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LEADERSHIP AND MOTIVATION IN OPEN SOURCE PROJECTS

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Abstract

There are nearly 75,000 open source projects and over 750,000 registered users on Sourceforge.net. Yet few of them are successful in attracting other developers and users to participate in the design, testing, and use of the intended software package. Why are some project leaders able to grow their project teams and guide their projects toward completion while others are stalled or abandoned? What attracts participants to a project and why do they continue to work on a project from which they can leave at any time? Using a model based on the Path-Goal Theory of Leadership and self-concept theory, this paper attempts to identify both the sources of motivation for participants in open source projects and the leadership behaviors that attract and motivate them to complete the project.

Keywords: Open Source, Motivation, Leadership, Path-Goal Theory

Introduction

The focus of this paper is the influence of leadership on the motivation and performance of members of Open Source projects. Specifically, we will employ path-goal theory as a conceptual framework to study leadership behaviors and their effects on specific motivation sources. By gaining a better understanding of these impacts, we expect to develop an effective approach for increasing the probability of open source project success. The paper proceeds as follows. First, a brief description of Open Source project teams is provided. This includes a discussion of project leadership functions and roles. Second, the path-goal theory is discussed, including constructs and significant moderating variables. Third, the research model is shown along with the hypotheses for the current study. Finally, the implications of this research are discussed.

Open Source Project Teams

Open source development is typically started by an individual or small group who has a need for a specific application and proceeds to build the application on their own. After a few iterations, they publicize the existence of their application informally on newsgroups or email. The initial owners register their project with an Open Source code repository such as SourceForge.net or Freshmeat.net. As others experience similar needs and try the application, the project team grows in size. More formal organizational structure is introduced with the initial developer (or a successor) designated as the project leader. While the project leader likely will still produce code, his or her contributions to the finished product becomes proportionally less as more developers and users become members of the team and his or her roles change.

For larger projects, the leadership is shared among a small group of key developers. For instance, Linux development is led primarily by its original creator Linus Torvalds. He oversees a group of trusted programmers (“maintainers”) who are responsible for contributing and reviewing code for specific segments of upcoming Linux releases. These maintainers are hand-selected by Torvalds based upon his opinions of their previous contributions.

Despite the size of the open source development project, project leadership is critical in the development and success of the endeavor. Since open source development environments differ significantly from traditional organizational environments, it becomes important to examine leadership behaviors in this context and to investigate their effect on project performance. Towards this end, the next section discusses the path goal theory of leadership that forms the basis of the research model.

Theoretical Background

Path-Goal Theory

The path-goal theory of leadership attempts to explain the relationship between leader behaviors and subordinate performance and satisfaction. Based on expectancy theory, it argues that as leaders alter the expected rewards and the path toward achieving these rewards, subordinates' motivation changes accordingly. Despite a number of conceptual issues, persistent measurement flaws by subsequent researchers, and mixed results, path-goal theory is generally regarded as a logical framework for explaining and researching the impact of leadership behaviors (Evans, 1996; Schriesheim & Neider, 1996; Wofford & Liska, 1993).

The basic path-goal model is shown below. According to the Path-Goal Theory, there are two general propositions of the theory. First, leader behavior will be acceptable by subordinates to the extent that it is perceived as satisfying or instrumental to future satisfaction. Also, leader behavior will be motivational to the extent that it makes the satisfaction of subordinate's needs contingent upon effective performance and that such behavior provides coaching, guidance, support, and rewards to subordinates as necessary for effective performance (House & Mitchell, 1974).

