Leadership characteristics and developers' motivation in open source software development

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ABSTRACT

Open Source Software (OSS) is generally developed by interested professionals who have decided to participate in the process. The presence of effective leaders who both steer the development and motivate the developers is crucial to ensure a successful product. Using path-goal theory and built on leadership and motivation theories, we proposed and tested a model that can be used to assess the relationship between an OSS project leader's leadership style and a developer's motivation to contribute to the software development. We specifically decomposed the leadership and motivation construct to understand the hidden mechanisms by which leadership impacts motivation. A set of survey data collected from 118 OSS developers on Sourceforge.net was used to test our hypotheses. Our results indicate that leaders' transformational leadership is positively related to developers' intrinsic motivation and that leaders' active management style is positively related to the developers' extrinsic motivation.

1. Introduction

Open Source Software (OSS) development differs from traditional proprietary software development because it is performed by a community rather than by paid employees [4]. Despite its voluntary basis, OSS has proliferated resulting in thousands of applications. For example, SourceForge.net, the world's largest OSS development web site, had successfully produced more than 324,000 software projects by the end of April 2012.[3] This suggests that OSS, though seemingly developed by a chaotic and anarchistic community, is becoming an important source of software.

One might wonder how an OSS project can attract substantial contributions from world-wide developers and yet be managed effectively [17]. In our view, the presence of leaders, who both steer the development direction and motivate the developers to contribute is crucial to ensure a successful outcome of an OSS project. For instance, the Apache project leader recognizes developers' effort by giving them rights to vote in determining the development direction of the project. Similarly, Linux and Perl projects have generated incentive structures to recognize developers' contributions.

In light of the importance of having authoritative figures, prior studies have postulated the importance of considering a good organization and coordination of activities in an OSS project, as well as the influence of motivation of an individual developer to contribute to an OSS project [15]. These factors correspond to the administration of the project and the participation of the co-workers (developers) respectively. However, no detailed study has previously been conducted to examine these factors together.

Given the fast development environment, practitioners are beginning to consider the possibility of incorporating OSS development strategies into the production of commercial software; this has been termed OSS 2.0, but unless knowledge is gained on the role of the OSS leader, the incorporation of OSS strategies into commercial software development will only be superficial.

We therefore sought to focus our research on understanding the effects of an OSS leader's leadership style on developers' motivation to contribute to a project. Using path-goal theory, we built on leadership and motivation theories to propose a model that posits the behavioral effects of OSS project leaders on developers' motivation to contribute. Contribution, here, was measured as the amount of time a developer spends on an OSS project. Our model was empirically assessed using survey data collected from 118 developers in an online OSS community. By

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decomposing leadership into different styles and investigating their influence on the OSS developers' decision to contribute to the OSS project, we were able to gain a better understanding of the types of leadership approaches needed to succeed in developing an OSS project.

2. Theoretical background

Path-goal theory posits that leaders' behavior will affect their subordinates' motivation and in turn influence the outcome of a task; it was developed to explain how leaders motivate subordinates to achieve work-goal attainment by providing a facilitating work environment. Joshi et al. [6] investigated inspirational leadership in the context of virtual team management; and Pieterse et al. [12] compared the effect of transformational and transactional leadership on employees' innovativeness.

Studies on path-goal theory have mainly been conducted in a formal organizational structure, such as a company, but not in OSS projects where leaders often need to be careful in motivating their subordinates (OSS developers).

We therefore conducted a deeper investigation of the leadership process in a virtual organization by decomposing the leadership and motivation constructs. Consequently, we had to delve into two major building blocks of path-goal theory: the leadership theory and motivation theory (though self-determination theory).

2.1. Leader – Transformational and transactional leaderships

In our research context, an OSS leader is formed when he or she initiates an OSS project by creating software from the start, inherits the source codes from a former project leader who has since stopped working on it, or becomes a leader due to recognition and support from other developers. A leader, in the OSS community, possesses exclusive rights to decide on what features to include, when to release updated source code to the community, how to reward or punish contributors, and who to choose as a successor.

