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Abstract

The traditional resource-based view (RBV) accentuates the heterogeneous and imperfect mobile resources serve as key determinants of the competitiveness of organizations. However, social capital theory seems to be advocated leveraging the resources residing in the relationships among individuals to facilitate the organizational performances. The open innovation product, i.e., an Open Source Software (OSS) project or an user-centric software like mobile application, consists of a group of self-organizing individuals who collaboratively co-create an innovation. Much of our understandings of OSS an open innovation is based on studies that focused on the internal resources (i.e., on the co-workers predominantly) leaving little regards to the fact that such an open innovation organization functions in a larger community of projects and people. In this regard, it is imperative to jointly build upon the RBV and social capital theory to take a broader, embracing investigation of an open innovation, i.e. open source software (OSS), system to unveil how internal and external resources can facilitate the innovation legitimacy. In particular, the internal resources include the tangible resources, such as workforce and extent of contribution, and intangible resource like governance structure. The external resources include diverse forms of social capital, such as structural, cognitive, and relational social capital. This ongoing work proposed a theoretical framework to articulate how the interplay between internal and external resources can promote the innovation legitimacy.

Keywords

Open innovative products, Resource-based View, Social Capital Theory

INTRODUCTION

As a pivotal form of network organization, an open-source software (OSS) project is characterized not only by a group of self-motivating, self-organizing individuals co-creating an open innovation, such as a mobile application (von Krogh and von Hippel 2006; Lakhani and Von Hippel 2003), but also are situated within a community of projects and people. Rapid proliferation of OSS as an open innovation affords a far-reaching opportunity for researchers to examine an organizational form that departs from the classical form, characterized by market-driven and hierarchical structures (Larson 1992). An OSS project thrives on drawing resources from its OSS community, as well as its translucent operations recruiting people through monetary employment and functioning in a well-defined, enclosed vicinity (Von Hippel and Von Krogh 2003; Shah 2006). Accordingly, numerous OSS studies were conducted to identify the motivation of an individual to co-develop an OSS, such as

those from the perspective of the developers (Hahn et al. 2008; Li et al. 2012; Roberts et al. 2006; Shah 2006; Stewart and Gosain 2006; von Krogh et al., 2003) and the innovation creation governance (Feller et al. 2008; Mehra et al. 2010; Sen et al. 2008; Singh and Tan 2010; Stewart et al. 2006). The majority of these OSS studies examine the internal dynamics of a project, with focus on attracting skilled developers and managing that project to ensure vitality. Consequently, whether and how an OSS project performs is rarely examined beyond the view of OSS as production yield, such as counting the number of OSS downloads and the number of Concurrent Versions System (CVS) commits (Singh et al. 2011; Sen et al. 2012).

As a depiction of a network organization (Gallivan 2001; Markus 2000), i.e., an organization that draws upon resources from individuals and other organizations to innovate (Hanssen-Bauer and Snow 1996), an OSS project is a social system in which individuals initiate, contribute and leave the organization, most at their own wills (Roberts et al.2006). Whereas most research continue to consider an OSS project and its contributors in isolation and independent of the other projects, it is increasingly recognized that an OSS project is situated within a bigger social system of people and projects, i.e., OSS ecosystem (Singh 2010). In other words, research on OSS projects should not only consider an OSS project as a network organization (intra-project) but also the entire ecosystem of OSS projects as an overarching network organization (inter-projects). Such perspective is echoed by Kane and Alavi (2008), who advocated the importance of considering that, in the context of user-system relationship, both the dyadic and multimodal network perspectives of users-systems interactions.

Given that an OSS project is located within the network organizations, an OSS project must be examined based on three perspectives, which this research proposal entails.

First, from the perspective that OSS is created in a societal community for open innovation, OSS must be examined by considering people who are directly (i.e., co-workers) and indirectly (i.e., onlookers) involved in OSS creation. However, prior studies have predominantly focused on co-workers while almost ignoring onlookers, those who indirectly participate in the OSS projects, such as inclination or efforts of developers (Roberts et al. 2006; Shah 2006) or the proliferation of innovation (Tuomi 2002; von Hippel and von Krogh 2006; Lounsbury and Crumley 2007; Kim and Mauborgne 2005), which remains a research gap to unveil the potential impact resulted from the power of onlookers.

Second, an open innovation such as OSS or user-centric software (desktop or mobile applications) etc. is deemed successful if the primary people within the community recognize or accept the innovation (considering that these people are most cognizant in the field). Such condition is referred to as innovation legitimacy (Kostova and Zaheer 1999; Lu and Xu 2006). However, previous studies considering code reuse as the outcome variable are limited to either impertinent research methodology (Frakes and Fox 1995) or insufficient samples (Haefliger et al. 2008). The second study, which utilizes data collected from Sourceforge, investigates the interactions among the projects, which were constructed by the affiliated networks in terms of the conjunct workforces.

