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Participating in Open Source Software Projects: The Role of Empowerment

Weiling Ke
Clarkson University, wke@clarkson.edu

Ping Zhang
Syracuse University, pzhang@syr.edu

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Clarkson University
wke@clarkson.edu

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Syracuse University
Pzhang@syr.edu

ABSTRACT

As a community-based innovation, Open Source Software (OSS) development intrigues researchers and practitioners, especially on why OSS projects succeed with light coordination and control mechanisms. In the view that the viability and sustainability of an OSS project rely on individuals' contribution and engagement, we investigate how the psychological feelings of empowerment derived from the assessments of OSS tasks affect participants' participation outcomes. In particular, we posit that empowerment can lead directly to participants' task performance and satisfaction in OSS projects. In addition, empowerment's effect on task performance and satisfaction can also be mediated by task effort. The research model is supported by data collected from 233 OSS participants. Theoretical contributions and managerial implications of this study are discussed.

Keywords

Empowerment, Open Source Software, participation

INTRODUCTION

In recent years, there are studies investigating how the context of OSS communities and individual characteristics such as values, beliefs and motives affect individuals' participation in OSS projects (e.g., Bagozzi and Dholakia, 2006, Lakhani and Wolf, 2005, Shah, 2006, Roberts et al., 2006). As an open innovation, OSS involves tasks that are of unique characteristics. A task refers to a set of activities directed toward a purpose (Thomas and Velthouse, 1990b). According to the empowerment theory, the assessments of a task have an impact on an individual's feelings and thus motivate the individual to perform the task (Hackman and Oldham, 1980, Gagne et al., 1997, Spreitzer, 1995). Empowerment is defined as positively valued experiences that individuals derive directly from a task (Thomas and Velthouse, 1990b). That is, empowerment is aroused by task assessments that occur within the person and refer to the task itself, rather than to the context of the task or to rewards mediated by others (Spreitzer, 1995). Unfortunately, few studies examined the effect of empowerment in the OSS context though tasks in OSS communities are unique and may allow participants to derive sense of empowerment. Also, most of the OSS research has investigated motivations to participate in OSS projects and ignored the outcomes of such participation. Investigating how an individual's sense of empowerment derived from tasks in OSS projects affects their participation outcomes can extend our understanding of the success of open innovation in general, and OSS communities in particular.

To bridge the gap in the extant literature, we develop the research model by drawing upon empowerment theory. Our research model is supported by data collected from OSS participants.

THEORETICAL UNDERPINNINGS AND RESEARCH HYPOTHESES

The drivers for participants to contribute to and remain engaged in OSS projects are of great interest to researchers and practitioners (Ke and Zhang, Forthcoming, Roberts et al., 2006, von Hippel and von Krogh, 2003, von Krogh and von Hippel, 2006). Prior research has mainly focused on effects of the context of OSS communities, the ideology of OSS movement and individual characteristics such as values, beliefs and motives (e.g., Shah, 2006, Roberts et al., 2006, Lakhani and Wolf, 2005, Bagozzi and Dholakia, 2006). For example, Stewart and Gosain (2006) investigate how ideology affects the effectiveness of OSS development performance. Stewart et al. (2006) assess the influence of license choice and organizational sponsorship on individuals' interest and participation in OSS projects. Roberts et al. (2006) and Shah (2006) study the effect of individual extrinsic and intrinsic motivation.

According to the empowerment theory, an individual's assessments of a task exert an influence on the individual's feelings and motivation to perform the specific task (Spreitzer, 1995, Gagne et al., 1997, Hackman and Oldham, 1980). Thus, we expect that the feeling of empowerment derived from task assessments in OSS may play a critical role in motivating an individual to make contributions and be committed to the OSS project. Empowerment refers to positively valued experiences that individuals derive directly from a task (Thomas and Velthouse 1990; Gagne et al. 1997). Specifically, it is defined as an individual's experience of motivation that is based on cognitions about him- or herself in relation to a specific task (Spreitzer, 1995,

Seibert et al., 2004). Stated alternatively, rather than referring to the context of the task, empowerment is aroused by task assessments that refer to the task itself (Spreitzer 1995).

It is established that empowerment should be conceptualized as a gestalt of four types of feelings, namely autonomy (or self-determination), competence, meaningfulness and impact (Spreitzer, 1995). Autonomy refers to a sense of freedom in making choices about how to perform the task and being personally responsible for the results; competence is defined as the belief in one's ability to perform the task successfully; meaningfulness is the perceived value of the task in relation to one's personal beliefs, attitudes and values; and impact refers to the belief that one is producing intended effects and has control over desired outcomes through one's task behavior (Spreitzer 1995; Thomas and Velthouse 1990).

