

The Impact of Person-Organization Fit and Psychological Ownership on Turnover in Open Source Software Projects

Full Papers

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Abstract

Open source software (OSS) projects represent an alternate form of software production by relying primarily on voluntary contributions. Despite the immense success of several mainstream OSS projects such as Mozilla, Linux, and Apache, a vast majority of such projects fail to sustain their development due to high levels of developer turnover. While existing research in the area has offered a rich foundation, we know little about how developers' perceptions of fit with the project environment may be moderated by the sense of ownership they have toward the project and how it may impact their turnover intentions. Using survey data from 574 GitHub developers, we tested a model to examine the impact of Person-Organization fit and psychological ownership on developers' turnover intentions. Our results suggest that two relevant dimensions of fit, namely, value and demands-abilities fit, negatively impact turnover intentions and that their sense of ownership moderates these effects.

Keywords

Open source software, Person-Organization fit, psychological ownership, turnover.

Introduction

With minimal financial backing, developers are the key resource driving the hugely successful open source software (OSS) phenomenon. From Linux to Apache, it is often the investment of individual developers that drive success. For this reason research has focused on developer motivations to join, (von Krogh et al. 2012), as well as factors that keep them committed to projects (Zhang et al. 2013). Participant turnover in OSS projects is a non-trivial issue because of its frequency of occurrence, and the potentially negative impact on project performance and succession. 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. In their analysis of the Freenet project von Krogh et al. (2003) reported similar results on turnover.

Turnover can lead to significant problems for projects by causing schedule overruns (Collofello et al. 1998). In addition, regenerating team membership 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.

We use the concept of Person-Organization (P-O) fit and Psychological Ownership 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). Psychological Ownership is the feeling of ownership a person develops toward an owned object. Traditional organizations

have used formal arrangements to develop a sense of ownership among employees as it is generally argued to have positive impact toward their work efficiency and reduce turnover (Pierce et al. 2001; Pierce and Rodgers, 2004). In this paper, we seek to answer the following research questions: How does an OSS participant's perception of P-O fit influence the participant's tendency to leave the project? And, does the perception of ownership moderate this effect?

Understanding the complex interplay between P-O fit and sense of ownership and their impact on developer 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 she or he is unlikely to have a binding contract that requires him or 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. Finally, developers may or may not be compensated for their contributions to the project.

To summarize, in the OSS context where the participant enjoys a relatively high level of freedom to join or leave projects, the interplay between P-O fit and the sense of ownership 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, the P-O fit, and psychological ownership literatures. 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 and ownership literatures beyond traditional contexts by examining how fit and ownership may interact while influencing developer turnover.

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 joining and motivations to sustain contribution to OSS development (Hertel et al. 2003; Hars and Ou 2002; von Krogh et al. 2012). 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), and prior ties (Hahn et al. 2008). Related work has looked at how projects can manage first impressions to attract developers (Choi et al. 2010). 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).

A more recent and separate stream of work has looked at the impact of different dimensions of developers' perceptions of fit with the projects and its impact on their retention (e.g. Sharma et al. 2010; Schilling et al. 2011; Schilling et al. 2012; and Ghosh et al. 2013). While this literature offers a rich foundation in developing the relevant dimensions of fit in the OSS context, it provides little explanation as to why developers may leave projects given the sense of ownership they may develop due to their association with the project. In addition, a critical shortcoming of this literature is the suitability of the respondent population studied that limits its generalizability. For example, Schilling et al. (2011 and 2012) studied students selected through a formal application process for participating in Google's summer of code (KDE project) and who received a monthly stipend for their involvement; while Ghosh et al. (2013) studied IT professionals who used OSS projects at work but were not necessarily involved in its development. Thus, we know little about how the complex interplay between actual OSS developers' perceptions of fit with the project environment and their sense of ownership impacts their turnover intentions, given that they are increasingly being compensated financially to contribute to OSS projects but not necessarily so. Using a survey of OSS developers from GitHub, this paper extends this stream of research by demonstrating that psychological ownership moderates the impact of perception of fit on turnover intentions, while controlling for the possible confounding effect of monetary compensation for their contributions to the project.

