An Analysis of Knowledge Management Challenges in Agile Global Software Development

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Abstract—**Agile global software development is an emerging trend in the software industry despite of the fundamental contradiction between the nature of agile methods and global software development. Agile methods heavily rely on informal communication and coordination mechanisms thus making use of tacit knowledge while in global software development, knowledge is mostly of the explicit nature owing to the formal communication methods. This major difference puts forth some serious challenges to knowledge management in an agile global software environment. This study identifies those challenges through the literature review to lay down the foundation for future research. Seven challenges have been identified as the result of the literature review of the studies between 2014 to 2016 in three databases. The identified challenges have been prioritized based on their frequency of occurrence. Knowledge management is an important aspect of software development and organizations round the globe are focusing on the efficient and effective ways to manage knowledge. It is recommended to address these challenges to pave way for the knowledge management when using agile methods in global software development to achieve better quality software products.**

Index Terms—**Agile; Challenges; Global Software Development; Knowledge Management.**

I. INTRODUCTION

Global Software Development (GSD) is increasing rapidly and the significance of knowledge management (KM) in the software projects is widely accepted in software community [1-7]. Along with the valuable benefits, globally distributed software projects face certain challenges as well due to the distribution of work across different locations; Lack of communication, coordination, distance, different time zones, and cultural differences being the most vital ones [1, 3, 4]. Agile software development is well recognized in the software industry to develop different kinds of software systems [8]. The literature reveals that the topic of agility is drawing attention in the global software companies [7]. Hanssen et al., in the year 2011, state that contrary to the belief that agile principles and GSD oppose each other, Agile Global Software Development (AGSD) is becoming more and more acceptable due to their motivating benefits, a drift which is visible from the rise in the research on GSD and agile [7]. Due to this, there are clear indications of "globalization" and "agilization" of software companies as the established tendencies of future [7]. They further stress upon the strong need of research on certain problems caused by the globalization of work on the agile principles [7]. One such challenge in this regard is the knowledge management in the agile global software development due to the fundamental differences between agile methods and global software development [4, 7, 9]. Literature reveals that in agile distributed projects, management of knowledge becomes difficult, reason being the deficiency of face-to-face communication, which also results in the lack of coordination and collaboration, thus affecting the efficiency and effectiveness of the software development [10, 11, 12].

Knowledge management is "a method that simplifies the process of sharing, distributing, creating, capturing, and understanding of a company's knowledge" [13, 14]. It is the fundamental aspect to deliver the product with right features and the desired level of quality [4, 9, 15]. Literature indicates that sharing knowledge between teams improves their effectiveness and helps them to prevent pricey misinterpretations [4, 9]. Also, uninterrupted development can be achieved if team members perform each other's tasks in high workloads in a way that all resources can be utilized on high priority tasks [4]. Tiwana indicates that better integration of domain and technical knowledge results in increased efficiency and effectiveness of software development process [16]. Kavitha and Ahmed state that effective sharing and transfer of knowledge improves the overall productivity [17].

There are number of knowledge management practices available in the literature but when these knowledge management practices are applied in the agile distributed projects, the challenges put forward by the distribution of work affect the ability to access, share and manage knowledge [4, 18]. This paper identifies and lists down the challenges related to knowledge management in the agile global software development based on the literature review. The rest of the paper is organized as follows. The Section II contains the related work that forms the basis of this research. Section III outlines the research methodology adopted for this research. Sections IV presents the results of the literature review in the form of the list of challenges. Section V contains the discussion followed by the Section VI, which is the conclusion.

II. RELATED WORKS

Knowledge management is fundamental for the success of any software project and the vitality increases in globally distributed projects because the team members are dispersed by time and space [6, 19]. In 2015, Mohammad et al. discovered that Software companies were managing knowledge in different ways to improve development team's performance and to achieve their objectives [6]. In the same year, Diebold et al., revealed that agile methods are often tailored to the context-specific requirements [8]. These customizations established changes in the agile practices [8,

20]. According to Diebold et al. the influence of such individual practices was not well known, which was critical to rationalize organizational changes [8]. Thus, they stressed upon the immense need to identify the challenges, practices to address those challenges, their context of use and their effects on the development [8]. Chau and Maurer stated in their study that agile teams incorporated different practices to share and manage knowledge but these practices were only effective in collocated teams and they did not assist knowledge sharing in global agile teams [21]. Desouza et al. also advocated that there was the need for new methods and models to address the challenges and to manage knowledge with the increase in global software development [22]. Sharma et al. explored in 2015 that strong collaboration and continuous communication between the stakeholders was the fundamental need of agile methods [23]. On the other hand, the distance separated the team members of global software development team, thus limiting the communication and coordination to the tools only [23]. Thus, it became hard to apply agile methods in global software development and required significant efforts to successfully get the job done [23]. They further found out that knowledge management was one of the most critical challenges in an agile global software development setting [23]. Niazi et al. in 2016 considered 'lack of knowledge management and transfer among teams' as the second most substantial challenge faced by project managers in GSD projects [24]. They observed that this challenge led to the low-quality software development, bad documentation and resulted in lack of team knowledge as well [24]. In 2014, Scheerer and Kude pointed out coordination among different levels in an organization as an important knowledge intensive task during the development of software [25]. They identified that the vital aspects of agile like tacit knowledge and informal communications were obstructed in large scale or distributed environment [25]. Mohammad et al. in 2014 explained that the practices used by agile teams to share and manage knowledge depended upon heavy communication, which was not present in the global software development so those practices did not provide an efficient knowledge sharing and management mechanism [26]. In 2016, Haig-Smith and Tanner concluded that the contradiction of agile and global software development led to KM challenges and thus, there was a need to modify the existing practices to achieve the best results [27]. Razzak and Smite, in their study in 2015, also pointed out that blend of agile and global software development led to new challenges for knowledge management [6]. Therefore, it is essential for the AGSD companies to adopt effective KM strategies for quality software development.

