Received: 30 December 2022 | Revised: 24 April 2023 | Accepted: 8 July 2023

DOI: 10.1002/smr.2600

REVIEW ARTICLE

Journal of Software: Evolution and Process WILEY

Stress, motivation, and performance in global software engineering

Julio Suárez | Aurora Vizcaíno

University of Castilla-La Mancha, Ciudad Real, Spain

Correspondence
Aurora Vizcaíno, University of Castilla-La Mancha, Paseo de la Universidad, 4, Ciudad Real 13071, Spain.
Email: aurora.vizcaino@uclm.es

Funding information
Fondo Europeo de Desarrollo Regional (FEDER), Grant/Award Number: SBPLY/21/180501/000115

Abstract

The objective of this study is to analyze the current perspective as regards knowledge related to what causes stress or motivates developers, how these two aspects are related to each other, and how this in turn affects their performance in the sphere of Global Software Development and how these can be controlled. This paper presents the results obtained after conducting a systematic mapping study of literature in order to analyze how stress, motivation, and performance affect the project members in Global Software Development teams. We carried out a systematic mapping of published studies dealing with stress, motivation, and performance in global software engineering. A total of 118 papers dealing with this subject were found. The literature analyzed provided a relatively significant quantity of data referring to the impact that the characteristics of distributed software development projects have on the performance and productivity of teams, along with the actions taken to improve that performance. However, when focusing on the analysis of the impact of this type of projects on team members' motivation, and on the actions that can be taken to improve that motivation, we discovered that the number of works decreases considerably and that works referring to the impact of this kind of development on developers' stress were virtually non-existent, as were those concerning ways in which to improve that stress. We are, therefore, of the opinion that it is necessary to carry out in-depth research into the aspects of working in distributed teams that may have a negative impact on developers' levels of motivation and stress, along with what could be beneficial in order to improve levels of motivation and decrease levels of stress.

KEYWORDS
global software development, motivation, performance, stress, systematic mapping study

1 | INTRODUCTION

Software development companies' interest in having geographically distributed and separated development teams had already increased in the last decade.[1] This tendency is known as either global software development (GSD) or distributed software development (DSD) according to whether the members of the team are, respectively, located in different countries or in the same one. Both models have various known benefits,

such as cost saving and the reduction in commercialization time[2] thanks to access to a more extensive labour market or development approaches such as "follow the sun."[3,4]

In spite of the benefits of GSD, this model also implies challenges that must be confronted, such as temporal, geographic, and socio-cultural distances,[5–8] aspects that have been widely dealt with since the first days of GSD. Although there is a clear tendency towards developing software in a distributed and global manner,[9,10] the circumstances brought about by the current COVID-19 pandemic have led this tendency to accelerate and become a necessity.[11–13] Therefore, in Šmite et al.[14] define work from home as a particular case of distributed work and, in their paper,[15] describe the social effects of this new trend, indicating that it increases the feeling of isolation, deteriorates social ties and team cohesion, and decreases the interest in collaborative work. The factors that affected well-being and productivity during the pandemic were also analyzed by Russo et al.,[16] who explained, for instance, how anxiety, distractions, or work motivation began to change in that period of time. We are now practically back to normal life, and it is very important to analyze what factors affect the levels of stress, motivation, and performance of developers working in distributed and global environments.

We have been unable to find any other literature reviews tackling this subject in its entirety and consequently consider ours to be the first. It may, therefore, be of assistance as regards attaining an idea of the material available on stress, motivation, and performance in distributed settings.

The concept of stress has numerous definitions, one of which is negative responses to situations or events that the subject may consider to be threatening from a physical or emotional point of view.[17] We may consider that the factors that provoke stress and are out of our control are detrimental to our psychophysical wellbeing.[18] Another more recent definition of the term is that of Sharmilee et al.,[19] which defines work-related stress as the physically harmful emotional interruption that occurs when work does not correspond to the worker's skills, resources, and needs.

The phenomenon of stress varies greatly among different people and depends on different aspects, such as individual vulnerability, resilience, or the work being carried out,[20] and in this respect, both the quantity and difficulty of the work demanded, and employees' capacities to make decisions in order to organize their workload are important. Stress occurs when individuals have to confront distressing situations caused by events or actors over which they have no control.[20]

The impact of stress on workers' production had been widely studied, and various works tackle this problem in the software development sector.[16,21,22] On the other hand, the impact of work-related stress has an important economic cost, since in the 1980s, losses related particularly to human error, absenteeism, and less productivity were estimated as being thousands of million dollars in the United States alone.[23,24] It is possible to state that work-related stress has become one of the most common professional illnesses[19] and it is, therefore, necessary to take various actions in order to not only increase workers' productivity and decrease the costs associated with high levels of stress but also improve employees' wellbeing.[22]

Some of the aspects that most affect work-related stress in the IT sector are an overload of work, ambiguity as regards a person's role at work or interpersonal relationships.[21] Furthermore, Forsgren[25] indicates that remote work leads people to spend more time working since it is difficult to separate their private life from work, and this can increase their feelings of stress and burnout as work is invading their personal space.

As occurs in the case of stress, there are numerous definitions of motivation, although in the sphere of work, that of Khatri[26] is highly appropriate, since it indicates that motivation consists of aligning the specific objectives of a determined person with an organization's objectives. Motivation is increasingly considered to be one of the principal problems in software engineering and is one of the most common causes of failure of projects of this type.[27]

Several theories analyze the concept of motivation from different points of view, of which it is possible to highlight Maslow's hierarchy of needs theory,[28] Herzberg's Two-Factor Theory,[29] McClelland's theory of needs,[30] or Vroom's Expectancy Theory.[31] From a purely work-related point of view, there are theories such as that of equity,[32] which explains the concept of motivation as the intention of making what workers contribute to the company and what it receives from them the same. New definitions of motivation continue to appear,[33–36] although one of the simplest might be as follows: the impulse to do something.[37]

Numerous researchers have studied the impact of motivation on the performance of professionals in the area of software development[38–41] and have found that an improvement to the levels of employees' motivation has repercussions on the quality and quantity of the software developed, and on the workers' commitment to the company. However, despite the fact that numerous studies have analyzed productivity in the software engineering sector, it is still a current topic, and new studies analyzing how to improve productivity measures continue to appear.[42] For instance, Šmite et al.[14] studied how home telework affected productivity during the Covid-19 pandemic. This could be influenced by technical aspects or social aspects, but our work focuses mainly on the social aspects.

The terms productivity and performance often appear together, and according to the book "Rethinking Productivity in Software Engineering" (chapter 4),[43] performance is even broader than productivity or profitability and covers many factors that influence a company's success. Chapter 5 of the same book provides a description of a software development productivity framework in which three dimensions are considered: velocity, quality, and satisfaction. The third captures human factors including fatigue, team comfort, and autonomy. Analyzing the human factors, it is consequently critical to increase satisfaction and, indirectly, performance in software development.

Therefore, given the importance of stress, motivation, and performance for software engineering in general and, mainly, for global software engineering, we have carried out the systematic mapping study shown herein. The objective of a mapping of literature is to find, evaluate, and analyze all those studies that are relevant for determined questions or research topics through the use of a rigorous and auditable methodology. In this work, we have used the guidelines defined in previous reviews,[44–46] which have been adapted to research in the area of software engineering.[47]

This paper has been organized as follows. Section 2 shows related work, while Section 3 provides a description of the method used to carry out the systematic mapping of literature, along with the criteria employed in order to select or discount papers. Section 4 presents the

demographic results of the synthesis of literature obtained. Section 5 shows the results regarding the five research questions. The threats to validity are presented in Section 6, and our conclusions are provided in Section 7.

2 | RELATED WORK

Numerous studies analyze both GSD and its human and social impact on software development or aspects that might influence developers' productivity. The summary of these works, which is shown below, is ordered by date.

In 2006, Holmstrom et al.[7,8] studied the challenges that aspects such as temporal, geographic, and socio-cultural distance pose in GSD projects. Furthermore, Beecham et al.[48] analyzed the impact of motivation on software engineers. The aim of that research was to describe the landscape of that motivates developers, what de-motivates, and how existing models address motivation. This work was updated by Acuña et al.[49]; the authors analyze the impact that the atmosphere of working in a team may have on the quality of the software developed, while Akula and Cusick[50] analyze the impact of an excessive workload and stress on software quality. In their work, Conchúir et al.[51] analyzed the benefits of GSD; the aspect of cultural distance was also studied by Casey.[52]

Canedo and Santos[53] carried out an empirical study in which they analyzed the factors that affect productivity in software development, while Oliveira et al.[54] also analyzed these factors in a similar work. Moreover, Johnson et al.[55] studied the effect that the work environment has on software engineers' satisfaction and productivity.

With regard to a mapping or a systematic literature review, we would like highlight the following:

Steinmacher et al.[56] describe a systematic literature review addressing the topic of awareness in communication, coordination, and cooperation in GSD. In the case of the review by Noll et al.,[57] the focus is on the analyses of barriers and solutions in GSD. Nurdiani et al.[58] conducted a systematic review on GSD literature and gather challenges associated with this kind of projects as well as their mitigation strategies. Anh et al.[59] investigate the importance of effective team coordination in global software projects. The objective of this systematic literature review was to summarize the evidence on the relationship among dispersion, team coordination, and performance in global software projects.

The work of Nguyen-Duc et al.[60] describes a systematic review on dispersion, coordination, and performance in global software teams. These authors found that the dispersion dimensions affect team outcomes and that, for example, geographical dispersion has a negative impact. The authors focus on analyzing how these dimensions principally affect team coordination, but no mention is made of stress or motivation.

In-depth research into the topic of soft skills is also taking place, as occurs in the work by Dubey and Tewary[61] in which the authors describe a systematic review of relevant soft skills in software engineering curricula.

Iriarte and Bayona[62] conducted a systematic literature review of soft skills in IT project success, which showed the importance of the role of project managers in the performance of a project. Massago et al. (2018) through a systematic mapping try to identify the sociocultural aspects that can influence a software production process. The objective of this paper was to propose an approach that classifies aspects in three perspectives: collaboration, people, and external, which allows the project manager to make decisions about the performance of human resources and mitigate problems arising from communication, cooperation, and coordination, generating better results in indicators of productivity, quality, and efficiency of GSD teams.

In the same year Wagner y Ruhe[63] analyzed those works that have dealt with the factors that influence productivity during software development.

With regard to soft skills, Matturro et al.[64] described a systematic mapping of soft skills in software engineering in general, without distinguishing DSD or GSD. Kuutila et al.[65] through a systematic review try to provide an overview of studies related to time pressure in software engineering; specifically, existing definitions, possible causes, and metrics relevant to time pressure were collected in distributed software projects. The authors stated that this is the most frequent cause of unhappiness among developers.

In the selected databases, three of the most important, we have not been able to find a mapping or systematic literature review dealing with motivation, stress, and performance in GSD settings. Because of this, and taking into account that since the pandemic most work is being carried out in a remote manner, this research could be an interesting contribution.

3 | RESEARCH METHOD

This study was carried out following the steps described by Kitchenham[44] and Kitchenham and Charters,[45] which were adapted to our requirements for a systematic mapping study by following the indications of Petersen et al.[47]

The steps followed are shown below:

1. Identify need
2. Formulate research questions

3. Carry out an exhaustive search for published works
4. Evaluate the quality of the works found and record them
5. Classify the data required to respond to the research questions
6. Extract the necessary data from each of the works selected
7. Summarize and synthesize the results
8. Interpret the results and determine their applicability
9. Write a study report

All the steps listed above were followed in this work. The papers were sought using the search engines of three important scientific repositories, and additional references were also obtained on the basis of a review of the bibliographies of the papers selected (snowballing process).

3.1 | Research questions

In order to obtain complete information about the topics that we wished to research, a total of six research questions were defined in this work:

RQ1. According to the literature selected, which factors cause stress in the members of DSD or GSD teams?
RQ2. According to the literature selected, which factors affect the motivation of the members of DSD or GSD teams?
RQ3. According to the literature selected, which factors affect the productivity and performance of the members of DSD or GSD teams?
RQ4. Does the literature selected propose any means to reduce this stress?
RQ5. Does the literature selected propose any means to increase motivation in DSD or GSD?
RQ6. Does the literature selected propose any means to increase productivity and performance in DSD or GSD?

3.2 | Search and selection procedures

The search for the papers was carried out during the month of January 2022, and they were reviewed and selected in February and March of the same year.

The paper containing the data and conclusions of the mapping study was produced in April and May 2022.