Third, according to Cattani and Ferriani (2008), a community portrayed by a core and periphery structure is the most innovative one. As the core individuals are relatively homogeneous and likely to share common values, attitudes, and interests (Knoke et al. 1996), communities composed of core alone may fail to extensively innovative. On the other hand, as the periphery individuals are not as socially engaged as those in the core, teams composed of periphery alone may not be able to maintain healthy interactions and integrate knowledge and ideas necessary for innovation. However, such emerging approach has not been examined in the OSS context.

Although some theoretical notions are distributed in the previous literatures, there is no study which comprehensively discusses how OSS project, being situated in network organization, leverage its internal and external resources, such as co-workers and onlookers, or core or periphery positions, to facilitate its innovation legitimacy. Hence, it is high time for us to propose an integrated theoretical framework to unveil the mechanism underlying such phenomenon.

LITERATURE REVIEW

An OSS project is rarely viewed as a network organization; instead, such a project is regarded as having observable traces from the studies by Von Hippel and Von Krogh (2006). The aforementioned study presents that OSS is a private–collective model of open innovation. Gallivan (2001) conceptualizes an OSS project as a virtual organization. Toral et al. (2010) illustrates an OSS community by social network analysis. Whereas the concept of network organization originates from the field of management, which focuses on commercially driven physical organizations (Larson 1992; Sydow and Windeler1998; Provan and Kenis 2008), two fundamental characteristics that reflect a network organization can most closely depict an OSS project. These two characteristics reflect the following views: (a) "relationship basis- communication and informal climate oriented toward mutual gain… knowledge-intensive skills that are best transferred through processes of collaborative information sharing" (Larson 1992, pp. 77) and (b) the synthesized consequence of achieving network effectiveness through "attainment of positive network level outcomes that could not normally be

achieved by individual organization participants acting independently … [for example] strengthened community capacity to solve public problems" (Provan and Kenis 2008, pp. 230). The first suggests cross-project resources; the second view indicates the involvement of people in the intra-project. However, both approaches are with limited understanding in the existing literatures.

For the first stream, current studies on the social interactions among OSS projects (inter-projects) vary considerably in sample size, ranging from 25 (Singh et al. 2011) to 8,627 projects (Singh 2010), they share three common themes. First, the OSS projects studied are often randomly sampled, and thus the observations interactions among the projects might be incomplete and do not reflect the OSS ecosystem. Second, utilizing different social network measures, these studies collectively indicate that the degree to which an OSS project is "located" and "connected" with the others could affect the performance of the project. In our proposed study, we will take a different perspective by examining the position of an OSS project in the OSS ecosystem, as a manifestation of its external legitimacy, on the change in the activity intensities of the OSS project, as an indicator of its survivability. Third, the source of connections among OSS projects is mainly based on the developers, with slight attention given to other roles, such as onlookers, administrators or communication moderators (e.g., Grewal et al. 2006; Singh 2010; Singh et al. 2011). In our study, we will investigate all potential roles within an OSS project to be aligned with the perspective that an OSS project is characterized by coordinated activity arising from the interactions among the management-development group, which engenders the users' interests and feedbacks for software improvement (Lakhani and Von Hippel 2003; Lerner and Tirole 2003).

For the second stream, current studies on the interactions among members of an OSS project (internal) are few with three related seminal works using tie strength (Conaldi et al. 2012), degree distribution of network (Singh et al. 2011), and network structure in terms of stability and efficiency (Singh and Tan 2011). Except for Singh et al. (2011) who utilized 2,378 OSS projects to test the proposed relationship between social network structure and OSS project performance, the other two studies focused on very few projects, i.e., one project in Conaldi et al. (2012) and two projects in Singh and Tan (2011). Despite their differences, they collectively motivate our research to examine the internal work structure of OSS projects as a potential indicator of OSS survivability. In a network organization, it is crucial to have internal structure that motivates and maintains innovations despite its permeable boundary.

