IEEE Access
Multidisciplinary ⋮ Rapid Review ⋮ Open Access Journal

Received 12 July 2023, accepted 24 July 2023, date of publication 1 August 2023, date of current version 18 September 2023.

Digital Object Identifier 10.1109/ACCESS.2023.3300836

RESEARCH ARTICLE

The Impact of Mitigation Strategies for Socio-Cultural Distance Issues in GSD: An Empirical Study

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ABSTRACT Global Software Development (GSD) offers several benefits to software development organizations, including reduced development costs, the availability of low-wage and highly skilled employees, and an improved marketplace. Meanwhile, it faces severe communication, coordination, and control issues. The most important of these is the communication issue which is further categorized into socio-cultural, temporal, and geographical issues. Among these issues, researchers believe the socio-cultural issue is the most critical factor and, if not mitigated properly, may lead to software project failure. Although, in the past, many studies have identified socio-cultural distance-related issues, and a few studies proposed mitigation strategies. However, studies have yet to be carried out to prioritize and empirically evaluate all mitigation strategies. Thus the main objectives of this study are: a) to identify socio-cultural distance issues and mitigation strategies through a Systematic Literature Review (SLR), b) to empirically evaluate the impact of identified mitigation strategies on identified socio-cultural distance issues through a survey, and c) to prioritize effective mitigation strategies through a recommended Analytical Hierarchy Process (AHP). A total of six socio-cultural issues and twenty-eight mitigation strategies are identified from the SLR and survey. Out of which, seven mitigation strategies are most effective. This study's findings will help software organizations to overcome socio-cultural distance issues by using the highest priority mitigation strategies to reduce losses.

INDEX TERMS Analytical hierarchy process, communication issues, distributed software development, empirical evaluation, global software development, mitigation strategies, socio-cultural distance issues, survey, systematic literature review.

I. INTRODUCTION

Global Software Development, Dispersed Software Development, Global Software Engineering, and Distributed Software Development are terminologies used to refer to the development of software applications in distributed environments [1], [2]. GSD benefits include reducing software development costs by delegating work to countries with low labor costs, access to a talented workforce, knowledge and resource transfer, rapid innovation, better-quality software, and increased productivity [2]. GSD-based software development companies in India, China, Pakistan, and Thailand provide low-cost software to developed countries of America and Europe [3]. Meanwhile, GSD faces challenges/risks/issues threatening the industry's prospects [4].

Aside from the benefits mentioned above, physical separation, less overlapping, language barrier, and cultural differences among team members may negatively impact GSD,

The associate editor coordinating the review of this manuscript and approving it for publication was Fabrizio Messina.

resulting in three significant challenges: communication, coordination, and control [5]. Communication issues have the most negative impact on GSD, and it costs billions of dollars yearly [6]. For instance, according to the Holmes Report [7], this issue cost around 37 billion euros. According to another study in which a survey is conducted of 400 organizations. It was found that the average corporation lost 62.4 million dollars per year due to poor communication among GSD teams [7].

Communication challenge being the most significant one, [8], [9], [10] is the major reason for software project failure [11], thus, obstructing the effective utilization of GSD benefits [12]. Communication challenges are further, categorized into 1) Socio-Cultural Distance, 2) Geographical Distance, and 3) Temporal Distance [12]. Authors in different studies [13], [14], [15], [16] claimed that socio-cultural distance is the most critical challenge that affects communication among dispersed teams. Therefore, it is necessary to look for mitigation strategies to reduce the effect of socio-cultural distance risk [17]. To counter socio-cultural challenges, researchers in [17], [18], and [19] suggested many mitigation strategies but did not evaluate their impact on socio-cultural distance issues. Due to time and budget constraints, an organization cannot implement multiple mitigation strategies. Therefore, researchers believe there is a need to prioritize mitigation strategies based on their effectiveness

Based on the issues mentioned above, this study aims: a) to identify socio-cultural distance issues and mitigation strategies through a Systematic Literature Review (SLR), b) to empirically evaluate the impact of identified mitigation strategies on identified socio-cultural distance issues through a survey, and c) to prioritize effective mitigation strategies through a recommended Analytical Hierarchy Process (AHP). Moreover, a conceptual framework was proposed to evaluate the identified socio-cultural distance issues, such as cultural differences, language differences, lack of mutual understanding, etc.

The rest of the paper is organized as follows. Section II provides recent literature on socio-cultural distance issues and their mitigation strategies. Section III presents the research methodology of this study. Section IV describes the results and analysis of the empirical study and the application of AHP. Following the results of this study in section V, a detailed discussion is given. Section VI provides study limitations and section VII presents conclusion and future work.

II. RELATED WORK

In this section, the related work of previous studies has been discussed. According to recent studies, GSD has become an effective practice because of numerous advantages like cost-saving, attain time to marketplace, technology revolution, and operational effectiveness [20], [21]. In recent years, GSD practice has captured the global market of the IT and software industry and has become an essential practice for software organizations [22]. However, GSD-based organizations experience several issues such as communication, coordination, and control [16]. Communication challenge being the most significant one, [6], [16], [23] is the major reason for software project failure [3], [8], [16].

The authors in [5] proposed a framework that identifies the risk factors of communication issues in GSD. These risk factors are classified into three categories: geographical distance, socio-cultural distance, and temporal distance. The identified factors of socio-cultural distance are poor business language skills, lack of cultural awareness, and lack of mutual understanding. However, the authors did not consider other affecting factors, such as different terminology usage and lack of frequent feedback exchange. Furthermore, mitigation strategies for socio-cultural distance issues were also not suggested.

In another study [9], the authors investigated the factors affecting communication challenges in GSD and proposed a conceptual framework. The five risk factors of communication issues in GSD have been identified. These risk factors are temporal distance, socio-cultural distance, geographical distance, team-member attitude, and social communication. However, limited sub-factors of socio-cultural distance, i.e., different cultural languages and lack of cultural trainers, were considered. Moreover, empirical evaluation was also not performed. The authors in [8] proposed a conceptual framework to fill the existing gap and introduce three other factors of communication issues in GSD, i.e., absence of a face-to-face meeting, absence of mutual understanding, and delay in response. However, the study considered the limited sample size, i.e., (166 respondents).

Furthermore, the authors in [16] illustrated a conceptual framework with eight communication issues: geographical distance, temporal distance, socio-cultural, team-member attitude, technical issues, team issues, organizational and architectural issues, and customer issues. The statistical analysis illustrates that geographical distance, temporal distance, and socio-cultural distance are the most significant issues of communication risk in GSD. The limitation of this study is that the authors did not have insight mitigation strategies for socio-cultural distance issues.

The authors in [23] used concept maps to illustrate communication barriers in GSD and their identified mitigation strategies by conducting SLR. The cultural barrier consists of only two factors: language differences and cultural differences. The mitigation strategies for cultural barriers are the members' relocation between remote sites, cultural exchange programs and workshops, frequent visits to remote locations, and intercultural communication. However, these identified mitigation strategies were not empirically evaluated. Many primary studies consider language differences as the critical issue of socio-cultural distance. Likewise, some studies discussed that the GSD teams' language difference is a significant factor.

Based on the operationalization, we conclude that language difference is the critical factor affecting socio-cultural

distance in GSD. Moreover, from the recent studies, we explore other factors of socio-cultural distance issue and their mitigation strategies, i.e., cultural differences [16], [24], lack of mutual understanding [25], [26], different terminology usage [9], [11], lack of business language skills [27], [28], and no frequent feedback exchange [27], [29]. Even though the mitigation strategies of the issue as mentioned above were already discussed in the literature but not empirically evaluated. Therefore, the impact of these strategies must be analyzed to fill the existing gap in the research by collaborating with GSD teams. Moreover, a conceptual framework is proposed in this study to empirically evaluate the identified mitigation strategies of socio-cultural distance issues in GSD.

