



From closed to open: Job role changes, individual predispositions, and the adoption of commercial open source software development

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ABSTRACT

When trying to attain the benefits of open source software (OSS), proprietary closed source software (PCSS) firms are struggling to adopt this radically different practice of software development. We approach these adoption challenges as a problem of gaining support for organizational innovation. Through a mixed-method research design consisting of qualitative interviews and a survey of employees of a large telecommunications firm, we find that the organizational innovation to commercially engage in OSS has different impacts on technical and administrative dimensions of different job roles. Accordingly, individuals enacting different job roles are—on average—more or less well aligned with the OSS practice and OSS processes per se. We find that individual-level attributes can counterbalance the job role changes that weaken support for adopting OSS, while perceived organizational commitment has no effect. Suggestions for PCSS firms are presented and implications for innovation literature are discussed.

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1. Introduction

In their pursuit of the efficiency and efficacy gains to R&D promised by open and collaborative models of innovation (e.g., Chesbrough, 2003; von Hippel and von Krogh, 2003), incumbent firms in software and related industries are increasingly getting involved in open models of innovation, such as open source software development (OSSD). Here, recent literature has shown how in a variety of circumstances, embracing OSSD may be commercially beneficial to companies that traditionally relied on proprietary closed source software (PCSS) development, which had allowed them to keep the source code of their software a trade secret. Specifically, prior research has addressed issues such as open business models (e.g., Chesbrough, 2006), the role of intellectual property in the commercialization of openly produced goods (e.g., Fosfuri et al., 2008), firm engagement in OSS (e.g., Dahlander and Magnusson, 2005; Dahlander and Wallin, 2006) and the effects of such engagement on firm value (e.g., Alexy and George, 2013).

It thus seems fair to say that the advantages of commercial OSS engagement are quite well understood; in other words, we know *why* firms decide to adopt OSS-based practices into their

software development. However, little is known about *how* firms actually do so, which is surprising given that it is particularly pronounced example of an organizational innovation. Generally, organizational innovations, i.e. an organization's adoption of a new idea or behavior (Daft, 1978; Damanpour, 1991; Damanpour and Evan, 1984), can be classified as administrative or technical, where the former modifies organizational structure and the latter introduces new technologies to the firm (Daft, 1978). For both technical and administrative innovations, successful adoption depends on top-down managerial decisions as well as bottom-up decisions where employees make individual adoption decisions (e.g., Swanson, 1994). We submit that OSSD brings fundamental changes of *both* technical and administrative nature to PCSS firms, which in turn means that it will likely affect the task and processes of (almost) any individual active in the software development process. Thus, any firm transitioning from a proprietary software development paradigm (i.e. a PCSS firm) to an open one needs to go through a process of organizational innovation in which they need to rally the support of individual employees.

Surprisingly, this issue has not been particularly salient in received literature. Here, the little work that exists centers on programmers (Henkel, 2009; Rolandsson et al., 2011) who—while of course an essential part—are by far not the only actors affected by the move toward OSSD. Accordingly, in this paper, we extend these studies by asking, for all individuals in software development, *what factors predispose an individual to support the adoption of organizational innovation in the form of OSS development?* To do so, we build on the literature connecting organizational innovation

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and the work conducted by individuals (e.g., Barley, 1986, 1990; Barley and Kunda, 2001; Edmondson et al., 2001). First, we theorize the organizational change that OSSD will bring to the task and processes captured by the job roles that exist in software development. We argue that the severity of change of technical and administrative nature for a job role will predictably shift the support of *any* individual enacting this job role. Second, individuals' varying perceptions, attributes, and experiences either counter-vail or reinforce the changes to their job roles. We maintain that the perceived degree of organizational commitment should render individuals more supportive of the firm's intent to introduce OSSD are. In addition, individual-level factors, most notably their general innovativeness, experience with OSSD, and identification with the OSS community will impact their evaluation.

We elaborate and test our hypotheses using a mixed-method study design, in which we follow a company in the telecommunications sector considering the introduction of OSSD to its software development business over a 3-year period. We conducted a series of 25 interviews, analyzed related company documents, and surveyed over 250 employees. Here, our qualitative work allows us to substantiate our theorizing regarding the intraorganizational consequences of the introduction of OSSD and guides us in the operationalization of our hypotheses. At the same time, it infuses a causal logic into a survey that would otherwise only capture a snapshot in time, which we further attempt to validate in a benchmark involving several additional organizations.