Collectively, the first stream denotes the internal resources and dynamics of a network organization, and the second stream represents the boundary of an organization, particularly its external relationships. One potential theoretical framework could be the extended resource-based view (RBV) approach. Gulati (1999) attempted to combine the traditional RBV and social network analysis to argue that the organizations can benefit from the external resources based on their internal immobile resources. Although Gulati (1999) provided the empirical evidence to support his idea but the theoretical explanation is not sufficient. By extending his work, Lavie (2006) first proposed the terminology, extended RBV, in his work via a rigorous deduction. Such work could be seen as the theoretical rudiment that elaborates the relationship between organizational internal (heterogeneous and imperfect mobile) resources and the external social resources. Although both of the works mentioned the external resources coming from the social capital resources, however, neither of them completely adopted the social capital theory in their works. Social capital theory is composed by three dimensions, which are structural capital, cognitive capital, and relational capital. The proposed external social resource from Gulati (1999) or Lavie (2006)'s work is limited to structural capital only, rather than the complete social capital approach. We attempt to strengthen such potential weakness in this work by integrating the social capital theory to the resource-based view approach to understand how these two seemingly contradicting theories contributing to innovation legitimacy in network organizational contexts.

INTERNAL RESOURCES AND DYNAMICS

An important aspect of an OSS project is its ability to attract, retain, and manage co-workers to orchestrate efforts toward creating an innovation (Subramaniam et al. 2009; Colazo and Fang 2009). An organization values the resources it acquires, as suggested by the RBV. According to the RBV, the degree to which an organization possesses internal resources e.g., tangibles such as facilities, specific investment, and skills (Miller and Shamsie 1996; Foss and Foss 2005) as well as intangibles such as knowledge, governance, and regimes (Leiblein 2003; Ray et al. 2004; Wade and Hulland 2004) determines competitiveness (Wernerfelt 1984; Barney 1991; Peteraf 1993). Acquiring necessary internal resources in a networked organization would pressurize administrators to attract and convince developers to participate in a project. Such acquisition of internal resources differs from the conventional organizational approach, which offers monetary incentives in exchange for resource acquisition.

In the context of OSS, human capital, i.e., developers, was deemed a key resource in software development (Hars and Ou 2002; Wu et al. 2007; Lakhani and Von Hippel2003). Most studies discussed the participatory contribution of different roles such as that of project administrators and developers to OSS development. The

most widely accepted view is that project managers or administrators are mainly responsible for governance or managerial tactics, such as OSS community governance (Sharma et al. 2002) or team composition (Stewart and Gosain 2006), and the source codes are mostly contributed by developers (Roberts et al. 2006; Mockus et al. 2002).

We elaborate on tangible resources with twofold facets, namely, the human capital of each OSS project, which is measured by the population of active developers, and the contribution. Developers handle code contribution to OSS projects. In addition to OSS product development, numerous maintenance jobs were found to be accomplished more competently by developers than administrators for three reasons. First, compared with project administrators, developers can more quickly complete important requirements such as adding new features or fixing bugs from the user side. Second, developers are more familiar with the source code, which allows them to complete maintenance jobs more efficiently. Finally, previous studies have demonstrated that developers rely on their own resources to solve several problems such as code bugs. In this regard, active developers and their contributions are the key internal tangible resources influencing the degree of product legitimacy. We present the following proposition:

P1: The internal resource 1) measured by the number of active project developers; 2) measured by the extent of commits by such active project developers, can enhance the level of legitimacy of this OSS project.

Beyond mere cultivation of internal resources, such as drawing developer participation in a project, the need to accentuate intangible resources such as collaborative structures also constitute a significant portion of the internal resource of each OSS project, as deduced by the RBV (Dunnette et al. 1976; Whetten 1989; Miller and Shamsie 1996; Brush and Artz 1999; Priem and Butler 2001). One approach to examining this scenario is to evaluate the OSS project administrators themselves and the governance structure of an OSS project. The development of OSS projects mainly relies on voluntary contributions rather than mandated work; this process differs from that involved in proprietary software development. Thus, as an informal social system, the traditional bureaucratic governance structure is not perfectly compatible with such collective forms of productions although bureaucracy at times operates efficiently and effectively (Jones et al. 1997; O'Mahony and Ferraro 2007; Markus 2007; De Laat 2005). O'Mahony and Ferraro (2007) empirically verified that a pure bureaucratic governance structure could not adapt to governing such a community-based structure by analyzing the data from the Debian (one of the leading Linux distributors) community collected over 13 years, as well as a series of interviews. They found that democratic mechanisms such as annual elections could cohere with the individuals and help them realize leadership and the importance of authority. Coincidentally, the core findings of such studies manifested a form of proposed governance regime in previous studies (Gerlach 1992; Uzzi 1996, 1997; Jones et al. 1997). Such a governance regime is intended to coordinate inter-firms that are characterized by organic or informal social systems (Gerlach 1992), or "to enhance cooperation on shared tasks…" (Jones et al. 1997, pp. 916). In essence, OSS as a collective achievement may not be effectively administered by traditional governance structures such as bureaucratic or protective mechanisms, which are mostly used in proprietary software development (De Laat 2005; Markus 2007). A social mechanism regime is recommended for managing such production but has yet to be fully understood empirically.