3.3 | Search chain

The research questions proposed included the following keywords:

"global software development, stress, fatigue, phobia, tiredness, nervousness, motivation, productivity, and performance," on the basis of which the search string shown below was employed:

keywords (((“productivity” or “stress” or “burnout” or “fatigue” or “anxiety” or “performance” or “nervous” or “fear” or “phobia” or “motivation”) and (“global software development” or “global software engineering” or “gsd” or “gse” or “distributed software development” or “distributed software engineering” or “multi-site software development” or “multisite software engineering” or “remote work”)))

The search was carried out solely for papers published from January of 2006 onwards, since that was the year in which the first international conference on GSD took place. The aforementioned keywords were adapted to each of the search engines employed.

3.4 | Databases used for the search

The search for papers took place in the following databases using the keywords indicated in the previous subsection.

- Scopus
- Web of Science
- ACM digital library

We chose these databases since they are the largest databases in the software engineering field. Currently, SCOPUS is the most representative library, encompassing Web of Science (WOS), the ACM digital library, IEEE, and other related databases. Moreover, in order to ensure that no

important paper was overlooked, a secondary search was also carried out in the references of the papers found during the first search, thus completing the material selected.

3.5 | Selection of papers

The papers required for the systematic mapping study were selected on the basis of the following criteria:

Inclusion criteria:

- Papers that directly answered one of the questions.
- Papers published from 2006 onwards, since this was the year in which the first ICGSE (International Conference on Global Software Engineering) took place.
- Papers that included aspects related to motivation/demotivation, low performance or synonyms.
- Papers referring to GSD workers' satisfaction.
- Papers referring to human or social problems in DSD or GSD teams.
- When two similar papers written by the same author(s) were found, the most complete was chosen.

Exclusion criteria:

- Books, presentations, or non-academic works.
- Papers not dealing with DSD or GSD.
- Opinion or point-of-view papers.
- Repeated papers.

One of the steps followed was that of checking all the papers selected in order to ensure that the same study had not been published in two different journals or that a publication was not an updated version of an already-existing paper.

The aforementioned selection process eventually led to the attainment of a total of 118 works.

3.6 | Quality criteria

In order to assess the quality of the papers found, we considered the following criteria:

QA1. Is there any mention of what causes stress in distributed projects or GSD?

- Yes (+1): Factors that affect stress in DSD or GSD are described
- Partly (+0.5): The causes are provided in an informal way and/or not clearly expressed or without indicating the setting.
- No (+0): No cause is mentioned.
- Unknown.

QA2. Does the paper describe any factors that affect motivation in distributed projects or GSD?

- Yes (+1): The paper describes some factors that affect motivation in DSD or GSD settings.
- Partly (+0.5): The factors are provided in an informal way and/or not clearly expressed or without indicating the setting.
- No (+0): No factor is mentioned.
- Unknown.

QA3. Does the paper describe any factors that affect the performance in DSD or GSD settings?

- Yes (+1): The paper describes some factors that affect the performance in DSD or GSD settings.
- Partly (+0.5): The factors are provided in an informal way and/or not clearly expressed or without indicating the setting.
- No (+0): No factor is mentioned.
- Unknown.

QA4. Does the paper describe any means of decreasing stress in DSD or GSD settings?

- Yes (+1): The paper explains how stress can be controlled or reduced in a DSD or GSD context.
- Partly (+0.5): The paper explains how stress can be controlled or reduced in general in software engineering teams without explaining the setting, but it could be used in DSD or GSD settings.
- No (+0): No explanation is provided.
- Unknown.

QA5. Does the paper describe how to increase motivation in DSD or GSD settings?

- Yes (+1): The paper explains how motivation can be increased in DSD or GSD contexts.
- Partly (+0.5): The paper explains how motivation can be increased in general in software engineering teams without explaining the setting, but it could be used in DSD or GSD settings
- No (+0): No explanation is provided.
- Unknown.

QA6. Does the paper describe how to increase performance in DSD or GSD settings?

- Yes (+1): The paper explains how performance can be increased in DSD or GSD contexts.
- Partly (+0.5): The paper explains how performance can be increased in general in software engineering teams without explaining the setting, but it could be used in DSD or GSD settings
- No (+0): No explanation is provided.
- Unknown.

3.7 | Data extraction and synthesis

The reference details of each paper were recorded, along with the research question(s) each one answered. These data were then synthesized in the results section of our papers, which reflects the number of times that each research question was identified in the various papers selected. The papers selected have been grouped according to year of publication, geographical location, and type of study.

3.8 | Selection of papers

The initial search led to the attainment of 770 results. After evaluating each title and abstract, and discounting duplicates, approximately 600 were rejected. This left 178 papers of which, after reading them in their entirety, 98 were maintained. However, once the references in the papers selected had been reviewed (snowballing), another 20 papers were found, leading to an eventual total of 118 works; that is, once a primary study had been identified in one of the data sources, the references in that primary study were explored recursively by following the same search criteria. The "Snowballing" method was conducted to find more documents, following the model described by Wohlin.[66] This was done with the intention of seeking additional papers referenced in those that had been completely reviewed. These papers were assessed according to the same quality criteria as the other publications and were either discarded or accepted on the basis of these criteria.

Figure 1 shows the results obtained after carry in gout each step in the paper-selection process.

4 | RESULTS: DEMOGRAPHIC INFORMATION

This section shows the demographic data, along with a description of the types of studies found and where and when they were published.

4.1 | Type of study

Figure 2 shows the type of study conducted in the 118 papers selected. These have been divided into three groups: theoretical studies (14), literature reviews (5), and empirical studies, which comprise the majority of the works (99).

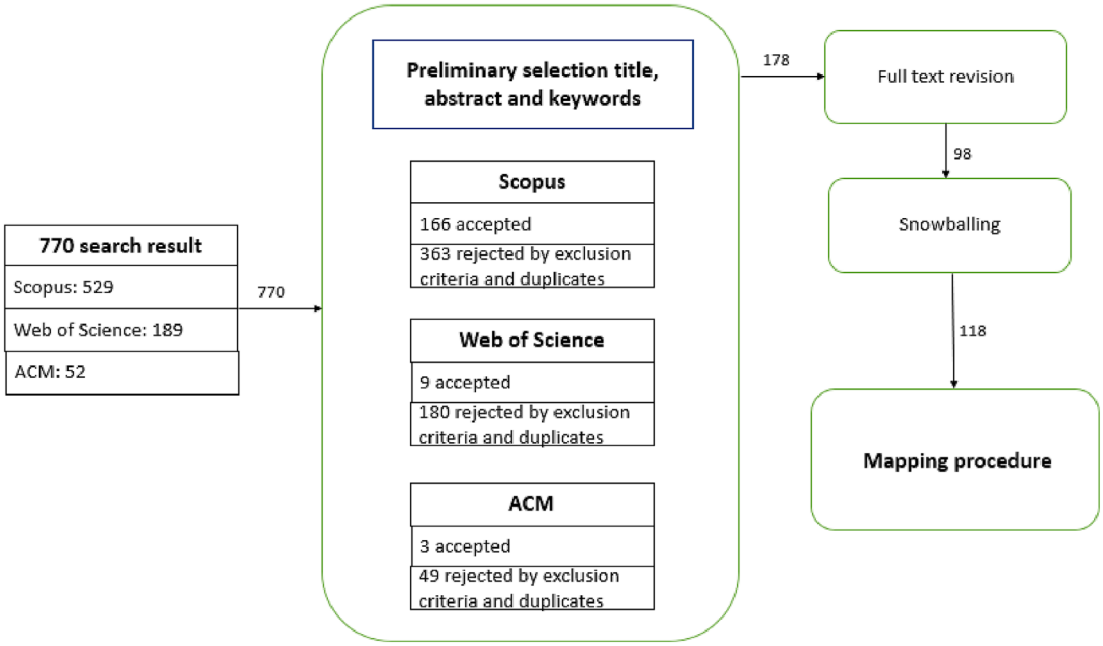

FIGURE 1 Search, filtering, and mapping procedure.

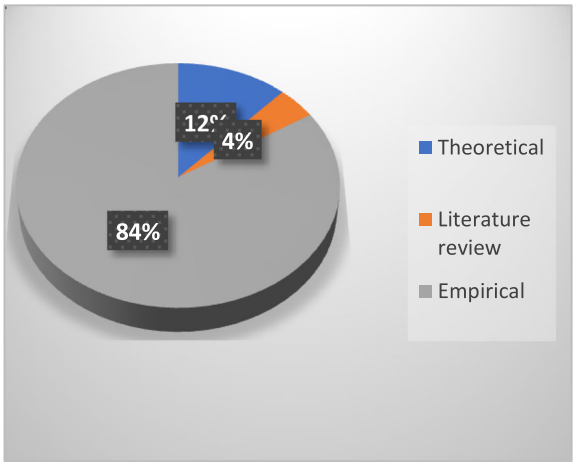

FIGURE 2 Type of study carried out in papers.

4.2 | Temporal view of the publications

Figure 3 shows the number of publications according to year.

It will be noted that there are few publications dealing with this subject each year and that, although there was a slight increase between 2011 and 2014, there has been a dramatic decrease in these numbers in the last 3 years.

4.3 | Geographical distribution of papers

Figure 4 shows the geographical distribution of the publications.

As will be observed, the research in the papers analyzed was affiliated to 34 different countries, with authors in the United States being the most active, followed by those from Brazil, Finland, and Ireland.

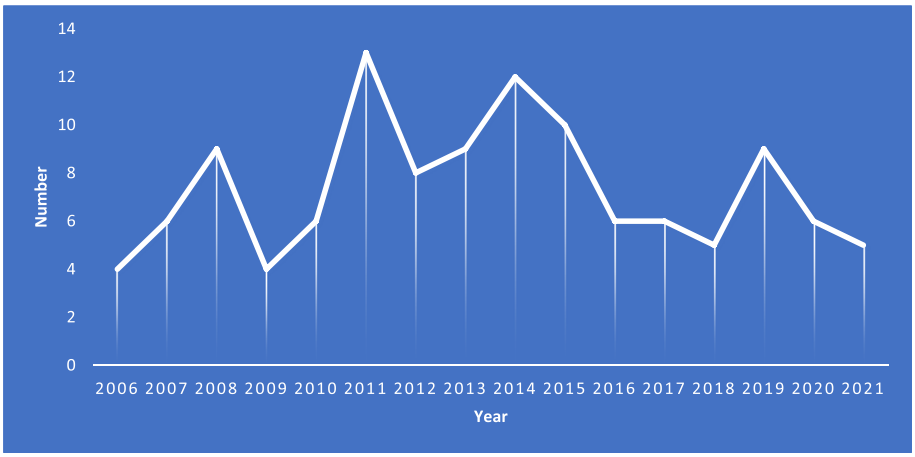

FIGURE 3 Number of papers per year included in review.

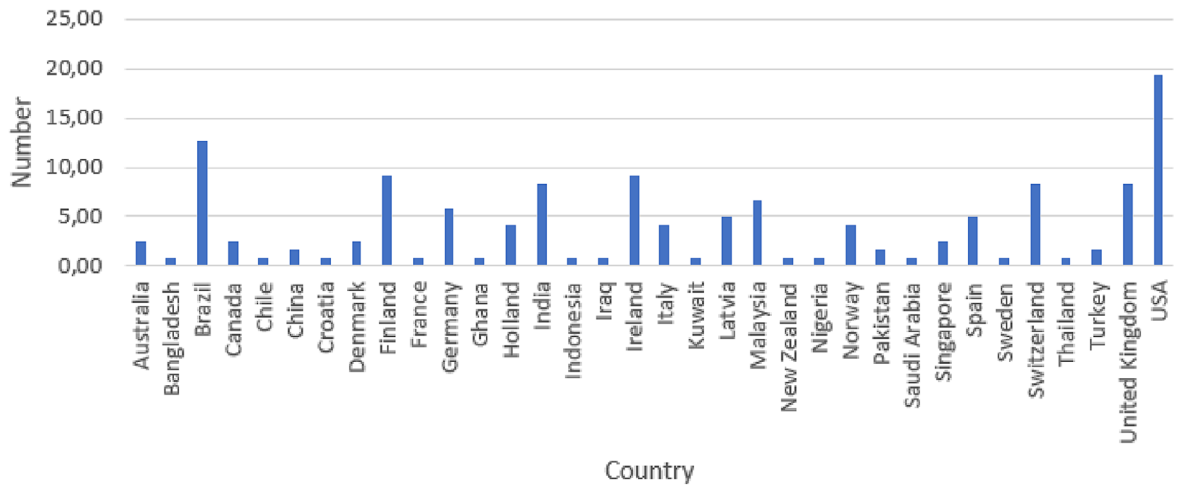

FIGURE 4 Countries represented in studies.