Theoretically, it is proposed that the empowering design of task provides opportunities for, rather than constraints on, individual mind-set and behavior (Thomas and Tymon, 1994, Mowday and Sutton, 1993, Spreitzer, 1995). As such, it is recognized as means by which managers can effectively manage organizations. Indeed, the positive effect of empowerment on task performance and satisfaction has gained empirical support (e.g., Liden et al., 2000, Thomas and Tymon, 1994, Spreitzer, 1995). Task performance refers to the cognitive outcome of individuals' conducting the task (Tsai et al., 2005). In contrast, satisfaction is defined as the affective consequence of effortful engagement in the task (Cherrington, 1980). Following the empowerment theory, we expect that empowerment, the psychological feelings derived from the cognitive assessments of a task, can have positive effect on OSS participants' task performance and satisfaction. In OSS projects, tasks can provide individuals with the feelings of autonomy and competence (Roberts et al. 2006). In addition, participants may gain feelings of competence by distributing their creation, receiving feedbacks from peers and enhancing their capability by leveraging the resources in the communities (von Hippel and von Krogh 2003). Also, tasks in OSS communities can be meaningful to participants. It is touted that the continuous improvement of OSS and its free distribution create value for the individuals, organizations and society (Lado and Ke, 2008). With the feelings of empowerment derived from a task, an individual experiences meaningfulness of the task, responsibility for the outcomes of the task, and knowledge of the actual results of the task (Kirkman et al., 2004). It motivates the individual to take greater risk and try out novel ideas, which is required by the complex, knowledge-based task. Since the individual performs the task for self-generated intrinsic reasons and if performing well can create positive affect, he or she would reduce the forms of task withdrawal that slows their effort. Such engagement helps to increase work quality and improve the acquisition of task-related skills (Kanfer, 1991). Thus, an individual with the sense of empowerment would achieve a higher level of task performance. In addition, the sense of empowerment derived from a task motivates an individual to execute discretionary behaviors which satisfies his or her higher-order individual needs. Aligning the behavior of participating in OSS projects with his or her individual values, the individual derives higher satisfaction from task accomplishment. Hence we have the following hypotheses:

Hypothesis 1 A participant's empowerment is positively related to his or her task performance in an OSS project.

Hypothesis 2 A participant's empowerment is positively related to his or her satisfaction with an OSS project.

As a motivational construct, empowerment is translated into accomplished work by means of task effort expended by an individual (Parsons 1968). Conceptually, task effort consists of three components: commitment (or duration), intensity (or force) and direction (Kanfer, 1991). Commitment is defined as "the determination to try for a goal and the persistence in pursuing it over time" (Hollenbeck et al., 1989). It has two aspects namely time commitment and task persistence. Time commitment is defined as the duration of time that the individual dedicates to the task, while task persistence refers to the individual's continued effort in overcoming difficulties when performing the task (Tsai et al., 2005, Yeo and Neal, 2004). Effort intensity refers to the amount of resources that are expended. That is, effort intensity refers to how hard a person tries to carry out a chosen behavior (Kanfer, 1991, Yeo and Neal, 2004). In contrast, task direction is a person's behavioral choice and is often measured as choice decisions between mutually exclusive courses of action(Kanfer, 1991). This study focuses on the first two dimensions of task effort, i.e., commitment and intensity, due to two reasons. First, we are interested in only individuals who participate in OSS projects (i.e., their effort direction is to work on OSS projects). Therefore, people who are not OSS community participants are not of relevance to the current research. Second, it is established that commitment and effort intensity constitute the essence of working hard (Brown and Leigh, 1996).Thus it is appropriate for the current study to focus on these two dimensions to investigate OSS participants' effort expended on the projects.

In OSS projects, individuals may be motivated by empowerment along the dimensions of autonomy and competence (Ryan and Deci, 2000) from their participating in OSS projects. Given that autonomy and competence are two social psychological needs (Deci and Ryan, 2000), these individuals will expend high levels of effort and remain engaged when working on OSS

projects. In addition, tasks in OSS communities not only provide a sense of enjoyment and fun. They also allow individuals to make a difference to the software, how the software is developed and how members interact with each other to work toward the common goal of continuously improving the software. Higher levels of meaningfulness and perceived impact are believed to result in commitment, involvement and concentration of energy (Kanter, 1968, Thomas and Velthouse, 1990a). As such, empowerment energizes and sustains an individual's performing OSS tasks (Kanter 1968; Thomas and Velthouse 1990).

