A systematic literature review to identify human related challenges in globally distributed agile software development: towards a hypothetical model for scaling agile methodologies

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***Abstract*—Currently, software organizations are implementing agile methodologies in global software development (GSD) because of low development cost, schedule and high quality product. However, GSD project is complex undertaken because of it distributed dimensions especially when the agile methodologies are concerned. The objective of this study is to identify the human related factors that can negatively influence agile practices in GSD organizations, and proposed a hypothetical model of the identified challenges related to the scaling agile methodologies. A Systematic Literature Review (SLR) method was used to identify the challenges. In the findings, a total of eleven challenges were identified using SLR. This study also reported the Critical Challenges (CChs) for scaling agile methodologies using a criterion of the challenges having a frequency $\geq$ 50%. Findings reported the six out of eleven challenges as critical challenges in scaling agile methods. Based on the identified challenges, a hypothetical model was presented that is highlighted a relationship between identified challenges and the implementation of agile methodologies in GSD environment.**

***Index Terms*—Agile development, Scaling, Human related challenges, Global software development, Systematic literature review**

I. Introduction

Presently, agile methodologies has become a tempting option for the software development organizations in order to manage highly volatile behaviour of development activities [1], [2]. Agile development was initially proposed for small project to help software firms to overcome the limitation of traditional (i.e. waterfall model) approaches [3], [4]. Agile methods follows iterative and incremental software engineering methods using small development cycle. Different agile software development approaches have been developed and the most commonly used methods are: extreme programming (XP), crystal, SCRUM, adaptive software development (ASD), feature driven development (FDD), and dynamic system development method (DSDM) [1], [2], [5]. The modern software organizations are currently working under tight schedule and low development cost. Therefore, agile methodologies are being adopted by the organizations for software development in order to deliver a quality software that fulfil customer needs and a faster development than traditional approaches [3], [4]. Due to increasing trend of implementing agile process, organizations adopting agile manifesto in global software development (GSD) [6]–[8].

Various models and standards have been designed by the organizations to assess their strength of implementing agile programs in large agile projects [5], [9]. Scaled Agile Framework (SAFe) designed to provide the procedure for adopting agile to the large scale enterprises [5], [10]. Agile process maturity model (APMM) developed by IBM to scale practices of the existing agile methodologies to the large software projects [10]. Similarly, distributed agile delivery (DAD) has also been developed for scaling scrum practices for large-sized organizations. These models and frameworks enable the software firms for the development a high quality product, low cost and time development and user satisfaction [10]. However, various models and frameworks are developed, but the success rate of agile development in distributed environment is still low. Paasivaara et al. [10] reported failure rate of agile projects in GSD is 71%. One of the primary concern of this unsuccessful completion of the agile projects is limited attention has been given to the scaling programs of agile methods by the organizations.

Nevertheless, limited attention has been paid to develop the model and standards to scale agile methods in the GSD context, which resulted as a limited success of agile development in GSD [7], [11]. Global software development (GSD) is a paradigm that provides various benefits including access to large pool of specialized workforces, low labour cost and round the clock development [7], [8]. GSD is carried out by teams positioned in different locations around the globe, developing commercially viable software systems [2]. GSD offers multiple advantages such as reduction in development time and cost, high ratio of team productivity, improvement in workforces skills and access to market for both client and vendor organizations, which facilitates the software organizations

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for applying agile practices in the distributed environment to get the key benefits of these two approaches [7], [10].

However, the development of the model and standard in general and the findings of the factors affecting the agile methods in GSD have received limited attention. [2], [12]. The growing trend of agile development in GSD encouraged us to develop an Agile Software Process Scaling and Management Model(ASPSMM) that can help GSD organizations improve their practices and management approaches for scaling agile methods. The first step to develop this model is discussed in this research. In our study, the factors related to human aspect that could have negative impact on scaling agile programs in GSD context have been identified.

According to Paasivaara et al. [10] all the individuals involved in agile development must be collaborated by intense interactions unlike in the traditional software approaches. In an agile process, development activities are carried out by individuals that enable rich communication between customers, developers, managers and testers, contrary to the waterfall model [10], [13]. In agile development, large size organizations struggle more than small and medium size organizations were believed as agile usually relied on individuals. Hence, large size organizations should properly manage human related challenges in globally distributed agile development.