5 | RESULTS: STRESS, MOTIVATION, AND PERFORMANCE IN GSD

This section shows how the literature selected has analyzed the stress, motivation, and performance of developers in GSD.

The 118 works dealt with in this section are referenced numerically online (in https://alarcos.esi.uclm.es/repo/Art%C3%ADculos%20seleccionados.pdf).

Figure 5 shows the number of papers that respond to each of the research questions.

It is important to indicate that some papers address more than one research question, which is why there is a difference between the sum of papers that address each question and the total number of selected papers.

The review of literature carried out herein made it possible to identify a significant number of aspects of GSD and distributed projects that may affect both the levels of stress and those of the motivation and performance of developers who work in this manner. However, it will be noted that the majority of the works selected (a total of 94) analyze the factors that affect performance, which are considerably fewer than those that analyze the factors that influence the developers' stress (only 13) or the impact on motivation (only 21).

As will be seen in the following subsections, the analysis of the papers found showed that the factors in question tend to be the same or very similar. We discovered that the aspects that affect workers' levels of stress also affect their motivation and performance, although it would also be true to say that not all the aspects that reduce workers' performance or lead to a lack of motivation in them in turn increase their levels of stress.

The factor analyzed will been classified in three blocks: those that depend on the characteristics of the project, those that depend on the companies (work philosophy, etc.), and those that depend on people. This classification or similar has been previously applied in literature, as occurs in Basili et al.,[67] in which the authors define the context in which software engineers work. This is divided into three factors: human, domain, and organizational, which could match our classification, since domain could be similar to factors related to the project and organizational

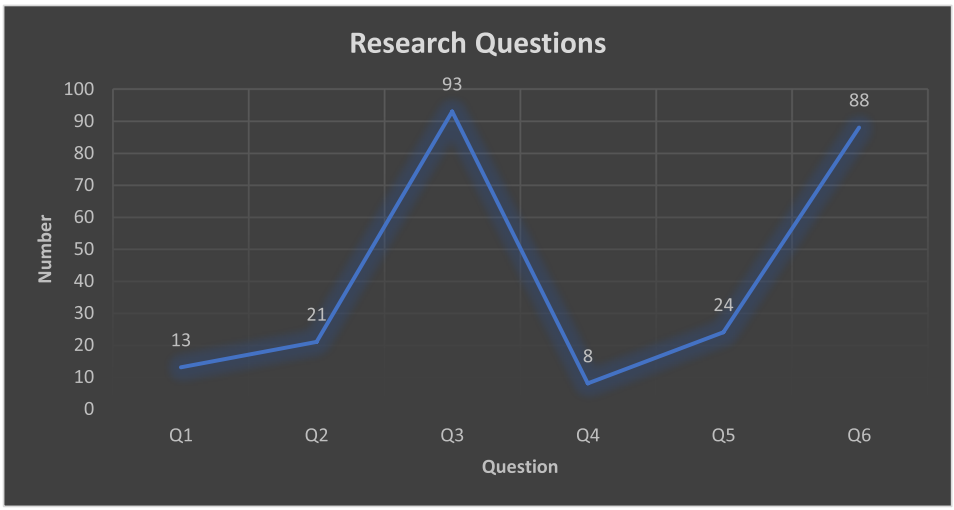

FIGURE 5 Papers responding to each research question.

could be similar to factors related to the company. Sadowski et al.[68] also consider that the particular project features and stakeholders are "lens" that, in this case, affect productivity in software engineering.

5.1 | Research Question 1

There were 13 papers responding to Research Question 1 (RQ1): "According to the literature selected, which factors cause stress in the members of distributed or global software development teams?" The papers show 22 factors that may lead to stress in the developers in these work teams. These factors are shown in Table 1.

It is interesting to note that the most influential factor of those related to a company is work pressure, while the factor most frequently cited as regards provoking stress in team members is cultural distance, ahead of development methodology, in the aspects related to the project. It is also interesting that the characteristics that intervene to the greatest extent as regards causing stress in team members are those of a personal nature and that the most important of these are, according to the literature studied, lack of confidence and external interruptions.

5.2 | Research Question 2

There were 21 papers responding to Research Question 2 (RQ2): "According to the literature selected, which factors affect the motivation of the members of distributed or global software development teams?" The papers contained 43 factors that may affect the levels of motivation of the developers in these work teams. These factors are shown in Table 2.

According to the literature on motivation, several aspects were related to the company's work philosophy intervene, from the lack of recognition to not having well-defined roles.

Cultural distance continues to head the list of factors related to the project, which denotes its importance. There are several personal factors affecting motivation; in the case of bad work environment, this factor may also depend on the company or even on project colleagues, and it could, therefore, be in all three categories.

5.3 | Research Question 3

There were 93 papers responding to Research Question 3 (RQ3): "According to the literature selected, which factors affect the productivity and performance of the members of distributed or global software development teams?" The papers contained 55 factors that may affect the levels of productivity and performance of developers on these work teams. These factors are shown in Table 3.

One of the main factors to affect productivity and performance in the case of the organization is knowledge management, since an adequate management of knowledge avoids "reinventing the wheel" and obviously improves productivity, as stated in the literature studied. With regard to

TABLE 1 Factors that cause stress in the members of DGS or GSD teams.

Factors related to the company	Papers	No. of papers
Work pressure	3, 6, 8, 11, 13	5
Daily time schedules	8	1
Lack of flexibility	8	1
Knowledge transfer	31	1
Technological issues	31	1
Work in distributed projects	60	1
Factors related to the project	**Papers**	**No. of papers**
Cultural distances	18, 31	2
Intermediate teams	3	1
Agile methodology	8	1
Communication issues	10	1
Linguistic distances	31	1
Temporal distances	31	1
The level of initial requirements definition quality	42	1
Changes in requirements	42	1
Factors related to human features	**Papers**	**No. of papers**
Lack of trust	1, 31	2
External interruptions	6, 7	2
Lack of motivation	7	1
Emotional aspects	7	1
Work organization	8	1
Lack of time	13	1
Increased competition	31	1
Lack of contribution	42	1

the characteristics of the project, all those related to cultural, temporal, geographic, and linguistic differences have a direct effect, as the literature regarding GSD has stated for many years.

In the case of the personal factors, it is interesting to note that the lack of personal relationships has an influence, which is an important aspect to consider after the pandemic, since personal relationships have decreased considerably as mentioned by Šmite et al.[14,15] and Russo et al.[16] A similar factor is the lack of face-to-face communication, which should be reinforced in order to increase productivity, along with some of the other factors cited, such as cohesion and identification with the team.

5.4 | Research Question 4

There were eight papers responding to Research Question 4 (RQ4): "Does the literature selected propose any means to reduce this stress?" The papers contained 14 factors that may reduce the levels of stress of the developers on these work teams. These factors are shown in Table 4.

It will be noted that almost all the factors related to reducing stress concern the company (eight factors) and human features (five), and it is for this reason that this study is relevant for companies, since it may allow them to become aware of how to improve these aspects.

5.5 | Research Question 5

There were 24 papers responding to Research Question 5 (RQ5): "Does the literature selected propose any means to increase motivation in global software development?" The papers contained 37 factors that may increase the motivation of the developers on these work teams. These factors are shown in Table 5.

TABLE 2 Factors that affect the motivation of the members of DGS or GSD teams.

Factors related to the company	Papers	No. of papers
Role ambiguity	14, 15, 16, 26	4
Inequity	14, 16, 26	3
Unfair reward system	14, 26	2
Lack of sufficient appreciation	3, 55	2
Lack of organizational motivation	3	1
Employment policies	9	1
Lack of workplace innovation	9	1
Daily time schedules	9	1
Long working hours	9	1
Work pressure	11	1
Lack of professional development	16	1
Staff turnover	53	1
Lack of appropriate infrastructure	55	1
Knowledge transfer	55	1
Work-life balance	24	1
Lack of feedback	55	1
Lack of standards	55	1
Factors related to the Project	**Papers**	**No. of papers**
Cultural distances	16, 26, 55	3
Work distribution	14, 16, 26	3
Boring work	6, 16, 55	3
Temporal distances	2, 9	2
Low development quality	9, 16	2
Geographical distance	2	1
Management problems	53	1
The level of initial requirements definition quality	53	1
Changes in requirements	53	1
Undefined development methodology	53	1
Lack of adequate staff	53	1
Poor attention to individualities	55	1
Factors related to the human features	**Papers**	**No. of papers**
Lack of trust	1, 2, 5, 10, 12, 26, 53, 55	8
Communication issues	5, 14, 15, 16, 26, 53, 54, 58	8
Fear of losing job	2, 4, 17, 38, 58	5
Bad work environment	14, 16, 26, 53	4
Lack of influence	14, 16, 26, 55	4
Difficulty in developing personal relationships	2, 56	2
Lack of participation	15, 55	2
Lack of autonomy	14, 55	2
Bad relationship with colleagues	14, 16	2
Teamwork problems	53, 55	2
Bad work experiences	53	1
Problems with shared leadership	55	1
Sense of lack of belonging	55	1

TABLE 3 Factors that affect the productivity and performance of the members of DGS or GSD teams.

Factors related to the company	Papers	No. of papers
Knowledge transfer	4, 11, 22, 27, 28, 34, 40, 45, 49, 52, 69, 70, 71, 98	14
Technological differences	29, 33, 34, 40, 49, 86	6
Differences in work methodology	8, 12, 48, 56, 71	5
Regulatory differences	33, 34, 45, 71, 86	5
Organizational differences	8, 40, 49, 56	4
Role problems	34, 40, 60	3
Lack of support for remote work	7, 73	2
Large employee turnover	9, 60	2
Work pressure	11	1
Lack of organizational commitment	21	1
Work-life balance	24	1
Temporary work teams	46	1
Factors related to the project	**Papers**	**No. of papers**
Cultural distances	2, 3, 4, 12, 17, 19, 23, 28, 32, 33, 34, 35, 36, 37, 40, 42, 45, 48, 49, 52, 61, 62, 63, 64, 86, 87, 88, 90, 96, 98, 118	31
Temporal distances	2, 17, 19, 23, 30, 32, 33, 34, 37, 40, 49, 52, 56, 61, 62, 66, 69, 77, 78, 86, 97	21
Geographical distances	2, 17, 19, 23, 30, 32, 37, 49, 52, 56, 62, 69, 71, 75, 77, 78, 82, 86, 89, 99	20
Linguistic distances	2, 4, 12, 17, 23, 30, 32, 34, 37, 40, 45, 52, 56, 69, 71, 78, 98	17
Coordination problems	22, 28, 33, 34, 35, 37, 40, 57, 67, 72, 86, 97, 98	13
Management problems	4, 7, 11, 18, 27, 29, 34, 57, 71, 80, 84, 86	12
Work dispersion	29, 40, 61, 77, 82	5
Redundant skills or tasks	34, 40, 45, 92	4
Changes in requirements	44, 59, 92, 98	4
Work distribution	40, 74	2
Differences in teams' contributions	35	1
Poor quality requirements	37	1
Software test problems	37	1
Team composition	40	1
Educational differences	42	1
Bad description of reused requirements	43	1
Transfer of tasks between locations	50	1
Bad project estimate	74	1
Large project scope	76	1
Inappropriate onboarding	81	1
Lack of control of the other offices tasks	98	1

Factors related to the human features	Papers	No. of papers
Communication issues	4, 5, 11, 12, 17, 20, 21, 22, 27, 28, 33, 34, 35, 36, 39, 40, 45, 54, 61, 64, 66, 71, 74, 84, 86, 90, 93, 95, 98, 107, 116	31
Lack of trust	1, 4, 5, 10, 12, 17, 23, 28, 34, 35, 40, 49, 52, 58, 65, 60, 63, 69, 71, 85, 93, 98, 111	23
Lack of collaboration	4, 7, 22, 23, 28, 29, 34, 35, 86, 98	10
Low motivation	3, 4, 5, 7, 9, 14, 16, 21, 25, 51, 53, 55, 69, 71, 114	15
Lack of personal relationships	34, 39, 63, 69, 86, 90, 93	7
Fear of losing job	4, 17, 23, 34, 58, 86, 93	7
Teamwork problems	32, 34, 60, 71, 74	5
Less team cohesion and identification	7, 34, 35, 49, 86	5
Problems with leadership	35, 52, 71, 84	4
Different work habits	35, 40, 49, 78	4
External interrupts	6, 7, 68	3
Lack of compromise	34, 35, 40	3
Feedback delay	12, 34, 40	3
Individual experiences and skills	7, 73, 107	3
Interpersonal conflicts	27, 83	2
Stress	6	1
Emotional aspects	7	1
Problems adapting to the work environment	7	1
Lack of face-to-face communication	36	1
Boredom	68	1
Lack of creativity	71	1
Behavior problems	83	1

TABLE 4 Papers that propose any means to reduce the stress.

