Motivators of Adopting Social Computing in Global Software Development: Initial Results

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Abstract— **context: Real-time collaboration is critical for developing high quality software systems at low cost in a geographically distributed Global Software Development (GSD) environment. It is anticipated that emerging Social Computing tools can play an important role in facilitating real-time effective collaboration among teams working in the GSD.**

Objective: The objective of this research paper is to identify motivators for adopting social computing in GSD organizations.

Method: We adopted a Systematic Literature Review (SLR) approach by applying customized search strings derived from our research questions.

Results: We have identified factors such as real-time communication and coordination, information sharing, knowledge acquisition and expert feedback as key motivators for adoption of social computing in GSD.

Conclusion: Based on the SLR results, we suggest that GSD organizations should embrace social computing as a tool for real-time collaboration between distributed GSD teams. The results of this initial study also suggest the need for developing the social computing strategies and policies to guide the effective social computing adoption by GSD teams.

Index Terms— **Global software development, Social Computing, Systematic Literature Review, Empirical Study**

I. INTRODUCTION

O VER the last decade, a number of new system development methodologies have emerged to deal with the complex undertaking of modern system development ranging from traditional single-site to communication focused multi-site GSD environments [1]. In GSD, a company (client) contracts out all or part of its software development activities to another company (vendor), who provides services for remuneration [2].

Client organizations benefit from software outsourcing because vendors in developing countries usually cost less and even are more cost effective when compared with in-house operations [3]. However, a number of challenges have been reported in GSD projects. These problems have affected half of the companies that have tried GSD as they failed to realize the anticipated outcomes due to poor global relationships, misunderstanding of the projects' requirements and poor services.

In a GSD project, communication is critical for enabling real-time effective collaboration between distributed GSD teams, which usually takes place via phone and video conferencing system [4]. Most recently, social computing has been used to facilitate real-time communication between geographically distributed teams. Social computing tools (for example, Skype, Twitter, Wikis etc.) are being used in the multi-site GSD environment as they provide additional contemporary channels that can be used to enable real-time communication for instant sharing knowledge and receiving feedback in different phases of a GSD project without unnecessary delays caused by traditional means of communications (e.g. requirements specifications, design documents, formal reviews).

Despite the increased use of social computing in GSD, little research has been carried out to better understand factors that support the strategic adoption of social computing in GSD organizations. We also need to investigate how to improve organizations GSD processes using social computing concepts.

We believe that understanding the social computing factors relating to GSD initiatives will help to ensure the successful outcome of projects and to maintain long lasting relationships between clients and vendors in different geographical locations.

The objective of this research paper is to identify factors via systematic literature review that are important for using social computing in globally distributed GSD projects. Our long term research goal is to provide GSD practitioners with a body of knowledge that facilitates the systematic less risky adoption of social computing tools in order to improve the GSD processes. To do this, we intend to address the following research question:

RQ: What motivate GSD organizations to adopt social computing in globally distributed projects?

The reminder of this paper is organized as follows: Section II describes the background. In Section III, we give

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an outline of our research methodology. Section IV describes initial results. Section V provides the conclusion and suggestions for future work.

II. Background

Social computing is "a large number of new applications and services that facilitate collective action and social interaction online with rich exchange of multimedia information and evolution of aggregate knowledge have come to dominate the web" [5]. It is essentially a collection of technologies that claims to support social interaction, rich multimedia information sharing and collaborative action facilitation. It seems to enable organizations to interact and collaborate with their customers, resolve issues, as well as distribute and advertise business information.

There are a number of social computing tools (e.g. Chatter, Facebook, HipChat, LinkedIn, Skype, Twitter, Yammer, Wikis), which are sometimes referred to as Web2.0, social networks or social media. These tools allow individuals to collectively contribute their knowledge and expertise for solving a known or unknown problem by achieving their desired objectives through volunteer interactions.

