A systematic review of knowledge sharing challenges and practices in global software development

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ABSTRACT

Context: Global Software Development (GSD) presents significant challenges to share and understand knowledge required for developing software. Organizations are expected to implement appropriate practices to address knowledge-sharing challenges in GSD. With the growing literature on GSD and its widespread adoption, it is important to build a body of knowledge to support future research and effective knowledge sharing practices.

Objective: We aimed at systematically identifying and synthesizing knowledge sharing challenges and practices. We also intended to classify the recurrent challenges and most frequently reported practices in different contextual settings.

Method: We used Systematic Literature Review (SLR) for reviewing 61 primary studies that were selected after searching the GSD literature published over the last 14 years (2000–September 2014). We applied thematic analysis method for analysing the data extracted from the reviewed primary studies.

Results: Our findings revealed that knowledge sharing challenges and practices in GSD could be classified in 6 main themes: management, team structure, work processes/practices, team cognition, social attributes and technology. In regard to contextual settings, we found empirical studies were mainly conducted in an offshore outsourcing collaboration model distributed between two sites. Most of the studied organizations were large enterprises. Many of the studies did not report any information for several contextual attributes that made it difficult to analyse the reported challenges and practices with respect to their respective contexts.

Conclusion: We can conclude: (a) there is a higher tendency among researchers to report practices than challenges of knowledge sharing in GSD. (b) Given our analysis, most of the reported knowledge sharing challenges and practices fall under the theme of "work practices". (c) The technology related knowledge-sharing challenges are the least reported; we discussed the available technologies for supporting knowledge sharing needs in GSD. (d) The organizational contextual information is missing from a large number of studies; hence, it was not possible to investigate the potential relations between knowledge sharing challenges/practices and the contextual attributes of GSD teams. We assert the need of exploring knowledge sharing in the context of small/medium sized organizations to avoid the risk of findings being biased by specific empirical setting (e.g., large enterprises distributed between US and India).

1. Introduction

Global Software Development (GSD) has become an established software development paradigm that promises several advantages but also suffers from well-known limitations (Herbsleb et al., 2001; Damian & Moitra, 2006; Bhat, Mayank, & Murthy, 2006). The promised benefits include enabling organizations to implement strategies like Follow The Sun (FTS), benefiting from cost advantages in certain parts of the world, being in close proximity to customers, and creating opportunities for merger and acquisition, and accessing a large pool of talented software developers (Damian & Moitra, 2006; Herbsleb & Moitra, 2002; Grinter, Herbsleb, & Perry, 1999). GSD can also result in significantly increased complexity for project teams, who may have to face several kinds of new challenges. Most of the GSD challenges stem from what is known as

GSD distances, i.e., temporal, geographical, cultural, and linguistic distances. These distances lead to communication, coordination, and collaboration challenges (Grinter et al., 1999; Ågerfalk et al., 2005; Carmel & Agarwal, 2001) that can impact several areas of software development. One of the key areas of software development being impacted by GSD is knowledge sharing as software development is a knowledge-intensive activity whose success is largely dependent upon effective knowledge sharing among software development teams (Kotlarsky & Oshri, 2005; Khan, Niazi, & Ahmad, 2009). GSD team members may find it difficult (or even impossible) to share both tacit and explicit knowledge within a team that is geographically distributed.

Knowledge sharing is an integral part of Knowledge Management (KM) (Choo & de Alvarenga Neto, 2010; Santos, Goldman, & de Souza, 2014). It is defined as « *provision of task information and know-how to a person, so that (s) he can collaborate with others to solve problems, develop new ideas or implement policies or procedures*» (Santos et al., 2014; Cummings, 2004). Choo and Alvarenga (Choo & de Alvarenga Neto, 2010) identified four major categories of conditions to enable knowledge sharing (Choo & de Alvarenga Neto, 2010): social/behavioral characteristics of teams (e.g., mutual trust, attentive enquiry, open dialogues), cognitive/epistemic attributes (e.g., common knowledge, shared values and goals), organizational structure/strategies (e.g. empowered divisions, leadership style) and provision of information systems (e.g., internet, intranet, yellow pages).

Ebert and De Man (Ebert & Man, 2008) discuss that effectively managing software engineering knowledge (i.e., project, product, and process) is of growing importance given the ever-changing environments of software development, e.g., globalization. They (Ebert & Man, 2008) argued that in GSD settings, vendors usually possess technical expertise and knowledge about a project, while clients hold requirements and application domain knowledge. However, vendors without proper understanding of requirements and application domain knowledge cannot effectively and efficiently apply their technical skills; and clients could not appropriately provide business requirements without understanding knowledge needs of vendors. Bjornson and Dingsøyr (2008) report that KM in software engineering is mainly based on utilizing information technologies.