In this study, findings by using our systematic literature review (SLR) have been discussed and provide a detailed overview of the human related factors that negatively affects the implementation of agile development in GSD [9], [14]. Understanding of these challenges can assist the GSD organizations to address key human related challenges before the implementation of agile methods in a distributed context. In this study, we are looking to answer the following research questions (RQs):

RQ1: What are the human related challenges, as identified in literature, do software firms need to focus to implement agile in GSD context?

RQ2: What are the most critical human related challenges which need to be focused for scaling agile in GSD?

RQ3: How a hypothetical robust model can develop for human related challenges for scaling programs of agile manifesto in GSD?

The rest of the article is as organized: in section II, research methodology is discussed. The results of the study are briefly reported in section III. In section IV, limitations of the study are discussed. Finally conclusions and future direction of the study are presented in section V.

II. RESEARCH DESIGN

In order to identify the factors that negatively affects scaling agile programs in GSD environment, We have chosen a systematic review of the literature (SLR). An SLR is a type of secondary study that reviews all primary studies (i.e. those explore to a specific research area) to identify, analyze, and explore all the evidences with reference to the specific research questions [4], [12]. According to the Kitchenham [15], SLR is performed in three different phases including planning, conducting and reporting the review as shown in Figure 1. SLR has been considered in a variety of domain by various researchers [8], [12], [16].

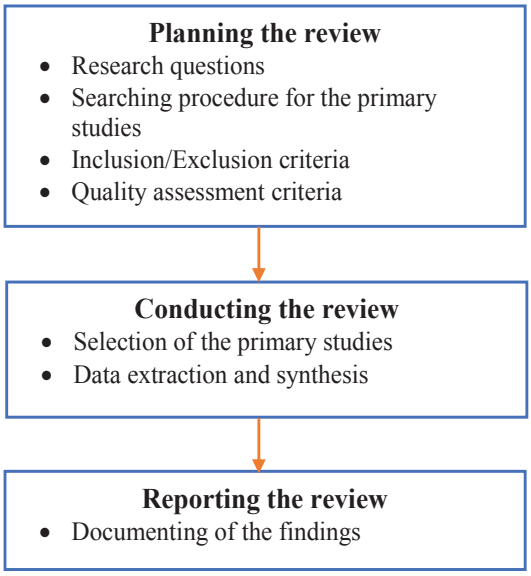

Fig. 1. Phases of the SLR

A. Planning of the review

In the planning phase of the SLR, a comprehensive guideline for research questions, search procedures, inclusion and exclusion criteria and quality assessment was developed [15].

1) Research questions: In section 1, we have described the research questions developed in this study.

2) Searching procedure for primary studies: A complete searching process was conducted to search relevant articles addressing to our research questions. In search process, keywords and their related words were selected from literature in the domain of agile and distributed environment. We have used Boolean operators such as OR and AND were adopted and the search strings were made in order to identify the primary studies by searching them in different digital databases [2], [15].Table I presents the search strings and digital databases in order to find the primary studies. Based on our research experience and suggestions provided by the various researchers, a total six databases were selected, i.e., IEEE, Google Scholar, John Wiley, Science Direct and ACM. We have selected libraries were chosen based on related studies [2], [12], [16]. The selected databases are different in terms of their searching capabilities, hence, articles were searched accordingly [15].

3) Inclusion and exclusion criteria: The articles were selected for primary study using the following inclusion and exclusion criteria proposed by Khan et al. [7].

a) Inclusion criteria:

- Article must be available in full text and written in English language.
- Articles must be journal, conference, magazine and book chapters.

TABLE I
SEARCHING KEYWORDS AND DIGITAL DATABASES

Search strings	("Challenges" OR "hurdles" OR "Factor" OR "Difficulties" OR "Human related challenges" OR "Parameters" OR "Motivators" OR "Hurdles" OR "Variables" OR "Characteristics" OR "Barriers") AND ("Offshore development" OR "Global software development" OR "Multi-site development" OR "Global outsourcing") AND ("Agile" OR "Kanban" OR "Extreme Programming" OR "XP" OR "SCRUM" OR "Agile", OR "ASD", OR "DASD", OR "GDASD")
Digital databases	(1) ACM digital library (https://dl.acm.org/), (2) IEEE explorer (https://ieeexplore.ieee.org), (3) John wiley (https://www.wiley.com), (4) Science direct (https://www.sciencedirect.com), (5) Springer link (https://link.springer.com) (6) Google Scholar (https://scholar.google.co.in/)

- All the selected articles must be published including year 2001 and onwards.
- Studies should be focused on human related challenges distributed agile development.

b) Exclusion criteria:

- Distributed agile development are not discussed in the articles.
- Articles written except for English language.
- Unpublished project, master thesis and Ph.D thesis.
- Articles other than software development like civil engineering.
- Duplicity in the articles.