III. RESEARCH METHODOLOGY

The research methodology of this study is given in this section. First, socio-cultural distance issues and their relevant mitigation strategies are identified through SLR. Next, a conceptual framework is proposed to evaluate the impact of mitigation strategies on their respective socio-cultural distance issues. Data is collected through an online survey to empirically evaluate the proposed conceptual framework. The online survey has multiple advantages [30]. In the survey, 235 IT professionals from Pakistan's software industry participate through Google Forms. The collected data is analyzed in two statistical tools, i.e., SPSS and WarpPLS. Finally, the recommended Analytical Hierarchy Process (AHP) is applied to prioritize the significant mitigation strategies. Figure 1 presents the overall research methodology of this research study.

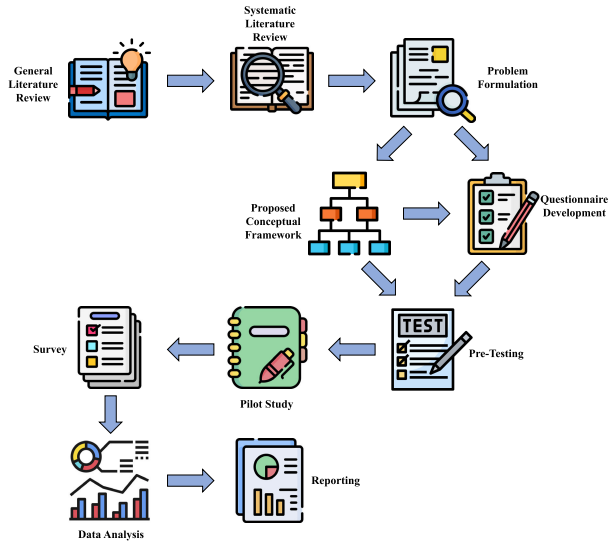

FIGURE 1. Research methodology.

A. SYSTEMATIC LITERATURE REVIEW

Systematic literature review (SLR) promotes the selection and compilation of the essential papers in a particular area of interest and the evaluation and analysis of the published discussions and findings. Three phases of SLR which are already followed in similar studies [18] have been adopted in this study which are given below and depicted in Figure 2.

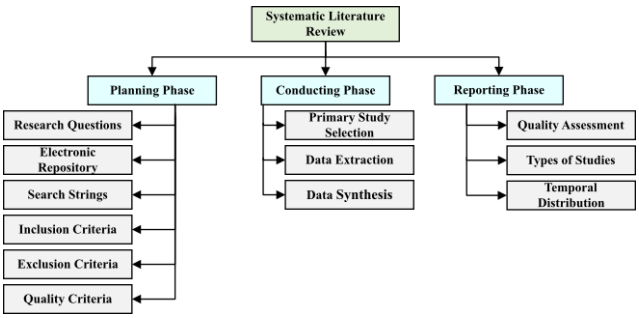

FIGURE 2. Phases of SLR.

1) PLANNING THE REVIEW

In this phase, research questions were formulated to obtain the objective of this study. Recent and relevant studies were collected from electronic databases. Furthermore, a well-defined search string was used for primary study selection, and appropriate criteria for inclusion and exclusion of studies were followed. Moreover, appropriate quality assessment criteria were followed for primary study selection. Planning the review phase consists of six steps which are discussed below.

a: RESEARCH QUESTIONS

The current study focuses on identifying the issues that affect socio-cultural distance in the GSD environment. The following research questions are considered.

RQ1: What are the challenges mentioned in the literature that affect socio-cultural distance in GSD?

RQ2: What are the mitigation strategies given in the literature for socio-cultural distance issues in GSD?

b: ELECTRONIC REPOSITORIES

We have selected the following five electronic databases based on the existing knowledge provided in [31].

- Google Scholar
- Science Direct
- IEEE Xplore
- ACM
- Research Gate

c: SEARCH STRING

In this study two search strings are used to extract the relevant studies from online repositories, as given in Table 1.

d: INCLUSION CRITERIA

Criteria for inclusion of the study is followed from [16]:

- *"Selected studies are published in conferences or journals."*
- *"Selected studies are written in the English language. "*

TABLE 1. Search strings.

Online Databases	Search String Used	Result
Google Scholar	("socio-cultural issues" OR "socio-cultural challenges" OR "cultural diversity") AND ("mitigation practices" OR "solution" OR "mitigation strategies") AND ("global software development" OR "distributed software development")	651
Science Direct	("socio-cultural issues" OR "socio-cultural challenges" OR "cultural diversity") AND ("mitigation practices" OR "solution" OR "mitigation strategies") AND ("global software development" OR "distributed software development")	18
IEEE Xplore	("socio-cultural issues" OR "socio-cultural challenges" OR "cultural diversity" OR "intercultural communication" OR "cultural problem") AND ("mitigation strategies" OR "solutions" OR "mitigation practices") AND ("GSD" OR "global software development" OR "distributed software development")	9773
ACM	("socio-cultural issues" OR "socio-cultural challenges" OR "cultural diversity" OR "intercultural communication" OR "cultural problem") AND ("mitigation strategies" OR "solutions" OR "mitigation practices") AND ("GSD" OR "global software development" OR "distributed software development")	27
Research Gate	("socio-cultural issues" OR "socio-cultural challenges" OR "cultural diversity" OR "intercultural communication" OR "cultural problem") AND ("mitigation strategies" OR "solutions" OR "mitigation practices") AND ("GSD" OR "global software development" OR "distributed software development")	77

- *"The links to the studies are accessible."*
- *"Selected studies were published in the time duration of 2005 to 2021, as the trend of GSD in Pakistan arose in 2005 - 06".*

e: EXCLUSION CRITERIA

Criteria for exclusion of the study is followed from [16]:

- *"Slides and tutorials, and other non-peer reviews are excluded. "*
- *"Books and various blogs are excluded. "*
- *"Duplicate studies were excluded from consideration."*
- *"Studies that are not in the English language are discarded."*

f: QUALITY ASSESSMENT CRITERIA

The quality assessment criteria defined for the selected studies is presented in Table 2. It is used to evaluate the quality of the selected studies. Those primary studies that completely fulfill the quality criteria are scored 1. Similarly, those studies that partially fulfill the assessment criteria are scored as 0.5. However, studies that do not fulfill the defined quality assessment criteria are scored as 0.

TABLE 2. Quality assessment criteria.

S. No.	Questions for Quality Assessment
QA1	Does the study address the socio-cultural in global software development?
QA2	Does the study suggest any mitigation strategy to overcome socio-cultural issues in GSD?
QA3	Does the study propose any model for socio-cultural challenges in GSD?
QA4	Does the study related to GSD?

2) CONDUCTING THE REVIEW

This phase deals with primary study selection, data analysis, and data synthesis. These steps are given in detail below.

a: PRIMARY STUDY SELECTION

A tollgate approach has refined all the studies found throughout the primary studies selection. The tollgate approach involves five levels, as presented in Table 3.

- *"Level 1: Relevant studies are searched based on the search-string and inclusion criteria."*
- *"Level 2: Inclusion and exclusion of selected studies based on the title and abstract."*
- *"Level 3: Inclusion and exclusion of the selected studies based on the introduction and conclusion."*
- *"Level 4: Inclusion and exclusion of the selected studies based on the full text."*
- *"Level 5: Finally, selected studies are included in the SLR."*

TABLE 3. Tollgate approach for primary studies selection.

