Power Relations Within an Open Source Software Ecosystem

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Abstract. Context: Relationships within open-source software ecosystems (OSSECO) emerge from the collaboration within the ecosystem. Power relations are present in this context whenever an entity has the power of making other entities act as it wants them to act. Therefore, these power relations could affect collaboration within an OSSECO. Objective: This research aims at investigating power relations, their benefits and challenges, and providing an understanding of them within OSSECO. The goal is to provide power relations forms description together with the power relations dynamics associated with them. Method: A systematic mapping study was conducted to extract information about power relations (forms, dynamics, benefits, and challenges) from previous studies. At the end, 10 studies reporting power relations within OSSECO were selected. Next, the data extracted from those was analyzed to understand what power relations affect the OSSECO and how this happens. Based on the results, the power relation forms and dynamics within OSSECO are defined. Results: The systematic mapping study show that power relations are present and affect relationships and interactions within an OSSECO. Moreover, 5 power relations forms and 7 power relations dynamics within OSSECO are presented. Implications: Identifying power relations that might be present within an OSSECO would enable those who study or are members of the ecosystem's community to enhance power relations that support collaboration and to avoid those who can lead developers to leave the OSSECO.

Keywords: Open source software · Software ecosystem · Power relations · Systematic mapping study

1 Introduction

In open-source software (OSS), a group of developers gets together in a project to solve common problems or because they share common needs [1]. When several OSS projects share their developers, artifacts and build relationships, creating a knowledge and collaboration network between them over a common technological platform (e.g., a programming language), we have an open-source software

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ecosystem (OSSECO) [2]. In the OSS development, power is usually referred to as decentralized and spread within the OSS community. This is highly related to the early years of OSS when the contribution was mostly voluntary [1]. The motivations to contribute with OSS have been changing recently, focusing more on learning, career, and payment motivations [3].

Power relations would be defined as asymmetric relations between an individual who has something to offer and some other individual who desires this something [4]. This concept has been deeply investigated in some areas of interest, such as Economics [5] and Sociology [6]. In Computer Science, other studies investigated different ecosystems' contexts and discussed benefits such as goals achievement [8] and collaboration support [9], through power relations management [10]. However, in the OSSECO context, the power relations have not been investigated yet.

This research aims to investigate power relations within an OSSECO and provide an understanding of how such relations affect developers, artifacts, and relationships within the ecosystem. This understanding must rely on how the power relations happen within the OSSECO. It must also clarify what benefits and challenges power relations can bring into the OSSECO. The research question that guides this work is *"What are the power relations and their dynamics within the OSSECO context and how they affect the ecosystem?"*. To answer this question, a systematic mapping study was conducted.

2 Systematic Mapping Study

This work investigates what power relations are present within an OSSECO and how their dynamics can affect the ecosystem, its actors and artifacts. Considering that power relations within an OSSECO have not been deeply investigated so far, the best option to gather information from the literature is performing a systematic mapping study (SMS) [11].

2.1 Planning

One inclusion criterion (IC) and four exclusion criteria (EC) were defined. The study selection process was divided into six steps (Fig. 1) and comprised from the search execution until the filtering of the returned studies. Next, a manual insertion of studies previously known as compliant to the IC and that did not present any problems regarding EC was executed. After the fifth step, the data extraction process was conducted aiming at answering the research questions. A search string was created combining terms that would relate to the studied topic. Since power relations could affect the interactions within an OSSECO, the term "interaction" was added to the string. The search string defined was: (("open source software ecosystem" OR "software ecosystem") AND ("power relation*" OR "relation*" OR "interaction*")).

2.2 Execution

The execution was intended to retrieve as many studies as possible reporting power relations within an OSSECO. The search engines used for the research were ACM, IEEE Xplore, ScienceDirect, Scopus, and SpringerLink. In the first step, 1,068 studies were found. At the end of the fifth step, 8 studies were selected. The manual insertion added 2 new studies to the list of selected studies. Therefore, at the beginning of the data extraction phase, 10 studies were enabled to be used to retrieve information about power relations within an OSSECO (Fig. 1).

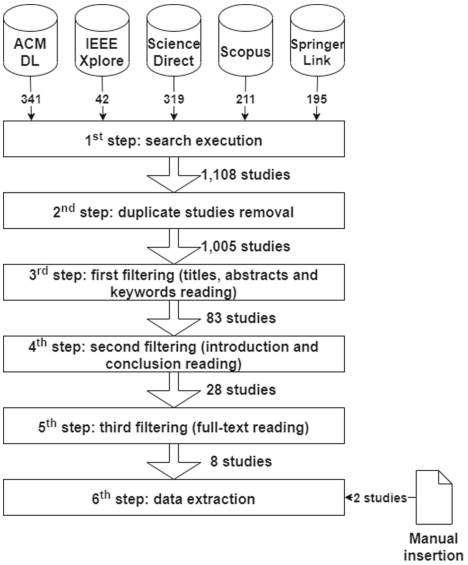

Fig. 1. Studies selection steps.

2.3 Results

The studies that were selected during this SMS were published from 2007 to 2021. From the 10 studies that were selected, none of them cited "power relations within OSSECO" directly. Were found studies that described situations in which it was possible to identify the occurrence of power relations within an OSSECO. Therefore, adding "interaction" as one of the search string's terms was determinant to retrieve those studies.

