and sponsorship situation (Stewart et al. 2006), forking (splitting the project into two or more projects developed separately), named credit norms (rules about removing someone's name from a project without the person's consent) (Stewart and Gosain 2006) and reciprocation norms (Shah 2006). If the values prevalent in a project are in conflict with an OSS participant's individually held values, then it is likely that the participant will be strained to maintain association with the project.

Byrne's similarity attraction paradigm suggests that people have a fundamental "need" for consensual validation of their perspectives, which are met by interacting with others similar to them (Byrne 1971). Therefore, achieving value fit may also be one way to have personal needs met (Kristof-Brown et al. 2005). Projects can be different from each other based on the license they select and their sponsorship situation. A project's license choice and organizational sponsorship choice influence a developer's perception of the likely utility of the software (Stewart et al. 2006). Lerner and Tirole (2005) present an in-depth study of the numerous Open Source Initiative (OSI) approved licenses that they classify as unrestrictive, restrictive and highly restrictive that projects on SourceForge use. Given that there is a variety of OSI approved licenses and sponsorship choices (representing different environments, *E*) and a variety in the reasons why participants seek to contribute (different motivations, *P*), we argue that it is the congruence between them that determines whether or not a participant perceives a fit and therefore continues to contribute. Similarly, the match between a participant's values and the value system prevalent in the project regarding forking, named credit and reciprocation is likely to positively influence the perception of fit and continued participation. Therefore we propose:

Hypothesis 1: An OSS participant's level of perceived value fit with the project will be negatively associated with turnover.

Needs-Supplies fit has been measured along the dimensions of an individual's needs from the organization such as financial incentives, peer support, reputation etc. An OSS participant expects a project to provide for certain needs when s/he contributes to the application's development (Hars and Ou 2002; Shah 2006). These needs may be broadly classified into:

• Psychological needs such as enjoyment in programming and peer recognition (Shah 2006) and feeling of competence (Hars and Ou 2002). Psychological needs-supplies fit exists if the project fulfils a participant's psychological needs.

• Pragmatic needs such as learning, personal use of software, self-marketing and financial compensation (Hars and Ou 2002). Pragmatic needs-supplies fit exists if the project fulfils participants' pragmatic needs.

A participant's needs may explain why s/he seeks to contribute to an OSS project (i.e. motivations, *P*), but it does not explain whether the participant perceives that the needs are being met by the particular project (i.e. environment, *E*). In spite of the existence of the needs, if a participant perceives the needs are not being met then s/he is likely to stop contributing. Based on this discussion we propose:

Hypothesis 2: An OSS participant's level of perceived psychological needs-supplies fit with the project will be negatively associated with turnover.

Hypothesis 3: An OSS participant's level of perceived pragmatic needs-supplies fit with the project will be negatively associated with turnover.

Demands-Abilities fit exists when an employee (or an OSS participant) is able to meet the demands of the organization (or an OSS project) in terms of the required knowledge, skills and abilities (KSA) and the effort level expected of him/her (Kristof 1996). Drawing on the critical issue of "contribution barrier", we argue that if the participant does not have the required KSA then the effort level required by him/her to contribute to the project increases. In their study of Freenet, von Krogh et al. (2003) found that among other skills the knowledge of the programming language also erected barriers for beginning participants. They confronted the need to learn the language before they could contribute, thereby increasing the effort required. The knowledge of software architecture and the development processes also raise this barrier (Crowston et al. 2004). If the cost of effort

required to contribute to the project is unsubstantially high as perceived by the participant, s/he may not be motivated to continue contributing to the project. As per Crowston and Fagnot (2008), the higher the domain knowledge of the *participant*, the lesser is the effort needed to contribute and more the motivation. If an OSS participant does not have the requisite resources to meet the demands of the OSS project his/her performance will suffer and the participant is more likely to quit (Kristof-Brown et al. 2005). Therefore:

Hypothesis 4: An OSS participant's level of perceived demands-abilities fit with the project will be negatively associated with turnover.

Selection processes may alter the relationship between these P-O fit dimensions and turnover in OSS projects. Selection in the OSS context usually involves the determination of whether participants receive CVS access that allows them to undertake key technical development (von Krogh et al. 2003). As discussed earlier, participants new to a project usually have to demonstrate their technical worth and interest in the project's development before they would be selected for CVS access (von Krogh et al. 2003; Jensen and Scacchi 2007).