Studies on leadership have considered four aspects of a leader:

1. Power influence, which attempts to understand leadership in terms of the type and degree of power of the leader.
2. Behavior, which looks at the actual tasks the leader performs.
3. Trait, which considers the personal attributes of leaders, such as their energy, intuition, creativity, persuasiveness, charisma, and foresight.
4. Situational, which evaluates the leader's relationships with others (superiors, subordinates, and peers).

There are two polarized yet important leadership styles that depend on followers' behavioral response: transformational and transactional [2]. They differ in the way that a leader focuses on intellectual stimulation/inspiration or provide inducements to obtain desired performance by their subordinates.

A development of the transformational and transactional leadership paradigm lies in its application in the IS discipline, especially in the investigation of the R&D project team or virtual team task accomplishment and performance. It has been observed, for instance, in an R&D project team research, that transformational leadership was a strong predictor of technical quality of the project, and in virtual team studies [1] that transformational or transactional leadership styles could lead to different impact on the subordinates' behavior. To the extent that OSS project is a variation of the virtual R&D project team, we decided that this leadership style paradigm could be applied to the OSS project development context.

An individual possessing *transformational leadership* tries to induce desired follower behavior by intellectually stimulating or inspiring followers to ignore their self-interests for a collective purpose. It should affect followers in three ways: (1) increase their awareness of task importance and value, (2) change their focus to team goals rather than individual interest, and (3) activate their higher order needs. Transformational leadership dimensions include *idealized behavior* (charisma), *inspirational motivation* (stimulating optimism about the project), *intellectual stimulation* (promoting of new ways of thinking and solving problems) *and individualized consideration* (providing individualized care and consideration). While it can be effectively exerted through face-to-face interaction between leaders and followers, its effect may be reduced in virtual teams. However, recent leadership research [13] has shown that its effect on team performance was stronger in virtual teams than in face-to-face teams. We thus assumed that transformational leadership could still be exhibited online if the leader could motivate and promote the ways of thinking in which he or she believed.

In contrast, *transactional leadership* is characterized by a leader-follower relationship built on a series of bargains or exchanges. This occurs in two ways: structure and the execution. Through *structure*, a leader focuses on defining clear reward and punishment structures so that the followers know what is required. If both the leader and followers find the structure mutually rewarding, the relationship persists and the expected performance will occur. To execute transactional leadership, the leader can either engage on *active management by exception*, i.e., proactive supervision, or *passive management by exception*, i.e., reactive supervision. In the more active form of management by exception, the leader continuously monitors followers' performance; however, a leader who practices passive management by exception intervenes only after mistakes are made or standards are violated.

We contend that decomposing the leadership styles into subtypes will help us understand its impact on OSS project performance (by motivating developers).

2.2. Developers – Their motivations

According to self-determination theory (SDT), an individual's motivation in embarking on a task can be either intrinsic or extrinsic [3].

Intrinsic motivation is the drive to do an activity in order to experience pleasure and satisfaction, either enjoyment-based (the drive to obtain satisfaction through participating in an activity), or obligation-based (to meet the morals, values. and ethics dictated by an individual).

Extrinsic motivation involves a drive to take action to attain rewards, including career, prestige and positive evaluations from others or to avoid punishment. They are classified into three primary forms: identified regulation (e.g., an individual is motivated to perform an activity because it seems important and valuable), introjected regulation (when a person has pride in the results or feelings of guilt or shame), and the external regulation (when an individual performs an activity in order to receive external rewards or avoid punishment).

Intrinsic and extrinsic motivation concepts from the SDT theoretical lens have been applied extensively in the IS field. Hsu and Lin [5] studied motivation in acceptance of blog usage. In the field of OSS research, a group of researchers have classified OSS developers' motivation to contribute to the project into intrinsic (such as believing in the openness and freedom of software usage and distribution, pursing programming as a hobby, and enjoying working in the OSS community) and extrinsic (including improving programming skills, being recognized inside or outside the community, and needing better software than that provided through a proprietary channel).