We find strong support for most of our arguments. Specifically, our qualitative findings allow us to elucidate *to what degree* the tasks and processes comprising the different job roles are differently affected by the move towards OSSD, and to theorize *why* this is the case and *how* it should affect individual-level support. We verify these insights in our quantitative analysis, through which we further highlight the importance of individual-level factors as drivers of individuals' support. Surprisingly, perceived organizational commitment exhibits no effect.

In doing so, we make three contributions to the literature on innovative activity and its organization, in particular with regards to open models of innovation. First, we elucidate the consequences of opening up software development to incorporate OSSD as a bundle of changes of technical and administrative nature. We present an original classification of job roles which allows us to relate these to the severity of the change caused by OSSD. Second, we broaden the debate of corporate OSS engagement beyond its current focus on developers (e.g., Henkel, 2009; Rolandsson et al., 2011) to include other job roles as well as individual-level attributes irrespective of job role. Third, taken together, we attempt to shed light on the adoption of open models of innovation more generally. In this context, our findings clearly point to a need to research what we label the *microfoundations of openness*. Specifically, if open and closed models are as different as existing literature credibly suggests (e.g., Chesbrough, 2003; Chiaroni et al., 2010), we need to understand the individual-level implications of opening up the innovation process to be able to fully grasp this model in theory as well as in practice.

2. Theory and hypotheses

2.1. PCSS and OSS development processes

Proprietary closed source software (PCSS) development, practiced successfully for decades by companies such as Microsoft, aims at producing software artifacts the source code of which is secret. Here, following initial specifications by the customer (who may well be internal to the firm), the firm builds nearly exclusively on the knowledge of its own employees to assemble the final product.

Developers write the source code according to use cases specified by software architects, without any significant interaction with the outside. In the end, product testing ascertains that the final software adheres to the requirements set initially as well as to company quality standards before the product is released (Jones, 2003; Lehman, 1980; Royce, 1987; Senyard and Michlmayr, 2004). Potential influence from the outside is restricted to licensed-in commercial third-party software and beta testing towards the end of the process. Obviously, this description resembles the waterfall model of software development which Cusumano et al. (2003) and Jones (2003) identify as the most widely used model of software development.³

Since the late 1990s, OSS has attracted millions of users and developers and is now a standard ingredient of the product mix of a large share of software developing organizations from a variety of industries (e.g., CED, 2006). OSS, simply defined, is software code that users can inspect, modify and redistribute, and usually developed in a public and collaborative manner in a community that spans organizational boundaries. Accordingly, commercial firms following a PCSS development logic that intend to engage in open source software development (OSSD) need to embrace substantial changes regarding the technical aspects of software development. Consider the case of a firm which reveals internally developed software as OSS, to launch a public OSS project: the first release of the software is usually still done in the same way as in a PCSS environment. The outcome is a prototype of the software that is good enough to solve the initially specified problem (Senyard and Michlmayr, 2004). Subsequently, however, outsiders such as users of the software are asked to report bugs, suggest new features, or even actively contribute source code to the original product for its further improvement. As such, OSSD might immensely reduce maintenance cost compared to PCSS development but require different modes of working (Lakhani and von Hippel, 2003; Raymond, 2001; Senyard and Michlmayr, 2004). For example, Rolandsson et al. (2011) point out how software developers need to develop specific coping mechanisms once their employers decide to embrace OSSD.

However, not only will OSS change the way in which software is developed, it also affects how software development is governed (Lee and Cole, 2003), as control over R&D and its outputs has to be shared with collaboration partners (Boudreau, 2010). Moreover, von Krogh et al. (2012) point toward differences between PCSS and OSS development along the lines of incentives, control, coordination mechanisms, and ethical standards. Finally, OSSD may also present novel challenges related to (project) management, in that people are typically not co-located or not even known to the organization or each other (Goldman and Gabriel, 2005).

2.2. Intraorganizational implications of OSS: an individual-level framework

The above makes clear that OSSD is an organizational innovation (e.g., Damanpour, 1991) that changes both the technical (how it is done) as well as the administrative (how it is governed) nature of software development work. In itself, the introduction of OSSD is a technical innovation—a new method of conducting software-related R&D (e.g., Lee and Cole, 2003). However, the application of such a—radically—new technique has the potential to fundamentally affect the firm's administrative structure and governance mechanisms (e.g., Jacobides and Billinger, 2006). Taken together, it seems clear that the introduction of OSSD should be cause to considerable degree of organizational change, with the potential to

³ In Section 5.2, we elaborate how our results hold *mutatis mutandis* for other development models.

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