



A systematic literature review on the barriers faced by newcomers to open source software projects



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ABSTRACT

Context: Numerous open source software projects are based on volunteers collaboration and require a continuous influx of newcomers for their continuity. Newcomers face barriers that can lead them to give up. These barriers hinder both developers willing to make a single contribution and those willing to become a project member.

Objective: This study aims to identify and classify the barriers that newcomers face when contributing to open source software projects.

Method: We conducted a systematic literature review of papers reporting empirical evidence regarding the barriers that newcomers face when contributing to open source software (OSS) projects. We retrieved 291 studies by querying 4 digital libraries. Twenty studies were identified as primary. We performed a backward snowballing approach, and searched for other papers published by the authors of the selected papers to identify potential studies. Then, we used a coding approach inspired by open coding and axial coding procedures from Grounded Theory to categorize the barriers reported by the selected studies.

Results: We identified 20 studies providing empirical evidence of barriers faced by newcomers to OSS projects while making a contribution. From the analysis, we identified 15 different barriers, which we grouped into five categories: social interaction, newcomers' previous knowledge, finding a way to start, documentation, and technical hurdles. We also classified the problems with regard to their origin: newcomers, community, or product.

Conclusion: The results are useful to researchers and OSS practitioners willing to investigate or to implement tools to support newcomers. We mapped technical and non-technical barriers that hinder newcomers' first contributions. The most evidenced barriers are related to socialization, appearing in 75% (15 out of 20) of the studies analyzed, with a high focus on interactions in mailing lists (receiving answers and socialization with other members). There is a lack of in-depth studies on technical issues, such as code issues. We also noticed that the majority of the studies relied on historical data gathered from software repositories and that there was a lack of experiments and qualitative studies in this area.

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1. Introduction

Several open source software (OSS) communities rely on volunteers. According to Qureshi and Fang [33], it is essential to motivate, engage, and retain newcomers to promote a sustainable number of developers in a project. However, newcomers often face barriers for contributing to a project [12]. On many occasions, these barriers lead them to give up. Besides, as stated by Fogel [16], "if a project does not make a good first impression, newcomers may wait a long time before giving it a second chance." Therefore, a major challenge for OSS projects is to provide ways to reduce these barriers.

Newcomers need to learn social and technical aspects of a project before making a code contribution. They generally post their questions and request help in project forums and mailing lists or send emails to specific developers who have central roles in the project (e.g., owners and project leaders) [32,44]. However, receiving replies that do not offer guidance or unpolished answers can result in the dropout of newcomers [40]. Lack of awareness and guidance during their first steps (setting up and choosing the right means to start with), for instance, also discourage further contributions [41]. Mainly before making their first contribution, newcomers may be susceptible to several barriers, such as expectation breakdowns, reception problems, setup misconfiguration, and learning curves. Each of these may have varying levels of importance to and impact on the overall joining process [39]. Therefore, it is important to understand the type of barriers newcomers face and their influence. This understanding is a start to making possible the creation of mechanisms and tools to reduce these barriers.

By lowering the barriers, it is expected that OSS communities will benefit from more contributions. Studies conducted on open collaboration communities from other domains showed that it is possible to receive more contributions by lowering the entry barriers. Wikipedia has been the subject of some of these studies. For example, Faulkner et al. [15] found that modifying first time warnings prompted additional newcomer contributions. Morgan et al. [30] showed that user-friendly tools, safe spaces for newcomers, and positive interactions between newcomers and established community members are promising tools for newcomer retention.

However, to date, to the best of our knowledge, no single study has directly focused on identifying and classifying the barriers faced by newcomers to OSS projects, despite specific problems being dealt with or reported upon in several studies in the literature. Moreover, the knowledge about the barriers faced by newcomers to OSS projects is spread across the literature from different domains, such as Software Engineering, Computer Supported Cooperative Work, and Information Systems. Therefore, a systematic review [25] can aggregate in a single location the information regarding the barriers that is currently dispersed across various studies.

Thus, the objective of this research is to identify, by means of a systematic literature review, the barriers faced by newcomers when contributing to OSS projects. The primary studies were identified by querying digital libraries. We also made use of two snowballing approaches: backward snowballing, i.e., looking at the references of the papers selected from the digital libraries, and author snowballing, i.e., searching for other papers published by the authors of the selected papers.

After identifying the primary studies, we extracted the barriers empirically evidenced in the papers and classified them using a coding approach inspired by the coding procedures from Grounded Theory [9]. Using this approach, we categorized the barriers identified by type and according to their origin.

The contributions of this paper include (i) summarizing the existing evidence on barriers faced by newcomers to OSS projects and organizing the barriers into a single model, (ii) providing a quick reference for researchers interested in conducting further studies on newcomers to OSS, and (iii) providing grounded evidence of barriers and some guidelines that can be useful for OSS communities in helping newcomers. We hope that OSS communities and researchers will take advantage of this paper to better understand the barriers in their context and design strategies to address them.

The remainder of this paper is organized as follows. The protocol of the systematic review is presented in Section 2. In Section 3, we characterize the projects considered by each study. In Sections 4 and 5, we report the results of the analysis of the selected studies, including the classification via the type of barrier and the origin of

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