Hypothesis 3 An individual's empowerment is positively related to his or her task effort expended on the OSS project.

Task effort should also play a mediating role between empowerment and behavior outcomes. That is, empowerment has an indirect effect on task performance and satisfaction through task effort. Parsons (1968) defined effort as the means by which motivation is translated into accomplished work. This definition suggests that effort plays a mediating role between motivation and behavior outcomes. Empowerment is an individual's psychological feelings. It may arouse an intention to act. But it may not be able to lead to behavior outcomes directly. Instead, it is the effort through which empowerment is translated into behavior outcomes such as task performance (Brown and Leigh, 1996, Klein et al., 1999). Alternatively, if there is no effort, empowerment may not have effect on behavior outcomes (Locke and Latham, 1990, Locke et al., 1981). Such mediating effect of task effort is empirically supported in psychology and marketing disciplines (Brown and Peterson, 1994, Brown and Leigh, 1996, Christen et al., 2006). We expect that this notion can be extended to the OSS context. Together, we have the following hypotheses:

Table 1. Internal Consistency and Discriminant Validity of Constructs

	Constructs	CR	AVE	1	2	3	4	5	6	7	8	9
1	EM_MEAN	.91	.76	.87								
2	EM_CMP	.91	.76	.34	.87							
3	EM_AUTO	.91	.77	.28	.44	.88						
4	EM_IMP	.94	.84	.45	.52	.38	.92					
5	TIME_CM	.89	.74	.47	.42	.10	.59	.86				
6	TASK_PST	.90	.75	.43	.41	.17	.57	.60	.87			
7	INTENSITY	.91	.66	.41	.41	.15	.45	.59	.73	.81		
8	TASK_PRF	.95	.86	.30	.51	.17	.67	.65	.49	.47	.93	
9	SAT	.83	.56	.53	.44	.31	.48	.54	.54	.57	.45	.75

Hypothesis 4 Task effort influences task performance in OSS projects.

Hypothesis 5 Task effort influences satisfaction in OSS projects.

RESEARCH METHODOLOGY

The data to test our model is collected as part of a larger data collection using the survey method from OSS project participants. We randomly selected potential respondents from the discussion forums hosted by sourgeforge.net and some other on-line forums, such as MySQL and OpenOffice. Then we sent out about 2000 invitations to these people and asked them to fill out a questionnaire posted on SurveyMonkey.com, an online survey service provider. One week later, we sent the first reminder to encourage participation in the survey. The second reminder was sent one week after the first reminder. A total of 233 responses were included to test our model in this paper. We tested the non-response bias by the method suggested by Armstrong and Overton (1977). That is, we compared the chi-squares of the responses from the first 25% of the respondents to that of the final 25%. The significant difference would indicate the presence of non-response bias. Our results showed that there was no non-response bias.

The measurement items in our questionnaire were adapted from existing validated and well-tested scales in the extant literature. These scales had been proved to have good validity and reliability. In the questionnaire, all items were measured with 5-point Likert scales, ranging from "strongly disagree" to "strongly agree." Also, we provided the choice of "not applicable". The instrument for empowerment was adapted from (Spreitzer, 1995). The measurement items for task effort were adapted from (Yeo and Neal, 2004) and Tsai et al. (2005). Task performance and satisfaction were measured by items adapted from Tsai et al. (2005) and Brown and Peterson (1994), respectively.

DATA ANALYSIS AND RESULTS

Table 1 shows the composite reliability (CR) of each reflective construct. It is recommended that CR should be .70 or higher, which is satisfied by all constructs. AVE measures the amount of variance that a construct captures from its indicators relative to the amount due to measurement error . It is recommended that it should exceed .50. As shown in Table 1, the AVEs of all constructs exceeded .50. Hence, all three conditions for convergent validity were met.

Discriminant validity between constructs was assessed using Fornell and Larcker's recommendation that the square root of the AVE for each construct should exceed the correlations between this construct and all the other constructs (Fornell, 1981, Chin, 1998). In Table 1, the shaded numbers on the diagonals are the square root of the AVEs. Off-diagonal elements are the correlations among constructs. All diagonal numbers are much greater than the corresponding off-diagonal ones, indicating satisfactory discriminant validity of all the constructs.

Structural Model and Hypotheses Testing

To test the research model, the second order constructs are treated as reflective constructs with the measures of the latent variable scores of the dimensions. That is, empowerment is measured by the latent scores of the four first-order constructs, and task effort is measured by the latent scores of the three first-order constructs. The R squares for Task Performance and Satisfaction are both 0.46. Also, all links are significant at the level of $p<.001$. Thus, all hypotheses are supported.