Databases	Level 1	Level 2	Level 3	Level 4	Level 5
Google Scholar	651	31	17	8	12
Science Direct	18	16	12	10	7
IEEE Xplore	9773	180	110	35	20
ACM	27	16	12	7	4
Research Gate	77	59	29	10	10
Total	10546	302	180	70	53

Figure 3 depicts the tollgate approach of the selected studies.

b: DATA EXTRACTION

Factors impacting socio-cultural distance issues of GSD teams such as: language difference, cultural difference, lack of mutual understanding, different terminology usage, lack of business language skills, and no frequent feedback exchange, were collected from 53 primary studies. A total of 28 mitigation strategies are extracted and classified into 6 categories: 1) mitigation strategy for language difference, 2) mitigation strategy for cultural difference, 3) mitigation strategy for lack of mutual understanding, 4) mitigation strategy for different terminology usage, 5) mitigation strategy for lack of business language skills and, 6) mitigation strategy for no frequent feedback exchange. These strategies help to reduce

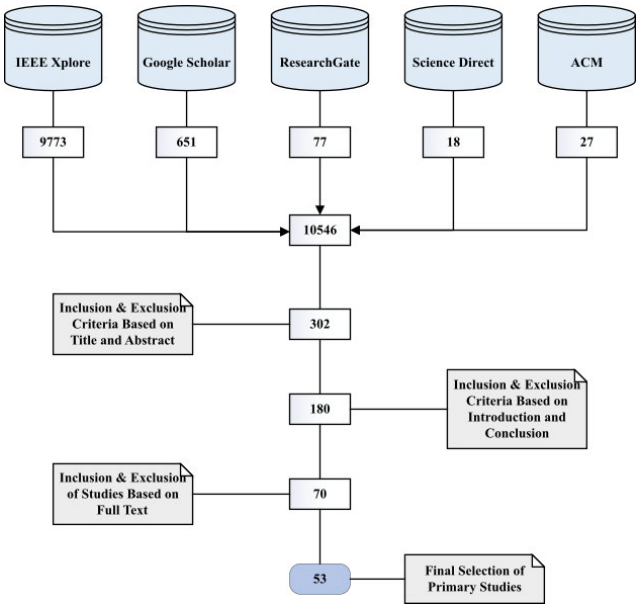

FIGURE 3. Tollgate approach.

the identified risk factors of socio-cultural distance issues in GSD.

c: DATA SYNTHESIS

The list of mitigation strategies for socio-cultural distance issues is obtained from 53 selected primary studies. According to the literature, these mitigation strategies positively influence the communication of GSD teams. Moreover, the GSD-based organization experiences several critical challenges without them, such as low productivity, misinterpretation of requirements, and revenue loss. The risk factors and their mitigation strategies extracted from the primary studies were evaluated against the proposed research questions.

3) REPORTING THE REVIEW

Reporting the review phase deals with quality assessment, types of primary studies, and temporal distribution of selected primary studies. These steps are discussed below.

a: QUALITY ASSESSMENT OF PRIMARY STUDIES

The quality evaluation criteria have been applied to selected primary studies for quality evaluation. The score of quality assessment is illustrated in Table 4. Those studies that did not answer the questions of quality criteria are discarded because their overall quality score was less than 50%. Only those studies with an overall quality score of more than 50% are considered. Finally, out of 70 total studies, 53 studies fulfill the quality criteria.

b: TYPES OF STUDIES

The types of selected primary studies are discussed in this section. These studies are classified into five categories. From the 53 primary studies, it is observed that 33% are empirical studies. The empirical study deals with data collection techniques such as focus groups, questionnaires, surveys, case studies, and interviews. 13% are systematic literature review studies that utilize a systematic method to acquire secondary information. Similarly, 22% are theoretical studies that were used to investigate the data from past studies. In addition, 22% are the studies that proposed a theoretical

TABLE 4. Score of quality assessment.

Ref	QA1	QA2	QA3	QA4	Total Score
[2]	1	1	0	1	3
[3]	1	0.5	0	1	2.5
[4]	1	0.5	0	1	2.5
[5]	1	0	0	1	2
[6]	1	1	0	1	3
[8]	1	0	0	1	2
[9]	1	0	0	1	2
[10]	0.5	0.5	0.5	1	2.5
[11]	1	0	0	1	2
[12]	1	0.5	0.5	1	3
[13]	1	1	0.5	1	3.5
[14]	1	1	0.5	1	3.5
[15]	1	0.5	0.5	1	3
[16]	1	1	0	1	3
[17]	1	1	0.5	1	3.5
[19]	1	0.5	0	1	2.5
[20]	1	0.5	0	1	2.5
[21]	1	0.5	0	1	2.5
[22]	1	1	0	1	3
[23]	1	0.5	0.5	1	3
[24]	1	0.5	0	1	2.5
[25]	1	0.5	0	1	2.5
[26]	1	0.5	0	1	2.5
[27]	1	0.5	0	1	2.5
[28]	1	0.5	0	1	2.5
[29]	1	0.5	0	1	2.5
[32]	1	1	0	1	3
[33]	1	0.5	0.5	1	3
[34]	1	0.5	0.5	1	3
[35]	1	0.5	0.5	1	3
[36]	1	1	0	1	3
[37]	0.5	1	0.5	1	3
[38]	1	1	1	1	4
[50]	1	0.5	0.5	1	3
[51]	1	0.5	0	1	2.5
[52]	1	0	0	1	2
[53]	1	0.5	0.5	1	3
[54]	1	1	0	1	3
[55]	1	0	0	1	2
[56]	1	0.5	0.5	1	3
[57]	1	0	0	1	2
[58]	1	0	0	1	2
[59]	1	1	0	1	3
[60]	1	1	0.5	1	3.5
[61]	1	1	0	1	3
[63]	1	0.5	0	1	2.5
[64]	1	1	1	1	4
[66]	1	0.5	0	1	2.5
[67]	1	0.5	0.5	1	3
[68]	1	1	0.5	1	3.5
[69]	1	0.5	0.5	1	3
[70]	1	0.5	0	1	2.5
[71]	1	0.5	0	1	2.5

or conceptual framework. Furthermore, 11% are exploratory studies used to tackle the research problem that has not been explored in-depth. This classification of selected primary studies helps to investigate the effective research strategy and data collection technique. Figure 4 presents the distribution of primary studies.

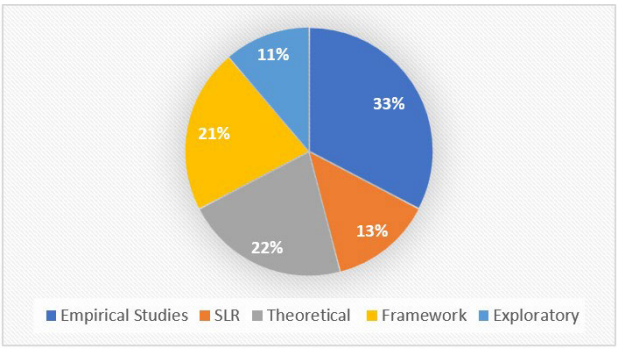

FIGURE 4. Types of studies.

c: TEMPORAL DISTRIBUTION

The selected primary studies were published from 2005 to 2021 as the trend of GSD in Pakistan emerged in 2005- 06 [16]. Out of 53 primary studies, 41% of studies were published in the first interval, i.e., 2005 to 2013. While, 59% of selected primary studies were published in the second interval, i.e., 2014 to 2021. The temporal distribution in Figure 5 illustrates the increasing trend of socio-cultural distance issues in GSD-based organizations in recent years.