Factors related to the company	Papers	No. of papers
Reduce work pressure	3, 8	2
Prioritize quality	1	1
Eliminate the middlemen	3	1
Changes in development methodology	8	1
Changes in the organization	8	1
Agile methodology	13	1
Improve knowledge transfer	31	1
Work from home	41	1
Factors related to the project	**Papers**	**No. of papers**
Team structure improvements	3	1
Factors related to the human features	**Papers**	**No. of papers**
Improve communication	10, 31	2
Improve collaboration	31	1
Improve trust	1	1
Improve team spirit	1, 18	2
Understand the different cultural models	3	1

TABLE 5 Papers that propose any means to increase motivation in GSD.

Factors related to the company	Papers	No. of papers
Give recognition for work	3, 9, 14, 15, 25, 26, 51	7
Provide feedback	15, 16, 21, 25, 51, 101	6
Challenging jobs	9, 25, 26, 51	4
Address cultural differences	14, 15, 25, 26	4
Improve work-life balance	9, 24, 51	3
Improve equity	15, 26, 51	3
Appropriate infrastructure (hard)	15, 25, 51	3
Improve knowledge transfer	15, 25, 58	3
Improve participation	26, 51	2
Professional development (hard)	26, 51	2
Ensuring continuity at work	4, 38, 51	3
Shared leadership	15, 25	2
Take care of individualities	15, 25	2
Use agile methodology (hard)	5, 79	2
Variety at work	6, 51	2
Improve working conditions	9, 51	2
Improve management (hard)	9, 51	2
Implement motivation programs	3	1
Improve development methodology (hard)	16	1
Improve sense of belonging	9	1
Establish common standards	25	1
Increase face-to-face meetings	43	1
Use of games	100	1
Work from home	6	1
Reduce time pressure	13	1
Give prizes and incentives	51	1
Challenging job	51	1
Give responsibility	51	1
Factors related to the project	**Papers**	**No. of papers**
Improve autonomy	9, 15, 16, 25, 51	5
Foster team spirit	9, 15, 25, 26	4
Improve teamwork	26, 51	2
Involve workers in the project	9, 51	2
Improve coordination	26	1
Improve project information	21	1
Build team spirit	51	1
Factors related to the human features	**Papers**	**No. of papers**
Improve trust	1, 2, 5, 10, 12, 51, 58	7
Improve communication	2, 5, 16, 58	4

According to the literature studied, the majority of the factors that help to improve motivation are partly related to the company (28), but if these factors are analyzed in order to see whether they contribute to improving hard or soft skills, it will be noted that almost all of them, with the exception of professional development, address improving confidence, communication, participation, team spirit, and sense of belonging, signifying that it is vital to improve employees' social skills.

5.6 | Research Question 6

There were 88 papers responding to Research Question 6 (RQ6): "Does the literature selected propose any means to increase productivity and performance in global software development?" The papers contained 65 factors that may increase the productivity and performance of the developers on these work teams. These factors are shown in Table 6.

According to literature, the majority of the factors that help to improve employees' productivity and performance depend principally on the company (46 factors), and the majority of them are also related to improving the atmosphere at work. Eight factors are related to the project and teams features, and 11 to the human features.

A conclusion that could be obtained after analyzing how to improve these indicators is that it seems that researchers are more concerned about analyzing the factors that impact on developers' performance than those that affect their levels of motivation and stress, such that in the study presented herein, 89 papers show how to improve performance, but only 24 indicate how to improve developers' levels of motivation and only 9 analyze how to reduce their stress.

5.7 | Common factors

Of all the factors analyzed above, there are seven that together affect the three variables analyzed: workers' stress, motivation, and performance. These aspects are shown in Table 7 and should, given their impact, be considered a priority for consideration by companies.

The first aspect considered, communication problems, is that which was found most frequently in this mapping study. It has been analyzed by Casey and Richardson,[69] who determined that this is one of the aspects that has a negative influence on workers' performance. On the other hand, in their work, Paasivaara et al. (2008) considered that communication problems, together with lack of confidence, have a negative impact on both the motivation and performance of developers; furthermore, Jarvenpaa et al[70] stated that communication problems have a negative impact on professionals' levels of stress.

Regarding the second factor cultural distance, the work by Casey and Richardson[69] indicated that this is, together with fear of losing one's job, communication problems, and lack of confidence of language problems, an aspect that has a negative impact on developers' performance. Casey[71] also refers to cultural distance as a problem as regards performance. In their work, Šteinberga and Šmite[72] discuss the negative impact that geographical, temporal, and cultural distance has on developers' motivation and also add that this lack of motivation has an impact on their performance. In another work, Šmite[73] states that factors such as geographic and temporal distance or cultural differences have a negative impact on professionals' levels of stress when developing software, and this opinion is shared by Amin et al (2011), who also indicates that geographical and temporal distance or cultural differences lead to stress in developers.

The third important factor considered is lack of confidence, an aspect that is once again dealt with by Casey and Richardson,[69] who emphasize that this lack of confidence, together with low motivation, fear of losing one's job or language problems are negative for developers' performance. The work of Misra et al.[74] also identifies that some of the aspects that affect performance are lack of confidence, in addition to communication problems, cultural distance, or knowledge management. With regard to stress, both Kabbur et al.[75] and Amin et al (2011) consider that lack of confidence has negative repercussions on the levels of stress of professionals in the IT sector. In the case of the impact that lack of confidence has on employees' motivation levels, Kabbur et al.,[75] Paasivaara et al (2008), and Moe and Šmite[76] all discuss the importance of this factor as regards reducing developers' levels of motivation.

When analyzing the third factor, temporal distance, we discovered that Casey[71] mentioned that geographical and temporal differences increase the complexity of software development projects, which has a negative influence on performance. Temporal distance also makes it difficult to keep in direct contact, thus limiting cooperation and the development of confidence. The same researcher also indicates that some of the risks confronted by a software development project are cultural and linguistic differences, motivation, and temporal distance[77] and that these affect aspects as important as coordination, the visibility of the project, cooperation, and communication. In their work, Šmite and Wohlin[78] stated that transferring software development work to locations that are geographically, temporally, and culturally distant negatively influences performance, while Bass et al.[79] analyzed the aspects that have an influence on software developers' motivation and found that things such as bad company policies, an excess of extra working hours, having to work antisocial hours and temporal distance may have a negative effect on employees' motivation. Furthermore, Amin et al (2011) focused on analyzing the aspects that cause work-related stress in software engineering professionals and discovered that pressure to update knowledge, lack of confidence, cultural, or linguistic differences or temporal distance, among others, have a negative effect on professionals' levels of stress.

The fifth aspect analyzed was the problem of knowledge management, which Casey and Richardson[69] consider to be negative for developers' performance, as do Humayun and Jhanjhi[80] or Zahedi and Babar.[81] According to Amin et al (2011), the problems of knowledge management have negative repercussions on stress levels. Furthermore, Vujdan et al.[82] include knowledge management, along with other aspects such as lack of autonomy, lack of confidence, or the nature of the work to be carried out, as key factors in developers' low motivation.

TABLE 6 Papers that propose any means to increase productivity and performance in GSD.

Factors related to the company	Papers	No. of papers
Improve knowledge transfer	4.6, 11, 13, 22, 27, 28, 30, 32, 33, 34, 35, 37, 46, 50, 62, 70, 75, 81, 108, 117	21
Improve coordination	2, 19, 30, 33, 50, 56, 57, 59, 67, 72, 91, 92, 97, 100, 102	15
Improve and adapt the management strategy	12, 13, 33, 37, 40, 44, 45, 49, 50, 59, 82, 91, 99, 112, 113	15
Improve trust	1, 4, 5, 10, 12, 17, 22, 28, 30, 40, 58, 63, 83, 112	14
Provide adequate infrastructure, tools and support	7, 11, 20, 29, 30, 32, 34, 37, 40, 41, 50, 59, 91	13
Improve motivation	3, 5, 6, 7, 9, 11, 14, 15, 25, 30, 37, 100, 112	13
Improve collaboration	1, 2, 7, 11, 17, 22, 30, 35, 91	9
Use agile methodology	5, 13, 64, 66, 79, 103, 104, 105	8
Establish common goals, standards, and rewards	17, 21, 23, 34, 37, 65, 66	7
Improve definition of roles and responsibilities	1, 29, 30, 37, 39, 112	6
Improve team work tracking	27, 29, 34, 65, 66, 92	6
Improve equipment stability and ensure job security	4, 28, 34, 46, 58	5
Improve documentation	23, 34, 41, 50, 62	5
Visits to other teams	27, 34, 39, 62, 112	5
Improve daily time schedules	33, 34, 39, 54, 94	5
Define a single working language	28, 30, 34, 94	4
Build team spirit	19, 28, 34, 39	4
Have qualified employees	41, 47, 50, 112	4
Rotation of teams between locations	4, 29, 34	3
Encourage face-to-face communication	10, 50, 54	3
Improve well-being and job satisfaction	6, 41, 68	3
Improve participation	87, 110	2
Improve self-management	10, 34	2
Minimize the number of workplaces	34, 76	2
Have a suitable workspace	7, 41	2
Evaluate results as a single team	17, 47	2
Improve communication tools	36, 41	2
Reduce the size of projects	47, 76	2
Improve development methodology	8	1
Adoption of a corporate culture	80	1
Improve worker flexibility	102	1
Good selection of team locations	61	1
Improve socio-technical convergence	19	1
Improve risk management	11	1
Improve feedback	12	1
Encourage informal communications	17	1
Create internet spaces to share information	17	1
Improve work-life balance	24	1
Combine waterfall and agile methodologies	44	1
Relocate to nearby locations	50	1
Create small teams	76	1

TABLE 6 (Continued)

Factors related to the company	Papers	No. of papers
Use of cloud infrastructures	109	1
Use of instant messaging tools	115	1
Recruit workers before transferring tasks between locations	62	1
Focus on key resources	62	1
Schedule transfer tasks	62	1
Factors related to the Project	**Papers**	**No. of papers**
Creation of adequate and diverse work teams	32, 33, 34, 37, 48, 83, 89, 110	8
Improve work organization	1, 8, 28, 34, 50, 91	6
Communicate project expectations and status to the team	12, 58, 92	3
Give visibility to the work of others	2, 30	2
Improve teamwork	34, 46	2
Document and leverage lessons learned	37, 43	2
Improve conflict management	12	1
Requirements reuse	43	1
Factors related to the human features	**Papers**	**No. of papers**
Improve communication	2, 4, 5, 7, 12, 17, 19, 20, 23, 28, 29, 30, 32, 33, 34, 35, 36, 39, 50, 56, 59, 61, 64, 65, 66, 80, 84, 91, 94, 95, 96, 104	32
Improve personal relationships	20, 30, 47, 59, 63, 65, 85, 94	8
Recognize cultural differences	3, 4, 34, 37, 39, 62, 94	4
Improve skills	9, 21, 47, 62	4
Improve autonomy	41, 68	2
Improve customer relations	11	1
Combine simple tasks with complicated ones	11	1
Improve language skills	12	1
Detail specifications	66	1
Perform interesting tasks	41	1
Previous employment ties	88	1

TABLE 7 Aspects that affect stress, motivation and productivity and performance in GSD and DGS.

Factors	Papers	No. of papers
Communication issues	4, 5, 10, 11, 12, 14, 15, 16, 17, 20, 21, 22, 26, 27, 28, 33, 34, 35, 36, 39, 40, 45, 53, 54, 58, 61, 64, 66, 71, 74, 84, 86, 90, 93, 95, 98, 107, 116	38
Cultural distances	2, 3, 4, 12, 16, 17, 18, 19, 23, 26, 28, 31, 32, 33, 34, 35, 36, 37, 40, 42, 45, 48, 49, 52, 55, 61, 62, 63, 64, 86, 87, 88, 90, 96, 98, 118	36
Lack of trust	1, 2, 4, 5, 10, 12, 17, 23, 26, 28, 31, 34, 35, 40, 49, 52, 53, 55, 58, 60, 63, 65, 69, 71, 85, 93, 98, 111	28
Temporal distances	2, 9, 17, 19, 23, 30, 31, 32, 33, 34, 37, 40, 49, 52, 56, 61, 62, 66, 69, 77, 78, 86, 97	23
Knowledge transfer	4, 11, 22, 27, 28, 31, 34, 40, 45, 49, 52, 55, 69, 70, 71, 98	16
Changes to requirements	42, 44, 53, 59, 92, 98	6
Poor quality requirements	37, 42, 53	3

The six common factor is changes in requirements which, according to Čavrak et al.,[83] cause stress in team members. Moreover, Shameem et al.[84] indicate that these changes negatively impact on developers' performance, while Verner et al.[85] discuss the impact that changes in requirements have on technicians' levels of motivation.