4) Quality assessment of primary studies: According to Kitchenham [15], quality assessment is important to select the articles for primary studies. In our study, a total of five questions (as shown in Table II) were used as a quality criteria (QC) to evaluate how well the selected papers define the quality of the papers. To evaluate the total quality score of each articles, we have used three point criteria as follows: Yes (Y): 1, No (N) = 0, Partial (P) = 0.5. After adding individual score each article, a total quality score was computed. If the total quality score was found to be greater than equal to 3, it is considered as a good quality paper and included in the primary study.

TABLE II
QUALITY ASSESSMENT

S.no	**Quality assessment criteria**	**Final score**
QC1	Are readers able to understand the research motive?	N = 0, P = 0.5, Y= 1
QC2	Does the findings clearly discuss about distributed agile development?	N = 0, P = 0.5, Y= 1
QC3	Is the study discussing any challenges in an agile distributed environment?	N = 0, P = 0.5, Y= 1
QC4	Are the logical arguments well-presented and justified in the articles?	N = 0, P = 0.5, Y= 1
QC5	Are the findings of the study related with the intended research questions?	N = 0, P = 0.5, Y= 1

B. Conducting the review

In the following sections, various steps while conducting the review process are discussed.

1) Selecting the primary studies: The relevant articles were selected after applying the search string as discussed in section 2.1.2. The whole searching process was conducting in four sequential phases as given in Table III. In first phase (P1), total 1375 articles were extracted after applying the search strings. After reading the title and abstract and applying inclusion and exclusion criteria on the papers selected in phase 2 (P2). We have selected 608 papers followed by the phase 3 (P3) in which the 73 articles were selected after reading the introduction and conclusion section. In phase 4 (final phase), 18 paper were finally selected after reading whole text of the papers selected in phase 3. The quality of the selected articles was computed using the quality assessment criteria as shown in Table III. The QA score for each primary study is available through the link https://goo.gl/rgmnje.

TABLE III
RESULTS OF THE SELECTION PROCESS

Digital libraries	**P1**	**P2**	**P3**	**Final pahse**	**%**
Science direct	310	183	11	5	28
IEEE	315	205	31	5	27
ACM	85	41	8	2	11
Springer	120	65	12	2	11
John Wiley	65	31	8	2	11
Google scholar	480	82	3	2	10
Total	1375	608	73	18	100

2) Data extracting and synthesis: We obtained the title, type of study and quality score of the selected primary studies listed in Appendix A that is available through the link https://goo.gl/rgmnje.

III. RESULTS: REPORTING THE REVIEW

We discussed the results of the study in the following sections to answer the research questions described in section I.

A. RQ1 (Human related challenges for scaling agile methodologies)

To address the RQ1, a total of 18 primary studies were selected in the SLR and 11 challenges related to human were identified from these studies for scaling agile methodologies. Table IV and Figure 2 shows the identified eleven challenges, and briefly discussed thereafter.

1) Lack of Effective Requirements Analysis (Ch1): Although some agile methods have quite structured approach to requirements analysis i.e. Scrum which was widely accepted approach. In agile manifesto, customer involvement plays an important role specifically for the requirements analysis [PS1, PS2]. When agile method is used in the GSD environment, many studies have reported that the problems occur due to the distributed dimensions which as a results creates the difficulties in customers and their representative not adequately involve in the system development [17]. Difficulties in customer involvement increase the requirements related issues

TABLE IV
SEARCHING KEYWORDS AND DIGITAL DATABASES

S.no	Challenges	Frequency	%
Ch1	Lack of effective requirements analysis	10	56
Ch2	Lack of customer involvement	15	83
Ch3	Lack of communication	17	88
Ch4	Lack of scaling agile awareness	6	33
Ch5	Lack of roles and responsibilities	9	50
Ch6	Lack of commitment	13	72
Ch7	Lack of knowledge sharing	10	56
Ch8	Lack of agile expertise	8	44
Ch9	Lack of Training	5	27
Ch10	Lack of cooperation	5	27
Ch11	Lack of motivation	7	38