There are two main governance structures in OSS projects summarized in the previous studies (Ni 2006; Arya and Lin 2007), which are open relational governance structure (Kogut and Metiu 2001; Sawhney et al. 2005) and closed relational governance structure (Hinds and Bailey 2000; Hahn et al. 2008). The open structure accentuates to accumulate more innovative and creative ideas from all participants (Kogut and Metiu 2001). A more open environment could collect more decentralized knowledge from individuals, benefitting the OSS project (Sawhney et al. 2005). However, a closed structure in OSS studies accentuates that people preferred working with people they had previously collaborated with (Hinds and Bailey 2000) on projects such as OSS development (Hahn et al. 2008). Both two governance structures receive attentions and supports. Hence, we proposed a set of competing propositions for such an intangible resource:

P2A (competing): An OSS project with open relational governance structure between administrators and developers could enhance the legitimacy of such project.

P2B (competing): An OSS project with closed relational governance structure between administrators and developers could enhance the legitimacy of such project.

EXTERNAL INTERESTS AND CAPITAL

Onlookers are at the boundary of an OSS project. Studies on onlookers are rarely reported, with most of them focusing on the feedback provided by users in forums. Viewing onlookers consist of OSS users who provide feedback. Fleming and Waguespack (2007) stressed that participative contribution, social brokerage, and boundary spanning between specialized areas positively influences the likelihood of an individual to become an opinion leader in the open-innovation community. Piller et al. (2004) defined and contextualized toolkits to

contain technological artifacts such as online chatting, forums, and peer-to-peer rating for transferring open innovation from the user side to mobile phone game development. The theoretical view of onlookers could be from social capital theory, which suggests that the external networks of an organization substantially contribute to its performance (Leenders and Gabbay 1999; Lee et al. 2001). Specifically, such contribution could consist of financial resource (Batjargal 2003), emotional support (Brüderl and Preisendörfer 1998), or improved information access (Birley 1985). For this reason, organizations prefer to acquire external social capital to obtain seek more consequent opportunities for growth and success. In the context of OSS, previous studies only emphasized the structural capital of each OSS project by examining the network structure constructed by collaborative activities (Singh et al. 2011; Grewal et al. 2006; Hahn et al. 2008). These studies provide plausible interpretations but lack consolidated metrics representing social capital.

Although social capital theory was either widely adopted as a theoretical framework or empirically exemplified in the previous works, it is still lack of explicit scales measuring the social capital. Measurements from existing studies are lot like a kind of self-justifications. Singh et al. (2011) used the extent of network cohesion to indicate the degree of social capital and regard network centrality as the control variable; however, network centrality was widely adopted to quantify social capital in multidisciplinary studies (Wasko and Faraj 2005; Conaldi et al. 2012). In the previous studies driven by social capital theory (Wasko and Faraj 2005; He et al. 2009), we can find that the social capital is composed of three dimensions, which are structural capital, cognitive capital, and relational capital. The network centrality can only represent the structural capital. Either cognitive capital or relational capital was not well interpreted in the previous OSS studies.

The cognitive capital denotes the resources, which make possible shared interpretations and meanings within a collective (Nahapiet and Ghoshal 1998). Such resources include the level of expertise or reputations in the community. O'Mahony and Ferraro (2007) studied the Debian community and found that the individual's domain expertise was one of the most important factor to make him/her receive respects and reputations. In other words, level of expertise is the antecedent for individuals to be promoted in the OSS community. The knowledge possessed by an OSS project comes from both its developers and the onlookers, which is similar to that consumer providing feedback or developers from other project making ad hoc contribution to some specific issues like bugs. Comparing with the direct contribution from developers or administrators to the OSS project, the expertise of the onlookers may also have the indirect contribution. Such situation is very similar to the product life cycle in marketing resource, which accentuates that an experienced consumer can provide more precious feedback for the product development because she/he is more familiar with that product (Sawhney et al. 2005).

The relational capital denotes the affective nature of relationship within a collective (Nahapiet and Ghoshal 1998). Such affective nature can be manifested by trust, personal relationships, or sense of commitment. Previous studies (Constant et al. 1996) found that the individual is willing to contribute to an organization by a sense of obligation. In the similar vein, if the OSS project obtained the commitments from its onlookers, end-users or developers from other projects, the more valuable advices are likely to being contributed. Besides the commitment to the organizations, previous studies also found the trust between individuals also influenced on the knowledge contribution (Putnam 1995). Such trust can help the individuals to build up the sense of reciprocity (Wasko and Faraj 2005) and facilitate the knowledge flow in the organizational context. In the OSS settings, the stronger sense of trust between OSS developers and onlookers, the higher likelihood of the advices from onlookers is adopted. Such interactive relationship can facilitate the legitimacy of the OSS project.