The last aspect considered was the poor quality of requirements, which, as also stated by Casey and Richardson,[77] has an influence on developers' performance. According to Čavrak et al.,[83] the bad quality of requirements, together with changes to them and a lack of contribution by

other team members, increases the level of stress in software development professionals. In their work, Verner et al.[85] analyzed the negative impact of the bad quality of requirements, along with other aspects such as communication problems, bad work atmosphere, or the rotation of personnel, on technicians' motivation.

Upon analyzing Table 7, it is possible to conclude that the first five factors are directly applicable to the challenges of GSE and that the last two concern requirements. More research should, therefore, be carried out in GSE field in order to mitigate these challenges.

6 | THREATS TO VALIDITY

We have carried out a fairly exhaustive review in which we have included the works of 289 researchers from 34 different countries in 118 papers.

Using the suggestions of Wohlin et al.[86] as a basis, in this section, we provide details on the threats to the validity of this work, along with descriptions of how we have attempted to deal with them.

6.1 | Construct validity

The choice of a search chain that would allow us to find the highest possible number of studies is a threat to the construct validity that should be considered. In order to avoid missing relevant publications, several tests with different variations of search chains were tried until the most representative chain was found that produced the least number of undesired publications. In order to ensure that it worked correctly, we took various publications that are relevant in the domain as a reference and ensured that they appeared in the results of the search. An effort was also made to verify that hardly any publications from outside the domain of our discipline appeared among those found.

With regard to the databases selected, the principal search sources used were Scopus, Web of Science, and ACM Digital Library, which are the largest and most extensive research databases in the field of study.

6.2 | Internal validity

Internal validity can be affected by the extraction, analysis, and publication classification process.

With regard to the process carried out, one person was in charge of the extraction, analysis, and mapping of the publications. This work was reviewed by another person, who was in charge of evaluating it and of mapping any other publication that had not initially been included. This evaluation was carried out individually by that person, thus ensuring the impartiality and individuality of decisions. Finally, the two people involved informed each other of the decisions made in order to ensure definitive impartiality. In the case of discrepancies, an additional review was carried out in order to eventually assign the publication.

Moreover, the inclusion, exclusion, and quality evaluations were selected individually and then pooled by the authors in an attempt to guarantee that the publications extracted were genuinely relevant.

6.3 | Conclusion validity

In order to guarantee the validity of the conclusions and, therefore, the reproduction of a similar mapping with the same results, each of the steps comprising the mapping process was expressing described. Moreover, the publications were mapped thanks to the agreement reached by two people in an attempt to reduce possible subjectivity in the choice of papers and the assignation to each of the objectives or categories of the work.

6.4 | External validity

With regard to the possibility of generalizing the results obtained, they cannot be completely extrapolated, both because of the possible existence of works dealing with the subjects analyzed in an indirect manner that were not found with the search terms used, and the possibility that some publications in gray literature (which was not contemplated) were missed. In spite of this, we consider that the study provides a general view of the state of the art of the performance, stress, and motivation of developers working on distributed projects.

7 | CONCLUSIONS

In this review, we have identified 22 factors that affect the stress levels of developers working on distributed projects. Forty-three factors that affect motivation and 55 that affect performance have been also found. Moreover, the factors have been classified according to whether they depend on the company, the project, or human features. This classification helps to reflect on the nature of each factor. With regard to the aspects that reduce the level of stress, eight factors were related to the company, one was related to the project, and five were related to human features. Upon analyzing the factors that increase motivation, it was discovered that 28 factors concern the company, 7 are related to the project, and 2 are related to human features. In the case of increasing productivity and performance, 46 factors were related to the company, 8 concerned the project, and 11 were related to human features. These results are very interesting for software factories, since the largest group of factors is that which depends on the company's policy. Companies could, therefore, study which factors to improve or enhance in order to create an optimum work environment with which to improve motivation and performance and reduce stress. This will have an indirect influence on other aspects such as turnover and will consequently reduce the probability of employees changing company and taking the intellectual capital formed by the company with them.

Another contribution is the analyses of the seven of the factors that jointly affect developers' levels of stress, motivation, and performance, which are temporal distance, cultural distance, lack of trust, bad quality of requirements, communication problems, knowledge management problems, and changes to requirements. We are of the opinion that, without ignoring the other aspects, it is necessary to focus mainly on controlling these factors.

Another interesting finding is that, according to literature, the usage of agile methodologies improves performance and motivation and reduces stress, and it would, therefore, also be convenient for those companies that have not yet done so to contemplate the use of agile methodologies.

Furthermore, this review verifies that, although significant number of works tackle the problems related to performance in GSD projects and how to deal with them, there are relatively few papers concerning the impact of these projects on motivation and very few concerning the impact of GSD projects on their team members' stress. We, therefore, consider that more studies on this area are necessary.

In summary, it is possible to state that the contributions of this paper are also useful for project heads for three reasons, since it may allow them to discover which factors have an influence on stress, motivation, and performance and help them to decide which employees might be best for a specific project or even what profile a person who is going to be hired should have. They might also be able to predict the problems could arise in a project owing to the projects' domain and the employees' features, thus allowing risks to be controlled in advance.

Furthermore, it is important to consider that team members could also take the soft skills mentioned in this paper into consideration and attempt to evaluate the extent to which they can be improved with the objective of increasing their performance, reducing their stress and improving their motivation.

This paper could also be interesting for universities, since it would allow them to discover which soft skills could be added to their curricula in order to improve students' professional identities, as this is currently a hot topic, as stated in Kapoor and Gardner-McCune[87] and Tomlinson and Jackson.[88]

This study is the first step towards the creation of a model that will help companies to detect problems in their projects and that will propose solutions to them. This model will be developed as future work, along with a tool that will help to automate that management.

ACKNOWLEDGMENTS

This work is part of the EMMA project "Evaluation and Improvement of the Environmental Sustainability of Applications" (SBPLY/21/180501/000115), funded by the Consejería de Educación, Cultura y Deportes de la Junta de Comunidades de Castilla La Mancha, and Fondo Europeo de Desarrollo Regional (FEDER) (Programa Operativo de Castilla-La Mancha 2021-2027).

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article, as no datasets were generated or analyzed during the current study.

ORCID

Julio Suárez https://orcid.org/0000-0003-2360-0220
Aurora Vizcaíno https://orcid.org/0000-0002-2072-5581

REFERENCES

1. Cico O, Jaccheri L, Nguyen-Duc A, Zhang H. Exploring the intersection between software industry and software engineering education—a systematic mapping of software engineering trends. *J Syst Softw*. 2021;172:110736. doi:10.1016/j.jss.2020.110736
2. Ebert C. *Global Software and IT: A Guide to Distributed Development, Projects, and Outsourcing*. Wiley-IEEE Computer Society Pr; 2011. doi:10.1002/9781118135105
3. Carmel E, Espinosa J, Dubinsky Y. "Follow the Sun" workflow in global software development. *J Manag Inf Syst*. 2010;27(1):17-38. doi:10.2753/MIS0742-1222270102

4. Kroll J, Richardson I, Prikladnicki R, Audy J. Empirical evidence in follow the Sun software development: a systematic mapping study. *Inf Softw Technol*. 2018;93:30-44. doi:10.1016/j.infsof.2017.08.011
5. Malik B, Faroom S, Ali M, Shehzad N, Yousaf S, Saleem H. Geographical distance and communication challenges in global software development: a review. *Int J Adv Comput Sci Appl Ijacsa*. 2018;9(5):406-414. doi:10.14569/IJACSA.2018.090553
6. Saleem N, Mathrani S, Taskin N. Understanding the different levels of challenges in global software development. In: *Proceedings of the 14th International Conference on Global Software Engineering (ICGSE'19)*. IEEE Press; 2019:66-67. doi:10.1109/ICGSE.2019.000-3
7. Holmstrom H, Conchúir EÓ, Agerfalk J, Fitzgerald B. Global software development challenges: a case study on temporal, geographical and socio-cultural distance. In: *2006 IEEE International Conference on Global Software Engineering (ICGSE'06)*. IEEE; 2006:3-11. doi:10.1109/ICGSE.2006.261210
8. Holmstrom H, Conchuir E, Agerfalk P, Fitzgerald B. Global software development challenges: a case study on temporal, geographical and socio-cultural distance. In: *2006 IEEE International Conference on Global Software Engineering (ICGSE'06)*. IEEE; 2006:3-11. doi:10.1109/ICGSE.2006.261210
9. Akbar M, Khan A, Khan A, Mahmood S. Requirement change management challenges in GSD: an analytical hierarchy process approach. *J Softw: Evol Proccess*. 2020;32(7):1-31.
10. Manjavacas A, Vizcaíno A, Ruiz F, Piattini M. Global software development governance: challenges and solutions. *J Softw: Evol Process*. 2020;32(10):1-31.
11. Machado L, Caldeira C, Perin M, de Souza C. Gendered experiences of software engineers during the COVID-19 crisis. *IEEE Softw*. 2020;38(2):38-44.
12. Miller C, Rodeghero P, Storey MA, Ford D, Zimmermann T. "How was your weekend?" Software development teams working from home during covid-19. In: *2021 IEEE/ACM 43rd International Conference on Software Engineering (ICSE)*. IEEE; 2021:624-636.
13. Ozkaya I. The future of software engineering work. *IEEE Softw*. 2021;38(5):3-6. doi:10.1109/MS.2021.3089729
14. Šmite D, Moe NB, Klotins E, Gonzalez-Huerta J. From forced working-from-home to voluntary working-from-anywhere: two revolutions in telework. *J Syst Softw*. 2023;195:111509. doi:10.1016/j.jss.2022.111509
15. Šmite D, Moe NB, Hildrum J, Gonzalez-Huerta J. Work-from-home is here to stay: call for flexibility in post-pandemic work policies. *J Syst Softw*. 2023;195:111552. doi:10.1016/j.jss.2022.111552
16. Russo D, Hanel, Altnickel S. Predictors of well-being and productivity among software professionals during the COVID-19 pandemic—a longitudinal study. *Empir Softw Eng*. 2021;26(4):62. doi:10.1007/s10664-021-09945-9
17. Baron R, Byrne D. *Psicología Social*. Prentice Hall Iberia; 1998.
18. Bandura A. Self-efficacy mechanism in psychobiological functioning. *Stanford Univ Psychol*. 1993;1:5-6.
19. Sharmilee S, Basit A, Hassan Z. Impact of job stress on employee performance. *Int J Account Bus Manag*. 2018;5(2):13-33.
20. Fink G. *Stress, Definitions, Mechanisms, and Effects Outlined: Lessons from Anxiety*. Academic Press; 2016:3-11. doi:10.1016/B978-0-12-800951-2.00001-7
21. Bharathi T, Gupta K. Job Stress and productivity: a conceptual framework. *Int J Emerging Res Manag Technol*. 2017;6(8):393.
22. Carneiro D, Novais P, Augusto J, Payne N. New methods for stress assessment and monitoring at the workplace. *IEEE Tran Affect Comput*. 2019;10(2):237-254. doi:10.1109/TAFFC.2017.2699633
23. Beehr T, Bhagat R. *Human Stress and Cognition in Organizations:An Integrated Perspective*. Wiley-Interscience; 1985.
24. Beehr T. *Psychological Stress in the Workplace (Psychology Revivals)*. Routledge; 2014. doi:10.4324/9781315795560
25. Forsgren N. An analysis of developer productivity, work cadence, and collaboration in the early days of COVID-19. Octoverse spotlight, May 6, 2020.
26. Khatri N. Emerging issues in strategic HRM in Singapur. *Int J Manpower*. 1999;8(8):516-520. doi:10.1108/01437729910302714
27. Demarco T, Lister T. *Peopleware—Productive Projects and Teams*. Dorset House; 1999.
28. Maslow A. *A Theory of Human Motivation*. Harper & Row; 1943.
29. Herzberg F, Mausner B, Snyderman B. *The Motivation to Work*. John Wiley; 1959.
30. McClelland D. *The Achieving Society*. Van Nostrand Reinhold; 1961. doi:10.1037/14359-000
31. Vroom V. *Work and Motivation. Carnegie Institute of Technologies*. John Wiley and Sons; 1964.
32. Couger J, Zawacki R. *Motivating and Managing Computer Personnel*. Wiley; 1980.
33. Arifin H. The influence of competence, motivation, and organisational culture to high school teacherjob satisfaction and performance. *Int Educ Stud*. 2015;8(1):38-45.
34. Kearney R. *Public sector performance: Management, motivation, and measurement*. Routledge; 2018. doi:10.4324/9780429497964
35. Lazaroiu G. Employee motivation and job performance. *Ling Philos Invest*. 2015;14:97.
36. Skaalvik E, Skaalvik S. Job demands and job resources as predictors of teacher motivation and well-being. *Soc Psychol Educ*. 2018;21(5):1251-1275. doi:10.1007/s11218-018-9464-8
37. Renata R, Wardiah D, Kristiawan M. The influence of headmaster's supervision and achievement motivation on effective teachers. *Int J Sci Technol Res*. 2018;7(4):44-49.
38. Baddoo N, Hall T. Motivators of software process improvement: ananalysis of practitioners' views. *J Syst Softw*. 2002;62(2):85-96. doi:10.1016/S0164-1212(01)00125-X
39. Baddoo N, Hall T. De-motivators for software process improvement: an analysis of practitioners' views. *J Syst Softw*. 2003;66(1):23-33. doi:10.1016/S0164-1212(02)00060-2
40. Couger D, Mcintyre S. Motivation norms of knowledge engineers compared to those of software engineers. *J Manag Inf Syst*. 1987;4(3):82-93. doi:10.1080/07421222.1987.11517802
41. Burn J, Couger J. Motivating IT professionals. *Hong Kong Challenge Inf Manag*. 1992;22(5):269-280. doi:10.1016/0378-7206(92)90074-P
42. Beller M, Orgovan V, Buja S, Zimmermann T. Mind the gap: on the relationship between automatically measured and self-reported productivity. *IEEE Softw*. 2021;38(5):24-31. doi:10.1109/MS.2020.3048200
43. Sadowski C, Zimmermann T. *Rethinking Productivity in Software Engineering*. Springer Nature; 2019:310. doi:10.1007/978-1-4842-4221-6
44. Kitchenham B. *Procedures for Performing Systematic Reviews*. Keele University and National ICT Australia Ltd; 2004:1-28.
45. Kitchenham B, Charters S. *Guidelines for Performing Systematic Literature Reviews in Software Engineering*. Scientific Research Publishing; 2007.
46. Kitchenham B, Mendes E, Travassos G. A systematic review of cross- vs. within-company cost estimation studies. In: *EASE 200610th International Conference on Evaluation and Assessment in Software Engineering*. Keele University; 2006:89-98.

