



# Governance strategies for open collaboration: Focusing on resource allocation in open source software development organizations



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## ABSTRACT

With rapid advancements in information and communication technology, open collaboration has become easier, thereby allowing people to participate through internet platform. Open source software is one of the representative examples of open collaboration. In this research, we examine the antecedents of innovation performance for open source software development organizations on Github ([www.github.com](http://www.github.com)), which is a leading web service for the open collaborations of developers. From the perspective of resource allocation, this study investigates effective governance strategies to allocate developers to multiple projects within an organization. Overall, we find that the organization with high performance have a small number of developers to participate in most projects and most developers to participate in a small number of projects.

## 1. Introduction

Rapid advancements in the field of information and communication technologies (ICT) have made open collaboration easier (Hossain & Wigand, 2004). Open collaboration refers to the system that relies on loosely coordinated participants who interact to create an innovative product (or service) through internet (Levine & Prietula, 2013). Various fields such as crowd funding, Wikipedia, and open source software (OSS) or open hardware development have shown how communities can be easily created for collaboration to accomplish certain goals. The aim of this study is to determine how open collaboration projects can be effectively managed in the field of open source software developments (OSSD). Among the various areas that actively adopt open collaboration for acquiring external knowledge, OSSD is one of the promising fields (Choi, Kim, Ferwerda, Moon, & Hahn, 2013). OSS has been consistently studied for around 20 years, and found to have caused a significant economic ripple effect (Hippel & Krogh, 2003). However, in reality, most of the OSSD projects are not being able to successfully serve the intended purposes (Chengalur-Smith & Sidorova, 2003; Ghapanchi & Tavana, 2015; Hagan, Watson, & Barron, 2007; Lima, Rossi, & Musolesi, 2014). Lima et al. (2014) reported that even among projects created before 18 months, only 62.9% of the projects have at least one line of code, and 46.7% have more than two developers. To suggest guidelines for successful OSSD performance, this research investigates the antecedent

variables – *Participation Structure* and *Participation Ratio*- of OSSD governance from the perspective of resource allocation in a multi-project management environment.

Considering a multi-project environment, this paper focuses on how resource allocation as one of the governance issues in OSSD organizations influences on innovation performance. Multi-project management requires firms to efficiently manage multiple projects with limited resources, therefore, resource allocation is a crucial decision (Hendriks, Voeten, & Kroep, 1999). In research and development (R & D) environments, projects require professional workers with knowledge on certain technologies. Thus, in an R & D environment, appropriate allocation of employees to projects is a decisive factor leading to the success or failure of projects (Hendriks et al., 1999). Similarly, OSSD also requires suitable allocation of developers to projects which could help enhance the innovation performance of organization.

As time goes on, evolutions in ICT and norms of collaboration bring changes in collaboration platforms. Developers repeatedly start new projects with other volunteers having experience in collaborating from other projects (Hahn, Moon, & Zhang, 2008). Considering repeated collaborations among volunteers, recently established OSSD platform services such as Github ([www.github.com](http://www.github.com)) have started providing features for creating communities called ‘*organization*’ (Gousios and Diomidis, 2012). Each organization has an official leader and more than one developer who is authorized to be involved in the organization. An organization can establish a number of new OSSD projects. If an

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organization creates a new project, the owner of the project is the organization. The main governance role of the organization involves making decisions regarding the acceptance of a new code from outside developers. Thus, developers of the organization have the authority to accept a code and apply it to the project. This research investigates the governance mechanism of OSSD organizations managing multiple projects at the organizational level. To develop OSS, developers could create organizations with other developers who can manage several OSSD projects at the same time.

In light of these considerations, the purpose of this study is to suggest proper governance strategies to enhance innovation performance of organizations through appropriate resource allocation. Thus, the study aims to answer the research question of how OSSD resource allocation status can influence the focus of *Organizational Performance* using *Participation Structure* and *Participation Ratio* as important elements of resource allocation. To investigate the resource allocation status of developers, we use two specific predictors of innovation performance: *Participation Structure* and *Participation Ratio*. The *Participation Structure* describes the network structure based on the participation link between developers and the projects within the organization. As OSSD organizations manage multiple projects, developers who are members of the organization could be involved in a numbers of projects at the same time. Further, *Participation Ratio* describes the degree of participations of developers to the number of projects among all projects of an organization.

This research verifies efficient resource allocation strategies in OSSD organizations that operate multiple projects. With new features of creating organization, researchers could extend the theoretical and empirical implications of existing studies of OSSD governance. We investigate the impacts of *Participation Structure* of organizations and *Participation Ratio* on *Organizational Performance*. To conduct an empirical test, we gather data of 18,844 projects owned by 251 organizations from Github. Furthermore, to analyze the organizational network structure, we perform social network analysis (SNA) (Kwak, 2014; Scott, 2012; Wasserman, 1994) to determine the interrelation among developers of an organization through developer-project relationships. Finally, a hierarchical regression analysis is conducted to evaluate the effects of governance characteristics on *Organizational Performance*.