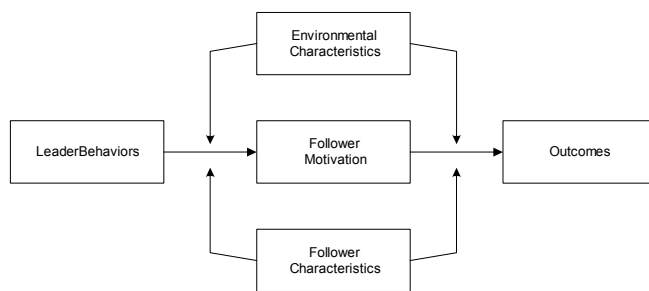


Figure 1: Path-Goal Model

In the original version of the theory, leader behaviors were classified as either supportive or directive (House, 1971). Later, two additional behaviors were added: participative and achievement-oriented. In 1996, the list of behaviors was extended further (see Table 1). Because the latter version incorporates aspects of work unit performance and effectiveness, it is the theoretical basis underlying our research.

The relationship between leader behaviors and subordinate performance and satisfaction is moderated by a number of environmental (which includes task and organization) or subordinate characteristics. Since the theory debuted, there have been a number of specific moderators evaluated.

In general, there has been little support for the moderators since the theory was first published. However, there has been growing concern that a number of instrumental and methodological errors have led to faulty conclusions being reached (Schriesheim & Neider, 1996; Villa, Howell, Dorfman, & Daniel, 2003; Wofford & Liska, 1993).

By far, the most commonly researched moderating variables have been task characteristics (Evans, 1996). Several variations of task design have been proposed as moderating variables for the path-goal theory, but the results have been decidedly mixed (Griffin, 1980; Levanoni & Knoop, 1985; Podsakoff, Mackenzie, Ahearne, & Bommer, 1995; Schriesheim & Denisi, 1981; Schriesheim & Schriesheim, 1980; Wofford & Liska, 1993). The most commonly evaluated subordinate characteristics have been expertise or ability, need for autonomy, and perceived locus of control (Evans, 2002; Howell, Dorfman, & Kerr, 1986).

Table 1: Path-Goal Leader Behaviors (House, 1996)

Directive	Letting subordinates know what they are expected to do; giving specific guidance
Participative	Consultative dyadic influence on subordinate decision making and work
Supportive	Satisfies subordinates needs and preferences; showing concern
Achievement-Oriented	Encourages performance excellence; sets challenging goals; shows confidence in subordinates
Representation/Networking	Build and maintain group reputation, positive relations with powerful external others.
Interaction Facilitation	Facilitate collaboration, communication and interaction; resolve disputes
Work Facilitation	Planning, scheduling work; provides mentoring, guidance, coaching, etc.
Group Decision Process	Gaining decision consensus and acceptance of solutions posed to group
Shared Leadership	Encouraging shared responsibility for leadership behaviors
Value-Based Leadership	Articulating and displaying passion for the group vision

Motivation

As stated above, any leader behavior which changes the expected rewards or the path toward achieving them affects the motivation of the subordinates. This implies that a person engages in behaviors that will rationally maximize their expected rewards to the exclusion of any other behaviors. However, this is obviously not a realistic viewpoint since people engage in behaviors that are decidedly less than optimal personally for the benefit of a collective (work, social organization, family, etc.). To address these behaviors, the self-concept theory has been proposed as an extension of path-goal theory (House & Shamir, 1993).

There are a set of assumptions underlying self-concept motivation (Shamir, House, & Arthur, 1993).

1. Humans are not only pragmatic and goal-oriented but are also self-expressive.
2. People are motivated to maintain and enhance their self-esteem and self-worth.
3. People are also motivated to retain and increase their sense of self-consistency, which is the correspondence between behavior and self-concept over time.
4. Self concepts are composed, in part, of value, social, and personal identities.
5. Humans may be motivated by faith.

There are five sources of motivation: intrinsic process motivation, goal internalization, extrinsic or instrumental motivation, external self-concept-based motivation, and internal self-concept-based motivation. (Leonard, Beauvais, & Scholl, 1999). Table 2 provides a description of the various types of motivation.