47. Petersen K, Feldt R, Mujtaba S, Mattsson M. Systematic mapping studies in software engineering. In 12th International Conference on Evaluation and Assessment in Software Engineering (EASE). Vol 12. 2008:1-10.
48. Beecham S, Baddoo N, Hall T, Robinson H, Sharp H. Motivation in software engineering: a systematic literature review. *Inf Softw Technol*. 2008; 50(9-10):860-878. doi:10.1016/j.infsof.2007.09.004
49. Acuña ST, Gómez M, Juristo N. Towards understanding the relationship between team climate and software quality—a quasi-experimental study. *Empir Softw Eng*. 2008;13(4):401-434. doi:10.1007/s10664-008-9074-8
50. Akula B, Cusick J. Impact of overtime and stress on software quality. In 4th International Symposium on Management, Engineering, and Informatics (MEI 2008), Orlando, Florida, USA; 2008. doi:10.13140/RG.2.2.12815.59041
51. Conchúir EÓ, Ågerfalk PJ, Olsson HH, Fitzgerald B. Global software development: where are the benefits? *Commun ACM*. 2009;52(8):127-131. doi: 10.1145/1536616.1536648
52. Casey V. Imparting the importance of culture to global software development. *ACM Inroads*. 2011;1(3):51-57. doi:10.1145/1835428.1835443
53. Canedo ED, Santos GA. Factors affecting software development productivity: an empirical study. In Proceedings of the XXXIII Brazilian Symposium on Software Engineering; 2019:307-316. doi:10.1145/3350768.3352491
54. Oliveira E, Conte T, Cristo M, Valentim N. Influence factors in software productivity—a tertiary literature review. *Int J Softw Eng Knowl Eng*. 2018; 28(11n12):1795-1810. doi:10.1142/S0218194018400296
55. Johnson B, Zimmermann T, Bird C. The effect of work environments on productivity and satisfaction of software engineers. *IEEE Trans Softw Eng*. 2019;47(4):736-757.
56. Steinmacher I, Chaves AP, Gerosa MA. Awareness support in global software development: a systematic review based on the 3C collaboration model. In: *International Conference on Collaboration and Technology*. Springer; 2010:185-201. doi:10.1007/978-3-642-15714-1_15
57. Noll J, Beecham S, Richardson I. Global software development and collaboration: barriers and solutions. *ACM Inroads*. 2011;1(3):66-78. doi:10.1145/1835428.1835445
58. Nurdiani I, Jabangwe R, Šmite D, Damian D. Risk identification and risk mitigation instruments for global software development: systematic review and survey results. In: *2011 IEEE Sixth International Conference on Global Software Engineering Workshop*. 2011:36-41.
59. Anh N, Pras D, Conradi R. Dispersion, coordination and performance in global software teams: a systematic review. In: *Proceedings of the 2012 ACM-IEEE International Symposium on Empirical Software Engineering and Measurement*. 2012:129-138.
60. Nguyen-Duc A, Cruzes D, Conradi R. The impact of global dispersion on coordination, team performance and software quality – a systematic literature review. *Inf Softw Technol*. 2015;57:277-294.
61. Dubey RS, Tewari V. A systematic review onrelevent soft skills in software engineering curricula. EDULEARN16 Proceedings; 2016:8880-8888.
62. Iriarte C, Bayona Orè S. Soft skills for IT project success: a systematic literature review. In: *International Conference on Software Process Improvement*. Springer; 2017:147-158. doi:10.1007/978-3-319-69341-5_14
63. Wagner S, Ruhe M. A systematic review of productivity factors in software development. *arXiv Preprint arXiv:180106475*. 2018:1-6. doi:10.48550/arXiv.1801.06475
64. Matturro G, Raschetti F, Fontán C. A systematic mapping study on soft skills in software engineering. *J Univ Comput Sci*. 2019;25(1):16-41.
65. Kuutila M, Mäntylä M, Farooq U, Claes M. Time pressure in software engineering: a systematic review. *Inf Softw Technol*. 2020;121:106257. doi:10.1016/j.infsof.2020.106257
66. Wohlin C. 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*; 2014:1-10.
67. Basili V, Briand L, Bianculli D, Nejati S, Pastore F, Sabetzadeh M. Software engineering research and industry: a symbiotic relationship to foster impact. *IEEE Softw*. 2018;35(5):44-49. doi:10.1109/MS.2018.290110216
68. Sadowski C, Storey MA, Feldt R. A software development productivity framework. In: *Rethinking Productivity in Software Engineering*. Apress; 2019:39-47. doi:10.1007/978-1-4842-4221-6_5
69. Casey V, Richardson I. The impact of fear on the operation of virtual teams. In: *2008 IEEE International Conference on Global Software Engineering*. IEEE; 2008:163-172.
70. Jarvenpaa S, Knoll K, Leidner D. Is anybody out there? antecedents of trust in global virtual teams. *J Manag Inf Syst*. 2015;14(4):29-64.
71. Casey V. Developing trust in virtual software development teams. *J Theor Appl Electron Commer Res*. 2010;5(2):41-58. doi:10.4067/S0718-18762010000200004
72. Šteinberga L, Šmite D. Towards a contemporary understanding of motivation in distributed software projects: solution proposal. *Comput Sci Inf Technol*. 2011;770:15-26.
73. Šmite D. Global software development projects in one of the biggest companies in Latvia: is geographical distribution a problem? *Softw Process: Improve Pract*. 2006;11(1):61-76. doi:10.1002/spip.252
74. Misra S, Colomo-Palacios R, Pusatlı T, Soto-Acosta P. A discussion on the role of people in global software development. *TehnickiVjesnik-Technical Gazette*. 2013;20(3):525-531.
75. Kabbur PK, Mani VS, Schuelein J. Prioritizing trust in a globally distributed software engineering team to overcome complexity and make releases a non-event. Proceedings of the 15th International Conference on Global Software Engineering, 2020, pp.66-70.
76. Moe NB, Šmite D. Understanding a lack of trust in Global Software Teams: a multiple-case study. *Softw Process: Improvement Practice*. 2008;13(3): 217-231. doi:10.1002/spip.378
77. Casey V, Richardson I. Implementation of global software development: a structured approach. *Softw Process: Improve Pract*. 2009;14(5):247-262. doi: 10.1002/spip.422
78. Šmite D, Wohlin C. Software product transfers: lessons learned from a case study. In: *2010 5th IEEE International Conference on Global Software Engineering*. IEEE; 2010:97-105.
79. Bass JM, Sarah B, Razzak MA, Noll J. Employee retention and turnover in global software development: comparing in-house offshoring and offshore outsourcing. In: *2018 IEEE/ACM 13th International Conference on Global Software Engineering (ICGSE)*. IEEE; 2018:77-86.
80. Humayun M, Jhanjhi N. Exploring the relationship between GSD, knowledge management, trust and collaboration. *J Eng Sci Technol*. 2019;14(2): 820-843.

81. Zahedi M, Babar M. Towards an understanding of enabling process knowing in global software development: a case study. Proceedings of the 2014 International; 2014.
82. Vujdan E, Thanh-Nam T, Kai R, Lutz K. The role of motivational factors in distributed software development teams: an empirical investigation. ECIS 2013 - Proceedings of the 21st European Conference on Information Systems. 2013.
83. Čavrak I, Bosnić I, Ciccozzi F, Mirandola R. Resilience of distributed student teams to stress factors: a longitudinal case-study. *Inf Softw Technol*. 2019; 114:258-274. doi:10.1016/j.infsof.2019.05.011
84. Shameem M, Chandra B, Kumar C, Khan AA. Impact of requirements volatility and flexible management on GSD project success: A study based on the dimensions of requirements volatility. *Int J Agile Syst Manag*. 2019;12:199-227.
85. Verner J, Babar M, Cerpa N, Hall T, Beecham S. Factors that motivate software engineering teams: a four country empirical study. *J Syst Softw*. 2014; 92:115-127. doi:10.1016/j.jss.2014.01.008
86. Wohlin C, Runeson P, Höst M, Ohlsson MC, Regnell B, Wesslén A. *Experimentation in Software Engineering*. Springer Science & Business Media; 2012. doi:10.1007/978-3-642-29044-2
87. Kapoor A, Gardner-McCune C. Understanding professional identities and goals of computer science undergraduate students. In Proceedings of the 49th ACM Technical Symposium on Computer Science Education; 2018:191-196.
88. Tomlinson M, Jackson D. Professional identity formation in contemporary higher education students. *Stud Higher Educ*. 2021;46(4):885-900. doi:10.1080/03075079.2019.1659763

How to cite this article: Suárez J, Vizcaíno A. Stress, motivation, and performance in global software engineering. *J Softw Evol Proc*. 2023; e2600. doi:10.1002/smr.2600