Data extraction was manually performed while reading the full text. It was important to consider the power relations implicitly reported by the studies. Those power relations were identified mostly because situations - called power relations dynamics - were described in those studies along with the actors or artifacts that would have the power and those that would be affected by the

power. To help in the identification of the forms of power relations found in the SMS, Leonidou et al.'s [7] power form classification was adapted to the OSSECO context, as seen in Table 1. The benefits that can be brought into the OSSECO rely on the possibility that the power relations can motivate the actors to keep contributing to the OSSECO and to maintain the OSSECO's health (S04 [12], S05 [13], and S08 [14]). However, the power relations could bring some challenges, especially for those who are newcomers and might have to transpose some barriers to have their contribution accepted and could decide to abandon the OSSECO. The power relations, their dynamics and the source studies in which they were found can be seen in Table 2.

Table 1. Power relations forms [7] and the adaption to the OSSECO context.

Power relation form	Leonidou et al. [7] definition	Definition within OSSECO context
Referent power	Source of power based on the identification of one firm with another firm, or the former's wish for being closely associated with the latter	The belief that one actor - due to his/her identification with another actor - would be more likely to collaborate and act according to another actor's desires
Expert power	Source of power based on the belief that one firm has specific knowledge needed by another firm	The belief that an actor has knowledge about something related to an OSSECO (e.g., he/she has skills that very few actors have) and that it might share this knowledge and help other actors if they act as the first one's desires
Legalistic power	Source of power based on the belief that one firm retains a legitimate right based on formal processes to influence another	The belief that an actor - due to legal processes and contracts - has the ability of making another actor acts as the first one's desires
Reward power	Source of power based on a firm's belief that another firm has the ability to mediate rewards and it will actually bring these rewards if the former complies	The belief that one actor has the ability of rewarding another actor (e.g., with money, higher privileges) if the second one acts according to the first one's desire
Coercive power	Source of power based on a firm's belief that another firm has the ability to punish the former if it fails to cooperate	The ability of an actor being able to punish another actor (e.g., by blocking him/her on the project) if the second one does something the first one disapproves

Table 2. Power relations dynamics extracted from SMS.

Dynamic	Power relations form	Source studies
Learning reference	Referent	S09 [3]
Technical leadership	Expert	S10 [15]
Control over development platform	Legalistic	S07 [16]
Role migration within the OSSECO	Reward	S02 [17], S10 [15]
Employment relation	Reward	S01 [18], S09 [3]
Conforming to stakeholders' requirements	Coercive	S06 [19]
Newcomers' contribution rejection	Coercive	S02 [17], S03 [20]

3 Discussion

The power forms and dynamics identified help to understand who are the ones that hold power within an OSSECO in different situations and how this power affects the relation between actors and artifacts. Therefore, it would be possible for OSSECO community members to make decisions according to their objective within the ecosystem depending on their goals and needs. It would also make it possible to understand why previous decisions or movements happened within an OSSECO based on the relations that led to them.

The *referent* power relations form appeared in the "Learning reference" power relations dynamic. In this dynamic, a project, an actor or the experience of contributing to an OSSECO itself would make an actor to play according to rules, desires or expected behaviors to be able to remain in touch with the knowledge and, therefore, learn [3]. The dynamic "Technical leadership" was identified and linked to the *expert* power relation form. In this dynamic, an actor, known by having a large technical skill in a specific technology, is seen by others as a reference. Therefore, other actors will play as the expert desires, so they can count on his/her assistance in their projects or in their problems [15]. The *legalistic* power relations form takes place through the "Control over development platform" dynamic. In this dynamic, an organization owns a specific platform and can decide how things are done within this platform because of such ownership [16].

The *reward* power relations form was identified in two power dynamics. "Role migration within the OSSECO", the actors would play as other actors who have the power to give them higher privileges within an OSSECO, and consequently, more power. This happens because having more privileges within an OSSECO means that the actor has the possibility of helping to make decisions about the ecosystem's evolution and because his/her contributions are more likely to be accepted [15,17]. "Employment relation", happens since the motivations for contributing with OSSECO have been changing and there are actors that contribute because of their work [3]. In this case, an organization employs an actor and he/she acts as the organization desires to keep his/her employment and to receive his/her payment.

When analyzing the *coercive* power relations form, two dynamics were found. "Conforming to stakeholders' requirements", usually happens when a project

tends to guide their development within the OSSECO according to some specific stakeholders' requirements. This happens because there are some stakeholders whose requirements are considered as a priority in relation to others. Therefore, actors that control the projects would be afraid of, if not conforming to their stakeholders' requirements, being replaced by others who would [19]. "Newcomers' contributions rejection", happens when a newcomer tries to contribute to a new project and he/she has his/her contribution rejected because the project's owner do not know him/her yet. This occurs because the nearly hierarchical structures that tend to appear within an OSSECO [17] acts as a barrier, where the ones that guide the projects' decisions and development decide if a newcomer's contribution is accepted or not [20].

This work has some limitations as follows: (i) as power relations have not been deeply explored yet, it was necessary to add more terms related to interactions into the search string to minimize the risk of some information not being gathered; (ii) the power relations dynamics were identified by a researcher and evaluated by two experts, both with experience of more than 10 years conducting SMS (one of them is an OSS expert and the other one is a software ecosystem expert); and (iii) other power relations dynamics might not have been identified from the selected studies.

4 Final Remarks

In an OSSECO, interactions are fundamental for maintaining an ecosystem [12]. In this paper, we reported on a SMS that aimed at exploring the power relations within OSSECO and how they can affect the OSSECO development. In the end, 10 studies were selected and 7 power relation dynamics were found and categorized into 5 power relations forms. Moreover benefits and challenges of power relations within OSSECO context were summarized.

As a contribution to the research and the practice communities, power relation forms were adapted to the OSSECO context and power relations dynamics within an OSSECO were identified. They can be used to enhance contribution or to prevent OSSECO abandonment. As future work, an ongoing study is focused on interviewing OSSECO community members to try to extract more information about power relations within an OSSECO.

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