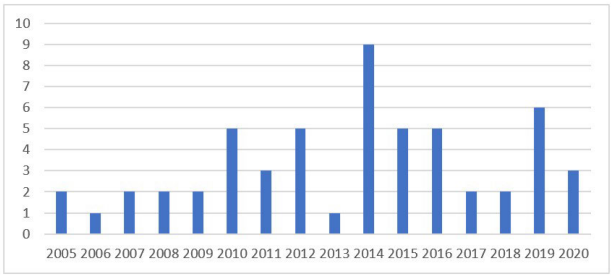

FIGURE 5. Temporal distribution of studies.

B. PROPOSED CONCEPTUAL FRAMEWORK AND HYPOTHESES DEVELOPMENT

A proposed conceptual framework is composed of two main second-order formative constructs: 1) socio-cultural distance mitigation practices and 2) socio-cultural distance issues. The socio-cultural distance mitigation practices second-order formative construct further consists of six first-order formative constructs: cultural difference mitigation strategies, language difference mitigation strategies, lack of mutual understanding mitigation strategies, different terminology usage between sites mitigation strategies, lack of business language skills mitigation strategies, and no frequent feedback exchange mitigation strategies. These first-order formative constructs are further comprised of 10, 4, 4, 5, 3, and 2 indicators, respectively. The socio-cultural distance issues second-order formative construct further comprised of 6 indicators. For the empirical evaluation of the framework, the impact of identified mitigation strategies on socio-cultural distance issues is investigated. The proposed conceptual framework is demonstrated in Figure 6.

1) CULTURAL DIFFERENCE (CD)

"Culture is defined as the norms, customs, and social behavior of a particular people or society. Cultural awareness among all team members is crucial" [16]. In GSD, distributed team members are unfamiliar with each other's culture, so it is not easy to understand their working behavior [32], [33]. Because of cultural differences, there is no desire between team members to communicate at distributed sites [32]. In [28], the authors discussed that cultural diversity could be reduced by providing cultural training to distributed team members. It can be minimized by conducting group exercises, which increases the cohesiveness among distributed team members [34], so they effectively communicate with each other. English language training also increases informal communication among distributed teams, increasing trust and enhancing group awareness [35]. Therefore, we propose the following hypothesis:

H1: *Cultural difference mitigation strategy has a significant role in measuring overall mitigation practices for socio-cultural distance for GSD.*

2) LANGUAGE DIFFERENCE (LD)

Language difference is defined as *"using a different language among distributed team members"* [16]. The difference in accent leads to poor communication [16]. Due to reduced intensity of communication, job conflicts and difference in opinion between team members arises [24]. They use idioms, elaborate styles, and different pronunciations, causing misunderstandings [23]. Due to the language barrier, it is challenging to create a feeling of "team-ness." Language differences can be resolved by frequent communication, language training, and asynchronous communication [36]. Therefore, we developed the given hypothesis on the basis of above discussion:

H2: *Language difference mitigation strategy has a significant role in measuring overall mitigation practices for socio-cultural distance for GSD.*

3) LACK OF MUTUAL UNDERSTANDING (LMU)

Mutual understanding is defined as a relation of affinity or harmony between people. Lack of mutual understanding occurs due to socio-culture differences. It creates misinterpretation between team members, by which communication can be negatively affected [8]. Lack of mutual understanding leads to poor quality products and destructive behaviors of team members with each other [28]. In [37] author suggested

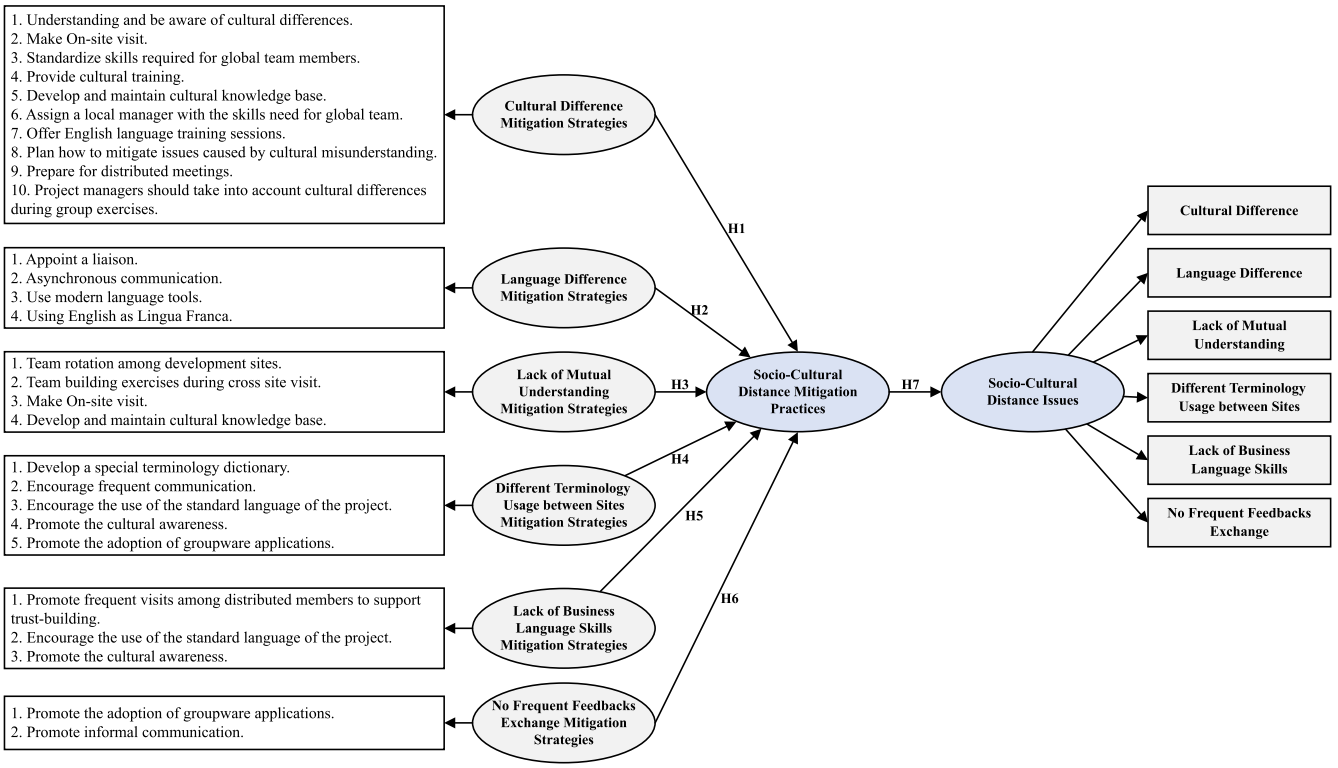

FIGURE 6. **Proposed conceptual framework.**

that a lack of mutual understanding can be resolved by team rotation, team-building exercises, and frequent visits. Therefore, we suppose the following hypothesis:

H3: *Lack of mutual understanding mitigation strategy has a significant role in measuring overall mitigation practices for socio-cultural distance for GSD.*

4) DIFFERENT TERMINOLOGY USAGE (DTU)

In GSD, different terminology usage between distributed sites creates misunderstandings and technical problems among team members [32]. By using inconsistent terminology, a lot of misinterpretation arises in requirements, which reduces productivity. The use of standard processes, methods, and terminology is recommended for distributed teams [38]. Therefore, we propose the following hypothesis:

H4: *Different terminology mitigation strategy has a significant role in measuring overall mitigation practices for socio-cultural distance for GSD.*

5) LACK OF BUSINESS LANGUAGE SKILLS (LOBLS)

English is considered a worldwide business language [5]. Communication issues might occur due to weak business language skills. Software developers use a common institutional language to communicate. However, organizational and socio-cultural distance affects comprehension of the intended meaning of such language, as interpretation is dependent on culture, organization, circumstances, profession, and local politics [5]. In [27], the authors recommend that frequent visits, the use of the standard language of the project, and promoting cultural awareness are the mitigation strategies of poor business language. Therefore, we propose the following hypothesis:

H5: *Lack of business language skills mitigation strategy has a significant role in measuring overall mitigation practices for socio-cultural distance for GSD.*

6) NO FREQUENT FEEDBACK EXCHANGE (NFFE)

In GSD, team members from various cultural and linguistic backgrounds typically collaborate on the same project but at several locations [37]. Language barriers will arise if the team members' native language is not the project's working language. In this situation, most people prefer to send emails rather than participate in conference calls since they are more comfortable with writing than speaking. Language difficulties cause limited feedback from remote locations. The authors in [39] stated that "*other sites reported that team members at his site don't say anything just listen and do not provide any active feedback!*." Coordination also does not work well, when there is limited feedback from remote locations [29]. In [27], the authors recommend that the adoption of groupware applications and informal communication are the mitigation strategies to increase the exchange of feedback. Therefore, we propose the following hypothesis:

H6: *No Frequent feedback exchange mitigation strategy has a significant role in measuring overall mitigation practices for socio-cultural distance for GSD.*

7) SOCIO-CULTURAL DISTANCE ISSUE

Socio-Cultural distance is the difference in cultural norms of dispersed team members over several distant locations [4]. Two sites within the same country with daily flights can be considered close because they have the same culture, even though a considerable distance separates them. However, this cannot be said for the two close locations with smaller kilometers between them, but they have different cultures, environments, religious practices, and possibly intervening borders [11]. Generally, less socio-cultural distance provides more opportunities for team members to meet and have informal communication [16]. Therefore, we propose the given hypothesis:

H7: *Socio-cultural mitigation practices have a significant impact on the socio-cultural distance among team members in GSD.*

C. EMPIRICAL ANALYSIS OF CONCEPTUAL FRAMEWORK

This study used the quantitative research method to investigate the conceptual framework empirically. A survey questionnaire was developed to gather the data as it is the most convenient and frequently used technique [40]. The targeted population of the survey was practitioners from Pakistan's SME- GSD-based IT organizations. Practitioners included but were not limited to programmers, developers, data analysts, designers, testers, project managers, and chief executive officers. Following the SLR's result, a closed-ended questionnaire was used to collect data from the targeted population. The questionnaire consists of three main sections. The first section was designed to get the respondents' demographic information. The second section lists socio-cultural distance issues affecting GSD's communication process, whereas mitigation strategies were listed in the last section. Generally, the measures for the mitigation strategies are viewed in terms of extent because each mitigation strategy can contribute to the Socio-Cultural Distance Mitigation Practices to some extent. Similarly, Cultural Differences, Language Differences, Lack of Mutual Understanding, Different Terminology Usage between Sites, Lack of Business Language Skills, and, No Frequent Feedbacks Exchange can contribute to Socio-Cultural Distance Issues to some extent. Therefore, a 6-point Likert scale ranging from 0 to 5 (0 = "No contribution at all", 1 = "slightly contributive", 2 = "Moderately contributive", 3 = "Noticeably contributive", 4 = "Very contributive", 5 = "Extremely contributive") was adopted from [41], and was used throughout the questionnaire to record the responses of the respondents against the indicators. In [40], the authors highlight that pre-testing the questionnaire is necessary to evaluate its reliability. Pre-testing of the questionnaire consists of four steps. i.e., content validity, questionnaire readability, pilot study, and final review [40]. Content validity involves domain experts observing the questionnaire's items and determining whether or not the respondents understood them.

Moreover, questionnaire readability deals with the grammatical mistakes, font consistency, and sentence clarity of each question. After accessing the readability, the pilot study was conducted by the two GSD-based organizations to evaluate the validity of the questionnaire. Based on the results of the pilot study, the questionnaire was revised. A sample size of 200 or more is required for Partial Least Square - Structural Equation Modeling (PLS-SEM) [40]. The data was collected from May 2021 to November 2021. The final survey was distributed to around 315 targeted respondents using Google Form. These respondents were engaged through LinkedIn and emails. By the end of November, 235 responses were received. Out of 235 responses, 33 (14.04%) responses were discarded due to duplicate and redundancy. The final selection included 202 correct responses. In this study, a response rate of 85.95% was achieved. Figure 7 presents the time period of survey responses.

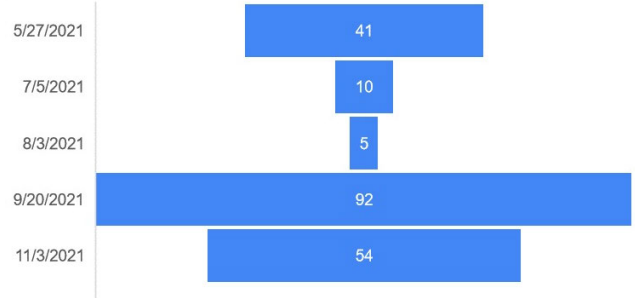

FIGURE 7. Time period of survey responses.

D. ANALYTICAL HIERARCHY PROCESS (AHP)

Finally, the AHP method was applied to prioritize the mitigation strategies for socio-cultural distance issues in GSD. AHP is the frequently used approach for multicriteria decision-making (MCDM) proposed by Saaty [42]. Many researchers have previously adopted this MCDM approach in different domains to resolve complex decision-making problems. In [43], the authors used the AHP approach to prioritize the challenging factors of agile development. While In [44], AHP is applied to enhance human decision-making difficulties. Similarly, in [42], RCM challenges have been prioritized using AHP. The traditional AHP is the best way to analyze the data gathered via the survey method [45], [46]. The AHP method consists of seven steps, given below [37]:

1) Identifying the goal, factors(mitigation strategies), and subfactors(items).The complex problem is decomposed into the hierarchical structure as presented in Figure 8.
2) Construct a pairwise comparison matrix of the factors and sub-factors.
3) Calculate the criteria weight of each factor and sub-factor.

4) Calculate the consistency of the comparison matrix. The consistency of the pairwise ratings of the decision-maker is calculated by using Equation 1 and 2 for consistency index (CI) and consistency ratio (CR), respectively [47], are given as:

$$CI = \lambda max - n/(n-1). \quad (1)$$

$$CR = CI/RCI. \quad (2)$$

where λ_{max} is the mean of the normalized new weights, n is the total number of weighted criteria or options, and RCI is Saaty's random consistency index [42]. The acceptable value of CR is < 0.10. An acceptable value of consistency ratio ensures the reliability of the decision-maker [42].

5) Rank the mitigation strategies into their corresponding categories (local ranking).
6) Determine the global weight of each mitigation strategy (global ranking).
7) Prioritization of mitigation strategies.

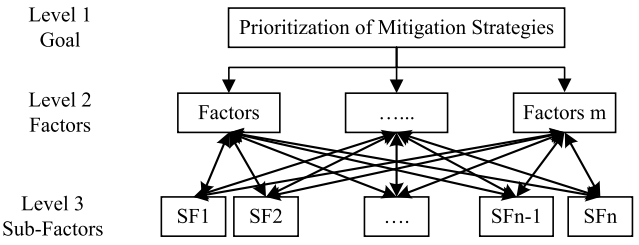

FIGURE 8. Hierarchical structure of AHP.

1) GEOMETRIC MEAN METHOD-ANALYTICAL HIERARCHY PROCESS (GMM-AHP)

The AHP was developed initially as a single decision-maker technique. GMM-AHP has been developed to combine pairwise comparison assessments from several decision-makers. The WGMM is effectively utilized to aggregate individual ratings and criterion weights when decision-makers are judged to behave as a group or as independent individuals when providing their pairwise comparison ratings on decision criteria with the AHP [47].