Participants with CVS access are responsible for most of the software maintenance work, such as making code commits, designing and executing new releases, and fixing bugs (Shah 2006). Such contributions require high levels of demand-abilities fit. If demands-abilities fit is weak because of mistakes in the attraction and selection phases (Schneider 1987), then participants with CVS access should be more likely to leave the project than those without CVS access. Contributors without CVS access tend to contribute through bug and feature requests etc (Shah 2006). Such activities may not demand high level of technical expertise from them and the presence (or absence) of demands-abilities fit should have much less bearing on a participant's decision to stay in or leave the project. Therefore we propose:

Hypothesis 5a: The relationship between an OSS participant's level of perceived demands-abilities fit and turnover is moderated by the participant's role. Specifically, the relationship between a participant's level of perceived demands-abilities fit and turnover will be more negative for a participant with CVS access.

Participants selected for CVS access may also differ from those without CVS access in terms of psychological and pragmatic needs fulfillment they seek. Shah (2006) found that very few OSS participants motivated by pragmatic needs ever became code committers with CVS privilege, and their roles were mostly confined to peripheral activities such as suggesting bugs or requesting features. Conversely, she found that participants with CVS access tended to be long-term hobbyists driven by enjoyment rather than pragmatic concerns. Shah's finding suggests that psychological needs-supplies fit may be more important for participants with CVS access, whereas pragmatic needs-supplies fit may be more relevant for participants without CVS access. When the relevant fit dimension is weak or no longer present, the participant is more likely to leave the project. Therefore we propose:

Hypothesis 5b: The relationship between an OSS participant's level of perceived psychological needs-supplies fit and turnover is moderated by the participant's role. Specifically, the relationship between a participant's level of perceived psychological needs-supplies fit and turnover will be more negative for a participant with CVS access.

Hypothesis 5c: The relationship between a participant's level of perceived pragmatic needs-supplies fit and turnover is moderated by the participant's role. Specifically, the relationship between a participant's level of perceived pragmatic needs-supplies fit and turnover will be more negative for a participant without CVS access.

The hypotheses are summarized in the research model presented in Figure 1.

Figure 1. Research Model
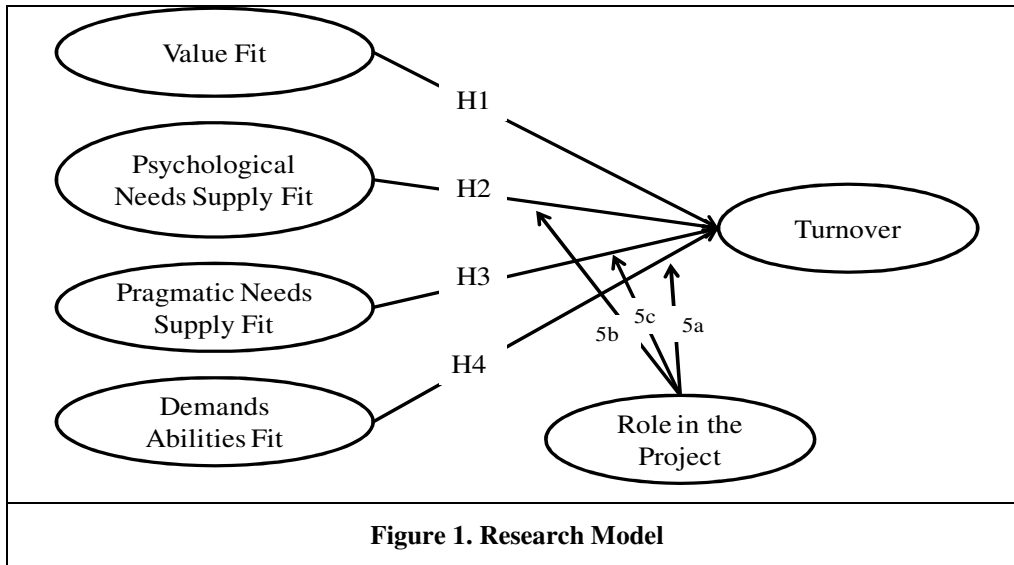
Methodology

To explore and explain the nature and impact of a participant's perception of fit on turnover, we will use the survey methodology and archival data. The sample of project participants will be drawn from SourceForge (www.SourceForge.net). SourceForge provides open source participants with a centralized place to manage their development and includes communication tools, version control processes, and repositories for source code. It is one of the largest open source repositories, estimated to host over 168,000 projects (Madey and Christley 2008). Drawing a sample from this site will allow this study to build on prior open source research by focusing on a larger and more diverse set of projects compared to previous case study work based on the largest projects such as Linux, Mozilla or Apache.

