UNIVERSIDADE FEDERAL DE CAMPINA GRANDE
CENTRO DE ENGENHARIA ELÉTRICA E INFORMÁTICA
UNIDADE ACADÊMICA DE SISTEMAS E COMPUTAÇÃO
CURSO DE BACHARELADO EM CIÊNCIA DA COMPUTAÇÃO

ANDERSON DALBERT CARVALHO VITAL

CHALLENGES IN THE USE OF SCRUM IN GLOBAL SOFTWARE ENGINEERING AND HOW TO FACE THEM

CAMPINA GRANDE - PB

2020

ANDERSON DALBERT CARVALHO VITAL

CHALLENGES IN THE USE OF SCRUM IN GLOBAL SOFTWARE ENGINEERING AND HOW TO FACE THEM

Trabalho de Conclusão Curso apresentado ao Curso Bacharelado em Ciência da Computação do Centro de Engenharia Elétrica e Informática da Universidade Federal de Campina Grande, como requisito parcial para obtenção do título de Bacharel em Ciência da Computação.

Orientador: Professor Dr. José Antão Beltrão Moura .

CAMPINA GRANDE - PB

2020

V836c Vital, Anderson Dalbert Carvalho.
Challenges in the use of Scrum in Global Software Engineering and how to face them. / Anderson Dalbert Carvalho Vital. – 2020.

13 f.

Orientador: Prof. Dr. José Antão Beltrão Moura.
Trabalho de Conclusão de Curso - Artigo (Curso de Bacharelado em Ciência da Computação) - Universidade Federal de Campina Grande; Centro de Engenharia Elétrica e Informática.

1. Scrum. 2. Metodologia Scrum. 3. Desenvolvimento ágil de software. 4. Global Software Engineering. 5. Desenvolvimento de software. I. Moura, José Antão Beltrão. II. Título.

CDU:004.41(045)

Elaboração da Ficha Catalográfica:

Johnny Rodrigues Barbosa
Bibliotecário-Documentalista
CRB-15/626

ANDERSON DALBERT CARVALHO VITAL

CHALLENGES IN THE USE OF SCRUM IN GLOBAL SOFTWARE ENGINEERING AND HOW TO FACE THEM

Trabalho de Conclusão Curso apresentado ao Curso Bacharelado em Ciência da Computação do Centro de Engenharia Elétrica e Informática da Universidade Federal de Campina Grande, como requisito parcial para obtenção do título de Bacharel em Ciência da Computação.

BANCA EXAMINADORA:

Professor Dr. José Antão Beltrão Moura
Orientador – UASC/CEEI/UFCG

Professora Dra. Francilene Procópio Garcia
Examinadora – UASC/CEEI/UFCG

Professor Dr. Tiago Lima Massoni
Professor da Disciplina TCC – UASC/CEEI/UFCG

Trabalho aprovado em: 2020.

CAMPINA GRANDE - PB

Challenges in the Use of Scrum in Global Software Engineering and How to Face Them

Anderson Vital, Antão Moura

November 18, 2020

Abstract

Scrum is the most used Agile methodology in the world. At the same time, enterprises are strongly adopting remote work encouraged by the benefits provided by Global Software Engineering (GSE) and by isolation needed after Covid-19 pandemics. However, it is known that the Scrum methodology is usually applied in small and colocated teams to keep things agile, and distributed projects lack this characteristic, which can lead to problems. Therefore, the objective of this work is to identify the main bottlenecks of using Scrum in GSE and ways to mitigate these problems, through a Systematic Literature Review focusing on summarizing the main challenges and solutions mapped by other Systematic Literature Reviews on this topic from 2013 to 2020. Results summarize major challenges faced by Scrum projects in GSE environments and suggest how to face them according to the literature. Then, we discuss the relation between the core topics concluding that the findings do not suggest a threat to the use of Scrum in GSE.

1 Introduction

The world has been seeing an increasing use of Agile methodologies in recent years. Since the Agile Manifesto [1] was published in 2001, the guidelines proposed in its declaration have conquered all the world.

