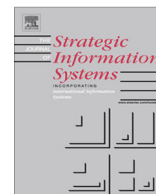




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# What makes a good contributor? Understanding contributor behavior within large Free/Open Source Software projects – A socialization perspective

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## ABSTRACT

Attracting new contributors is a necessary but not a sufficient condition, to ensure the survival and long-term success of Free/Open Source Software (FOSS) projects. The well-being of a FOSS project depends on the turning of project newcomers into 'good contributors' that is to say into individuals that substantially contribute to the project - but also that perform citizenship behaviors that protect and nurture its community. This study is a mixed-methods investigation of the socialization factors that influence contributor performance in large FOSS projects. A qualitative research component resulted into the development of a FOSS socialization framework as well as into the identification of key FOSS project citizenship behaviors. A conceptual model was then developed and empirically examined with 367 contributors from 12 large FOSS projects. The model hypothesizes the mediating effect of two proximal socialization variables, social identification and social integration, between FOSS newcomer socialization factors and contributor performance (conceptualized as task performance and community citizenship behaviors). The results demonstrate the influence of social identification and social integration in predicting contributor performance, as well as the importance of key socialization factors that are: task segregation, task purposefulness, interaction intensity, and supportiveness. Theoretical and practical implications are discussed.

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## Introduction

The prominence garnered by Free/Open Source Software (FOSS) development along with the software industry's transformation it has engendered (Morgan and Finnegan, 2014), are unquestionable testaments of the overall attractiveness and success of FOSS development as a viable alternative to the conventional proprietary model of producing software (Daniel and Stewart, 2016; Sacks, 2015). While firms are more and more aware of the business value that can be derived from Free/Open Source Software (Marsan et al., 2012; Morgan and Finnegan, 2014; von Krogh and Spaeth, 2007), they have also realized that managing the use and development of FOSS can be a critical factor towards firm success (Dahlander and Magnusson, 2005; Gulati et al., 2012). A key feature that differentiates FOSS projects from traditional proprietary software projects is the reliance on an active and dedicated community consisting of talented individuals whose skills tap into a wide

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spectrum of software-related domains. The leveraging of such communities by firms has been shown to lead to substantial economic and organizational benefits (Chesbrough, 2007; Morgan et al., 2013).

Despite the success of the overall FOSS movement, research has demonstrated that FOSS projects are characterized by high project abandonment rates (Stewart et al., 2006), a lack of new developers' enrolment (Hahn et al., 2008) and a lack of sustained participation (Fang and Neufeld, 2009), altogether seriously endangering their survival, long-term success, and sustainability. Ensuring the continuing enrolment of newcomers is not, in and of itself, a guarantee that new members will perform well and help to sustain their FOSS communities. A FOSS community that attracts a large number of new contributors from which a majority does not successfully or satisfactorily carry out project tasks may not prosper in the long run and may even disappear. In addition, one of the key factors for maintaining the strength of FOSS communities concerns the manifestation of citizenship behaviors among contributors, behaviors such as sharing and helping (Kuk, 2006; Wu et al., 2007). If such citizenship behaviors begin to fade, the survival of the community may be seriously jeopardized.

FOSS communities have traditionally believed that access to the source code repository and to the interaction logs (such as mailing lists or forums) was sufficient for prospective contributors to attain a necessary level of performance, and engage in citizenship behaviors. FOSS communities are becoming aware that joining a FOSS project is characterized by (often important) entry obstacles that pertain to the specificity and complexity of development practices. Unless more is done, their sustainability is endangered. Adopting a wide range of strategies, they have launched various initiatives to attract new participants (e.g. creating newcomer sub-communities, running formal mentoring programs, implementing formal joining processes, etc.) but also to ensure that appropriate contributor behaviors are generated from new contributors.

Moreover, a unique feature that characterizes FOSS project engagement is that the experience through which an individual goes during the socialization phase is unique to each individual. As a result, it is not enough for FOSS communities to make sure socialization resources and initiatives are available for potential newcomers. Communities need to identify the practices that generate behaviors which are aligned with a project's values and goals. As a result, the overarching research question guiding this study is: *What socialization factors influence contributor performance in FOSS communities?*

To date there has been no careful scientific investigation of the effectiveness of such initiatives. There is then a need for FOSS communities and academic researchers to collaborate in order to help communities design appropriate socialization practices that generate satisfactory contributor behaviors. Drawing upon theories of socialization and citizenship behaviors from organizational behavior research, this research is an 'embedded' mixed-methods research design (Creswell and Plano, 2011; Venkatesh et al., 2016). The first stage consisted of conducting a qualitative research component which objective was twofold: to identify the important aspects that characterize the socialization experience of FOSS project newcomers, and to delineate the various instances of citizenship behaviors that are specific to the FOSS community context. The second step involved the development of a socialization model that hypothesizes the mediating effect of two proximal socialization variables, social identification and social integration, between FOSS newcomer socialization (captured as six distinct constructs) and contributor performance, conceptualized as task performance and community citizenship behaviors. The model was tested through an online survey involving 367 contributors from 12 large FOSS projects.

The rest of this paper is organized as follows. A review of the literature constituting the theoretical foundations of this study is first provided. We then explain how our research model was developed by integrating results from the literature as well as from a prior qualitative research component. After having described the implemented methodology, the data analysis and results are presented, followed by a discussion of the key findings, limitations, as well as implications for both research and practice.

## Theoretical background

### *Towards a dynamic community-centered view of FOSS projects*

FOSS practices started attracting the attention of IS researchers when they realized that a totally different software development methodology could engender high quality software with the potential of transforming the entire software industry (Morgan and Finnegan, 2014; Sacks, 2015). Ensuring the long-term success and sustainability of FOSS projects has become a critical concern for a number of organizations that derive strategic value from the use of FOSS (Chengalur-Smith et al., 2010; Marsan et al., 2012). The social structure of FOSS projects have been recurrently depicted as an 'onion-like' model with contributors ranging from passive users, active users, co-developers, to core developers within which are included project initiator and release coordinator and often project and community managers (Crowston and Howison, 2005; Jensen and Scacchi, 2007). The widespread acceptance of the onion-like model has acted as a theoretical converging lens orienting most FOSS research efforts towards the technical side of FOSS project development. As a result, a number of research projects adopted a techno-centric approach to assess contributor participation through programming-related measures such as the number of lines of code written in a project's source code, number of commits (AlMarzouq et al., 2015; Colazo, 2014; Colazo and Fang, 2010), or software downloads (Peng et al., 2013).

However, the static nature of the onion-like model is limited in its capacity to capture the mechanisms that govern the FOSS project reality as it was shown that the core group of a FOSS project does not persist for long periods of time; new generations take the lead over after a certain amount of time (Herraiz et al., 2006). Moreover, the onion model tends to assume that a new contributor, starting as a user, has to work his way through all layers of the onion model in order to reach the core

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