Therefore, in this study, GMM-AHP is used to aggregate the individual judgments due to numerous experts. GMM is applied after the pairwise comparisons are obtained from experts by using Equation 3 [47].

$$GMM = Z^{[G]} = (z_{ij}^{[G]}),$$

where,

$$z_{ij}^{[G]} = (z_{ij}^{[G]})^{a_p}, i, j(1, n) \quad (3)$$

"where $Z^{[G]}$ is the geometric mean of the group; $z_{ij}^{[G]}$ is the aggregated judgments for the compared criteria i and j; α represents the number of decision-makers, p is the p-th decision-maker with weight represented as α_p. The value for α_p is dependent on the weights assigned to decision-makers, and α_p=1/p if the decision-makers are considered to have the same weight. Thus, the individual ratings from various pairwise comparisons are aggregated to form a single-group matrix" [47].

IV. RESULTS AND FINDINGS

This section discusses the findings of SLR. After that, an empirical analysis of the conceptual framework is discussed. Finally, AHP is applied to prioritize six mitigation strategies and their respective techniques.

A. SLR RESULTS

The list of socio-cultural distance issues and their mitigation strategies are extracted by conducting an SLR. Here 53 primary studies are selected by applying the tollgate approach. A total of six risk factors for socio-cultural distance issues and their mitigation strategies are extracted from select studies after conducting data analysis. The number of occurrences is analyzed to calculate the frequency of the identified risks and their mitigation strategies. Most studies have discussed socio-cultural distance issues. Besides, very few of them have suggested mitigation strategies for those issues. A list of socio-cultural distance issues (SCDI) is present in Table 5 and their mitigation strategies are given in Table 6. Additionally, there is no study to prioritize the mitigation strategies of socio-cultural distance issues. Therefore, this empirical study aimed to identify all mitigation strategies and empirically evaluate their impact on socio-cultural distance issues and prioritize those strategies.

TABLE 5. Socio-cultural distance issues identified in SLR.

ID	Issues	Reference	Freq.
CD	Cultural differences	[52] [37] [57] [71] [13] [60] [16] [8] [25] [26] [61] [62] [32] [32] [4] [24] [5] [55] [54] [17] [50] [11] [19] [64] [65] [14] [20] [66] [35] [36]	30 (56%)
LD	Language differences	[54] [8] [4] [5] [9] [53] [11] [20] [71] [32] [59] [16] [26] [61] [37] [13] [55] [51] [63] [17] [64] [67] [23] [24] [70] [36]	27 (50%)
LMU	Lack of mutual understanding	[8] [5] [52] [25] [26] [37] [13] [55] [4] [64] [16] [11] [36]	13 (24%)
DTU	Different terminology usage between sites	[2] [9] [11] [16] [38] [27]	6 (11.3%)
LOBLS	Lack of business language skills	[5] [27] [28]	4(7.5%)
NFFE	No frequent feedback exchange	[6] [28] [13] [27] [29]	5(5.6%)

B. RESULTS OF EMPIRICAL STUDY

In this section, the results of the empirical study are discussed in detail. For empirical evaluation, a survey was organized in Pakistan's GSD-based software industries.

TABLE 6. Mitigation strategies for socio-cultural distance issues identified in SLR.

ID	Mitigation Strategies	Reference	Freq.
	Cultural Difference		
MSCD1	Understand and be aware of cultural differences	[35] [28] [14] [37] [34]	5(9.4%)
MSCD2	Make On-site visit	[35] [14] [23]	3(5.6%)
MSCD3	Standardize skills required for global team members	[35] [37]	2(3.7%)
MSCD4	Provide cultural training	[35] [58] [69] [28] [34]	5(9.4%)
MSCD5	Develop and maintain cultural knowledge base	[35] [14] [50] [28] [34]	5(9.4%)
MSCD6	Assign a local manager with the skills needed for a global team	[35] [14]	2(3.7%)
MSCD7	Offer English language training sessions	[35] [28] [34]	3(5.6%)
MSCD8	Plan how to mitigate issues caused by cultural Misunderstanding	[35] [34]	2(3.7%)
MSCD9	Prepare for distributed meetings	[35] [28] [50] [72]	4(7.5%)
MSCD10	Project managers should take into account cultural differences during exercises	[35] [50] [34]	3(5.6%)
	Language Difference		
MSLD1	Appoint a liaison	[38] [36] [34] [28]	4(7.5%)
MSLD2	Asynchronous communication	[36] [28] [72] [34]	4(7.5%)
MSLD3	Use modern language tools	[36] [28]	2(3.7%)
MSLD4	Using English as Lingua Franca	[36] [50] [28] [14]	4(7.5%)
	Lack of Mutual Understanding		
MSLMU1	Team rotation among development sites	[38] [37] [28] [34] [23]	5(9.4%)
MSLMU2	Team building exercises during cross site visit	[38] [34] [28]	3(5.6%)
MSLMU3	Make On-site visit	[35] [37] [14] [23]	4(7.5%)
MSLMU4	Develop and maintain cultural knowledge base	[35] [37] [50] [28] [23]	5(9.4%)
	Different Terminology Usage		
MSDTU1	Develop a special terminology dictionary	[38] [34]	2(3.7%)
MSDTU2	Encourage frequent communication	[27] [50] [28]	3(5.6%)
MSDTU3	Encourage the use of the standard language of the project	[27] [28]	2(3.7%)
MSDTU4	Promote the cultural awareness	[27] [50] [28]	3(5.6%)
MSDTU5	Promote the adoption of groupware applications	[27] [28] [34]	3(5.6%)
	Lack of Business Language Skills		
MSLOBLS1	Promote frequent visits among distributed members	[27] [37] [28]	3(5.6%)
MSLOBLS2	Encourage the use of the standard language of the project	[27] [50] [72]	3(5.6%)
MSLOBLS3	Promote the cultural awareness	[27] [50] [28] [72]	4(7.5%)
	No Frequent Feedback Exchange		
MSNFFE1	Promote the adoption of groupware applications	[27] [34]	2(3.7%)
MSNFFE2	Promote informal communication	[27] [50] [28]	3(5.6%)

1) DEMOGRAPHIC INFORMATION

The demographic statistics of survey respondents were analyzed in this section. In this study, the respondent's demographics and organizational information were collected using a survey and illustrated in Table 7. From the survey results, out of 202 respondents, 176 (88%) were male, while 26 (12%) were female. The qualification statistics of the respondents illustrate that (5%) were diploma holders, (72%) were bachelor's degree holders, (21%) were master's degree holders, and Ph.D. were (2%). It is also necessary to determine the experience of respondents. The results present that (29%) of respondents had work experience of between 1-4 years, (21%) of respondents had work experience between 5-9 years, and (2%) of respondents had more than ten years of experience in the GSD industry. The roles of respondents are categorized as developers (49%), designers (12%), tester (11%), analysts (7%), project managers (10%), test managers (5%), CEO (3%), and others (3%) to analyze their positions. This study targeted the GSD-based small and medium-sized enterprises (SMEs) in Pakistan's software industry. It is analyzed from the survey results that 55% of organizations have 10-25 employees, 32% of organizations have 26-50 employees, 8% of organizations have 51-100 employees, and 4% of organizations have 100-250 employees.

TABLE 7. Demographic profile of respondents.