Many Agile methodologies have taken along with this trend. A report published in 2017 affirms that 86% of respondents had at least some distributed teams practicing Agile [2]. Among them, Scrum is the most adopted methodology, since a 2020 report shows that 75% of Agile practitioners use Scrum or hybrid that includes Scrum [3].

This methodology, proposed by Ken Schwabber and Jeff Sutherland, was born in the universe of Software Development and is still very relevant today, where the Scrum Guide [4] serves as the core reference of Scrum guidelines and practices.

At the same time, another wave is growing in size and expressivity in the software industry: Global Software Engineering (GSE), which is also referred to by "development" instead of "engineering" or by more generalistic words such

as “distributed” instead of ”global”, because it refers to the development of software driven by remote teams that can be spread across different regions, whether it be at the same country or at different continents [5].

The use of GSE gives a lot of benefits, such as follow-the-sun development, access to a wider pool of talents and lower production costs [6]. It also adds new difficulties in comparison to colocated projects, as Ghani [7] says, since distributed Agile development introduces distances which create barriers to developing a strong awareness of others.

The cross relationships between the use of Agile and Scrum in the context of GSE is the matter of study in dozens of papers. According to Lous [8], these two trends seemingly create a contradiction because, in one side, GSE requires a number of rules and formalisms to coordinate the different teams that (can be) spread across the globe, while Agile software development is driven by instant collaboration and direct communication.

Therefore, the goal of this study is to identify the main challenges faced by Scrum in Global Software Development projects, answering the Research Question (RQ) “What are the main challenges (and respective solutions) proposed in literature about using Scrum in GSE projects?”. We accomplish that through a Systematic Literature Review where we have summarized the findings in an article designed in a way to provide an easy reading, focusing on the core challenges and respective solutions according to different authors and perspectives.

In section two, we will describe in more details the methodology used in this research. In section three, we will show the results of this work, which includes challenges and proposed solutions found in literature. In section four, we will discuss the findings in a critical way. Finally, in section five, the conclusion and ideas for additional work will be presented.

2 Methodology

To answer the RQ, we have conducted a Systematic Literature Review (SLR) based on Kitchenham and Charters [9] approach to conduct SLR in the Software Engineering field.

We have applied a snowballing - both backwards and forwards - search procedure to find relevant articles, following the guidelines suggested by Wohlin [10] on performing snowballing procedures in SLR studies in the Software Engineering field. The initial set of papers was selected manually based on a search through Google Scholar to find a starting set that avoids bias in favour of any specific publisher [10], using search terms linked to the research question and its synonyms and publications from different years and authors. Three papers were manually selected as the initial set.

We have selected only SLRs as a way to gather a large amount of information and provide an overview of the topics involved, therefore, primary studies

Table 1: Papers included in initial set

Reference	Title	Year of publication
1	Challenges in Distributed Agile Software Development Environment: A Systematic Literature Review	2019
2	Diminution of Issues and Challenges when Using Scrum in Global Software Engineering	2016
3	Is Scrum fit for global software engineering?	2017

are not directly included. The articles must have been fully available online in the moment of search and published in English language journals.

According to Ghani [7], GSE projects live a new fasis starting from 2013 because many of the problems faced before are already solved [7]. So, the results of this study will only consider articles published between 2013 and 2020, although the studies considered may include references to papers dated before this range. We also have excluded articles that 1) do not focus on Scrum or Agile methodologies or 2) do not focus on GSE projects or 3) do not present a cross-relationship between both previous topics.

In the procedure of deciding which papers should be included or excluded, we first have analysed the titles, then abstracts and if necessary studied the entire publications before moving on to snowballing. By the end of the search we have ended up with a set of five articles, which were used as the source of true to the conduction of the present study. Then, we have extracted and summarized the data found and presented it in the following section.

3 Results

The results show that there is a lot of information about the challenges faced when using Scrum and Agile in GSE projects. Many of the challenges are specific to scaling Scrum processes but others can be applied to all sizes of remote teams.

Some of the studies analysed focus on more general challenges, while others emphasizes more specific issues. The diversity of focus in each paper helps this study at providing a comprehensive overview of the area of study.