Boden and colleagues (Boden et al., 2012) criticize the implementation of traditional KM approaches that tend to de-contextualize by codifying knowledge but neglect behavioral aspects and social learning that are specifically influential in GSD teams. GSD impedes the opportunities for face-to-face interaction and informal chats between distributed team members (Grinter et al., 1999; Ågerfalk et al., 2005) which are considered quite helpful for sharing knowledge (Grinter et al., 1999; Noll, Beecham, & Richardson, 2011). Time zone differences also decrease the mechanisms of *ad-hoc* knowledge sharing by answering on-the-spot questions. Cultural and linguistic distance plays a significant role in communication gaps between distant colleagues. From socio-behavioural perspectives, several studies (e.g., Kotlarsky & Oshri, 2005; Hinds & McGrath, 2006) indicate that developing trust and rapport between dispersed members facilitate knowledge sharing. The argument is that when individuals are socially bonded they are more likely to share identity (Hinds & McGrath, 2006) and cooperate with each other due to trustworthiness, obligations, and expectations (Coleman, 1988). Yet, building and maintaining a social network among individuals in the absence of face-to-face communication and informal chats could be a costly undertaking.

Given the increasing trend of GSD and the importance of knowledge sharing in GSD, researchers and practitioners have been dedicating significant amounts of effort to help understand knowledge sharing challenges and devise appropriate practices to address the challenges. This has resulted in a growing amount of literature that warrants periodic reviews in GSD. Hence, we decided to systematically identify and critically review the literature on knowledge sharing challenges and practices in GSD.

Our review aims at contributing to a growing body of knowledge on knowledge sharing. We assert that systematic and periodic reviews will help build an evidence-based body of knowledge about knowledge sharing challenges and relevant practices in GSD. Such a body of knowledge can inform the research community about commonly reported (or unaddressed) challenges and direct provision of solutions to support knowledge sharing needs of GSD teams. Besides, it could be used as comprehensive guidelines for practitioners to become more aware of the challenges and implement appropriate practices that suit their work context. That is why we decided to conduct a systematic literature review (SLR) in order to systematically collect, investigate and summarize knowledge sharing challenges and practices of GSD teams from real-world scenarios.

We consider the study by Nidhra et al. (2013) as the most relevant to our review. The authors have reported knowledge transfer challenges and mitigation strategies in GSD. Whilst our study and the review by Nidhra and colleagues (Nidhra et al., 2013) are on the same topic, both studies have significant differences that we will explain in the later part of this paper.

The rest of this paper is organized as follows: Section 2 describes details of conducting this SLR. Section 3 reports the demographic information of the reviewed primary studies. Section 4 analyzes the research methodologies used by the reviewed studies. Section 5 analyzes the contextual settings of the reviewed studies. Sections 6 and 7 report the knowledge sharing challenges and practices identified. The limitations of this study are discussed in section 8. Section 9 compares our study with an existing SLR on this topic. The results are discussed in Section 10 and conclusions are provided in Section 11.

2. Method

As previously stated, we used a Systematic Literature Review (SLR) that is one of the most widely used research methods of Evidence-Based Software Engineering (EBSE) (Kitchenham, Dyba, & Jorgensen, 2004). SLR provides a well-defined process for identifying, evaluating, and interpreting all available evidence relevant to a particular research question or topic (Kitchenham & Charters, 2007). For this review, we followed Kitchenham and Charters's guidelines (Kitchenham & Charters, 2007) for applying a SLR research method that involves three main phases: defining a review protocol, conducting the review, and reporting the review. Our review protocol consisted of these elements: (i) research questions, (ii) search strategy, (iii) inclusion and exclusion criteria, (iv) study selection, (v) study quality assessment, and (vi) data extraction and synthesis. We discuss the followed steps in the following subsections.

2.1. Research questions

Table 1 presents the research questions (RQs) and their respective motivations. We aimed at gaining an understanding of knowledge sharing challenges (i.e. RQ1), and practices (i.e. RQ2) reported by empirical studies in GSD, and identify the contextual settings from which the challenges and practices are found (i.e. RQ3).

2.2. Search strategy

Defining a search strategy for a SLR is considered as one of the most important prerequisites. A search strategy can help the researcher to retrieve as many relevant studies as possible