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Reputation management in an open source developer social network: An empirical study on determinants of positive evaluations

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ABSTRACT

Successful development of open source software (OSS) projects requires a steady supply of self motivated software developers. Thus a large body of OSS studies focuses on studying the developers' participation motivations. One important motivation is an OSS developer's desire to gain good community reputation which is largely based on positive evaluations from his peers. Therefore, to better motivate developers' project participations through their reputation needs, our empirical analysis adopted a social network perspective to study what factors may affect a developer's decision to positively evaluate one other in a large online open source community called Ohloh. The results surprisingly show that a developer's positive evaluation decision does not depend on his evaluatee's level of OSS-related experience, but rather based on 1) his past reputation (i.e. existing number of positive evaluations), 2) their shared affiliations such as mutual acquaintances, as well as 3) their homophily in location (city), nationality, programming language preference, and community status. We then discuss these findings and their implications for inducing more positive evaluations and better reputation management among open source project members. To the best of our knowledge, this paper is the first research that investigates issues of reputation building and relationship management in an open source development context.

1. Introduction

In recent years a novel model of production has emerged in which self-organizing individuals voluntarily collaborated online with one another to produce goods and service ranging from software to encyclopedias [46]. A phenomenal success of this production model is open source software (OSS) development whose flagships include Linux, Firefox, MySQL, and many others. The OSS development is characterized by its voluntary developers distributed globally who mainly collaborated in online communities such as Sourceforge. This software development approach, facilitated by today's digitally network environment, has provided new ways for business to interact and collaborate with customers in software development and maintenance [12]. Thus the OSS model has been supported by more and more major software vendors such as IBM. Previous studies found that OSS project success largely depends on its volunteer participants who contribute considerable time and efforts in project development activities [3,35]. Therefore it is crucial to understand developers' participation motivations and how to promote such motivations for achieving better project success.

Among the widely quoted motivations for participating in OSS development projects such as altruism, learning, and career advance opportunities, a very important one is a developer's desire to gain good reputation [15,16,34,39] which is mainly based on the positive evaluations received from his peer developers in OSS communities. In the OSS community of our study – Ohloh, positive evaluation is represented by a Kudo link sent from one developer to another. An Ohloh developer A may choose to send a Kudo link to another developer B for admiring his OSS development work (e.g., source code, code comments) in general or for appreciating B's contributions if they both work in the same project(s). It may also be due to that A receives one-to-one help from B in OSS development (e.g., fixing a software bug, solving a programming problem). To summarize, a Kudo link represents the sender's explicit positive evaluation on the receiver's individual characteristics or actions, such as outstanding performance, great programming skills or valuable contributions. For an individual OSS developer, receiving a large number of Kudo links and consequently gaining a good reputation can be an effective approach to attract attentions and potential collaborations. If an OSS developer is well known for his generosity, intelligence, excellent programming skills and leadership, it becomes much easier to convince others that collaborating with this developer will greatly benefit them [34]. From an OSS project manager's perspective, improving the project members' opportunities to receive positive evaluations

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may enhance their reputation-based motivations for contributing to project development. OSS projects with many reputable developers may be able to attract more high quality developers through the preferential attachment process. Therefore, it is important to study what social and technical factors affect positive evaluation relationships. Although the importance of developers' reputation-based motivation has been acknowledged in OSS literature, the foundation of good reputation – positive evaluation – has received little theoretical attention.

A developer's positive evaluations received from her peers are often influenced by many social and technical factors embedded in the OSS environment. In this study, we defined these factors as the determinants of positive evaluations. These determinants shape the evaluative perceptions of OSS community members on each other and eventually build up their reputations. We use social network analysis (SNA) and statistical methods to empirically identify and examine the determinants of positive evaluation relationships in an OSS developer network. We aim to provide insights and suggestions for both individual developers and project managers to promote participations, better manage positive evaluation relationships, and thereby achieve better OSS project success.

Although a growing body of research has explored the collaboration relationships among OSS developers, there is little effort in understanding developers' positively evaluation relationships mainly due to two problems. Firstly, there is a lack of large-scale real-world data sources on positive evaluations among OSS developers. Secondly, since each positive evaluation connects two parties – evaluator and the developer being evaluated, relational/network perspective is greatly needed to study positive evaluation relationships. Existing OSS studies that adopt relational/network perspectives mainly focused on developers' collaboration relationships which are derived from their joint project participations. Such derived collaboration link is a relatively weak proxy of personal relationships since two developers in a large project may not know each other at all. On the other hand, a developer positively evaluating another is an intentional and explicit relationship building action, indicating the evaluator has certain knowledge of the evaluatee. To address these two problems, we conduct an empirical investigation of an OSS developers' social network in which their positive evaluation relationships as links. We hypothesize that three types of network-related factors significantly affect these developers' positive evaluation choices: 1) preferential attachment and accumulative advantage factors, 2) homophily in various individual attributes, and 3) shared affiliations.