The main challenges to Agile in GSE, according to Ghani [7], are control, collaboration, cooperation, coordination and communication (the five C's), caused by physical, temporal, socio-cultural and knowledge distances. Among these challenges, the main challenge is communication [7].

Usman [6] considers three of these categories also mentioned in Ghani's research as being the most relevant to Scrum challenges faced in GSE. Table 3 summarizes the challenges we find most critical in this study.

Table 2: Challenges groups and respective solutions according to Ghani [7]

Challenge category	Solutions
Communication	- structured approach to waste identification and mitigation; - use of a "feature tree" to improve the communication of changes in requirements throughout the software development process;
Others (control, collaboration, cooperation, coordination)	- use of additional frameworks.

Lous [8] gathered information about challenges in Scrum core processes. There are four general challenges related to the use of Scrum in GSE projects, which are scaling Scrum, knowledge management, communication and coaching [8]. Table 4 presents an overview of the main challenges summarized by Scrum core processes, according to Lous [8].

Alzoubi [11] research focused on communication issues, which Ghani [7] then confirmed as being the most challenging category of problems. The most relevant challenges and solutions have been summarized in Table 5.

Analysing this topic from a different point of view, Alsahli [12] not only points the challenges but also shows that Scrum core practices are by themselves a good way to mitigate the problems faced by people in GSE projects. These results mention that, among other things, Daily Standup, Sprint Review and requirements in Backlog help in mitigating the communication issues [12]. Moreover, Sprint Planning and Retrospective meetings help in reduce the coordination issues [12].

4 Discussion

The results show that the number of studies found using the approach specified in this paper methodology were not very large, with only five papers being used as reference to the results. The reduced number of papers may be due to only including SLR studies or even to the choosen inital set of papers.

The small number of papers made possible to provide an individual analysis to the different perspectives taken by each study, providing a general and rich overview. Even though the overall number of studies analysed is small, together they reference lots of challenges and solutions described in each study's references, which indirectly have included dozens of primary studies.

About the challenges summarized, Ghani [7] emphasizes how communication is a relevant problem in GSE environments. This can be attributed to reduced face-to-face interaction, described by Alzoubi [11].

Back in 2001, the Agile Manifesto [1] had already statified the need for individuals interaction over tools and processes. Now, in the context of GSE, we

Table 3: Challenges and solutions identified by Usman [6] [7]

Challenge category	Major challenges	Solutions
Communication	- Reduced opportunities for synchronous communication and face to face meetings - Frequency - Cultural misunderstandings	- Synchronized work hours - ICT-mediated synchronous communication - ICT-mediated asynchronous communication - Visits - Frequent (or Improved) communication
Coordination	- Reduced informal contact can lead to lack of critical task awareness - Inconsistent work practices - Reduced cooperation arising from misunderstanding - Team members are less likely to perceive themselves as the part of the team	- Iteration (cyclical repetition allow multiple incremental opportunities to observe progress and resolve issues) - Planning (establish the scope of work, resourcing, scheduling, and the processes to be employed)
Control	- Delays in artefacts - Difficulties to convey vision and strategy - Different perceptions of authority can undermine morale - Adaptation of management to local regulations - Continuous integration - Create and prioritize the backlog	- Review (formal or informal activities that consider prior activities, assessment of completed work, and the opportunity for stakeholders to provide feedback to the teams)

can see that as the results shows, the communication by itself highly depend upon tools, so it is important to choose the ones that best suits the needs for each team's situation.

It is relevant to mention that as Hossain [13] have explained, Scrum is a flexible Agile methodology that offers an opportunity to project stakeholders to tailor and modify certain Scrum practices according to their needs.

So, if by one side Ghani [7] suggests in its more general research that to mitigate the "5C's" of challenges in Agile additional frameworks should be used, Alsahli [12] on the other hand explains that the core practices of Scrum helps in mitigating a lot of challenges faced in GSE. Usman [6] also points up in details practices implemented by Scrum as a way to mitigate issues.