Two Dimensions of Person-Organization (P-O) Fit

Fit with an organization may be conceptualized in a variety of ways.. The most frequently used operationalization of 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).

In addition, demands-abilities fit exists when the individual has the abilities to meet the organizational demands (Kristof 1996). Organizations demand knowledge, skills, abilities and effort from the employees. Demands-abilities fit is achieved when the employees meet the organizational demands. This fit typology is summarized in Table 1.

Table 1. Fit Constructs	
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).

Psychological Ownership

Psychological ownership is the feeling of ownership that a person may develop toward an owned object or that they have helped create. People may develop feelings for ownership toward a variety of objects that may be material (e.g. objects) or immaterial (e.g. ideas, project code) (Pierce et al. 2001). Psychological ownership is generally argued to produce positive effects toward an owned object because of the sense of fulfilment, self-esteem, and belonging it provides (Avey et al. 2009). Organizations have used formal arrangements to develop a sense of psychological ownership among employees (e.g. through stock ownership) to improve their work efficacy and reduce turnover (Pierce and Rodgers, 2004). In the OSS context, developers may develop a sense of ownership toward the project due to their involvement with it. Thus, ownership can negatively impact their turnover intentions. In the following section, we develop a set of hypotheses about the relationship between P-O fit dimensions and turnover, and how the developer’s level of psychological ownership 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.

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

Psychological ownership, or "the psychologically experienced phenomenon in which an employee develops possessive feelings for the target," may play a critical role in determining the open-source developer's turnover intentions. OSS participants with a strong sense of project ownership may behave very differently from those without one when their perceived level of value fit with the project is weakened. 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. When the value fit with the project is weak, those who feel a strong sense of ownership of the OSS project may continue to stay on the project despite the poor fit. Therefore we propose:

Hypothesis 3: The relationship between an OSS participant's level of perceived needs-supplies fit and turnover is moderated by the participant's reported level of psychological ownership. Specifically, the relationship between a participant's level of perceived needs-supplies fit and turnover will be less negative for a participant with a strong level of psychological ownership.

OSS participants, especially those who supply technical skills, 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), these developers may choose to stay on the project despite the poor fit, due to a strong sense of ownership of the project. Therefore we propose:

Hypothesis 4: The relationship between an OSS participant's level of perceived demands-abilities fit and turnover is moderated by the participant's reported level of psychological ownership. Specifically, the relationship between a participant's level of perceived demands-abilities fit and turnover will be less negative for a participant with a strong level of psychological ownership.