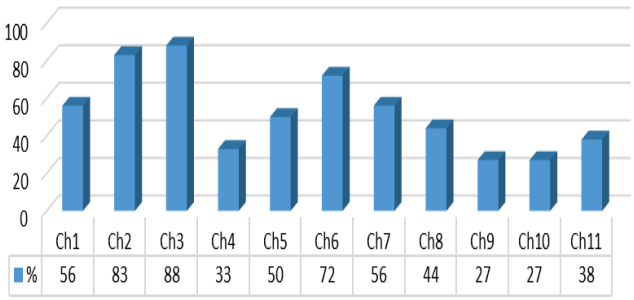

Fig. 2. Challenges with their frequency analysis

[PS1]. The lack of effective requirement analysis directly relates to success of the agile projects in a GSD environment. Hence we proposed the following hypothesis:

H1: *Lack of effective requirements analysis has a negative relationship with the scaling program of agile methodologies in GSD.*

2) Lack of Customer Involvement (Ch2): The role of customer involvement is limited in traditional (i.e waterfall model) approaches that provide to gather system requirements, which are conducted in the beginning of development. In the agile development, Hoda et al. [PS1] discussed the importance of customer involvement and reported that the success of various activities (i.e. requirements gathering) in agile development significantly depends on the involvement of customer. In agile methodologies, the customer role and their responsibilities are expanded by involving them in the project life cycle. Various activities such as developing user stories, product features and their prioritizations, and rapid feedback are carried out by continuously involving customer unlike traditional development [PS2, PS4]. Hence, we come up the following hypothesis.

H2: *Lack of customer involvement has a negative impact with the scaling program of agile methodologies in GSD.*

3) Lack of Communication (Ch3): Ch3 (lack of communication) was found to be a second first most significant factor that negatively influence scaling programs of agile methodologies in a geographically distributed environment. Yage, and Agustin, et al. [PS5] reported that communication is a most important factor which has a direct impact on success of agile development. In co-located environment, the synchronous communication is used by the team members to interact face-to-face in order to exchange knowledge and project related documents [PS6]. However, GSD is different from the co-located process in terms of geographic distance, cultural distance, and time zones [18]. Hence, the following hypothesis is structured.

H3: *Lack of communication has a negative impact with the scaling program agile methodologies in GSD.*

4) Lack of Scaling Agile Awareness (Ch4) : Yage, Agustin et al. [PS6] explained lack of scaling agile awareness as the degree to which the top management takes the initiatives of scaling agile in GSD certification and provides training opportunities to the team members. Implement agile development in GSD is the practice of deployment new approaches in an organization [PS4]. Moreover, it could be important to motivate their development staff to conduct and participate in the awareness sessions related to scale agile programs. Therefore, we have developed the following hypothesis.

H4: *Lack of scaling agile awareness has a negative relationship with the scaling program of agile methodologies in GSD.*

5) Lack of Roles and Responsibilities (Ch5): Hoda et al. [PS1] discussed about the roles and responsibilities assigned to agile team members which can support agile practitioners for successfully completing their task in the distributed environment. The roles and responsibilities in agile development should be clearly defined. Lack of understanding about role and responsibilities may occur confusion between the team members which can lead to the unsuccessful completion of agile project [PS8]. Therefore, we hypothesize that

H5: *Lack of role and responsibility has a negative relationship with the scaling program of agile methodologies in GSD.*

6) Lack of Management Commitment (Ch6): Around 50% of the selected articles reported the importance of management commitments in globally distributed agile development. Paasivaara et al. [PS4] indicated that the organizational management commitments plays an important role in the successful implementation of agile practices in GSD environment. Khan et al. [16] defined the management commitment as the degree to which the lower and higher level management in an organization financially support to mitigate the significant challenge that undermine the implementation of agile development in a distributed projects.

H6: *lack of management commitment has a negative relationship with the scaling program of agile methodologies in GSD.*

7) Lack of Knowledge Sharing (Ch7) : Information sharing is defined by Niazi et al. [11] "as a degree how the distributed team members communicate and coordinate to share information among themselves in the development process". Rathod et al. [PS2] reported lack of information sharing among the developers located across the different geographical locations could not assist to successfully execute agile practices. Hence the following hypothesis is developed:

H7: *Lack of knowledge sharing has a negative relationship with the scaling program of agile methodologies in GSD.*

