Investigating Power Relations in Open Source Software Ecosystems

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Abstract. *Context: Relationships within open-source software ecosystems (OSSECO) emerge from collaborations within an 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 and providing an understanding of them in OSSECO. A conceptual model will be refined and will represent the power relations and their dynamics. Method: A systematic mapping study was conducted to gather knowledge about power relations from previous studies, and a survey research, considering this knowledge, was conducted with randomly selected npm OSSECO community members to evaluate that knowledge. Next, interviews with selected ecosystem community members will be conducted to identify the types of power relations and their dynamics within an OSSECO. Based on the results from the previous phases, a conceptual model to represent power relations and their dynamics in OSSECO will be refined. Results: The literature review and the survey research with the npm OSSECO community show that, as expected, power relations are present and affect relationships and interactions within an OSSECO. Hierarchy and financial rewards seem to be related to the power relations within the OSSECO. 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 understand previous movements and predict future decisions based on the power relations present in their OSSECO.*

Keywords. *Software Ecosystem, Open-Source Software, Power Relation.*

CBSoft Event: *SBES*

1. Problem Characterization

In open-source software (OSS), a group of developers gets together to solve common problems or because they share common needs. This group of developers is called as an OSS community, responsible for OSS development [Angeren et al. 2011]. When several OSS projects share their developers and artifacts and build relationships, creating a knowledge and collaboration network that flows between them over a common technological platform (a programming language, for example), we have an open-source software ecosystem (OSSECO) [Franco-Bedoya et al. 2017].

In the OSS development, power is usually referred to as decentralized and spread within the OSS community [Angeren et al. 2011]. This is highly related to the early years of OSS when the contribution was mostly voluntary. Thus, the only motivation for contribution was to help to solve problems or to evolve a project [AlMarzouq et al. 2015]. For some time now, open-source contributions are made not only by volunteers, but also by paid developers [Schaarschmidt and Kortzfleisch 2015]. The motivations to contribute with OSS have been changing recently, focusing more on learning, career, and payment motivations [Gerosa et al. 2021]. However, this is not the only change: OSS presents a nearly hierarchical structure composed of the roles and privileges each developer has within a project [Palazzi et al. 2019].

In this context, it is important to highlight that power has been explored in other areas of interest. Power is not centralized but spread through society. It has different types and can be found everywhere [Foucault 1977]. Therefore, power relations would be asymmetric relations between an individual (or group) who has something to offer and some other individual (or group) who desires this something [Foucault 1977]. In Economics, power relations are observed in the relationship between governments and organizations regarding the fulfillment of development goals [Telleria 2017]. Sociology, for example, analyzes occurrences of these relations in society [Stehr and Adolf 2018]. In Computer Science, it is not different. More specifically, in the proprietary software ecosystems context, power relations aid organizations in achieving goals [Costa et al. 2020]. This happens because understanding power relations can foster collaboration and avoid conflicts [Alves et al. 2019]. Therefore, understanding power relations can enhance its management to a great extent [Valença et al. 2018]. However, in a previous systematic mapping study (SMS), no study regarding power relations within an OSSECO as the central matter of interest was found.

Differently from projects' perspective that consider only their developers, artifacts, and relationships, OSSECO's perspective considers developers, artifacts, and relationships from all the projects that are part of the ecosystem, and there might be significant differences between them [Marsan et al. 2019]. The only two aspects projects share to be part of OSSECO are: (i) the technical platform; and (ii) the flow of developers, artifacts, and relationships across projects [Franco-Bedoya et al. 2017]. This means that rules for collaboration, roles, permissions, and other aspects of the development may vary from a project to another [Marsan et al. 2019].

The objective of this research is to investigate power relations within an OSSECO and, therefore, provide an understanding of how such relations affect developers, artifacts, and relationships within the ecosystem. Based on this knowledge, a conceptual model will be presented to represent the power relations within an

OSSECO. This model will help those who are part of an OSSECO to understand those relations, being able to support the ones that promote innovation and more interactions within the ecosystem and to avoid those that can decrease interactions. For example, power relations that represent barriers to newcomers onboarding could be avoided, allowing those to collaborate within the OSSECO more easily. To guide this investigation, the research question defined is "*How power relations within an open-source software ecosystem affect the projects' developers, artifacts and relationships?*".

2. Methodology

In this section, we present the research methodology. The methodology, shown in Figure 1, has five phases and will guide this research.