Hypotheses H3 and H5 imply the mediating effects of task effort on the relationships between empowerment and task performance and between empowerment and satisfaction. We followed the three-step procedure to test such mediating effects. When task effort is not in the model, empowerment has a .67 co-efficient on task performance. As indicated in Figure 2, the coefficient between empowerment and task performance decreased to .37 when task effort is introduced as a mediator. Similarly, empowerment has a coefficient of .60 on satisfaction when task effort is not in the model, and this coefficient is reduced to .35 when task effort is introduced as a mediator. Thus the implied mediating effects are supported. Task effort partially mediates empowerment's effect on task performance and satisfactory. Overall, empowerment has both direct and indirect effects on task performance and satisfaction. Furthermore, the variances explained for both Task Performance and Satisfaction were greatly increased in the model with task effort being controlled (0.46 vs. 0.37, and 0.46 vs. 0.36 for Task Performance and Satisfaction, respectively).

DISCUSSIONS AND CONCLUSION

Our interest in investigating how empowerment affects participation outcomes in OSS communities is triggered by the lack of research that examines the effects of individuals' psychological feelings derived from the assessments of tasks. In the view that the design of tasks in OSS communities are quite different from proprietary software development tasks, such research unveils the underlying influencing mechanism that lead participants to contribute to and remain engaged in OSS projects and thus extends our understanding of OSS success. Our data analysis results indicate that empowerment aroused by task assessments plays an important role in affecting participants' task performance and satisfaction in OSS projects. In particular, as a construct of a gestalt of four types of feelings (meaningfulness, autonomy, competence, and impact), empowerment satisfies individuals' psychological needs, makes them favor the opportunities to create value for themselves and communities and keep them remain committed to the goal of continuous improvements of software in OSS projects. Such a conceptualization allows us to gain a more complete view of the influencing process of task assessments on individuals' participation outcomes.

Our research further reveals that, in addition to directly affecting task performance and satisfaction, empowerment indirectly influences participation outcomes through task effort. As a process variable, task effort partially mediates the relationships between empowerment and task performance and satisfaction. Therefore, different from prior studies that only investigate empowerment's direct effect, this research finding shows that it is critical to have task effort controlled when investigating empowerment's effect. Stated alternatively, leaving out the variable of task effort from a research model on empowerment may lead to inaccurate findings and dubious results.

It is important to evaluate the current study's results and contributions in light of its limitations. First of all, there are other salient factors that can affect an individual's performance in and satisfaction with an OSS project, such as leadership styles and individual competence. While the focus of the current study is on empowerment and examining the effect of these other factors is beyond the scope of the current study, future research should formulate a more integrated model so that we can compare and contrast different drivers' effects. Second, we collected data during one period of time. All the major constructs were measured by respondents' perceptions, which are subjective. Future research should use some objective measures and across multiple time points. A longitudinal study may enrich research findings by offering additional information on the causal relationships between independent and dependent variables.

Our study makes two major theoretical contributions. First, this study unveils how empowerment is translated into outcomes in the OSS context, directly and indirectly through task effort. Examining the mediating role played by task effort extends our understanding of the underlying influencing process of empowerment in OSS communities. Second, this is one of the first studies that examine the effect of psychological feelings derived from task assessments. Different from previous studies that investigate the effect of personal motivations aroused by the environment and personal dispositions (e.g., Shah 2006; Roberts et al. 2006), we focus on the intrinsic motivation derived from the assessments of tasks in OSS projects. Such focus provides more insights into the design of tasks which can be managed by project leaders.

Our study also has practical implications for the management of OSS projects. In particular, empowerment has significant impacts on participation outcomes. OSS project leaders and other stakeholders thus should find ways to maximize participants' sense of empowerment. For example, designing tasks to fit participants' capability

(such as high modularity and fine granularity), allowing participants to self-assign tasks, articulating the rhetoric of the project, encouraging active participation and highlighting possible changes that can be made by individual participants are all possible ways to affect participants' task assessments and thus enhance sense of empowerment. In addition, knowing that task effort partially mediates the empowerment-participation outcome relationships, practitioners should realize that, in addition to task design, they can influence outcomes by directly affecting task effort expended. Specifically, project leaders can call upon participants to work hard on the chosen task and encourage and support participants when they face difficulties and barriers.