8) Lack of Agile Expertise (Ch8) : Paasivaara et al. [PS4] defined agile expertise as the extent to which individuals can achieve specific project goals in the scaled environment. According to Hoda [PS1], the success of agile programs in GSD environment depends on the team members who expertise in agile. More specifically, if the development staff has lack of knowledge and awareness about the scaling of agile methodologies, then there is more chance of not implementing agile successfully which as a result may end project failure and frustration. Hence the following hypothesis is developed:

H8: *Lack of agile expertise has a negative relationship with the scaling program of agile methodologies in GSD.*

9) Lack of Training (Ch9) : Ch9 (lack of training) was also reported as an important (44%) human related challenge to scale agile methodologies in GSD. Shrivastava and Rathod et al. [PS2] indicated that implementing agile programs in a distributed environment can be ineffective if the organizations have not conducted adequate training sessions. Lack of training can also undermine the entire scaling programs of agile development in GSD context. Paasivaara et al. [PS15] found that all of the people involved in a distributed agile program require a complete understanding of agile principles, scaling standards, models such as DAD, CMMI and SAFe, and software quality.

H9: *Lack of training has a negative relationship with the scaling program of agile methodologies in GSD.*

10) Lack of Cooperation (Ch10) : The results reveals Ch10: lack of cooperation as a significant factor that plays an important role for scaling agile development in GSD environment. Various researchers have discussed the significance of cooperation among the stakeholders in agile development activities. Steinberga and Smite [PS16] emphasized on the cooperation between the agile practitioners. They considered lack of cooperation as a most important challenge between the agile developers for scaling agile development in GSD industry. Therefore, we hypothesize that

H10: *Lack of cooperation has a negative relationship with the scaling program of agile methodologies in GSD.*

11) Lack of Motivation (Ch11) : Beecham et al. [19] described motivation as a source of performance improvement which can enhance the productivity gains through effective teamwork in which team members' act selflessly. According to Steinberga,& Smite [PS16], motivation is considered as a largest influencing factor that enhance the quality and productivity of an individual or a software development team. In their survey study, Peterson [18] reported lack of motivation as a one of the most significant factor that negatively cause agile software development project failure. Hence, we followed the following hypothesis.

H11: *Lack of motivation has a negative relationship with the scaling program of agile methodologies in GSD.*

B. RQ2 (Critical Challenges)

The idea of critical factors was introduced by Niazi et al [12] to evaluate key findings where the organizations should focus to achieve specific business goals. Giving a lack of attention on critical challenges can reduce the business performance. The critical factors depend on the position of individual within an organization and geographical location of managers, so these could be differ due to the geographical location of team members. Critical challenges may also differ with the passage of time [8], [9]. We have considered following criteria to evaluate critical challenges:

- If a factor has a frequency $\geq$ 50% in the literature then it can be considered as a critical factor.

The above criteria was considered by many researchers in a variety studies [12], [16]. Using the above mentioned criterion, a total of six critical challengers were evaluated which are as follows: Ch1: lack of requirements analysis (56%), Ch2: lack of customer involvement (83%), Ch3: lack of communication (88%), Ch5: lack of roles and responsibilities (50%), Ch6: lack of management commitments (72%) and Ch7: lack of knowledge sharing (56%). The identified challenges were labelled as critical challenges because they satisfied the condition of critical challenges ($\geq$50%).

C. RQ3 (Hypothetical model based on human related challenges)

In Figure 3, a hypothetical model was developed based on the challenges reported in Table IV. The model is developed using the identified eleven challenges and their relationship with scaling programs of agile development as discussed in section 3.1. We have used eleven independent variables (i.e. the reported challenges in Table IV) and dependent variable (i.e human based model for scaling agile development) to construct our proposed hypothetical model. In addition, one more variable such as organizational size (moderating variable) was also included in our proposed model. The purpose of moderating variable is to analyze the similarity and differences between the independent variables on the dependent variables. Based on the literature discussed [1], [10], [13], the small, medium and large organizations have operational differences. Small and medium- sized organizations focus more on agile practices, but large organizations are more concerned with formal approaches to development [10]. To the best of our knowledge, no systematic attempt was made to investigate whether small, medium and large software organizations scale agile programs differently [16]. Hence, it would explore some interesting findings when the organizational size is verified on agile development in GSD context. Hence, the following hypothesis is developed.

