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Distributed software development in an offshore outsourcing project: A case study of source code evolution and quality

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ABSTRACT

Context: Offshore outsourcing collaborations can result in distributed development, which has been linked to quality-related concerns. However, there are few studies that focus on the implication of distributed development on quality, and they report inconsistent findings using different proxies for quality. Thus, there is a need for more studies, as well as to identify useful proxies for certain distributed contexts. The presented empirical study was performed in a context that involved offshore outsourcing vendors in a multisite distributed development setting.

Objective: The aim of the study is to investigate how quality changes during evolution in a distributed development environment that incurs organizational changes in terms of number of companies involved.

Method: A case study approach is followed in the investigation. Only post-release defects are used as a proxy for external quality due to unreliable defect data found pre-release such as those reported during integration. Focus group meetings were also held with practitioners.

Results: The results suggest that practices that can be grouped into product, people, and process categories can help ensure post-release quality. However, post-release defects are insufficient for showing a conclusive impact on quality of the development setting. This is because the development teams worked independently as isolated distributed teams, and integration defects would help to better reflect on the impact on quality of the development setting.

Conclusions: The mitigation practices identified can be useful information to practitioners that are planning to engage in similar globally distributed development projects. Finally, it is important to take into consideration the arrangement of distributed development teams in global projects, and to use the context to identify appropriate proxies for quality in order to draw correct conclusions about the implications of the context. This would help with providing practitioners with well-founded findings about the impact on quality of globally distributed development settings.

1. Introduction

Offshore outsourcing is a sourcing strategy in which a company contracts part or all of the development or maintenance activities to an external company that is located in another country (an offshore vendor) [42,44,59]. Such development environments often result in nontrivial, difficult to manage distributed development collaborations [11,59], much more demanding than those formed by outsourcing within the same national boundaries [42,49]. What is perhaps more worrisome is that distributed development is infamous for failures, including failures of delivering quality software [14,37].

Almost half of the projects in industry are said to fail to realize benefits, like cost savings, because of inadequate planning of, for example, knowledge transfer and communication between onshore and offshore sites, and not taking into consideration the complexities that come with offshore outsourcing ventures [16,21]. Such statistics are troubling given the astronomical amount of money, which range in the billions of US-dollars, that has been associated with offshore outsourcing projects over the last decade [33,42,51]. There are also indications that distributed software development affects quality [5], though the number of research studies, especially based on in-depth analyses with an empirical focus, is scarce

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[34], and reported results are contradicting. Thus, there is a need for more empirical studies on distributed development [12,34] as well as to better understand the possible source of contradicting results reported in literature. This will help with providing better support to practitioners with well-founded evidence that they can use to make informed decisions about current or future globally distributed projects.

The studied case can be characterized as a distributed outsourcing project with development teams located in separate countries (offshore outsourcing). The context consists of multiple locations involved in development activities, which is a characteristic that is uncommon in studies on global projects [4]. The number of vendors involved in development activities also changes whilst the product evolves. This makes it an interesting case for understanding how quality changes in such environments. An evolutionary view of quality is used to help with the investigation. The study reveals that the case company successfully ensured post-release quality, and the key practices that contributed to the success are presented. However, because of lack of reliable integration defects, and because the development teams at each vendor worked independently, the impact on quality of the distributed setting and organizational changes is unclear. In such a case, integration defects would be needed to better understand the impact on quality of the development setting. The study, thus, reveals the importance of understanding the nature of the distributed development context, and using appropriate measures as quality proxies in order to derive correct conclusions about the context.