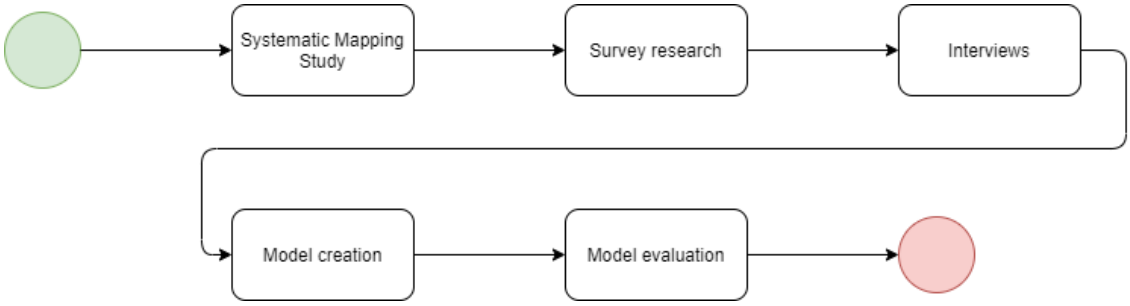

Figure 1. Methodology

Systematic Mapping Study: in this phase, the main goal was to investigate power relations in the context of OSSECO. An SMS was conducted to find studies that previously identified those power relations in this context. The procedures introduced by Kitchenham et al. (2015) were used in this phase. For this SMS, only studies written in English were considered. This phase's results are evaluated in the next phase.

Survey research: based on the findings from the previous phase, a questionnaire was formulated. The goal was to understand the opinions community members have about power relations in OSSECO. During this phase, a pilot was run with a group of experts (2), and some adjustments in the questionnaire were performed according to the feedback. Next, the survey was conducted with the complete npm OSSECO community members' sample. All the data was anonymously extracted and analyzed after the study. In the execution, a randomly selected sample of the npm OSSECO [Constantinou and Mens 2017] was used. To do so, 1,620 npm OSSECO community members were invited to participate and, from January 30th, 2021, to February 28th, 2021, 14 responses were received. This phase also evaluates the previous phase's results. This evaluation, especially considering OSS communities, shows communities' opinions on the subject. As the power relations within the OSSECO have not been deeply investigated yet, it is likely that the OSS communities are able to help in the identification of other types of power that would not be able to be found in the literature and at the same time evaluate the ones that were already investigated.

Interviews: inspired by a related work (Valença and Alves 2017), interviews will be conducted in this phase. The goal is to identify types of power relations as well as the benefits and challenges that those power relations can bring to the OSSECO, according to the community. In this phase, a semi-structured script will be used, making it possible to ask follow-up questions and, therefore, enabling a deeper investigation compared to

the survey method. Valença and Alves (2017) presented PRM-SECO as a model in which the power relations within an SME ecosystem were identified. In the present research, we aim at identifying power relations in the OSSECO context. The information extracted from the interview will help to refine the model to embrace the OSSECO context. The interviewees will be selected based on the analysis of their role within the npm OSSECO considering if they are members of an organization related to the npm OSSECO and their activities in Twitter advocating for npm or the open-source cause. Interviews will take place until the moment that theoretical saturation is reached, or 20 interviews occur [Steglich et al. 2020]. At this point, Grounded Theory procedures [Strauss and Corbin 2007] will be used to analyze the data extracted from the interviews and to emerge the concepts that will be used in the model refining.

Model creation: based on the outcomes obtained from the previous phase and inspired by the PRM-SECO creation, the goal of this phase is to refine the model so it can help to understand the power relations in OSSECO. The answers provided by the community during the interviews will be analyzed and types of power relations and characteristics that aid the identification of such types should be considered in the model. The model must contain the types of power relations as its main elements as well as their dynamics, which are interactions between different actors in which the power relation takes place. Therefore, when all of power relations dynamics are assembled, the model will be a representation of the power relations within an OSSECO.

Model evaluation: to evaluate the model that will be refined in the previous phase, OSSECO community support is needed since its members experience power relations daily and could state if the model was applicable or not. In this phase, a survey with members from different open-source communities (other than npm OSSECO) will be conducted. The idea is to present the model and ask questions in which the respondents will say if the model can be applied to their context or not. This phase aims at evaluating the results from interviews as well as model creation phases.