The practices used to mitigate the challenges faced by Scrum in GSE gathered in this study does not seem to modify Scrum core ceremonies, roles, rules or artifacts described in the Scrum Guide [4]. Actually, the results show that Scrum helps in solving many of the issues faced in GSE [12].

Table 4: Challenges and respective solutions in Scrum processes according to Lous [8]

Process affected	Major challenges	Solutions
Ceremonies	- organizing and holding meetings; - fixing processes.	- improved organization of meetings; - implementing higher levels of integration of the management (e.g. Scrum-of-Scrums or complex Agile frameworks).
Artifacts	- shared management; - technical debt as part of the evolution; - awareness; - misunderstood requirements across sites.	- individual, role- or team-specific backlogs or (at the opposite) using a shared backlog only; - use of a global Scrum board.
Roles	- shared knowledge management; - defining/scaling the role of the Product Owner in large setups; - lack of political power in technical management and Scrum Master roles; - no shielding from Scrum Master on last minute changes.	- refining roles by defining proxies agents; - fostering collaborative development practices (e.g., "virtual" pair programming, code buddies); - implementing trust- and team-building measures (e.g. improved communication, visits, annual gatherings, team member rotation); - Scrum Master should be a strong negotiator; - Product Owner could use extensive follow-up questions to spot communication misunderstandings (e.g. about requirements).

It is also important to contextualize these findings in our new reality post-pandemics. GSE should gain further interest spurred by the spread of remote working prompted by the Covid-19. The world's lockdown forced employees to go back to their home city, and companies that did not worked with distributed development before needed to adapt to this new reality. We shall be seeing even more articles about this matter and watch possible new challenges described in literature in the next years.

5 Conclusions

The trending application of Agile in the Global Software Engineering field adds new challenges to the use of Scrum, that usually was applied in small and colocated projects. To help in identifying and solving these challenges, a macro visualization of this picture based on well structured academic studies was needed.

We have conducted this study upon published Systematic Literature Reviews from the last seven years to show what are the current main challenges

to the use of Agile, focusing on Scrum, that shall be taken into account in distributed environments of software development.

Then, we have gathered possible solutions related to these problems, which led to the conclusion that the solutions described in literature do not offer a threat to the validity of Scrum, but an opportunity to adapt it by extending its processes with new sets of practices or even complete frameworks. Also, we saw that Scrum practices by themselves help in mitigating GSE problems.

We hope that this study serves as a contribution to enterprises that are starting to adopt Scrum in GSE projects or which have already adopted it but are feeling difficulties and want to do better, identifying problems and testing solutions already mapped in literature to improve their processes. We also hope that it serves as an overview to academics or anyone who wants to learn more about this specific topic briefly.

This study purposefully presents the topics in a general overview, so ideas for future work could include to extend the present findings using a survey to verify if these challenges and solutions match reality faced in industry. Another possibility could be developing a complementary study describing the challenges and overcomes found in more details, in the form of a guide to Scrum in the context of GSE projects.

Table 5: Communication challenges and respective solutions mapped by issue category according to Alzoubi [11]

Category of issues	**Major challenges**	**Solutions**
People differences	- less mutual understanding (possibly related to language); - confusion among the team; - work diversity; - different interpretations to the negative and sensitive issues of the project; - longer time for information and knowledge sharing.	- stimulate communication; - synchronizing working hours and distributing work within same time-zone; - build trust and shared understanding through exchanging visits; - increasing the communication formality by using documentation (e.g. architectural designs and project plans).