A number of researchers have reported the use of social computing technologies in GSD. These studies present the experience of using social computing tools in a specific phase of software development life cycle phases (e.g. requirement [6], [7] for improving overall software quality [8]). To date, majority of the social computing literature reports the experience of adopting individual social tools or technologies such as wiki [7],[9], blogging [10] and discuss their impact on brainstorming [9], collaborative authoring [11] and team performance [12].

Al-Ani et al. [13] presented the factors that hinder people from using web 2.0 tools and how social computing tools assist in software engineering paradigm. Similarly, Tamburri [14] proposed a new architecture for global software development based on agile social network. Lately, Portillo-Rodriguez et al. [15] presented a systematic mapping review of tools used in GSD projects.

There is a significant interest in the adoption of social computing in GSD [16]. However, the question is: what are the key motivators of its adoption in GSD? To the best of our knowledge, no SLR study has been conducted on factors that motive organizations to adopt social computing for GSD projects. The results of SLR study are important as they can assist GSD organizations in better understand issues related to adopting social computing in globally distributed GSD projects.

III. Methodology

A Systematic Literature Review (SLR) process [17] was used as the main approach for data collection because SLR is a defined and methodical way of identifying, assessing and analyzing published primary studies in order to investigate a specific research question. Systematic reviews differ from ordinary literature surveys in being formally planned and methodically executed. In finding, evaluating and summarizing all available evidence on a specific research question, a systematic review may provide a greater level of validity in its findings than might be possible in any one of the studies surveyed in the systematic review.

A systematic review protocol was written to describe the plan for the review. The major steps in our methodology are:
• Construct search strategy and then perform the search for relevant studies.
• Perform the study selection process.
• Apply study quality assessment.
• Extract data and analyze the extracted data.

This paper focuses on the motivating factors of adopting social computing in global software projects. In order to do that, we intend to address the following research question:

RQ1: What motivate global software development organizations in adopting social computing in globally distributed projects?

Our search strategy is based on the following steps:
• Derive the major terms from Population, Intervention and outcome.
• Find synonyms and similar spellings of the derived terms obtained above.
• Verify these terms in various academic databases
• AND operator is used to connect major terms (if allowed).
• OR operators, is used to connect synonyms and similar spellings. (If allowed).

Based on the above search strategy we have constructed the following search terms:
• POPULATION: Global Software Development (GSD) firms.
• INTERVENTION: motivation/ demotivation factors.
• OUTCOME OF RELEVANCE: motivation - demotivation factors of adopting social computing.
• EXPERIMENTAL DESIGN: SLRs, empirical studies, theoretical studies and expert opinions.

We tested our terms in various academic databases and the following terms shows potential relevance to the topic:
• GLOBAL SOFTWARE DEVELOPMENT: Global Software Development OR GSD OR distributed software development OR multisite software development OR multi-site software development OR global software teams.
• SOCIAL COMPUTING: Social Computing OR Social Media OR Social Network OR Web2.0 OR online collaboration OR mash up technology OR SNS.
• ADOPTION: adoption OR realize OR apply OR implement OR use OR exploit OR embrace OR support OR utilize OR select or choose OR concern OR fear

We eliminated some terms which don't retrieve any additional studies. For example, motivation is not a search term in our search string because any paper that describes the implementation of social computing in GSD will consequently discuss (de)motivation factors implicitly. Hence, we find it impeccable to substitute motivation terms with adoption.

After trial search we have designed the final search string:
{Global Software Development OR GSD OR distributed software development OR multisite software development

OR global software teams} AND

{Social Computing OR Social Media OR Social Network OR Web2.0 OR online collaboration OR mash up technology OR SNS} AND

{Adoption OR realize OR apply OR implement OR use OR exploit OR embrace OR support OR utilize OR select or choose OR concern OR fear}

Based on the available access, the following digital libraries were used:

- ACM Digital Library.   (http://dl.acm.org)
- IEEE Explore. (http://ieeexplore.ieee.org)
- Science Direct. (http://www.sciencedirect.com/)
- Google Scholar (http://scholar.google.com/)
- ISI Web of Science. (http://wokinfo.com/)
- Springer Link. (http://link.springer.com/)

Since these libraries differ in their search mechanism and capability, we tailored our search strings accordingly.

The following inclusion criteria were used:

• Conference Proceedings, Magazines and Journals published after 1980.

• Papers published in any of the primary or secondary resources mentioned previously.

• Studies focus on answering our research question.

• Studies focus on enhancing collaboration, communication or productivity.

• Studies focus on motivation factors or de-motivation factors.

• Studies foresee the future of social computing tools in aiding software projects.

The following exclusion criteria were used:

• Papers published before 1980 are excluded since Internet starts after that date.

• Manuscripts written in non-English language is excluded.

• Poor English writing papers are excluded as it may cause ambiguity.

• Pure psychology or motivation studies are rejected.

• Papers that show adoption of collaboration tools in a single department are excluded

• Technical reports, and white papers are excluded.

• Graduation projects, master theses and PhD dissertations are excluded

• Textbooks whether in print or electronic are excluded from this systematic review.

• Studies in other domains of knowledge like civil engineering projects are excluded.

For any paper to pass the initial phase, a quality assessment was done. Four quality criteria were prepared as show in Table I. We have finally selected 36 articles which meet our inclusion and quality criteria.

From the finally selected papers we have extracted data in order to address our research question. The following data was extracted from each paper: Publication Type, Authors, Publisher, Publication Name, Publication Date, Organization Size, Project Size, Social Computing Tools, and Motivation Factors.

IV. INITIAL RESULTS

This section presents initial results of applying our quality criteria on all retrieved papers. The number of studies that passed the initial phase is 84 as shown in Table II. Then, we selected 36 studies in the final phase after applying the inclusion and exclusion criteria. We obtained all the motivation factors from the extraction form of each publication. We grouped similar motivation to a general category and calculated the frequency.

TABLE II

SEARCH EXECUTION

Database	Retrieved	Primary Studies	Final
ACM	792	19	10
IEEE	40	20	18
Science Direct	73	15	4
Springer	169	30	4
Total	1074	84	36

We have grouped the papers found through SLR into nine study strategies, which are commonly used in the empirical software engineering, as shown in Table III. These study strategies were initially identified by the primary reviewer during the data extraction process. However, secondary reviewer has validated these study strategies. Most of the articles used interviews as a research method. Nine articles have used observation and seven have used implementation as their research methods.

TABLE I

QUALITY ASSESSMENT

Criteria	Score	Notes
Are the findings and results clearly stated in the paper?		Yes =1 No =0
Is there any empirical evidence on the findings?		Yes =1 No =0
Are the arguments well-presented and justified?		Yes =1 No =0
Is the paper well referenced?		Yes =1 No =0

TABLE III

STUDY STRATEGIES USED

Study Type	Count
Interviews	13
Observation	9
Implementation	7
Survey	6
Analyzing Files (Logs, Email, IM)	4
Literature review	2
Experiment	2
Expert Opinion	1
Focus Group	1

Table IV shows the motivators of adopting social computing in global software development. Our results indicate that the frequently cited motivator of adopting social computing in GSD projects is 'communication and coordination' as reported by 81% of articles. The study conducted by Tsuji et al. [18] concluded that communication capabilities have a significant impact on the results of GSD projects. In another study, Erickson et al. [19] described the case of one offshore software development outsourcing project which completely failed due to the lack of adequate communications. Due to different cultures and languages in GSD it is quite possible that a message is misunderstood by one or more of the outsourcing parties. In addition, due to the geographical distributed teams in GSD (as shown in Figure 1), face-to-face communication and coordination is not possible where one can clarify any misunderstanding. Moreover, the differences in time zones increase the coordination cost and complexity [20]. Nevertheless, rudimentary communication tools such as emails are not sufficient in solving communication and coordination problems in GSD [21]. These findings indicate that communication and coordination is one of the important motivators of adopting social computing in GSD projects.

Information sharing is the 2nd most frequently cited motivator (64%). Typically there are five structures of GSD projects [22]:
- Centralized project management
- Distributed project management with local coordinators
- Distributed project management with functional coordinators
- Round-the-clock project management
- Project management global network

Information sharing is an important task in all these GSD project structures as different teams have to share information with each other to perform different software development activities. Storey et al. [23] stated that searching and managing source code is a critical issue faced by many software developers. This issue is magnified in distributed project since team members are working in different geographical location with different technical infrastructure.
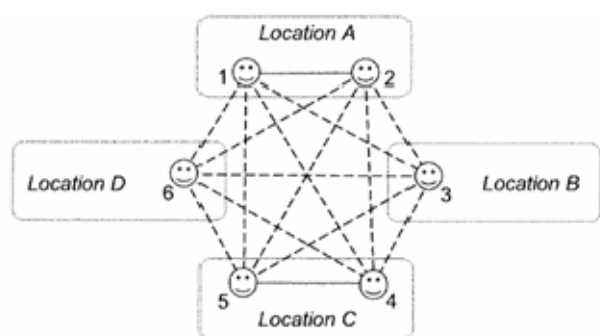

Fig. 1. Communication and coordination in GSD [22]

Familiarity with GSD team motivator has been cited by 42% of the articles. One of the key challenges in GSD projects is creating confidence and trust among different teams [24], [25]. In general, researchers agreed that trust refers to an aspect of a relationship between client and vendor in which the parties are willing to establish a relationship that will result in a positive desired outcome. It is always difficult to create such a relationship unless one is fully familiar with all members of the globally distributed team.

More than quarter of the articles has cited expert feedback as one of the motivators of adopting social computing in GSD projects. This is true that at different stages in the GSD one needs to get timely expert feedback and social computing tools can help in quickly getting these expert feedbacks.

Ten out of 36 articles stated that social computing can play a vital role in knowledge acquisition. According to [20], one reason for adopting a distributed project process by software firms is the ability to reach a wider range of skills and knowledge. One study [11] presented an implementation of a wiki-like tool that allows multi users to access centralized information at the same time. WikiTables tool works as a central tool for different users to acquire knowledge. In the GSD projects technical specialization are not the only elements to consider when evaluating potential team members to work on global projects but team members must have global skills to work on global projects [22]. One can acquire such knowledge if adequate tools such as social computing are used.

Only three articles have mentioned innovation as a motivator. We believe some of the GSD organizations like innovation in their projects in order to better compete in the outsourcing market.

TABLE IV

MOTIVATION FACTORS OF USING SOCIAL COMPUTING

MOTIVATION FACTORS CATEGORIES	FREQ N=36	%
REAL-TIME COMMUNICATION & COORDINATION	29	81
INFORMATION SHARING	23	64
FAMILIARITY WITH GSD TEAM	15	42
EXPERT FEEDBACK	11	31
KNOWLEDGE ACQUISITION	10	28
INNOVATION	3	8

V. CONCLUSION

. Real-time collaboration is critical for the success of GSD projects. The emerging social computing tools claim to support real-time effective collaboration among geographically distributed GSD teams. There is a significant interest in the adoption of social computing tools for facilitating the collaboration among teams working in the geographically distributed GSD project environment. However, the adoption of social computing for the GSD is a strategic initiative and demands the systematic identification

of the factors that motivate its strategic adoption. Based on our initial SLR study results, this paper presented a set of factors for social computing adoption for facilitating collaboration in GSD projects. The SLR study results highlighted that the real-time communication and coordination is one of most important motivation factors of social computing adoption in GSD. Our analysis provided a deeper insight into the social computing adoption factors, which must be considered for the effective (and less-risky) use of social computing. We anticipate that this study would reduce uncertainties related to social computing adoption. The identified factors highlighted in this paper can be used as a lens when developing the social strategies and polices for GSD.

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