REFERENCES

1. Armstrong, J. S. and Overton., T. S. (1977) *Journal of Marketing Research*, **14,** 396-402.
2. Bagozzi, R. P. and Dholakia, U. M. (2006) *Management Science*, **52,** 1099-1115.
3. Brown, S. P. and Leigh, T. W. (1996) *Journal of Applied Psychology*, **81,** 358-368.
4. Brown, S. P. and Peterson, R. A. (1994) *Journal of Marketing*, **58,** 70-80.
5. Cherrington, D. J. (1980) *The work ethic: working values and values that work*, Amacom, New York.
6. Chin, W. W. (1998) In *Modern Methods for Business Research*(Ed, Marcoulides, G. A.) Lawrence Erlbaum Associates, Mahwah, NJ, pp. 295-336.
7. Christen, M., Iyer, G. and Soberman, D. (2006) *Journal of Marketing*, **70,** 137-150.
8. Deci, E. L. and Ryan, R. M. (2000) *Psychological Inquiry*, **11,** 227-268.
9. Fornell, C., and Larcker, D.F (1981) *Journal of Marketing Research*, **18,** 39-50.
10. Gagne, M., Senecal, C. B. and Koestner, R. (1997) *Journal of Applied Social Psychology*, **27,** 1222-1240.
11. Hackman, J. R. and Oldham, G. R. (1980) *Work Redesign*, Addison-Wesley, Reading, MA.
12. Hollenbeck, J. R., Williams, C. L. and Klein, H. J. (1989) *Journal of Applied Psychology*, **74,** 18-23.
13. Kanfer, R. (1991) In *Handbook of industrial and organizational psychology*(Eds, Dunnette, M. D. and Hough, L. M.) Consulting Psychologists Press, Palo Alto, CA.
14. Kanter, R. M. (1968) *American Sociological Review*, **33,** 499-517.
15. Ke, W. and Zhang, P. (Forthcoming) *International Journal of Electronic Commerce*.
16. Kirkman, B. L., Rosen, B., Tesluk, P. E. and Gibson, C. B. (2004) *Academy of Management Journal*, **47,** 175-192.
17. Klein, H. J., Wesson, M. J., Hollenbeck, J. R. and Alge, B. J. (1999) *Journal of Applied Psychology*, **84,** 885-896.
18. Lado, A. A. and Ke, W. (2008) Clarkson University, Potsdam, NY.
19. Lakhani, K. R. and Wolf, R. G. (2005) In *Perspectives on Free and Open Source Software*(Eds, Feller, J., Fitzgerald, B., Hissam, S. and Lakhani, K. R.) MIT Press, Cambridge, MA.
20. Liden, R. C., Wayne, S. J. and Sparrowe, R. T. (2000) *Journal of Applied Psychology*, **85,** 407-416.
21. Locke, E. A. and Latham, G. P. (1990) *A theory of goal setting and task performance*, Prentice-Hall, Englewood Cliffs, NJ.
22. Locke, E. A., Shaw, K. N., Saari, L. M. and Latham, G. P. (1981) *Psychological Bulletin*, **90,** 125-152.
23. Mowday, R. T. and Sutton, R. I. (1993) *Annual Review of Psychology*, **44,** 195-229.
24. Parsons, T. (1968) *The structure of social action*, Free Press, New York.
25. Roberts, J. A., Hann, I. H. and Slaughter, S. A. (2006) *Management Science*, **52,** 984-999.
26. Ryan, R. M. and Deci, E. L. (2000) *The American Psychologist*, **55,** 68-78.
27. Seibert, S. E., Silver, S. R. and Randolph, W. A. (2004) *Academy of Management Journal*, **47,** 332-349.
28. Shah, S. K. (2006) *Management Science*, **52,** 1000-1014.
29. Spreitzer, G. M. (1995) *Academy of Management Journal*, **38,** 1442-1465.
30. Stewart, K. J. and Gosain, S. (2006) *MIS Quarterly*, **30,** 291-314.
31. Thomas, K. W. and Tymon, W. G. J. (1994) *Journal of Management Systems*, **26,** 1-13.
32. Thomas, K. W. and Velthouse, B. A. (1990a) *Academy of Management Review*, **15,** 666-681.
33. Thomas, K. W. and Velthouse, B. A. (1990b) *Academy of Management. The Academy of Management Review*, **15,** 666-681.
34. Tsai, W.-c., Chen, C.-C. and Liu, H.-L. (2005) *Academy of Management Proceedings*.
35. von Hippel, E. and von Krogh, G. (2003) *Organization Science*, **14,** 209-223.
36. von Krogh, G. and von Hippel, E. (2006) *Management Science*, **52,** 975-983.
37. Yeo, G. B. and Neal, A. (2004) *Journal of Applied Psychology*, **89,** 231-247.