Table 2: Motivation Sources (Leonard et al., 1999)

Motivation Source	Focus
Intrinsic	Work itself if personally rewarding and enjoyable
Instrumental	Work will result in pay, promotion, bonuses, etc.
Goal Internalization	Work goals converge with one's own
Internal Self-Concept	Work satisfies internal goals and values, not group's
External Self-Concept	Work leads to acceptance, later increased status or rank

There have been several efforts to research the motivation of open source developers, especially since these developers are typically not paid for their performance in open-source projects. The results have been inconclusive regarding the most significant type of motivation. Although most of the studies have affirmed the significance of both external and internal motivation, some have concluded that external rewards were more significant, while others have concluded that internal

motivation was more significant (Hars & Ou, 2002; Hertel, Niedner, & Herrmann, 2003; Lakhani & Hippel, 2003; Lakhani & Wolf, 2003). However, none of these studies have considered the environmental or subordinate characteristics as moderators in the relationship between motivation and performance.

Research Model and Hypotheses

The research model is shown in Figure 2 below. Based on path-goal theory, we propose that leader behaviors (LB), moderated by the environmental and developer characteristics, affect motivations of the developers. Motivation in turn influences performance of the individual developer.

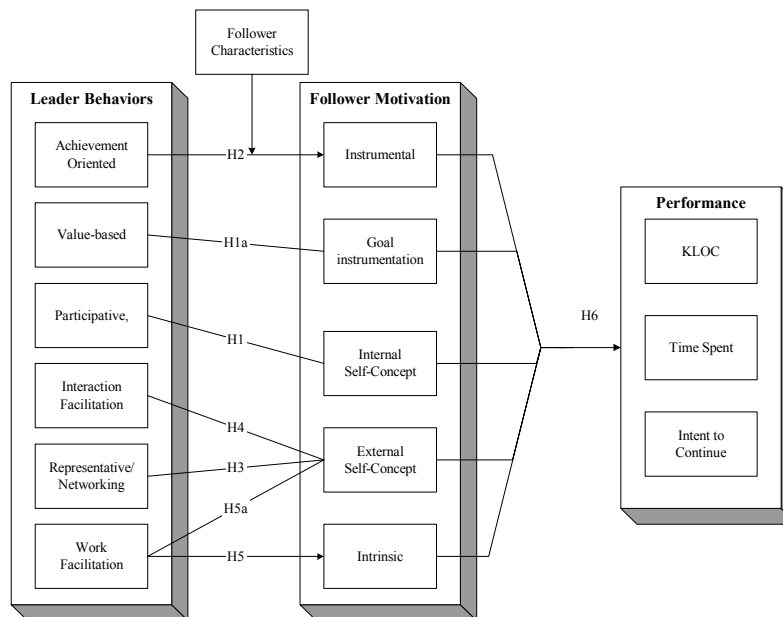


Figure 2: Research Model

The most basic leader responsibility is defining the vision and goals of an organization. For the Open Source world, the leader (or delegates) is responsible for decisions regarding a given project such as releases, features, architecture, marketing, and team structure. As the leader clarifies the team's goals, Path-Goal theory states that the members are better able to understand and accept their roles in the success of a project. These path-goal clarifying behaviors can be enacted in either a directive or participative manner. Given the high involvement and independence of open source development teams, path-goal theory asserts that participative leadership behaviors will be more effective than directive leadership. As a result, project members are able to ensure that their internal needs and goals are addressed.

H1: Leader behaviors which define and clarify the vision and goals of a project in a participative manner increase internal self-concept motivation for the members.

Of course, this is only effective to the extent that the values of both open source development in general and the specific project itself match the values of the members of the project team. Therefore, value-based leadership behaviors such as goal articulation, communication of high performance expectations, and demonstration of confidence in the direction and capabilities of the project team will also significantly affect motivation.

H1a: Leader behaviors which clarify the vision and goals of a project will increase the goal internalization for the members to the extent that the goals and values of the project correspond with those of the team members.

Most open source team members are not compensated financially for their participation and contributions. One of the most common forms of compensation is the recognition of peers and users. The feedback a developer receives about the quality of their work encourages them to contribute again in the future (Hars & Ou, 2002). Thus, behaviors by the leader which lead to the personal achievement satisfaction will positively affect motivation to the extent that the members themselves have high needs for achievement.