APPENDIX A

1. Kabbur, P. K., Mani, V. S. and Schuelein, J. Prioritizing Trust in a Globally Distributed Software Engineering Team to Overcome Complexity and Make Releases a Non-Event. Proceedings of the 15th International Conference on Global Software Engineering, 2020, pp.66–70.
2. Amin, A. Rehman, M. Basri, S. and Hassan,. M. A proposed conceptual framework of programmer's creativity. 2015 International Symposium on Technology Management and Emerging Technologies (ISTMET). 2015, pp. 108-113
3. Shah, H., Harrold, M. and Sinha, S. Global software testing under deadline pressure: Vendor-side experiences. 2014. Information and Software Technology, 56(1), pp. 6-19
4. Casey, V., & Richardson, I. The impact of fear on the operation of virtual teams. In 2008 IEEE International Conference on Global Software Engineering. IEEE. 2008, pp. 163-172.
5. Paasivaara, M., Durasiewicz, S., & Lassenius, C. (2008). Using scrum in a globally distributed project: a case study. Software Process: Improvement and Practice, 13(6), 527-544.
6. Meyer, A. N., Barr, E. T., Bird, C., & Zimmermann, T. (2019). Today was a good day: The daily life of software developers. IEEE Transactions on Software Engineering, 47(5), 863-880.
7. Bezerra, C. I., de Souza Filho, J. C., Coutinho, E. F., Gama, A., Ferreira, A. L., de Andrade, G. L., & Feitosa, C. E. (2020, October). How human and organizational factors influence software teams productivity in covid-19 pandemic: A brazilian survey. In Proceedings of the 34th Brazilian Symposium on Software Engineering (pp. 606-615).
8. Bjørn, P., Søderberg, A. and Krishna, S. (2019) Translocality in Global Software Development: the Dark Side of Global Agile. Human–Computer Interaction. 2019, 34(2), pp. 174-203
9. Bass, J. M., Sarah, B., Razzak, M. A., & Noll, J. (2018, May). Employee retention and turnover in global software development: Comparing in-house offshoring and offshore outsourcing. In 2018 IEEE/ACM 13th International Conference on Global Software Engineering (ICGSE) (pp. 77-86). IEEE
10. Jarvenpaa, S., Knoll, K. and Leidner, D. Is Anybody out There? Antecedents of Trust in Global Virtual Teams, Journal of Management Information Systems. 2015, 14(4), pp. 29-64
11. Shah, H., Sinha, S., & Harrold, M. J. (2011, August). Outsourced, offshored software- testing practice: Vendor-side experiences. In 2011 IEEE sixth international conference on global software engineering (pp. 131-140). IEEE.
12. Moe, N. B., & Šmite, D. Understanding a lack of trust in Global Software Teams: a multiple-case study. Software Process: Improvement and Practice, 2008, 13(3), pp. 217-231.
13. Kuutila, M., Mäntylä, M., Farooq, U., & Claes, M. (2020). Time pressure in software engineering: A systematic review. Information and Software Technology, 121, 106,257.
14. Noll, J., Beecham, S., Razzak, A., Richardson, B., Barcomb, A., and Richardson, I. Motivation and Autonomy in Global Software Development. Global Sourcing of Digital Services: Micro and Macro Perspectives. 2017,pp. 19-38

15. Junior, I., Duarte, L., Oliveira, J., Dantas, A., Barbosa, J. and Moura, H. Motivational Factors for Distributed Software Development Teams. 2012 IEEE Seventh International Conference on Global Software Engineering Workshops. 2012, pp. 49-54
16. Šteinberga, L. and Šmite, D. Towards a Contemporary Understanding of Motivation in Distributed Software Projects: Solution Proposal. Computer science and information technologies. 2011, 770, pp. 15-26
17. Casey, V. (2010). Developing trust in virtual software development teams. Journal of theoretical and applied electronic commerce research, 5 (2), 41-58.
18. Šmite, D. Global software development projects in one of the biggest companies in Latvia: is geographical distribution a problem?. Softw. Process: Improve. Pract. 2006, 11,pp. 61-76
19. Sievi-Korte, O., Fagerholm, F., Systä, K. and Mikkonen. Dimensions of Consistency in GSD: Social Factors, Structures and Interactions. Product-Focused Software Process Improvement, 2020, pp. 315--330.
20. Ammad, G., Iqbal Janjua, U., Madni, T., cheema, M. AND Shahid, A. An Empirical Study to Investigate the Impact of Communication Issues in GSD in Pakistan's IT Industry. IEEE Access. 2019, 7, pp. 171648-171,672.
21. Gheni, A. Y., Jusoh, Y. Y., Jabbar, M. A., Mohd Ali, N., Shanmugam, M., & Yousif, H. A. (2019). Measuring the performance of the virtual teams in global software development projects. Journal of Information Technology Management, 11(1), 42-59.
22. Humayun, M. and Jhanjhi, N. Exploring the relationship between GSD, knowledge management, trust and collaboration. Journal of engineering science and technology. 2019, 14(2), pp. 820-843
23. Iftikhar, A., Alam, M., Musa, S. and Su'ud, M. Trust Development in virtual teams to implement global software development (GSD): A structured approach to overcome communication barriers. 2017 IEEE 3rd International Conference on Engineering Technologies and Social Sciences (ICETSS), 2017, pp. 1-5
24. Sarker, S., Ahuja, M., & Sarker, S. (2018). Work–life conflict of globally distributed software development personnel: An empirical investigation using border theory. Information Systems Research, 29(1), 103-126.
25. de Farias, I., de Sá Leitão, N. G., & de Moura, H. P. (2017, June). An empirical study of motivational factors for distributed software development teams. In 2017 12th Iberian Conference on Information Systems and Technologies (CISTI) (pp. 1-6). IEEE.
26. Beecham, S. and Noll, J. What Motivates Software Engineers Working in Global Software Development?. Product-Focused Software Process Improvement. 2015, pp. 193--209
27. Zahedi, M. and Babar, M. Towards an Understanding of Enabling Process Knowing in Global Software Development: A Case Study. Proceedings of the 2014 International
28. Misra, S., Colomo-Palacios, R., Pusatlı, T. and Soto-Acosta, P. A discussion on the role of people in global software development. Tehnicki Vjesnik-Technical Gazette 2013, 20(3), pp. 525-531
29. Tunkelo, T., Hameri, A. and Pigneur, Y. Improving globally distributed software developm. Ent and support processes – A workflow view. Journal of software: Evolution and Process. 2013, 25 (12), pp. 1305-1,324
30. Richardson, I., Casey, V, McCaffery, F., Burton, J. and Beecham, S. A Process Framework for Global Software Engineering Teams. Information and Software Technology. 2012, 54(11), pp. 1175-1,191
31. Amin, A., Basri, S., Hassan, M. and Rehman, M. Occupational stress, knowledge sharing and GSD communication barriers as predictors of software engineer's creativity. 2011 IEEE International Conference on Industrial Engineering and Engineering Management. 2011, pp. 394-398
32. Garcia Guzman, J., Saldaña Ramos, J., Amescua Seco, A. and Sanz Esteban, A. Success Factors for the Management of Global Virtual Teams for Software Development. International Journal of Human Capital and Information Technology Professionals. 2011, 2(2)
33. Kroll, J., Hess, E., Audy, J. and Prikladnicki, R. Researching into Follow-the-Sun Software Development: Challenges and Opportunities. 2011 IEEE Sixth International Conference on Global Software Engineering. 2011, pp. 60-65
34. Nurdiani, I., Jabangwe, R., Šmite, D. and Damian, D. Risk Identification and Risk Mitigation Instruments for Global Software Development: Systematic Review and Survey Results. 2011 IEEE Sixth International Conference on Global Software Engineering Workshop. 2011, pp. 36-41
35. Hernández-López, A., Colomo-Palacios, R., García-Crespo, Á., Soto-Acosta, P. Team software process in GSD teams: A study of new work practices and models. International Journal of Human Capital and Information Technology Professionals. 2010, 1(3), pp. 32-53
36. Almeida, A. C. M., Farias Junior, I. H. D., & S Carneiro, P. J. D. (2009, July). Managing Communication among Geographically Distributed Teams: A Brazilian Case. In International Conference on Software Engineering Approaches for Offshore and Outsourced Development (pp. 130-135). Springer, Berlin, Heidelberg.
37. Casey, V. and Richardson, I. Implementation of Global Software Development: a structured approach. Softw. Process: Improve. Pract. 2009, 14, pp. 247-262
38. Casey, V. and Richardson, I. Virtual teams: understanding the impact of fear. Softw. Process: Improve. Pract.2008, 13, pp. 511-526
39. Oshri, I., Kotlarsky, J and Willcocks, L. Global software development: Exploring socialization and face-to-face meetings in distributed strategic projects. The Journal of Strategic Information Systems. 2007, 16(1), pp. 25-49
40. Setamanit, S. O., Wakeland, W., & Raffo, D. (2007). Improving global software development project performance using simulation. In PICMET'07-2007 Portland International Conference on Management of Engineering & Technology (pp. 2458-2,466). IEEE.

41. Ford, D., Storey, M. A., Zimmermann, T., Bird, C., Jaffe, S., Maddila, C., ... & Nagappan, N. (2021). A tale of two cities: Software developers working from home during the covid-19 pandemic. ACM Transactions on Software Engineering and Methodology (TOSEM), 31(2), 1-37.
42. Čavrak, I., Bosnić, I., Ciccozzi, F. and Mirandola, R. Resilience of distributed student teams to stress factors: A longitudinal case-study, Information and Software Technology, 114, 2019, pp 258-274.
43. Hossain, S. S. (2019, July). Challenges and mitigation strategies in reusing requirements in large-scale distributed agile software development: a survey result. In Intelligent Computing-Proceedings of the Computing Conference (pp. 920-935). Springer, Cham.
44. Shameem, M., Chandra, B., Kumar, C., & Khan, A. A. (2019). Impact of requirements volatility and flexible management on GSD project success: A study based on the dimensions of requirements volatility. Int J Agile Syst Manag, 12, 199-227.
45. Ebert, C. Supplier Performance Management: Risk Mitigation and Industry Benchmarks. 2017 IEEE 12th International Conference on Global Software Engineering (ICGSE). 2017, pp. 86-95
46. Britto, R., Šmite, D. and Damm, L. Experiences from Measuring Learning and Performance in Large-Scale Distributed Software Development. ESEM'16: Proceedings of the 10th ACM/IEEE International Symposium on Empirical Software Engineering and Measurement. 2016, 17, pp. 1–6
47. Rubin, J., & Rinard, M. (2016, May). The challenges of staying together while moving fast: An exploratory study. In 2016 IEEE/ACM 38th International Conference on Software Engineering (ICSE) (pp. 982-993). IEEE.
48. Consoli, C., Rocchi, P., & Spagnoletti, P. (2014). An empirical study of offshore software development: The case of a ticketing application. Journal of computing and information technology, 22(4), 267-275.
49. Holtkamp, P. and Pawlowski, J. A Competence-based View on the Global Software Development Process. Journal of universal computer science. 2015, 21(11), pp. 1385-1,404
50. Jabangwe, R., Börstler, J., & Petersen, K. (2015). Handover of managerial responsibilities in global software development: a case study of source code evolution and quality. Software quality journal, 23(4), 539-566.
51. Beecham, S. (2014). Motivating software engineers working in virtual teams across the globe. In Software project management in a changing world (pp. 247-273). Springer, Berlin, Heidelberg.
52. Kiely, G., Finnegan, P. and Butler, T. Managing global virtual teams: An exploration of operation and performance. Pacific Asia Conference on Information Systems, PACIS 2014. 2014.
53. Verner, J., Babar, M., Cerpa, N. Hall, T. and Beecham, S. Factors that motivate software engineering teams: A four country empirical study. Journal of Systems and Software. 2014, 92, pp. 115-127
54. Wagstrom, P., & Datta, S. (2014, May). Does latitude hurt while longitude kills? geographical and temporal separation in a large scale software development project. In Proceedings of the 36th International Conference on Software Engineering (pp. 199-210).
55. Vujdan, E., Thanh-Nam, T., Kai, R. and Lutz, K. The role of motivational factors in distributed software development teams: An empirical investigation. ECIS 2013 - Proceedings of the 21st European Conference on Information Systems. 2013.
56. Anh, N., Pras, D. and Conradi, R. Dispersion, coordination and performance in global software teams: A systematic review. Proceedings of the 2012 ACM-IEEE International Symposium on Empirical Software Engineering and Measurement. 2012, pp. 129-138
57. Li, Y., & Maedche, A. (2012). Formulating effective coordination strategies in agile global software development teams.
58. Piri, A., Niinimäki, T., & Lassenius, C. (2012). Fear and distrust in global software engineering projects. Journal of Software: Evolution and Process, 24(2), 185-205.
59. Wiredu, G. Global Software Development and the Problem of Increased Uncertainties: Information Processing Requirements for Coordination. Journal of global information management. 2012, 20(2), pp.1-24
60. Piri, A., & Niinimaki, T. (2011, August). Does distribution make any difference? Quantitative comparison of collocated and globally distributed projects. In 2011 IEEE Sixth International Conference on Global Software Engineering Workshop (pp. 24-30). IEEE.
61. Sarker, S., Sarker, S. and Jana, D. The impact of the nature of globally distributed work arrangement on work–life conflict and valence: the Indian GSD professionals' perspective. Eur J Inf Syst. 2010, 19, pp. 209–222
62. Šmite, D., & Wohlin, C. (2010, August). Software product transfers: Lessons learned from a case study. In 2010 5th IEEE International Conference on Global Software Engineering (pp. 97-105). IEEE.
63. Mikawa, S. P., Cunnington, S. K., & Gaskins, S. A. (2009, February). Removing barriers to trust in distributed teams: understanding cultural differences and strengthening social ties. In Proceedings of the 2009 international workshop on Intercultural collaboration (pp. 273-276).
64. Summers, M. Insights into an Agile adventure with offshore partners. In Agile 2008 Conference. IEEE. 2008, pp. 333-338
65. Moe, N. and Šmite, D. Understanding lacking trust in global software teams: A multi- case study. Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics). 2007, 4,589 LNCS, pp. 20-34
66. Treinen, J. J., & Miller-Frost, S. L. (2006). Following the sun: Case studies in global software development. IBM Systems Journal, 45(4), 773-783.
67. Gustavsson, T. Team Performance in Large-Scale Agile Software Development. Information Systems Development: Crossing Boundaries between Development and Operations (DevOps) in Information Systems (ISD2021 Proceedings). 2021.