Sample

To gather the survey data there will be two phases to the study. In the first phase we plan to pre-test our survey instrument on a sample of local OSS participants (N=30) and interview them during their local group meetings. This will allow us to verify and refine our understanding of the issue of turnover and verify the validity of our fit survey measures. The pre-test will also give us preliminary data to present in December.

In the second phase of the study, a sample of project participants will be drawn from SourceForge and asked to complete an online version of our survey. Participants will be offered a chance to win a $100 lottery as well as an opportunity to be informed of the results. Because multi-unit samples permit a broader range of environments to be represented according to Kristof et al. (2005), we will survey participants from multiple projects spanning multiple application types, thereby ensuring enough diversity in the project environment. Following Stewart and Gosain (2006), we will select projects that show some activity in the past week and have more than four active participants to ensure that the projects are indeed active and that there are enough team members to render the notion of fit important. We will send the survey to approximately 2,000 active SourceForge participants in order to get a sample size of 200 (assuming a 10% response rate).

Variable Measurement

To develop survey items for the four fit constructs, we culled prior literature for measures indicating the participant's decision to select one project over another for OSS participation. We then mapped these project-specific content dimensions onto the four fit constructs. A content dimension is a relevant characteristic under investigation along which the fit between *P* and *E* is measured. Table 1 summarizes the constructs and content dimensions.

Direct measures will be used in measuring the fit constructs. Direct measures involve asking people explicitly whether they believe a good fit exists. Compared to other measures, direct measures have been consistently shown

to have the largest effect if the construct is perceived fit, i.e. when fit is conceptualized as the judgment that a person fits well in the organization (Kristof 1996). Furthermore, it has been shown that it is not the actual P-O fit rather the perceived P-O fit that best predicts individual outcomes (Lauver and Kristof-Brown 2002). That is, good P-O fit exists as long as it is perceived to exist, regardless of whether or not the person has similar characteristics to, or complements/is complemented by the organization (Kristof 1996).

We will model the independent variables as formative constructs, and will follow Petter et al.'s (2007) suggestions to ensure content validity by using expert panels and Q-sorting procedure. The Q-sort method is used for assessing the reliability and construct validity of questionnaire items that are being prepared for survey research. It is an iterative process in which judges are asked to match the questionnaire items with the construct. Finally we will follow guidelines presented by Cenfetelli and Bassellier (2009) to interpret our formative measures. For our dependent variable, turnover, we will follow the approach by Joyce and Kraut (2006) who analyzed turnover from online newsgroups (Mozilla User Interface and Usenet Support). We will observe participants for a period of six months after surveying them to analyze their activity levels. Turnover will be indicated by a lack of activity in the focal project during this period. Activity will be measured using archival data drawn from the SourceForge Research Data Archive (Van Antwerp and Madey 2008). We will control for project size, as the bigger the online community the more is the attraction to and turnover from it (Butler 2001). Since mature projects may attract more participants (Chengalur-Smith and Sidorova 2003), we will control for project stage. Finally, we will control for participant tenure in OSS participation, occupation, gender, age, and location since previous research has suggested that tenure and demographic variables also predict individual turnover (Jackson et al. 1991; O'Reilly III et al. 1989).

Discussion & Conclusion

For-profit companies are increasingly leveraging open communities (Gurbani et al. 2010). As they do so, it is important for them to understand factors that lead an individual to contribute to one OSS project instead of another, especially since OSS participant contributions may not be motivated solely by financial concerns. As barriers for contribution to software projects can be quite significant (von Krogh et al. 2003), it is in the project's interest to retain contributors for as long as possible and to minimize turnover. Further, since 80 percent of OSS projects fail due to lack of long-term participants (Fang and Neufeld 2009), OSS managers must resort to tools other than financial compensation to retain talented participants.

This study contributes to the OSS literature by providing a novel way to understand OSS project turnover. Currently the dominant approach is to examine an individual contributor's motivation. This approach, while proffering much insight into why participants contribute to OSS projects in general, falls short in understanding why participants may leave a project. This is especially important since OSS projects offer a multitude of different environments based on their characteristics such as license choice, market sponsorship, and application type. The concept of P-O fit allows us to consider both project characteristics and participant characteristics when predicting turnover. Project characteristics alone, or participant characteristics alone, would be insufficient in understanding why a participant may leave a project. We hope to demonstrate that the complementarity between personal and project characteristics affects OSS contribution activities.