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

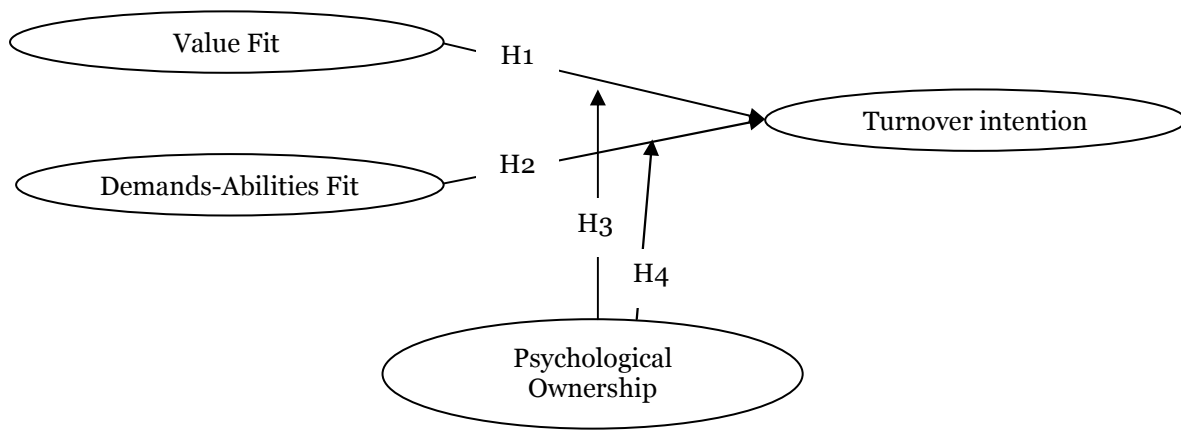


Figure 1. Research Model

Methodology

To explore and explain the nature and impact of a participant’s perception of fit on turnover, we used the survey methodology. The sample of project participants was drawn from Github (www.github.com) as part of a larger survey study¹. Github, as one of the largest open-source repositories, provides open source participants with a centralized place to manage their development and includes communication tools, version control processes, and repositories for source code.

Because multi-unit samples permit a broader range of environments to be represented according to Kristof et al. (2005), we surveyed participants from multiple projects spanning multiple application types, thereby ensuring enough diversity in the project environment. Following Stewart and Gosain (2006), we selected projects that showed some activity in the past week and have more than four active participants to ensure that the projects were indeed active and that there were enough team members to render the notion of fit important.

We drew a sample from 2,379 randomly selected active developers, out of over 3 million registered developed on Github. 768 participants responded to the survey, resulting in a 32% response rate. 574 of those who responded provided complete responses. More details of the survey methodology are available in Mollick (2015).

Variable Measurement

To develop survey items for the fit constructs, and turnover intention, we culled prior literature for measures indicating the participant’s decision to select one project over another for OSS participation. Direct measures were 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 then pre-tested these measures on a sample of local OSS participants and interviewed them during their local group meetings. This allowed us to verify and refine our understanding of the issue of turnover and verify the validity of our fit survey measures. The final measures for the survey study and their sources are listed in the Appendices.

¹ Data collection was conducted in conjunction with Mollick (2015).

Results

Partial Least Squares Path Modeling was used to test the impact of the fit constructs on turnover intention. Interaction terms were created to test the role of Psychological Ownership in moderating the direct effects². Table 1 summarizes results: Model 1 was designed to test Hypotheses 1 and 2 (main effects), and Model 2 was designed to test Hypotheses 3 and 4 (interaction effects).

Table 1. Model results using Turnover Intention as the Dependent Variable (standardized beta values with t values in parentheses)

INDEPENDENT VARIABLES	Model 1 (Main Effects)	Model 2 (Interaction Effects)
Value Fit	-.202 (3.69)**	-.195 (.074)
Demands-Abilities Fit	-.132 (2.91)**	-.156 (2.730)**
Psychological Ownership	-.142 (1.813)**	-.250 (.159)
Value Fit x Psychological Ownership		-.046 (1.832)**
Demands-Abilities Fit x Psychological Ownership		.160 (1.638)
Financial Compensation (Control)	-.147 (3.498)**	-.147 (3.734)**
R ²	10.1%	16.3%

Model 1 shows that Hypothesis 1 is clearly supported. An OSS participant's level of perceived value fit with the project is negatively associated with turnover. Model 1 also evidence to support Hypothesis 2. An OSS participant's level of perceived demands-abilities fit with the project is negatively associated with turnover intention.

Model 2 shows that Hypothesis 3 is clearly supported. The relationship between an OSS participant's level of perceived demands-abilities fit and turnover is moderated by the participant's reported level of psychological ownership. Specifically, the relationship between a participant's level of perceived demands-abilities fit and turnover will be less negative for a participant with a strong level of psychological ownership. On the other hand, Model 2 provides no evidence to support Hypothesis 4. Our results fail to support the conjecture that the relationship between an OSS participant's level of perceived demands-abilities fit and turnover is moderated by the participant's reported level of psychological ownership.

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.