Continued on next page

Table 5 – continued from previous page

Category of issues	Major challenges	Solutions
Distance differences	- delayed feedback on work products; - miscommunication between teams or team's members; - limited communication and coordination between teams or team's members.	- synchronize work hours and create local teams among same time-zone; - reduce the number of distributed project meetings; - use asynchronous, project management and backlog management tools and use tracking systems; - enhance regular visits and face-to-face communication; - split the project into small parts;
Team	- slow communication speed; - mismatching in processes, practices, values and attitudes; - less collaboration.	- promote training in communication tools; - create communication protocols; - promote informal interactions; - apply Agile practices; - start a new project with face-to-face meeting with all teams; - encourage collective and individual responsibilities using a monitoring system; - promote mutual trust; - rotate the staff between different roles of Agile project on a regular basis.
Technology	- unsuitable tools used by team; - technical incompatibilities across sites; - unreliable tools with poor transmission; - conflicts on the preferred technology; - incompatibility of artifacts;	- offering different communication tools; - promoting group chat; - use communication models; - using communication technologies assessment tool (CTAT).
Architectural	- knowledge sharing and communication; - misunderstanding; - unnecessary flow of communication due to the insufficient definition of system/software structure.	- increasing the trust among distributed members; - increasing the transparency; - increasing common interest such as project and team goals; - providing organizational chart to all teams and members;

Continued on next page

Table 5 – continued from previous page

Category of issues	Major challenges	Solutions
Process	- unclear responsibilities; - confusion among Agile GSD teams; - less team spirit; - less goals sharing and technical knowledge; - unnecessary communication. - no match between difference processes; - communication opportunities between team members;	- frequent face-to-face communication; - coordination to discuss the strategic elements; - overall strategy and local processes; - documentation and standards for the common design and goals; - monitoring project's teams and members.
Customer communication	- lack of customers' involvement.	- enhance the rapid communication; - promote regular Agile meeting; - customer involvement; - promote the existence of a customer's representative who plays the role of the customer up front.

References

[1] Kent Beck, Mike Beedle, Arie Van Bennekum, Alistair Cockburn, Ward Cunningham, Martin Fowler, James Grenning, Jim Highsmith, Andrew Hunt, Ron Jeffries, et al. The agile manifesto, 2001.

[2] Scrum Alliance. The state of scrum report 2017 edition. Technical report, Scrum Alliance, Tech. Rep., 2017.[Online]. Available: https://www ..., 2016.

[3] Version One. 14th annual state of agile report. *Online: http://stateofagile. versionone. com*, 2020.

[4] Ken Schwaber and Jeff Sutherland. The scrum guide (2013). *No. November*, pages 6–17, 2017.

[5] Darja Šmite, Claes Wohlin, Zane Galviņa, and Rafael Prikladnicki. An empirically based terminology and taxonomy for global software engineering. *Empirical Software Engineering*, 19(1):105–153, 2014.

[6] Muhammad Usman, Qamar Abbas, Beebarg Akram, and Junaid Hussain. Diminution of issues and challenges when using scrum in global software engineering. *International Journal of Technology and Research*, 4(2):31–43, 2016.

[7] Imran Ghani, Angelica Lim, Muhammad Hasnain, Israr Ghani, and Muhammad Imran Babar. Challenges in distributed agile software development environment: A systematic literature review. *KSII Transactions on Internet & Information Systems*, 13(9), 2019.

[8] Pernille Lous, Marco Kuhrmann, and Paolo Tell. Is scrum fit for global software engineering? In *2017 IEEE 12th International Conference on Global Software Engineering (ICGSE)*, pages 1–10. IEEE, 2017.

[9] Barbara Kitchenham and Stuart Charters. Guidelines for performing systematic literature reviews in software engineering. 2007.

[10] Claes Wohlin. Guidelines for snowballing in systematic literature studies and a replication in software engineering. In *Proceedings of the 18th international conference on evaluation and assessment in software engineering*, pages 1–10, 2014.

[11] Yehia Ibrahim Alzoubi and Asif Qumer Gill. Agile global software development communication challenges: A systematic review. In *Proceedings-Pacific Asia Conference on Information Systems, PACIS 2014*, 2014.

[12] Abdulaziz Alsahli, Hameed Khan, and Sultan Alyahya. Agile development overcomes gsd challenges: A systematic literature review. *International Journal of Computer Science and Software Engineering*, 6(1):7, 2017.

[13] Emam Hossain, Muhammad Ali Babar, and Hye-young Paik. Using scrum in global software development: a systematic literature review. In *2009 Fourth IEEE International Conference on Global Software Engineering*, pages 175–184. Ieee, 2009.