3. Current State of the Work

Some phases of this research were already executed, and their results helped in the next phases. An SMS that helped in the understanding of how literature describes power relations in OSSECO was performed. This SMS returned eight studies that gave us different insights into the power relations in the OSSECO context. Results show that the hierarchical power (based on role migration through meritocracy) [Teixeira et al. 2015] and monetary power (based on a labor relation or paid reward) [Linaker and Runeson 2020] are commonly present in OSSECO. Hierarchical power is also related to the possibility of role migration. However, there is a difference between autocratic and democratic governance models in OSSECO. In autocratic (centralized power), an individual or organization decides when a developer has merits for role ascension, while in democratic (decentralized power), community acceptance guides role migrations [Jergensen et al. 2011]. Developers' motivation for collaboration within OSSECO would also be affected by power relations since the desire to role ascension would motivate developers to contribute more frequently. However, the hierarchy can also affect newcomers' access to the OSSECO once they could be blocked by a high hierarchy position developer [Linaker and Runeson 2020].

Considering what was previously analyzed in the SMS, a survey research was conducted with npm OSSECO community members. Results allowed us to identify that the respondents recognized the hierarchical power within the OSSECO since different developers claimed that maintainers held power to either make decisions within the OSSECO or block the collaboration of those who disagree with them. Other respondents claimed that if a well-known organization sponsors an initiative within the OSSECO, developers would be more likely to contribute to this initiative. This can be related to a recognition power, where the fame of an individual or organization influences developers to collaborate. These findings start to help us in the understanding of power relations within an OSSECO and designing of the next steps of this research.

4. Related Work

Power relations in software ecosystems have been previously investigated in other works. Valença and Alves (2017) studied power relations within the small and medium enterprises (SME) software ecosystem. The authors interviewed members from different SME to understand the dynamics of partnerships among SME in a software ecosystem and how power and dependency manifest within these partnerships. As an outcome, a theory called the PRM-SECO model was designed to represent the power relations and dependencies that were identified within the SME ecosystem partnerships. This model considers five types of powers: legitimate, expert, reward, coercive, and referent.

In OSSECO, other relationships that could present power relations were investigated. An example is the study of Linaker et al. (2020). This work analyzes the relations among stakeholders and how they affect the ecosystem's requirement engineering process. After performing a literature review and analyzing studies and knowledge on how stakeholders influence the requirements engineering process, the stakeholders' influence analysis (SIA) method is proposed and evaluated in the Apache Hadoop OSSECO. The goal of this method is to help in the characterization of stakeholders within OSSECO based on their influence in the requirements engineering process. It also supports the identification of stakeholders' interests, common partners according to their agendas, and how they invest their resources.

In the present research, power relations has been investigated in the OSSECO context. Based on questions proposed by Valença and Alves (2017), interviews will take place with the npm OSSECO community to extract information about power relations between developers, artifacts, and projects in the OSSECO context. The npm OSSECO is formed by a set of npm projects that share developers and artifacts and has been previously defined and explored in previous studies [Constantinou and Mens 2017]. The information extracted will be used in the refinement of the PRM-SECO model once the OSSECO and the SME software ecosystem present differences in their structures that could lead to differences based on their contexts. Differently from Linaker et al. (2020), the present research will focus on investigating all types of power relations within an OSSECO and not only the stakeholders' power relation with the ecosystem regarding requirements engineering. Due to those differences, the present study will provide results that are more likely to help those who are seeking to understand not only one of the possible power relations (e.g., the stakeholder's influence over requirements), but the main power relations in OSSECO context. As it focuses on the OSSECO context, it will be more suitable to be used for those who are working on this kind of ecosystem rather than using knowledge on power relations in other kinds of ecosystem.

5. Expected Contributions

The expected contributions for this research are: (i) an understanding of power relations in an OSSECO with an evaluation from community members; (ii) a clear perspective about power relations within OSSECO and their types; and (iii) a model to represent the power relations and their dynamics within OSSECO based on their characteristics.

These contributions will help in future research since there is no previous work exploring power relations within OSSECO according to the SMS performed in this research. As power relations will be explored in OSSECO, this research aims at paving the way for further studies on refining this knowledge, investigating social interactions within such ecosystems, or understanding decisions made within an ecosystem based on an OSSECO power relation model. In addition, this work can help practitioners to understand the OSSECO they are part of and to make decisions that would help them to achieve their goals. In the case of a developer, a decision could be made about role ascension, or only having an issue that was opened by it resolved, for example. In the case of an individual or organization that manages an OSSECO, a decision could be made about preventing developers who do not follow quality or development rules from getting their code merged into the repository.

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