The remainder of this paper is organized as follows. In the second section, previous theoretical studies, including OSSD governance and resource allocation, are reviewed. In Section 3, a research model and relevant hypotheses to verify the model are suggested. Section 4 explains the data from GitHub, which is the OSSD platform used for analysis. Section 5 suggests analytical results. Finally, section 6 presents the conclusions of this study as well as research limitations.

## 2. Literature review

In this research, we investigate the impact of resource allocation on *Organizational Performance* as a part of OSSD governance strategies. Since OSS require complex development process like R & D environment, allocating specialized developers in certain projects is important issue in OSSD governance. Thus, section 2 revisits the research streams of OSSD governance issues and resource allocation.

### 2.1. Governance of open source software developments

Although OSS does not have one clear definition (Aksulu & Wade, 2010), it is commonly defined as “the software that is capable of modifying the source code, free to distribute, technically neutral, and is given with an autonomous license right” (Perens, 1999). OSS as a means for open collaboration was initiated by Richard Stallman in 1983. Stallman introduced the General Public License, wherein every part of the program could be modified or shared. In February 1998, Netscape opened their source code online for free, thereby ushering the beginning of OSS (Aksulu & Wade, 2010; Raymond & Young, 2001).

According to McPherson, Proffitt, and Hale-Evans (2008), the economic value of Linux, a typical example of an OSS-developed system, was approximately \$10.8 billion in 2008. Andersen-Gott, Ghinea, and Bygstad (2012) indicated that commercial firms also adopt the OSSD approach for their products to enhance innovative performance. Melchor-Ferrer and Buendía-Carrillo (2014) stated that various industries and government adopt OSS for reducing budgets and modifying detail functions. Maican & Lixandriou (2016) also examined the efficiency of adopting OSS in academic organizations. In this manner, OSSD is required by not only the owners of OSSD organizations but also other types of organizations (Andersen-Gott et al., 2012; Melchor-Ferrer & Buendía-Carrillo, 2014; Maican & Lixandriou, 2016). With the emergence of OSS, researchers have recognized the difference between the governance of OSS and that of traditional firms. OSS governance is defined as “the means of achieving the direction, control, and coordination of wholly or partially autonomous individuals and organizations on behalf of an OSSD project to which they jointly contribute” (Markus, 2007). Developers of OSS are autonomous individuals and have no explicit responsibilities. Therefore, their motivations to work governance mechanisms of OSSD organizations are different from those in traditional firms. To enhance the success of OSS performance, various researchers have begun investigating the definitions of governance and the various dimensions of OSSD governance (Markus, 2007; Scacchi & Jensen, 2008). Markus (2007) provided a comprehensive research area of OSS governance through literature review. He suggested six categories of OSS governance issues: ownership of assets, chartering of projects, community management, software development processes, conflict resolution and rule changing, and the use of information and tools. Scacchi and Jensen (2008) explained that governance issues of OSSD are related to decision-making authority, resource allocation, personal motives, leadership, social control, coordination mechanisms, organizational forms, etc. Among the above-mentioned issues, this research focuses on complex resource allocation. Although resource allocation is a critical component in a multi-project environment, there is lack of research on this in the OSSD field.

### 2.2. Resource allocation

Producing high-quality outcome and enhancing efficiency are critical goals for any company. With the help of rapid technological developments in management, companies have been managing multiple projects at the same time. Multiple projects are defined as “a setting in which more than one project is carried out at the same time” (Fricke & Shenbar, 2000). Projects differ in size, importance, required skills, and urgency. However, they use the same resources in companies. According to this definition, multiple projects exist in almost every organization where functional divisions undertake a number of duties in the form of projects (Fricke & Shenbar, 2000). In a multi-project environment, project management, which is a systematic approach of assigning functional personnel to specific projects is crucial (Kerzner, 2013). Managers recognize the importance of human resource management for the success of the company (Söderlund, 2011; Zwikael and Unger-Aviram, 2010). Various studies on multi-project management focus on problems such as limited resources, project interdependencies, and resource re-allocation (Engwall & Jerbrant, 2003; Fricke & Shenbar, 2000).

Previous studies on project management have focused on efficient and effective decision making with respect to human resource allocation for successful project performance. Previous studies have studied how human resource involved in multiple projects can specialize, or how it can maximize the efficiency of performance with resource allocation perspectives (Barreto, Barros, & Werner, 2008; Certa, Enea, Galante, & La Fata, 2009; e Silva & Costa, 2013; Engwall & Jerbrant, 2003; Hendriks et al., 1999; Murch, 2001). Hendriks et al. (1999) considered how specialized human resources need to be allocated and scattered in multi-project in R & D sectors. More specifically, for soft-

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