Demographics	Respondents	Frequency	%age
Gender	Male	176	88%
	Female	26	12%
Education	Diploma	10	5%
	Bachelor's degree	146	72%
	Master's degree	43	21%
	PhD	3	2%
Role	Developer	99	49%
	Tester	23	11%
	Designer	24	11%
	Analyst	15	8%
	Test Manager	10	5%
	Project Manager	19	10%
	CEO	6	3%
	Others	6	3%
No of employees	Between 10-25	113	55%
	Between 26-50	64	32%
	Between 51-100	18	9%
	Between 100-250	7	4%
Work experience	1-4 Years	156	77%
	5-9 Years	42	21%
	More than 10 years	4	2%

2) RELIABILITY ANALYSIS

To examine the validity of the survey, the Cronbach alpha test was used. It examines the internal consistency of the questionnaire's variable. The value of Cronbach alpha should be greater than 0.7 [48]. For reliability analysis, the Cronbach value of each construct was analyzed individually and presented in Table 8. The results present that reliability of the questionnaire is statistically significant.

TABLE 8. Results of reliability analysis.

Constructs	No. of Items	Cronbach Alpha
MSCD	10	0.951
MSLD	4	0.864
MSLMU	4	0.855
MSDTU	5	0.903
MSLOBLS	3	0.823
MSNFFE	2	0.796

3) CORRELATION ANALYSIS

Correlation analysis was conducted between endogenous and exogenous variables before performing PLS-SEM analysis. Correlation analyses help to access the association between endogenous and exogenous variables. According to [48], the correlation value lies between $+1$ and -1. A correlation value close to $+1$ presents a strong correlation, close to 0 presents a weak correlation, and a value close to -1 depicts a negative correlation among variables [48]. The correlation analysis results of the proposed conceptual framework are given in Table 9.

4) RESULT OF STRUCTURAL EQUATION MODELING

In this study, PLS-SEM has been applied to supports the result of regression analysis and observe the authenticity and significance of models. It shows the cause and effect relationship between endogenous and exogenous variables. It is a two-step process; In the first step, the measurement model is followed to assess the accuracy and authenticity of the construct. Next, a structural model is followed to find the significance of the relationship or association between the constructs.

a: ASSESSMENT OF STRUCTURAL MODEL

For the assessment of the structural model, the R-square, beta coefficient, and significance level of each construct have been analyzed using WarpPls version 7.0. The R-square value indicates the percentage of the variance in the endogenous variable caused by the exogenous variable [16]. The beta-coefficient value shows the strength of each exogenous variable. If the P-value is less than 0.05, then the relationship among variables is significant [16].

In [49], the authors split the proposed conceptual framework into eight individual frameworks due to multicollinearity in exogeneous variables. This splitting of the proposed framework is based on the relevancy of the hypotheses to their endogenous variables. Therefore, in this study, the correlation between variables is very high ($r > 0.85$); this affects the significance of the overall results. So, to test the impact of each mitigation strategy on their relevant risk, the proposed conceptual framework is split into six sub-frameworks based on hypothesis relevancy, as discussed below.

- **Cultural Difference Mitigation Strategy (MSCD)**
  Cultural difference mitigation strategy (MSCD) helps to reduce the issue of CD, which is the leading risk that causes communication issues among the GSD team. Distance is a significant obstacle as team members do not know each other, so it's difficult for the organization to understand the cultural norms among members of the distributed team [50]. MSCD help to avoid these issues. It consists of ten items strategies which are: ''understand and be aware of cultural differences'' (MSCD1), ''make on-site visits'' (MSCD2), ''standardize skills required for global team members'' (MSCD3), ''provide cultural training'' (MSCD4), ''develop and maintain cultural knowledge base (MSCD5), ''assign a local manager with the skills needed for a global team'' (MSCD6), ''offer English language training sessions'' (MSCD7), ''plan how to mitigate issues caused by cultural misunderstanding'' (MSCD8), ''prepare for distributed meetings'' (MSCD9), ''project managers should take into account cultural differences during group exercises'' (MSCD10). Figure 9 presents a mitigation strategy for MSCD.

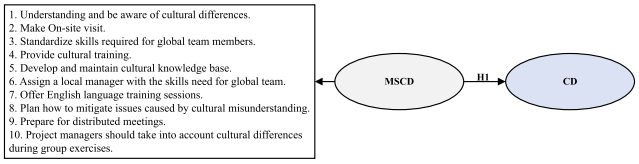

FIGURE 9. Framework for cultural difference mitigation strategy.

- **Language Difference Mitigation Strategy (MSLD)**
  Language difference mitigation strategy (MSLD) helps to reduce the issue of language difference (LD) in GSD. Because of the language difference, it is difficult for dispersed team members to communicate in GSD environments efficiently [51]. MSLD help to minimize the effect of the LD issue. It consists of four items, ''appoint a liaison'' (MSLD1), ''asynchronous communication (MSLD2), ''use modern language tools'' (MSLD3), and ''using English as Lingua Franca'' (MSLD4). Figure 10 presents a framework for MSLD.

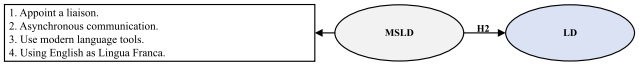

FIGURE 10. Framework for language difference mitigation strategy.

- **Lack of Mutual Understanding Mitigation Strategy (MSLMU)**
  In GSD, group interaction among team members is low because of the cultural gap, which causes mutual understanding issues [8]. MSLMU help to reduce this issue. It consists of four items, ''team rotation among development sites'' (MSLMU1), ''team-building exercises during cross-site visits'' (MSLMU2), ''make on-site visits'' (MSLMU3), and ''develop and maintain cultural knowledge base'' (MSLMU4). Figure 11 presents a framework for MSLMU.

TABLE 9. Correlation analysis.

	SCDI	MSCD	MSLD	MSLMU	MSDTU	MSLOBLS	MSNFFE
SCDI	1						
MSCD	-0.735*	1					
MSLD	-0.756*	0.803*	1				
MSMU	-0.687*	0.819*	0.859*	1			
MSDTU	-0.698*	0.779*	0.823*	0.895*	1		
MSLOBLS	-0.633*	0.740*	0.736*	0.825*	0.876*	1	
MSNFFE	-0.660*	0.690*	0.663*	0.662*	0.717*	0.686*	1

*. Correlation is significant at the 0.05 level (2-tailed).

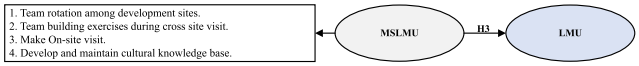

FIGURE 11. Framework for lack of mutual understanding mitigation strategy.

- **Different Terminology Usage Mitigation Strategy (MSDTU)**
  Different terminology usage mitigation strategy (MSDTU) helps to reduce the issue of DTU. Because of the cultural distance, there exists a usage of different terminology in daily routine, resulting in a lot of misunderstanding among distributed teams [32]. MSDTU help to reduce this issue. It consists of five items, ''Develop a special terminology dictionary'' (MSDTU1), ''encourage frequent communication'' (MSDTU2), ''encourage the use of the standard language of the project'' (MSDTU3), ''promote the cultural awareness'' (MSDTU4), ''promote the adoption of groupware applications'' (MSDTU5). Figure 12 presents a framework for MSDTU.

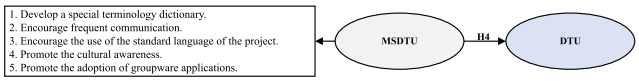

FIGURE 12. Framework for different terminology usage mitigation strategy.

