

## Chapter 5.3

# Social Network Structures in Open Source Software Development Teams

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### ABSTRACT

Drawing on social network theories and previous studies, this research examines the dynamics of social network structures in open source software (OSS) teams. Three projects were selected from SourceForge.net in terms of their similarities as well as their differences. Monthly data were extracted from the bug tracking systems in order to achieve a longitudinal view of the interaction pattern of each project. Social network analysis was used to generate the indices of social structure. The finding suggests that the interaction pattern of OSS projects evolves from a single hub at the beginning to a core/periphery model as the projects move forward.

### INTRODUCTION

The information system development arena has seen many revolutions and evolutions. We have witnessed the movement from structured devel-

opment to object-oriented (OO) development. Modeling methods, such as data flow diagram and entity relationship diagram, are facing new OO modeling languages, such as the unified modeling language (UML) (see Siau & Cao, 2001; Siau, Erickson, & Lee, 2005; Siau & Loo, 2006) and OO methodologies, such as unified process (UP). The latest development includes agile modeling (see Erickson, Lyytinen, & Siau, 2005), extreme programming, and OSS development. While many of these changes are related to systems development paradigms, methodologies, methods, and techniques, the phenomenon of OSS development entails a different structure for software development teams.

Unlike conventional software projects, the participants of OSS projects are volunteers. They are self-selected based on their interests and capability to contribute to the projects (Raymond, 2000). In addition, the developers of OSS projects are distributed all around the world. They communicate and collaborate with each other through the Internet, using e-mails or discussion boards.

Therefore, effective and efficient communication and collaboration are critical to OSS success. However, little empirical research has been conducted to study the underlying interaction pattern of OSS teams, especially the dynamics of the social network structures in OSS development teams. To fill this gap, this study examines the evolvement of social structure in OSS teams. The study contributes to the enhancement of the understanding of OSS development, and provides foundation for future studies to analyze the antecedents and consequences of social networks in the OSS context.

The remainder of the paper is structured as follows. First, prior studies on social network structures in OSS teams are reviewed. Second, theories related to social structure and social network theory are discussed. Third, the research methodology is presented, and the research results are reported. Next, discussions of the results, the limitations, and the implications are provided. The paper concludes with suggestions for future research.

## **LITERATURE REVIEW**

The phenomenon of OSS development has attracted considerable attention from both practitioners and researchers in diverse fields, such as computer science, social psychology, organization, and management. Because of the multifaceted nature of OSS, researchers have investigated OSS phenomenon from varied perspectives. For example, focusing on technical perspective, researchers studied issues such as OSS development methodology (e.g., Jørgensen, 2001) and coding quality (e.g., Stamelos, Angelis, Oikonomu, & Bleris, 2002). Based on social psychology, researchers investigated individual motivation (e.g., Hann, Robert, & Slaughter, 2004), new developers (Von Krogh, Spaeth, & Lakhani 2003), the social network (e.g., Madey, Freeh, & Tynan, 2002), and the social structure (e.g., Crowston & Howison,

2005). In terms of organizational and managerial perspective, researchers examined knowledge innovation (e.g., Hemetsberger 2004; Lee & Cole 2003, Von Hippel & von Krogh, 2003) and the governance mechanism (e.g., Sagers 2004).

An OSS development team is essentially a virtual organization in which participants interact and collaborate with each other through the Internet. Compared to conventional organizations, the structure of virtual organizations is decentralized, flat, and nonhierarchical (Ahuja & Carley 1999). However, some researchers challenge the belief (e.g., Crowston & Howison 2005; Gacek & Arief, 2004;; Mockus, Fielding, & Herbsleb, 2000; Mockus, Fielding, & Herbsleb, 2002; Moon & Sproull, 2000). They argue that the social structure of OSS projects is hierarchical rather than flat, like a tree (Gacek & Arief, 2004) or an onion (Crowston & Howison, 2005). The social structure of OSS teams directly influences the collaboration and the decision-making process and further affects the overall performance of the teams as well as individuals' perception of belonging and satisfaction. Therefore, one wonders what form of social structure might be present in the OSS development and what type of structure will emerge—centralized or decentralized, hierarchical or nonhierarchical, onion-like or tree-like, or a combination of the above depending on certain specific situations?

A social network, as stated by Krebs and Holley (2004), is generally built in four phases, each with its own distinct topology (as shown in Figure 1).

1. scattered clusters,
2. single hub-and-spoke,
3. multihub small-world network, and
4. core/periphery.

Most organizations start from isolated and distributed clusters (Krebs & Holley, 2004). Then an active leader emerges and takes responsibility for building a network that will connect the sepa-

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