Our findings extend the work of Schilling et al. that focused on person-job fit and person-team fit by exploring values and demonstrating psychological ownership as a moderator (Schilling et al. 2011; Schilling et al. 2012). We also add to their work by exploring the notion of fit in a sample beyond students (which they studied). Our findings suggest that value fit is an important fit dimension that predicts turnover intention amongst OSS participants. This finding is consistent with prior literature that suggests the critical role of value or ideology in motivating OSS contribution (Stewart et al. 2006). Our findings also suggest that psychological ownership can be a key factor in OSS participant retention, even when value fit is low. These findings demonstrate that the complementarity between personal and project characteristics affects OSS contribution activities.

² Appendix 2 and 3 present the assessment of construct reliability and validity.

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.

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. Future research 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.

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.

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.

Conclusion

Synthesizing the ASA and OSS literatures, we empirically tested a model examining how P-O fit dimensions may affect turnover in OSS projects. Specifically we found that value fit between the participant and the project was negatively associated with turnover intention. Furthermore, we found that psychological ownership moderated the negative relationship between value fit and turnover intention. Findings from this research will provide important contributions to both OSS research and practice.

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Appendix 1: Survey Items

Construct	Survey Items
Value Fit (VFit) (Cable and DeRue 2002)	VF1: My personal values about open source software use and sharing match the project's license. VF2: The project's norms about forking are a good fit with my personal norms. VF3: My personal norms about reciprocating favors are shared by the members of the project. VF4: The project's norms about named credit policy match well with my personal norms. VF5: My personal values about external sponsorships for supporting open-source projects match well with the external sponsorship(s) that support this project. VF6: My personal beliefs about open source practices match well with the project.
Demands-Abilities Fit (DAFit) (Cable and DeRue 2002)	DAF1: There is a good match between the effort I put in the project and what is expected of me. DAF2: My skills match well with the requirements of the project. DAF3: My abilities are well matched with the demands that the project places on me. DAF4: There is a good fit between my knowledge and the demands of the project.
Turnover Intention (TOI) (O'Reilly et al. 1991; and Lauer and Kristof-Brown 2001)	TOI1: To what extent would you prefer another more ideal project than the one you now work in? TOI2: To what extent have you thought seriously about changing projects since beginning to work here? TOI3: To what extent do you think you will be working on this project six months from now?
Psychological Ownership (POwnership) (Van Dyne and Pierce, 2004)	PO1: I feel a very high degree of personal ownership for this project. PO2: I sense that this project is MY project. PO3: It is hard for me to think of this project as MINE.
Financial Compensation	Did you receive any financial compensation for contributing to this project?

Appendix 2: Item Loadings and Average Variance Extracted

Construct	Item	Loading	AVE
Value Fit	VF1	.72	.53
	VF2	.60	
	VF3	.80	
	VF4	.70	
	VF5	.77	
	VF6	.75	
Demands-Abilities Fit	DAF1	.63	.53
	DAF2	.74	
	DAF3	.78	
	DAF4	.81	
Psychological Ownership	PO1	.92	.83
	PO2	.91	

Turnover Intention	PO3	.89	.52
	TO1	.62	
	TO2	.67	
	TO3	.86	

Appendix 3: Cross Loadings

Construct	Item	Value Fit	Demands Abilities Fit	Psychological Ownership	Turnover Intention
Value Fit	VF1	0.72	0.34	0.19	-0.19
	VF2	0.61	0.27	0.14	-0.18
	VF3	0.81	0.36	0.23	-0.28
	VF4	0.70	0.29	0.19	-0.18
	VF5	0.78	0.34	0.20	-0.28
	VF6	0.76	0.35	0.19	-0.20
Demands-Abilities Fit	DAF1	0.35	0.66	0.14	-0.23
	DAF2	0.30	0.81	0.22	-0.15
	DAF3	0.36	0.85	0.23	-0.16
	DAF4	0.38	0.85	0.20	-0.21
Psychological Ownership	PO1	0.26	0.24	0.93	-0.23
	PO2	0.28	0.28	0.92	-0.23
	PO3	0.18	0.15	0.89	-0.24
Turnover Intention	TO1	-0.14	-0.10	-0.09	0.62
	TO2	-0.15	-0.11	-0.07	0.67
	TO3	-0.31	-0.26	-0.29	0.87