H2: Achievement-oriented leader behavior which encourages members' recognition increases instrumental motivation moderated by their need for achievement.

Similarly, developers receive some benefit for participation in open source projects from their ability to publicize their programming competence to others. However, the value of their contributions is minimal if there is no one familiar with their work. Compare the promotional value of being an active contributor on the Linux Kernel with that of a single developer, beta-version application with less than 100 downloads per month. Thus, leaders can increase the value of a project and thus the value of each participant's contributions by employing representation or networking behaviors such as promoting the project to other developers, potential new users, the technical or popular media, etc.

H3: Representation leader behaviors which promote the project to new users and other developers increase the external self-concept motivation

There is a degree of social interaction in virtual team members, even with a wide geographic dispersion of the team members. For virtual teams, it is difficult to underestimate the importance of being able to communicate with each other as necessary to complete the project goals. The complexity of the typical open source project (with respect to the interdependence of the patches and modules that compose each application) necessitates the integration use of technology into each team. As a result, open source leaders employ tools such as those found on SourceForge.net and Freshmeat for such functionality as collaborative development tools, release management, mailing lists, discussion forums, and more.

These behaviors can be classified as interaction facilitation behaviors. House (1996) postulates that increasing the ability for all members to be heard and encouraging communication, collaboration, and teamwork not only increases work unit effectiveness but reduces attrition as well. We postulate that this interaction is accomplished by impacting the external self-concept motivation of the users.

H4: Leader behaviors which facilitate interaction within the entire team by encouraging the use of technology or enforcing team norms increases external self-concept motivation.

Typically, specific tasks are self-assigned to individual team members or sub-teams. Therefore, each function in a project functions is the responsibility of someone who will accordingly develop a measure of social motivation to complete it. If these tasks are interdependent, the perceived responsibility to complete them is even stronger. The modularity of open source projects encourages the efficient division of efforts, but it is up to the leader to initiate and encourage the software design to support this efficiency.

Leader behaviors that influence the ownership and interdependence of project tasks can be classified in several ways. Work facilitation behaviors refer to the planning, scheduling, and organizing of work. In open source projects, much of this is handled by the team members themselves, so these functions are intertwined with group decision process and shared leadership goals.

H5: Work facilitation leader behaviors which promote and encourage task ownership and interdependence increase the intrinsic motivation to perform each task to the extent that these actions are agreed upon through the decision processes of the group.

The ultimate goal of leadership is increased performance. The portfolio of behaviors that a leader exhibits toward each member of the team has a direct affect on the specific motivation sources as discussed in the previous hypotheses. Although each individual has a dominant source of motivation that they use in specific situations, all motivation sources are experienced simultaneously. However, when two or more sources are in conflict with one another, individuals tend to act in accordance to the impact upon the dominant source (Leonard et al., 1999). The aggregate impact of leader behaviors on an individual's motivation source profile impacts the individual's performance.

H6: Motivation leads to individual performance.

Research Methodology

A survey instrument will be developed to investigate the hypotheses identified in the research model above. Specifically, the instrument will include scales to measure the leader behaviors (achievement-oriented, participative, interaction facilitation, representative/networking, and work facilitation), motivation types (instrumental, internal self-concept, external self-concept, intrinsic, and goal internalization), and individual performance (lines of code, time spent, and/or intent to continue). The instrument will also contain scales to evaluate a limited number of control variables such as project size, project structure, follower expertise, and follower need for achievement. The resulting instrument will be administered to open source developers and passive and active users randomly selected from Sourceforge.net.

Implications/Conclusions

The anticipated results of this research study will have both research and practical implications. For researchers, this study will provide an investigation of the motivation mechanisms through which leader behaviors influence performance outcomes. For practitioners, this study will also provide a better understanding of the potential impact of their actions and assist in the development and leadership of open source projects.

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