- **Lack of Business Language Skills Mitigation Strategy (MSLOBLS)**
  Business language skills are required to make profitable business deals among dispersed team members. Communication issues arise due to weak business language skills [16]. To minimize the potential effect of this issue, MSLOBLS will be helpful. It consists of the following three items, ''promote frequent visits among distributed members to support trust-building'' (MSLOBLS1), ''encourage the use of the standard language of the project'' (MSLOBLS2), and ''promote cultural awareness'' (MSLOBLS3). Figure 13 presents a framework for MSLOBLS.
- **No Frequent Feedback Exchange Mitigation Strategy (MSNFFE)**
  Coordination also does not work well when there is limited feedback from remote locations [39]. No frequent feedback exchange mitigation strategy (MSNFFE) helps to improve the frequency of feedback exchange. It consists of two items, ''promote frequent visits among distributed members'' (MSNFFE1) and ''promote informal communication'' (MSNFFE2). Figure 14 presents a framework for MSNFFE.

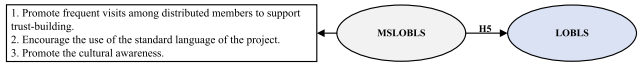

FIGURE 13. Framework for lack of business language skills mitigation strategy.

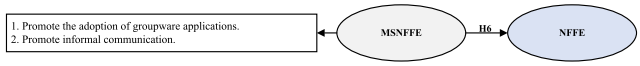

FIGURE 14. Framework for no frequent feedback exchange mitigation strategy.

The SEM analysis is performed individually on six sub-frameworks. Results in Tables 10 and 11 show that the MSCD impacts the socio-cultural distance issues with a beta-coefficient of 0.68 and an R-square value of 0.46 at $p<0.01$, which is statistically significant. Moreover, the MSLD significantly impacts the socio-cultural distance issues with a beta-coefficient of 0.66 and R-square of 0.43 at $p<0.01$. In addition, the MSLMU has a significant impact on socio-cultural distance issues with a beta-coefficient of 0.73, R-square of 0.53, and $p<0.01$. Also, the MSDTU impacts the socio-cultural distance issues with a beta-coefficient of 0.66, R-square 0.43, and $p<0.01$, which is statistically significant. Similarly, MSLOBLS significantly impacts socio-cultural distance issues with a beta-coefficient of 0.64, R-square 0.41, and $p<0.01$. Moreover, the MSNFFE has a significant impact on socio-cultural distance issues with the beta-coefficient of 0.60, R-square 0.36, and $p<0.01$. Overall, mitigation practices significantly impact socio-cultural distance issues with a p-value less than 0.01. Based on the above discussion, the hypothesis of mitigation practices for socio-cultural distance issues supports our findings.

b: ASSESSMENT OF MEASUREMENT MODEL

A conceptual framework that is formative is presented in this study. It is a second-order formative model that consists of six independent variables and one dependent variable.

TABLE 10. Regression analysis results.

Independent Variable	Dependent Variable	R-Square Value	Beta Value	Significance
MSCD	CD	0.46	-0.68	$P < 0.05$
MSLD	LD	0.43	-0.66	$P < 0.05$
MSLMU	LMU	0.53	-0.73	$P < 0.05$
MSDTU	DTU	0.43	-0.66	$P < 0.05$
MSLOBLS	LOBLS	0.41	-0.64	$P < 0.05$
MSNFFE	NFFE	0.36	-0.60	$P < 0.05$

TABLE 11. Structural model evaluation.

Hypothesis Testing	P- Value	Results
H1: MSCD → CD	$P < 0.01$	Accepted
H2: MSLD → LD	$P < 0.01$	Accepted
H3: MSLMU → LMU	$P < 0.01$	Accepted
H4: MSDTU → DTU	$P < 0.01$	Accepted
H5: MSLOBLS → LOBLS	$P < 0.01$	Accepted
H6: MSNFFE → NFFE	$P < 0.01$	Accepted
H7: MS → SCDI	$P < 0.01$	Accepted

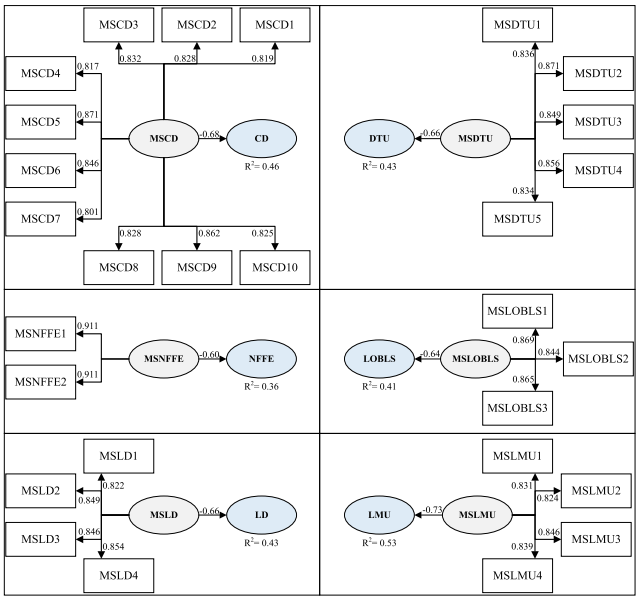

FIGURE 15. Factor analysis with outer loadings and path coefficient.

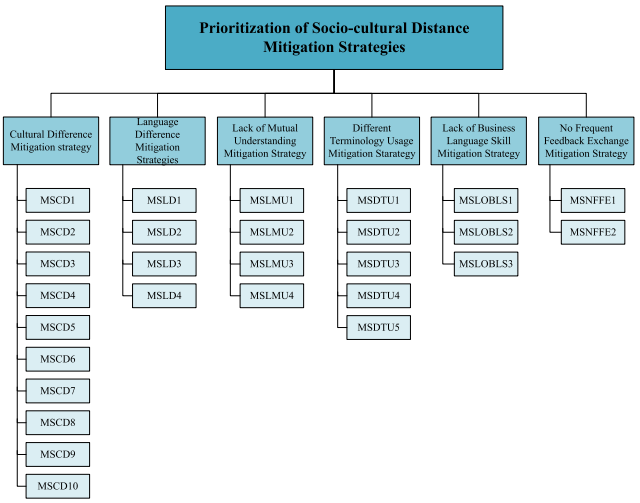

FIGURE 16. Proposed hierarchical structure.

In [16], the author specified that the ''PLS Mode B'' algorithm is very helpful for the critical assessment of formative measurements. The ''PLS Mode B'' algorithm is employed in the present study. One should calculate the variance inflation factor (VIF) to assess the construct validity by considering the following criteria.

- VIF is preferable if <3.3 and acceptable if < 5 [16].
- A Tolerance value of .989 or less is acceptable [16].
- To evaluate the validity of the formative construct, loading, weight, VIF, full collinearity, and significant level of items should be assessed [16].
- The loading value of an item > 0.5 is acceptable [16].

Table 12 presents the assessment of the measurement model. The evaluation results of the measurement model presents that all constructs are statistically significant. Item loading is presented in Figure 15, where gray color ovals present six exogenous variables of the proposed model, while blue color presents endogenous variables, and boxes show the factors of the independent variables.

C. APPLICATION OF AHP

This section discusses the application of AHP for prioritizing mitigation strategies of socio-cultural distance issues in GSD. The goal of the proposed hierarchical structure is the prioritization of mitigation strategies, whereas the six mitigation strategies are considered as factors and their respective techniques as sub-factors. The three-level hierarchical structure is presented in Figure 16.

The mitigation strategies are compared by adopting a pairwise comparison approach. For pairwise comparison of mitigation techniques within each strategy and between six strategies, MSCD, MSLD, MSLMU, MSDTU, MSLOBLS, and MSNFFE were compared to calculate Criteria Weights (CW).

AHP is a subjective approach that accepts on very small sample size [42], [43]. In order to implement the AHP, the respondents of the first survey were engaged to conduct a second survey. A total of 18 respondents were targeted, and 12 willingly filled the survey. From the 12 responses, 2 were discarded because of redundancy. