Review of Social Media Influence on Software Development

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ABSTRACT

The Software Development (SD) process requires collaboration and sharing of information in order to achieve the best results required and Social Media (SM) has helped this process immensely. SM is frequently utilized by programmers to strengthen their SD tools. In particular, communication is a key component in collaborative development, when designing large-scale software. An engineer can ask his colleagues around the world for help in solving problems or contact users for feedback. However, there is still a need to do research about the benefits as well as limitation of usage of SM in SD process. This study examines research conducted from 2009 until 2019 to help the researchers as well as businesses to learn more about the relation between SM and SD. Inclusion and exclusion criteria is imposed to sort out the research done during the mentioned time period. Type of data extracted from the selected papers includes authors' name(s), title of the paper, year of publication, type of publication, country of origin, method used, data analysis, study setting and data collection approach. Furthermore, this paper answers to the questions posed in the study, such as what are the potential limitations of using SM for SD, and what reasons are given by the organizations for utilization of SM for SD. This paper provides a systematic literature review of 31 studies on SM and SD.

Key Words: Social Media, Software Development, Software Engineering

1. INTRODUCTION

SM has made a huge impact on how the businesses communicate with their customers. It is inexpensive and yet very effective way to approach and collaborate with others. By collaborating, businesses have more clear idea about the needs of their customers. This helps them immensely to improve their products or services [1].

When it comes to software engineering, there is a well-recognized need to support tools for formal and informal activities [2]. Developers today widely use SM to improve their SD tools [3]. Especially, in collaborative development, communication is the key component. When designing larger software, an engineer can ask help from his colleagues from around the world to solve an issue, if it comes up or gets in touch with the users for feedback [4]. If we want to see this issue more broadly, according to Ali *et. al.* [5], Global Software Development (GSD) is also facing same challenges. For instance, in communication, any mishaps might happen while exchanging information. When working in teams there is always a challenge of task awareness and contribution to the project, and lastly, control and management of the project.

SD research is expanding and there is increasing use of Systematic Literature Reviews (SLRs) to organize the literature. The SLR is a way to synthesize available research by observing a comprehensive, predefined bias reduction procedure. Guidelines have been

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developed for the application of SLRs within SD, and numerous SLRs have been published on SD and related topics [6].

However, the comprehensive and systematic research on the role of SM in SD is rare despite the SM's importance. This paper's motivation is to provide a comprehensive and useful insight into the SM effect on SD. To implement SM tools effectively, a detailed understanding of SM limitations and benefits in the context of SD is necessary for software developers. Therefore, authors of this study define following research questions:

RQ1: How many research papers have been published on SM use for SD?
RQ2: What are the purposes of using SM for SD?
RQ3: What are the limitations of SM for SD?

2. RESEARCH METHODOLOGY

The objective of this SLR is to synthesize available data in fair, rigorous and open manner. After defining the research questions, here are the next steps to be taken in SLR [6]:

- the search process, including search strings and other search criteria,
- inclusion and exclusion criteria
- the selection process
- the data extraction process
- data synthesis

2.1 Search Process

A wide search process was performed to pinpoint articles published related to our topic, combining automated and manual search to expand coverage. All the collected research articles were published between January 2009 and March 2019. This process used the following search engines and indexing systems: Google Scholar, Springer Link, Science Direct, IEEE Explore, ACM Digital Library, Scopus, EI Compendex and Citeseer. For manual search, the following libraries were used: ACM Computer Surveys, ACM Transactions on Software Engineering Methodologies, Software Practice and Experience, Empirical Software Engineering Journal and Information and Software Technology.

Search terms used were: ("software development" OR "software engineering" OR "software process" OR "software development phases" OR "software development lifecycle" OR "software planning" OR "software testing" OR "software analysis" OR "software maintenance" OR "software design" OR "software quality" OR "software configuration management" OR "software validation" OR "software verification") AND ("social media" OR "new media" OR "participatory media" OR "user-generated content" OR Facebook OR MySpace OR Twitter OR YouTube OR Second Life OR LinkedIn OR wiki* OR blog* OR "Web 2.0" OR "online social network" OR "social networking").

Necessary adjustments were made according to the syntax of the search engines.

2.2 Inclusion Criteria

The research used the following inclusion criteria:

- include studies published between January 2009 and March 2019 (including these dates).
- include studies related to SD
- include studies related to SM
- the main objective of the research article is the usage of SM in SD

The number of citations for the selected studies was not part of inclusion criteria. The reason not to include this criterion is that it will further reduce the number of studies used for this paper. Irrespective of how many times a paper is cited, if the paper is related to SM and SD, it was included in this study.

2.3 Exclusion Criteria

The research used the following exclusion criteria:

- Exclude duplicates
- Exclude studies published in different languages (other than English)
- Exclude keynotes, lab reports, presentations and tutorial summaries
- Exclude studies which are not related to SD process and SM.

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2.4 Paper Selection

After extracting the research articles from the search, they were evaluated considering the title and the abstract of the papers. Afterwards all the papers which were not relevant to the topic were rejected. Next based on the inclusion and exclusion criteria the rest of the papers were either rejected or selected. After the above-mentioned steps, 31 papers were chosen as relevant to the topic. To tackle the issue of collaboration bias and reliability issues, studies published in journals and conferences were considered for this research.

2.5 Data Extraction

The title of the paper, authors name, publication venues and year of publication was extracted during the first phase. In the next phase, following details were extracted and compared:

- type of the study conducted
- number of respondents
- research questions were explored
- factors for SD
- factors for SM
- limitations
- future works

3. RESULTS

In this section, authors report the findings in relation to each of the research questions. After removing studies based on the added timeframe, the first screening resulted in the retention of 71,796 studies for a more in-depth review of the abstract. Furthermore, studies were removed based on their tittle, abstract and keywords. Finally, duplicates were removed and only 31 studies were selected for the literature review as shown in Table 1. Table 2, display the extraction categories used for this research paper.

In addition to the databases mentioned above, below are the other journal databases, which were searched for related research articles:

- Journal of Systems and Software
- IEEE Transactions on Software Engineering
- IEEE Software

TABLE 1: SUMMARY OF DATABSES AND NUMBER OF STUDENTS IDENTIFIED			
Databases	Studies	Adding Timeframes 2009-2019	Selected based on the Abstract, title and keywords
Google Scholar	18,300	18,300	6
Springer Link	2,207	2,201	4
Citeseer	178,058	48,237	0
Science Direct	936	934	3
Scopus	431	431	20
Total	201,632	71,796	33
After removing duplications, in total			31

TABLE 2: CATEGORIES USED IN EXTRACTING AND ANALYZING DATA		
Area	Category	Remarks
Descriptive	Authors	Name of Author(s)
	Title	Complete title of the paper
	Year	Year of publication
	Type of Publication	Published in journal, conference or workshop proceedings, etc.
	Country	Country where the research was conducted
Methodology	Method used	The method used to conduct the research
	Data Analysis	Method used to analyze the data
	Study Setting	Academic or industrial
	Data Collection Approach	Which approach used to collect the data? (e.g. observation, questionnaire, etc.)
Thematic	Usage / Keywords	What are the purposes of using SM for SD?
	Limitations	What are the limitations of SM for SD?

- Communications of the ACM
- ACM Computer Surveys
- ACM Transactions on Software Engineering Methodologies
- Software Practice and Experience
- Empirical Software Engineering Journal
- Information and Software Technology

Due to irrelevance of the articles or after removing the duplicates, no results were found.

RQ2:   What are the purposes of using SM for SD?

According to the information collected from papers, there are number of purposes of using SM for SD. Most common purpose was found to be Collaboration. When developing software, it is important to have easier access or communication channel with other stakeholders using SM, like other software developer or management. The other purpose is Knowledge Management, it is crucial for any organization or software developers to have access to the knowledge and being able to share it with others using SM. Customers are the center of any project, as it is easier to develop any software if developer could get in touch with the customers using SM. Lastly, SM is great productivity tool, as it helps employees to manage their formal and informal affairs. Further details are mentioned in Table 3.

RQ3:   What are the limitations of SM for SD?

According to the collected research papers, main limitation for SM usage for SD is having lack of knowledge about SM. Most authors indicate that there is a gap of knowledge to be filled in order to have best use of SM for SD. Another limitation of SM for SD is distractions while using SM as mentioned in Table 4. Employee might get too involved with informal issues and entertainment rather than only focusing on the given tasks. Some authors note that privacy issues and intellectual property issues are worth considering while using SM for SD, as SM usage might end up harming the SD rather than assisting.

Additional Data Collected: The findings show that 69% of all collected research papers used Empirical Studies as a research methodology. Theoretical Study

and Literature Review methodologies were 17% and 14% respectively.

TABLE 3: REFERENCES FOR PURPOSES OF USING SM ACCORDING TO THE SELECTED YEARS				
Year	KM	C	CRM	PT
2009	[7]	[7]	-	-
2010	-	[4, 22, 23]	[4, 31]	[2, 23, 31]
2011	-	-	[1]	0
2012	[8-10]	[8-10]	-	[9]
2013	[11, 12]	[12, 24,25]	[24, 32]	[11,32,33]
2015	[13]	-	-	-
2016	-	[26, 27]	[26]	-
2017	[5, 14, 16]	[14, 16, 28]	-	[14, 28]
2018	[16-20]	[17, 20, 29, 30]	-	[16, 18]
2019	[21]	[21]	-	[21, 34]

Note:
KM = Knowledge Management
C = Collaborations
CRM = Customer Relationship Management
PT = Productivity Tools

According to the data collected, out of 31 studies the highest number of studies were conducted in UK, followed by USA, Denmark and India. Other papers were based on Canada, New Zealand, Malaysia and others as shown in Fig.1.
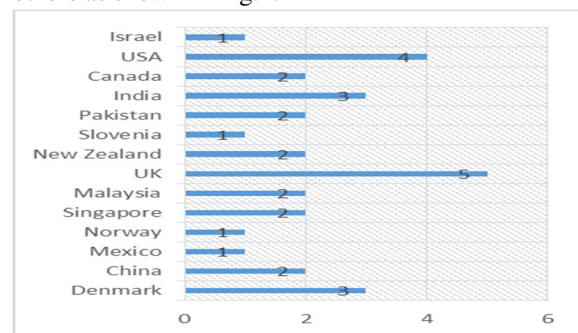

FIG. 1: COUNTRY OF ORIGINS

When it come to the type of publications used for the papers Journal papers got the top ranking followed by Conference and Workshop papers as shown in Fig. 2.

As in Fig.3,   most of   the authors,   42%,   used

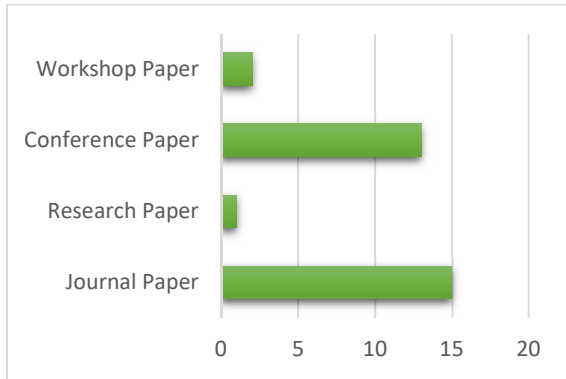| TABLE 4. REFERENCES FOR LIMITATIONS OF USING SM ACCORDING TO THE SELECTED YEARS							
	2009	2010	2013	2016	2017	2018	2019
Lack of knowledge of SM	-	-	[12,33]	[26]	[16]	[29-30]	[34]
Privacy issues	-	[4,31]	-	-	-	-	-
Intellectual Property	[7]	-	-	-	-	-	-
Distractions	-	[4]	-	-	[28]	-	[21]

FIG. 2: TYPE OF PUBLICATIONS

quantitative data analysis for their research papers, some of the papers did not reveal about the data analysis methods. Qualitative analysis used was only 10% out of all the papers. Others used mixed method of data analysis, both quantitative and qualitative analysis were used.
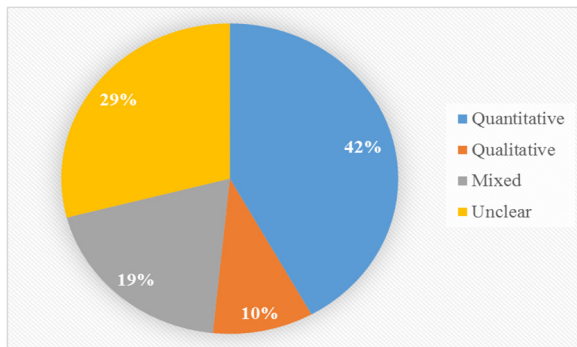

FIG. 3. DATA ANALYSIS USED

Table 5 entails the additional information retrieved during the data analysis. From this information we can conclude that most of the study settings were Industry settings, the rest were academic settings, and some of the papers did not mention the type of settings used. When it comes to data collection, most of the authors used Questionnaire or Archival technique to retrieve the data needed. Additionally, to collect data authors used Interviews, Observations and Experiments.

4. DISCUSSIONS

In this section, answers to the research questions are discussed.

RQ1:   How many papers are there on SM using for SD?

During the review process, 31 studies were analyzed. Based on our inclusion and exclusion criteria, which covered papers written from 2009 until 2019, most of the studies were published in the year 2013 and 2018. Out of which, 31 studies were selected for the literature review. This number includes Empirical Studies, theoretical Studies and Literature Reviews as shown in Fig.4. Authors excluded keynotes, lab reports, presentations and tutorial summaries. Additionally, studies published in different languages (other than English) and not related SM or SD were also excluded.
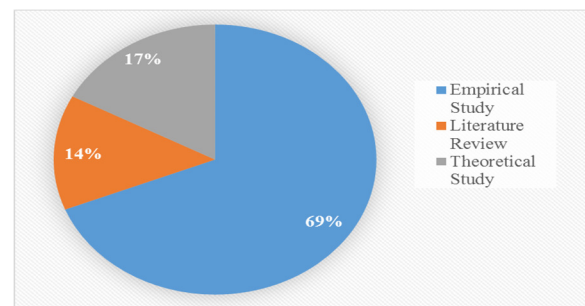

FIG. 4. METHODS USED IN THE ACCEPTED STUDIES

RQ2:   What are the purposes of using SM for SD?

Knowledge Management: Effective knowledge exchange among software developers is crucial in competitive market of SD and SM. It is seen extremely important for the developer resource because this provides updated documentation and high-quality answers as well as dialogue opportunities.

Collaboration: SM is also a critical factor in collaborative development, especially when designing large scale modern software systems that have to meet the needs of a diverse group of users and stakeholders.

No.	Author	Method	Data Analysis	Study Setting	Data Collection
TABLE 5. ADDITIONAL DATA REGARDING TO THE COLLECTED PAPERS					

No.	Author	Method	Data Analysis	Study Setting	Data Collection
1.	Sarka and Ipsen [35]	Literature Review	Quantitative	Academic	Archival
2.	Zhang et. al. [26]	Empirical Study		Industry	
3.	Juárez-Ramírez et. al. [11]		Unclear	Academic	
4.	Andersen and Mørch [32]		Mixed	Industry	Interview and Questionnaire
5.	Giuffrida and Dittrich [12]	Literature Review	Mixed	Industry	Archival
6.	Cheliotis [7]	Literature Review	Unclear	Academic	Archival
7.	Wong et. al. [8]	Empirical Study	Unclear	Academic	Experiment
8.	Brooker [34]			Industry	Observation
9.	Chen et. al. [21]		Quantitative	Industry	Questionnaire
10.	Yasir et. al. [17]				
11.	Rainer & Williams [29]				
12.	Sharma et. al. [30]				
13.	Forsgren and Byström [28]				Interviews
14.	Trkman and Trkman [18]		Mixed		Questionnaire and Interviews
15.	Mughal et. al. [19]				Experiment and Questionnaire
16.	Mushtaq et. al. [20]	Theoretical Study	Unclear	Academic	Archival
17.	Mukherjee and Natrajan[14]	Empirical Study	Quantitative	Academic	Experiment
18.	Sagar and Saha [15]			Industry	Questionnaire
19.	Sarka and Ipsen [16]	Literature Review	Quantitative	Unclear	Archival
20.	Storey et. al. [27]	Empirical Study		Industry	Questionnaire
21.	Wu et. al. [13]			Unclear	
22.	van Osch and Coursaris [24]	Theoretical Study	Unclear	Academic	Archival
23.	Correa and Sureka [25]	Empirical Study	Mixed	Industry	Questionnaire
24.	Black et. al. [22]				Questionnaire, Interview
25.	Black et. al. [23]		Qualitative		Observation
26.	Storey et. al. [4]	Theoretical Study	Quantitative	Academic	Archival
27.	Bajic et. al. [1]	Empirical Study	Mixed	Industry	Questionnaire and Interviews
28.	Adetola et. al. [33]	Theoretical Study	Unclear		Observation
29.	Begel et. al. [31]	Theoretical Study		Academic	Archival
30.	Dabbish et. al. [9]	Empirical Study	Qualitative	Industry	Interviews
31.	Zagalsky et. al. [10]				Experiment

Customer Relationship Management: Customer is the main asset of many companies, whose input has to be leveraged, allowing continual learning and improvement of SD. And SM is best way of reaching out to the customers.

Productivity Tools: Social media help influences individual and team performance by giving employees tools to improve in formal and informal SD environment.

RQ3:   What are the limitations of SM for SD?

Lack of knowledge of SM: Limited knowledge exists about use of SM for developers, due to lack of experience regarding SM. As well as pace and aims of information sharing, un-optimized functionality, caused inconsistencies in use and adoption. Companies do not yet fully understand it
how to effectively take advantage of it for improving product innovation process.

Privacy Issues: Privacy and security, as well as its influence on productivity and product quality is concern for SD organizations.

Intellectual Property: The risk of duplication of the intellectual property as well as recreating different versions of the same item in order to abuse intellectual property.

Distractions: Employees who are utilizing SM, sometimes can be distracted by personal use and interests. Employees immerse in using social media for fun but overlook work-related purposes.

5. STUDY LIMITATIONS AND FUTURE WORKS

Regarding to the limitations of this study, even though thorough search has been conducted, due to increasing number of studies in Software Engineering and papers having very similar areas, it cannot be claimed to have obtained all the research articles in this field of study. Also, there might be other papers which are not available through open access.

The future work might include other communication and collaboration ways that can simplify the collaborative development process. Especially, Web 3.0 features would be an unexplored topic. Social media is constantly developing, and therefore researchers struggles to keep up with its progress. There should be a new framework to make it easier for researchers to review any given topic.

6. CONCLUSIONS

In this paper, authors targeted to deliver a comprehensive overview of papers focused on to improve SD via SM. Besides, purpose was to determine use of SM for SD and limitations to assist future research agendas.

Kitchenham and Charters guidelines were followed for the Research Methodology. Firstly, papers were searched using search strings. Next papers were selected according to the inclusion and exclusion criteria, followed by the selection process, where title of the paper, name of the author, methods used were extracted. Lastly, authors looked for the answers to research questions from the selected papers.

Based on this review, there are number of motivating factors of choosing SM for SD as an organizational tool. It is a collaboration tool between the organization and the customers. Usage of SM positively affects the organizations as easier and cheaper communication is carried out through this channel. Another positive outcome of using SM is knowledge management. Social media is fastest way of getting latest information needed for growth of the company. Lastly, it is also suitable as a tool which enhances productivity and customer relationship management, which has huge positive impact for the improvement of the SD of organizations.

However, studies showed that there might be some factors which discourage use of SM for SD. For example, lack of knowledge is one of the factors. In order to fully adopt SM, firstly the employee must be trained to cope with this tool. Some companies are concerned with SM being a distractive tool because employees may use it for personal reasons rather than professional use during office hours, and others hold back on utilizing SM for SD for intellectual property and privacy related issues as well.

Even though, there are some limitations of using SM for SD, like lack of knowledge, privacy issues or potential distraction of usage, there are still way more benefits of using SM in order to enhance SD, as well as business performance of the organizations.

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