Our study innovates by adopting a set of social network related factors and analytical methods to study OSS developer networks [17,22,33]. While OSS phenomena are not new, research interest in its social network perspective has only recently emerged. Social network analysis (SNA) methods have been widely used to study the collaboration relationships derived from joint participation in OSS projects [11,14,18,19,25,44]. However, those studies mainly focused on the static topologies and largely ignored the dynamic relationship formation processes behind the network evolution. We modeled that a developer choosing to positively evaluate another as a link formation process which is influenced by various social and technical determinants. We then empirically examined the hypothesized factors which are based on previous OSS and network studies [5,9,22,28,33,37].

In addition, we suggest this study has both theoretical and practical contributions. Theoretically, this study contributes to the theoretical understanding about how social network related factors affect individual behaviors by examining determinants of OSS developers' positive evaluation choices in an online collaborative environment. On the other hand, the empirical findings from this study can offer insights to OSS group leaders for increasing positive evaluations and thereby promote trust among group members. To this end, we have made a set of suggestions based on the discovered determinants of positive evaluations to facilitate more positive evaluations in an OSS community. The long term goal is to improve OSS group performance by cultivating a positive development environment.

The remainder of this paper is structured as follows. In Section 2, we briefly review the related studies and develop the research hypotheses. Section 3 describes the data we collected from a large online OSS community for our empirical analysis. In Section 4, we present the research design in detail. Section 5 shows the results and Section 6 discusses their implications. At last, we conclude the paper and discuss future research directions.

2. Related studies and research hypotheses

2.1. Reputation-based participation motivation and positive evaluation

Since open source software development largely relies on the voluntary efforts of software developers, a large body of OSS research has focused on developers' participation motivations [16,23,35,41]. In general, the motivations can be categorized into two types – intrinsic and extrinsic motivations [23]. The intrinsic motivations for participations are the factors related to OSS developers' needs for satisfying themselves such as altruism and enjoyment, while extrinsic motivations are usually derived from external rewards such as desire for good reputation and career advancement opportunities. A motivation discovered in previous OSS studies and central for our research is the developers' desire to gain reputation from his peers. The lack of traditional monetary reward in an OSS development environment has made the reputation-based motivation as a major drive for developers' participations and contributions [40]. One of the most cited studies on OSS participation motivations done by Roberts et al., [35] has examined the relationships among developers' participation, performance, and motivation using empirical data from the Apache project. It found that Apache developers' desire to gain high community reputation can lead to above average participation levels. Moreover, developers with higher status (i.e. better reputation) within the Apache project community are found to have significantly higher wages. This suggests that an OSS developer's community reputation could be a signaling mechanism to his potential employers [40]. Another major study on Linux project participation [16] found that the intentions to improve one's own career opportunities are important motives for participation. These empirical findings provide additional supports and explanations for OSS developers' reputation-based motivation other than self-satisfaction.

However, a developer's desire to gain reputation can only influence his participation choices but not directly build his reputation. A major source of an individual's community reputation is the peer evaluations he received. Zaacharia [48] categorized reputation mechanisms in electronic markets into two types – non-computational and computational ones. Non-computational reputation mechanism often relies on a central repository which keeps information about user activities (e.g., the scoring systems of credit rating agencies). On the other hand, computational mechanisms, based on the evaluation information collected from the evaluators (e.g., buyers at eBay), calculate an overall reputation score for the individual being evaluated (e.g., sellers at eBay). Such a reputation score reflects an aggregated view on how this individual's peers perceive him. The computational reputation mechanisms have been adopted in many collaborative online communities and ecommerce Web sites such as YouTube and eBay. With such mechanisms, we suggest that positive evaluations can influence the composition and performance of an OSS project group through its members' reputation-based participation motivation. This conjecture is consistent with our previous empirical findings about the Ohloh community, which partly motivated this study. We found that the average user rating of each software project, which is an indicator of project success, is positively related to the total number of positive evaluations received by project members.