The previous literatures on OSS only accentuates on the importance of structural capital to the legitimacy of an OSS project (Singh et al. 2011; Conaldi et al. 2012). However, we deduced that the other two facets of social capital, namely cognitive capital and relational capital, from externals could also influence on the innovation legitimacy. Hence, we proposed the following proposition:

P3: *The external social capital, manifested by a) structural capital; b) cognitive capital; 3) relational capital, possessed by an OSS project can facilitate the legitimacy of such project.*

Collectively, by integrating the extended RBV and social capital theory, we proposed our research propositions in the above paragraphs. The detailed research model is drawn in Figure 1. The detailed future agenda and potential implications of this ongoing research work are elaborated in the next section.
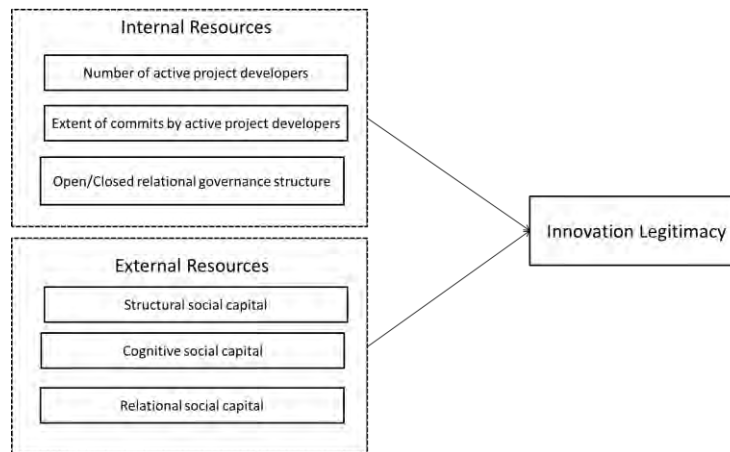
Figure 1: Research Model

FUTURE AGENDA AND POTENTIAL IMPLICATIONS

In this ongoing work, we are attempting to propose a theoretical framework to address the contradicting issue in open innovation research by integrating the extended resource-based view (RBV) and social capital theory. In this study, we contextualized our proposed theoretical framework in the circumstance of OSS projects. For future agenda, we can generalize such theoretical rudiment and empirically investigate it in different context, especially for some user-centric open innovative products, such as mobile application development with users' participation and engagement. For instance, by tracking the users' browsing behaviours from their mobile devices, we can analysed such user-generated data and mobile usage information to assist to develop the novel mobile applications, such as context-awareness applications etc. In this regard, the innovation legitimacy can be measured by multiple dimensions such as time spent on such application or the frequency of usage etc. Additionally, a pluralist research methodology (Mingers 2001) will be conducted by collecting the user-centric feedbacks. As what we have elucidated in the previous sections, the innovation legitimacy can be achieved from internal resources and external capital. The feedback from the users can serve as important supplements for external capital, and such external capital can eventually be transformed as internal resources, namely competitive advantages.

This ongoing research will contribute to the research community by proposing theoretical and methodological implications in two aspects. First, in term of open innovation research, this research proposal theoretically argued for two main determining factors of open innovative projects survivability: 1) the internal attribute of the project that promotes healthy interactions among the project members, and 2) the allocation of the external social capitals from users contribute to the innovation legitimacy. Second, this ongoing work is attempting to address the contradicting issues between RBV and social capital theory. RBV (Miller and Shamsie 1996; Foss and Foss 2005) accentuated that the imperfect mobility of resources determine the success of organizations. However, the social capital theory (Leenders and Gabbay 1999; Lee et al. 2001) advocated leveraging the resources residing in the diverse social relations to enhance the organizational performance. But we demonstrate how these two different natures of theories can co-exist in terms of articulating the interplays between internal resources (i.e., tangible and intangible resources) and external social capital (i.e., structural, cognitive, and relational social capital), which affect organizational legitimacy (i.e., code reuse) for collective intelligence and open innovation.

The eventual work will be conducted based on the proposed research model and theoretical arguments. We believe this piece of work can help scholars to strengthen the existing theoretical paradigms, and even initiate and construct novel theoretical framework for open innovation, especially in the area of information technology or software development.

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