H12: *The reported challenges influence agile practices to the greater extent in large organization than small and medium organizations.*

IV. LIMITATIONS

A possible threat is related to the construct validity in this study. Construct validity refer to that specifically whether a test measures the intended construct [16]. The challenges identified in our study were obtained from an extensive body of literature and a through discussions practitioners. The discussions with practitioners indicated that all of the identified challenges were

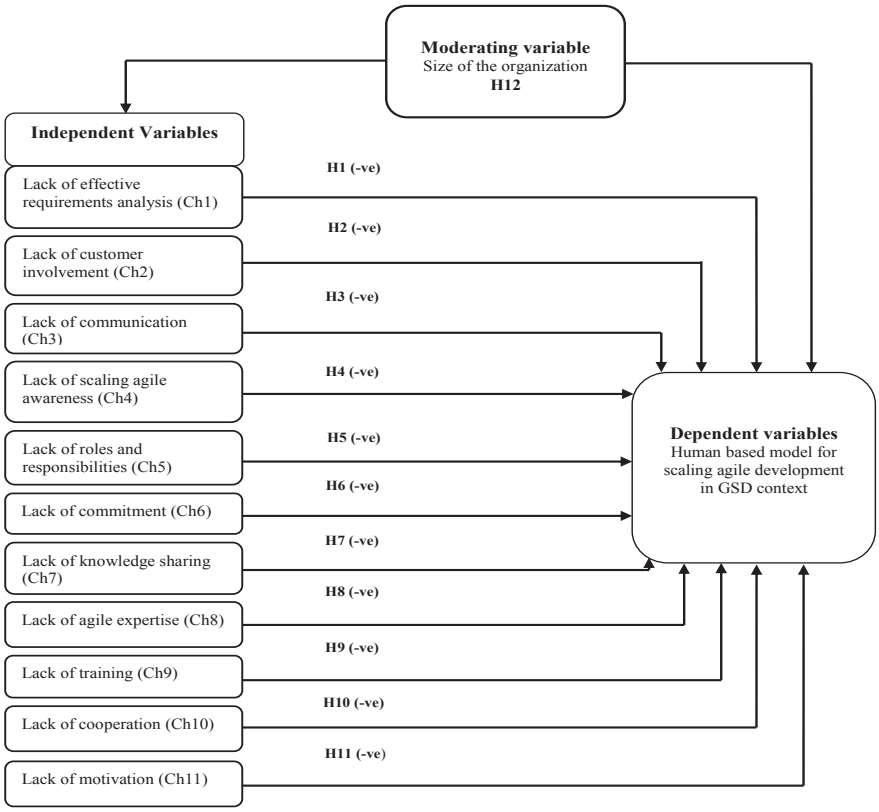

Fig. 3. Proposed hypothetical model

encountered in their work. One of the limitation is related to its content validity. In our study, we have limited the scope of SLR to the five digital libraries (IEEE, ACM, Springer, Science Direct, John Wiley and Google Scholar) and used limited search strings. Due to large number of publications and different search mechanism, there could be search string have missed some other relevant articles. But it was not a systematic omission. To overcome this limitation, we will performed a snowball sampling approach for selecting more primary studies after applying more relevant search string and other digital databases. Almost all the selected studies were conducted by authors who comes from academia. They might have a lack of depth understanding about recent advancement for scaling agile methodologies. To overcome this limitation, we intended to conduct an empirical study in future from industries to assess the validation of the identified challenges.

V. CONCLUSIONS AND FUTURE WORK

Nowadays, software organizations are currently adopting agile methodologies in the domain of GSD in order to efficiently develop a software product. The increasing trend of combining agile and GSD motivated us to identify human related factors that negatively affect scaling program of agile in GSD. An SLR approach was followed and 18 research studies related to the distributed agile process were selected. A total of 11 human related challenges were identified from the selected primary studies. In the identified eleven challenges, total six challenges were evaluated as most critical challenges. These critical challenges can be considered as guide for agile practitioners to scale effectively agile methods in the GSD environment. The critical challenges presents key areas which have much more impact on scaling agile programs as compare to other identified challenges. Moreover, a hypothetical model was developed based on the identified challenges and their relationship with the scaling agile in GSD are discussed in literature. The authors believe that the outcomes of our study can possibly acts as a knowledge base for GSD organizations to successfully complete agile projects and their progression in the GSD context.

We have mentioned the following topics as the future direction of this study.

- Identify the human related factors that positively affects agile practices in GSD.
- Empirical validation of the challenges by conducting survey from the GSD organizations.
- Empirical assessment of the hypothetical model in order to test the hypotheses developed in this study by questionnaire study conducted with the agile and GSD experts.
- Investigation practices for addressing the human related challenges in scaling agile development.

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