Implications for Research

This study bodes numerous implications for research. The ASA literature suggests that, driven by P-O fit, similar people will choose to do similar work in similar ways, and hence will be attracted to jobs and organization of similar kind (Schneider 1987). In other words, homogeneity may develop over time within organizations. If our research demonstrates that P-O fit indeed plays an important role in OSS contribution, researchers could explore if patterns of homogeneity develop in OSS projects, and how homogeneity impacts project performance. We expect the patterns of homogeneity to be different in OSS context from conventional organizations where homogeneity develops more along personality variables (Schneider et al. 1998). The virtual nature of OSS contribution with minimal face to face contact may attenuate the role of personality variables. However, we expect that there will be sufficient lack of within project variability (with respect to between project variability) in terms of the content dimensions that we analyze in this paper (Table 1).

In addition to the implications related to homogeneity, there are other ways to extend the current study. The OSS P-O fit framework developed here can be used to establish a hierarchy of relative fit importance. It is plausible that different types of fit affect contribution pattern or performance differently. Researchers could examine if certain

types of fit are more important than others in specific areas of OSS contribution (e.g. bug fixes versus discussion forum). It is also quite possible that the strength of P-O fit may evolve over time due to socialization (Schneider et al. 1998). Socialization is an important factor in OSS context as well (Ducheneaut 2005). Studying the dynamic evolution of P-O fit will help us understand how P-O fit evolves and whether it affects contribution level and performance. Further, OSS represents only one of many different kinds of online communities. P-O fit dimensions may affect different kinds of online communities differently. For instance, chat communities are predominantly attachment-based which operate quite differently from identity-based communities such as OSS projects (Ren et al. 2007). Future studies may investigate how the P–O fit framework presented here may be modified for other online community types.

Implications for Practice

This research offers many important implications for practitioners. P-O fit dimensions that matter in traditional work environments may differ from those that are relevant in OSS settings. Based on this study's findings, corporate managers may consider how they can modify their Human Resource practices when operating OSS projects (Gurbani et al. 2010). For example, financial compensation that works well in attracting talent in conventional work arrangements may not necessarily be useful in attracting an OSS participant. In addition, a participant with CVS commit privilege may be managed differently from a participant without CVS commit privilege. Moreover, this study distinguishes between two types of needs-supplies fit – psychological versus pragmatic. The relative importance of psychological versus pragmatic needs-supplies fit may be very different in traditional versus OSS settings. This study will help managers focus on the most relevant P-O fit dimensions and hopefully minimize turnover in OSS projects.

This study will also help OSS managers decide whether they should interview and select contributors, and, if they do so, which relevant factors they should consider during the selection process. Fit-based selection, however, may lead to homogeneity over time (Schneider 1987) that may not be beneficial for long term organizational effectiveness (Schneider et al. 1998). Future research should help OSS managers understand whether fit-based selection increases homogeneity and reduces creativity, and take conscious steps to guard against it.

Limitations

Like all empirical studies, this work will be limited in several ways. The survey approach takes a cross-sectional snapshot of P-O fit perceptions. An assessment of P-O fit may evolve over time, but this research design will capture participants' P-O fit assessments only at an arbitrary time point. Measuring turnover in the OSS context is also quite challenging. As no formal employment contract is involved, clear and objective indicators of turnover (i.e., termination of employment) found in traditional work arrangement is absent in OSS projects. Although we use decrease in activity level to approximate turnover based on prior literature (Joyce and Kraut 2006), other factors besides turnover may also lead to activity decrease. For example, personal reasons or professional engagements may prevent a participant from contributing even when s/he has every intention to stay. To address this potential concern, we will collect participants' intention to leave as part of the survey questionnaire. We hope that this self-report data will help us triangulate the activity data and increase the validity of our dependent measure.

Conclusion

Synthesizing the ASA and OSS literatures, we are in the process of conducting an empirical study examining how P-O fit dimensions may affect turnover in OSS projects. Specifically we argue that value, needs-supplies and demands-abilities flit between an individual and a particular project will be negatively associated with turnover. Furthermore, we suggest that how these fit dimensions affect turnover will be moderated by the participant's role. These fit dimensions will matter to varying degrees depending on whether the participant has CVS commit privilege. Findings from this research will provide important contributions to both OSS research and practice.

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