III. RESEARCH METHODOLOGY

Literature review has been used as the research method to identify the Knowledge Management challenges in Agile Global Software Development. The research questions (RQ) for this study are as follows:

RQ1: What are the challenges to manage knowledge when agile methods are used in global software development?

RQ2: How to prioritize the elicited challenges based on their criticality?

The databases/search engines used for the literature review included IEEExplore, SpringerLink and Google Scholar.

Since the primary purpose of this research is to identify the current key research areas for the future research so the duration of the literature search was selected from 2014 to 2016 to only obtain the recent challenges pointed out in the literature. The study inclusion criterion was that "the article discusses or highlights one or more challenges of knowledge management in the agile global software development". The study exclusion criterion was that "the study does not highlight or does not discuss any challenge in the context of agile global software development". There were two phases in the study selection process. In the first phase, titles and abstracts were reviewed in the light of study inclusion criterion. Then, the same criterion was applied on the full text of the selected papers from phase 1. The final count of the selected studies was 22 papers. The results from the selected studies are presented in the next section.

IV. RESULTS

This section lists down the results of this study. To answer RQ1, the challenges found from the selected studies, which are faced by the globally distributed teams to manage knowledge while using agile methods, are presented in Table 1. The challenges are mentioned with respect to the study reference number which highlighted or discussed the respective challenge. A total of seven challenges have been identified.

The frequency of occurrence of each challenge in the selected studies along with their percentage of occurrence is provided in Table 2. The references of the studies which mentioned a certain challenge are also provided along with the challenge title for easy traceability. The challenges have been presented in a prioritized manner based on their frequency of occurrence to answer RQ2.

V. DISCUSSION

It is apparent from the results that the challenges of "Knowledge Sharing"; "Managing and Storing Knowledge"; "Knowledge Transfer" and "Tacit Knowledge Management" are the most critical challenges according to the literature. Therefore, it is vital to discover practices and strategies to address these challenges of knowledge management in agile global software development. Though the challenges of "Knowledge creation", "Lack of Documentation and "No Common Universal Language" possess less value in our results, yet these cannot be neglected as well specially the "Knowledge creation" and "Lack of Documentation" challenges. In the future, it will be beneficial to investigate the existing practices from the literature to map them against the listed challenges to help the practitioners. Furthermore, it will be interesting to come up with new specialized strategies in the given context to address the identified challenges. The verification and validation of the applicability of the practices is also an important aspect.

Table 1
List of Challenges w.r.t. Studies References

Challenges	Paper # Reference #	1 [31]	2 [23]	3 [24]	4 [29]	5 [25]	6 [30]	7 [26]	8 [32]	9 [33]	10 [34]	11 [35]
Knowledge Sharing			☑		☑			☑	☑			☑
Managing Knowledge (includes Storage)		☑	☑	☑	☑		☑	☑	☑			
Knowledge Transfer			☑	☑			☑		☑		☑	
Tacit Knowledge Management (includes codification, loss of knowledge)						☑	☑	☑				☑
Knowledge Creation/ Building												☑
Lack of Documentation							☑	☑		☑		
No common universal language			☑					☑				
Knowledge Sharing		☑			☑		☑	☑	☑	☑	☑	☑
Managing Knowledge (includes Storage)			☑	☑	☑							
Knowledge Transfer				☑	☑	☑	☑					
Tacit Knowledge Management (includes codification, loss of knowledge)				☑			☑	☑				
Knowledge Creation/ Building								☑	☑		☑	☑
Lack of Documentation							☑					
No common universal language												

Table 2
Challenges w.r.t their frequency of Occurrence and Percentages

C#	Challenge	Frequency (Out of 22)	Percentage
C1	Knowledge Sharing [5] [6] [18] [23] [26] [28] [29] [32] [35] [39] [40] [41] [42]	13	60%
C2	Managing Knowledge (includes Storage) [23] [24] [26] [29] [30] [31] [32] [36] [37] [38]	10	46%
C3	Knowledge Transfer [6] [23] [24] [30] [32] [34] [37] [38] [39]	9	41%
C4	Tacit Knowledge Management (includes codification, loss of knowledge) [5] [6] [25] [26] [30] [35] [37]	7	32%
C5	Knowledge Creation/ Building [5] [35] [40] [41] [42]	5	23%
C6	Lack of Documentation [6] [26] [30] [33]	4	18%
C7	No common universal language [23] [26]	2	9%

VI. CONCLUSION

Knowledge is the backbone of software development and this knowledge is usually residing within the team members. The challenges of communication, coordination and control faced by globally distributed teams lead to the increased problems of knowledge management. When agile methods are incorporated in the GSD settings, the problems of managing knowledge get even worse because of the fundamental contradictions of agile methods and GSD. This blend has introduced new challenges in a new way where the existing strategies are not as workable as they used to be in the traditional settings. Inefficient and ineffective knowledge management may lead to the failed projects. Therefore, it is critical to focus on this aspect. The identified challenges must be addressed and there is a strong need of devising efficient and effective strategies for successful knowledge management, which may lead to more successful software development along with many other benefits.

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