68. Russo, D., Hanel, P. H., Altnickel, S., & van Berkel, N. (2021). Predictors of well-being and productivity among software professionals during the COVID-19 pandemic–a longitudinal study. Empirical Software Engineering, 26(4), 1-63.
69. Anwar, R., Rehman, M., Wang, K. S., Hashmani, M. A., & Shamim, A. (2019). Investigation of knowledge sharing behavior in global software development organizations using social cognitive theory. IEEE Access, 7, 71286-71298.
70. Anwar, R., Rehman, M., Wang, K. S., & Salleh, R. (2018, March). Job Performance Through Knowledge Sharing Behavior in Global Software Development Organizations. In 2018 Fourth International Conference on Information Retrieval and Knowledge Management (CAMP) (pp. 1-5). IEEE.
71. Massago, Y., Leal, G. C. L., Balancieri, R., & Galdamez, E. V. C. (2018). Towards classifying sociocultural aspects in global software development. JISTEM-Journal of Information Systems and Technology Management, 15.
72. Widiyatmoko, C. B., Overbeek, S. J., & Brinkkemper, S. (2017, October). Methodological support for coordinating tasks in global product software engineering. In OTM Confederated International Conferences" On the Move to Meaningful Internet Systems" (pp. 213-231). Springer, Cham.
73. Czekster, R. M., Fernandes, P., Lopes, L., Sales, A., Santos, A. R., & Webber, T. (2016). Stochastic performance analysis of global software development teams. ACM Transactions on Software Engineering and Methodology (TOSEM), 25(3), 1-32.
74. Manoj Ray, D., & Samuel, P. (2016). Improving the productivity in global software development. In Innovations in Bio-Inspired Computing and Applications (pp. 175-185). Springer, Cham.
75. Mishra, D., & Mahanty, B. (2016). A study of software development project cost, schedule and quality by outsourcing to low cost destination. Journal of Enterprise Information Management.
76. Prikladnicki, R., Perin, M., & Marczak, S. (2016, September). Virtual Team Configurations that Promote Better Product Quality. In Proceedings of the 10th ACM/IEEE International Symposium on Empirical Software Engineering and Measurement (pp. 1-5).
77. Nguyen-Duc, A., Cruzes, D. and Conradi, R. The impact of global dispersion on coordination, team performance and software quality – A systematic literature review. Information and Software Technology. 2015, 57, pp. 277-294
78. Shrivastava, S. V., & Rathod, U. (2015). Categorization of risk factors for distributed agile projects. Information and Software Technology, 58, 373-387.
79. Bergadano, F., Bosio, G., & Spagnolo, S. (2014). Supporting collaboration between customers and developers: a framework for distributed, agile software development. International Journal of Distributed Systems and Technologies (IJDST), 5(2), 1-16.
80. Colomo-Palacios, R., Casado-Lumbreras, C., Soto-Acosta, P., Garcia-Peñalvo, F. and Tovar, E. Project managers in global software development teams: a study of the effects on productivity and performance. Software Qual J. 2014, 22, pp. 3–19
81. Fagerholm, F., Guinea, A. S., Borenstein, J., & Münch, J. (2014). Onboarding in open source projects. IEEE Software, 31(6), 54-61.
82. Langer, N., Slaughter, S. A., & Mukhopadhyay, T. (2014). Project managers' practical intelligence and project performance in software offshore outsourcing: A field study. Information Systems Research, 25(2), 364-384.
83. Licorish, S and MacDonell, S. Personality profiles of global software developers. 2014. EASE'14: Proceedings of the 18th International Conference on Evaluation and Assessment in Software Engineering, 45, pp. 1-10
84. Brooks, I., & Swigger, K. (2013, October). Leadership's effect on overall temporal patterns of global virtual teams. In 9th IEEE International Conference on Collaborative Computing: Networking, Applications and Worksharing (pp. 371-379). IEEE.
85. Calefato, F., Lanubile, F. and Sportelli, F. Can Social Awareness Foster Trust Building in Global Software Teams?. Proceedings of the 2013 International Workshop on Social Software Engineering. 2013, pp. 13-16
86. Tervonen, I., Haapalahti, A., Harjumaa, L. and Similä, J. Outsourcing Software Testing: A Case Study in the Oulu Area. 2013 13th International Conference on Quality Software. 2013, pp. 65-74
87. Fernandez-Sanz, L., Misra, S. Analysis of cultural and gender influences on teamwork performance for software requirements analysis in multinational environments. IET Software. 2012, 6(3), pp. 167–175
88. Ranganathan, C., & Alfaro, I. (2011). Project Performance in Global Software Development Teams: Do Prior Work Ties and Nationality Diversity Matter?.
89. Ramasubbu, N., Cataldo, M., Balan, R. and Herbsleb, J. Configuring global software teams: a multi-company analysis of project productivity, quality, and profits. 2011 33rd International Conference on Software Engineering (ICSE). 2011, pp. 261-270
90. Shah, H., Harrold, M. J., & Nersessian, N. J. (2011, August). Studying the influence of culture on outsourced, offshored software-testing practice: an ethnographic approach. In 2011 IEEE Sixth International Conference on Global Software Engineering Workshop (pp. 105-107). IEEE.
91. Tamburri, D. and Lago, P. Supporting Communication and Cooperation in Global Software Development with Agile Service Networks. Software Architecture. 2011, pp. 236-243
92. Tihinen, M., Parviainen, P., Suomalainen, T., Karhu, K., & Mannevaara, M. (2011, August). ABB experiences of boosting controlling and monitoring activities in collaborative production. In 2011 IEEE Sixth International Conference on Global Software Engineering (pp. 1-5). IEEE.
93. Piri, A., Niinimaki, T., & Lassenius, C. (2009, July). Descriptive analysis of fear and distrust in early phases of GSD projects. In 2009 Fourth IEEE International Conference on Global Software Engineering (pp. 105-114). IEEE.

94. Setamanit, S. O., & Raffo, D. (2008, May). Identifying key success factors for globally distributed software development project using simulation: A case study. In International Conference on Software Process (pp. 320-332). Springer, Berlin, Heidelberg.
95. Damian, D., Lanubile, F. and Mallardo, T. On the Need for Mixed Media in Distributed Requirements Negotiations. IEEE Transactions on Software Engineering. 2008, 34(1), pp. 116-132
96. Shachaf, P. Cultural diversity and information and communication technology impacts on global virtual teams: An exploratory study. Information & Management. 2008, 45(2), pp. 131-142
97. Espinosa, J. A., Nan, N., & Carmel, E. (2007, August). Do gradations of time zone separation make a difference in performance? A first laboratory study. In International Conference on Global Software Engineering (ICGSE 2007) (pp. 12-22). IEEE.
98. Kommeren, R., & Parviainen, P. (2007). Philips experiences in global distributed software development. Empirical Software Engineering, 12(6), 647-660.
99. Ramasubbu, N., & Balan, R. K. (2007, September). Globally distributed software development project performance: an empirical analysis. In Proceedings of the 6th joint meeting of the European software engineering conference and the ACM SIGSOFT symposium on The foundations of software engineering (pp. 125-134).
100. Ribeiro, M., Czekster, R. and Webber, T. Improving productivity of local software development teams in a global software development environment. 2006 IEEE International Conference on Global Software Engineering, ICGSE 2006, pp. 253-254. isar
101. Marinho, M., Camara, R., & Sampaio, S. (2021). Toward Unveiling How SAFe Framework Supports Agile in Global Software Development. IEEE Access, 9, 109671-109692.
102. Ozkaya, I. The Future of Software Engineering Work. IEEE Software. 2021. 38(5), pp. 3-6.
103. Akbar, R., Khan, A. R., & Adnan, K. (2020). Software development process evolution in Malaysian companies. In Data Management, Analytics and Innovation (pp. 139-150). Springer, Singapore.
104. Alzoubi, Y. I., & Gill, A. Q. (2020). An empirical investigation of geographically distributed agile development: The agile enterprise architecture is a communication enabler. IEEE Access, 8, 80,269-80,289.
105. Feitoza Gonçalves, W., Farias Junior, I. D., Paulo Alves, R. K. D., Saraiva Barbosa, P. L., Ribeiro Parente Cortez, H., Bezerra de Oliveira, I., ... & Leitão Júnior, N. (2016, November). Using agile methods in distributed software development environments. In Brazilian Workshop on Agile Methods (pp. 16-27). Springer, Cham.
106. Šmite, D., Britto, R., & Van Solingen, R. (2017, May). Calculating the extra costs and the bottom-line hourly cost of offshoring. In 2017 IEEE 12th international conference on Global Software Engineering (ICGSE) (pp. 96-105). IEEE.
107. Lima, A. M., Reis, R. Q., & Reis, C. A. L. (2015, May). Empirical evidence of factors influencing project context in distributed software projects. In 2015 IEEE/ACM 2nd International Workshop on Context for Software Development (pp. 6-7). IEEE.
108. Razzak, M. A., Bhuiyan, T., & Ahmed, R. (2014). Knowledge management in distributed agile software development projects. In IFIP International Workshop on Artificial Intelligence for Knowledge Management (pp. 107-131). Springer, Cham.
109. Al-qadhi, M., & Keung, J. (2014, November). Cloud-based support for global software engineering: Potentials, risks, and gaps. In Proceedings of the International Workshop on Innovative Software Development Methodologies and Practices (pp. 57-64).
110. Daniel, S., Agarwal, R. and Stewart, K. The Effects of Diversity in Global, Distributed Collectives: A Study of Open Source Project Success. Information Systems Research. 2013, 24(2), pp. 312-333
111. Marczak, S., & Gomes, V. (2013, May). On the development of a theoretical model of the impact of trust in the performance of distributed software projects. In 2013 6th International Workshop on Cooperative and Human Aspects of Software Engineering (CHASE) (pp. 97-100). IEEE.
112. Vizcaíno, A., García, F., Villar, J. C., Piattini, M., & Portillo, J. (2013). Applying Q-methodology to analyse the success factors in GSD. Information and Software Technology, 55(7), 1,200-1,211.
113. Huzita, E. H. M., Leal, G. C. L., Balancieri, R., Tait, T. F. T. C., Cardoza, E., de Moura Penteado, R. R., & Vivian, R. L. (2012, August). Knowledge and contextual information management in global software development: Challenges and perspectives. In 2012 IEEE seventh international conference on global software engineering workshops (pp. 43-48). IEEE.
114. Šteinberga, L., & Šmite, D. (2011, August). Towards understanding of software engineer motivation in globally distributed projects. In 2011 IEEE Sixth International Conference on Global Software Engineering Workshop (pp. 117-119). IEEE.
115. Zhang, S., Köbler, F., Tremaine, M., & Milewski, A. (2012). Instant messaging in global software teams. In Advancing Collaborative Knowledge Environments: New Trends in E-Collaboration (pp. 158-179). IGI Global.
116. Lima, A. M. (2010, May). Risk assessment on distributed software projects. In 2010 ACM/IEEE 32nd International Conference on Software Engineering (Vol. 2, pp. 349-350). IEEE.
117. Oshri, I., Fenema, P. C. V., & Kotlarsky, J. (2008). Knowledge transfer in globally distributed teams: the role of transactive memory. In Knowledge processes in globally distributed contexts (pp. 24-52). Palgrave Macmillan, London.
118. Egan, R. Tremaine, M., Fjermestad, J., Milewski, A. and O'Sullivan, P. Cultural Differences in Temporal Perceptions and its Application to Running Efficient Global Software Teams. 2006 IEEE International Conference on Global Software Engineering (ICGSE'06). 2006, pp. 55-61