Given that there are very few empirical studies that investigate GSD contexts and their implication on quality [40], this study is a valuable addition within the research area. The contribution of this study can be summarized as follows:

- The study provides an empirical investigation into the links between organizational changes and quality in a distributed development environment. Despite many pessimistic views (often of speculative nature), empirical results from this paper show that it is possible to achieve good post-release software product quality when outsourcing development to two offshore vendors,
- Based on the qualitative analysis, the paper further describes practices that can help ensure post-release quality when working with offshore vendors.
- In addition, the study demonstrates that valid conclusions regarding the implications of distributed development on quality require selection of appropriate measures as proxy for quality and careful attention to the context of the distributed development environments. For example, the current investigation failed to reliably conclude whether distributed development resulted in any quality changes due to the lack of pre-release defect data traceable to the concrete vendors.

The remainder of this paper is structured as follows. Related work is described in Section 2. Section 3 begins with the research question, and then further details the studied case and context, and the research approach followed. Section 4 presents the results, discussed in Section 5. Threats to validity and limitations of the study are described in Section 6. Section 7 concludes the paper with the summary of the major findings and an outline of future work.

2. Related work

2.1. Offshore outsourcing and distributed development

Offshore outsourcing is one of various sourcing scenarios, often studied under the research umbrella of global software development (GSD) [55,59]. However, studies on their effect on quality is scarce [55]. Studies on offshore outsourcing collaborations generally focus on vendor selection, e.g., [30], while some studies focus specifically on the relationships between the outsourcing company and the vendor [1,2].

Risks and success factors are well documented in GSD literature as shown in various reviews of empirical studies, e.g., [17,41,55]. The areas of concern when engaging in offshore work include communication and coordination breakdown [13,21], vendor competency and attrition [37], cultural differences [32,61], and building and maintaining trust and rapport between sites [3,28,38]. These areas are also said to pose a great risk in achieving desired quality goals [29].

Offshore outsourcing collaborations can result in distribution of teams or team members [56]. Quality concerns emerge even stronger in such development settings in comparison to single-site or collocated development teams [8]. This is because large geographical and temporal distance can complicate collaborations and hinder effective communication [19]. Because of this issue, and many other challenges faced in distributed development projects [12], it is important to take note of the possible effects on quality of the development settings.

A number of studies link distribution with a decrease in quality, for example, [5], [46] and [9]. Bird and Nagappan [5] have studied two open source systems, Eclipse and Firefox, and found that the number of pre-release defects can increase as a consequence of developing components distributedly. Ramasubbu and Balan [46] have also linked distributed development with a decrease in quality based on an analysis of customer reported issues during acceptance testing at a large multinational corporation working with India and US. Similarly, Cataldo and Herbsleb [9] found that the possibility of integration failures was higher for geographically distributed feature teams than in a setting with collocated teams.

There are, however, other studies that report on opposing results in terms of the link between distribution and software quality. Spinellis [53], who assessed coding style and defects, found negligible effect on quality associated with geographical dispersion. Similarly, Bird et al. [6] analyzed post-release defects and internal source code measures, i.e., cyclomatic complexity and code churn measures, and found little difference in quality when comparing collocated and distributed teams working on Windows Vista. However, the distribution here was mainly within the same country. Sutherland et al. [54] found no observable negative effect on quality when shifting from collocated to distributed development. In that study by Sutherland et al. [54] the distributed development setting consisted of cross-functional scrum teams, and each team had team members that were dispersed across multiple locations.

The differences in research results can be explored by the variation in the context in which the studies are carried out, and the data used to measure quality. Studies discussed above contain teams distributed in relative proximity - different buildings or cities, as studied by Bird et al. [6] versus large geographic separation as studied by, e.g., [46]. Also, different number of sites involved in distributed development has been studied. Notably, Spinellis [53] and Bird and Nagappan [5] studied open source systems, which is a special case of distributed development. The implications of open source research results for commercial development is, however, often debated. Finally, since most of the studies focus on a single proxy for software quality (pre-release defects, post-release defects or customer reported defects), the versatile view of quality changes, and the use of an appropriate quality proxy in certain distributed contexts, is another potential research direction.

2.2. Measuring distribution and quality

Related studies are summarized in Table 1. The differences in the proxies for quality are alarming. Although many studies aim at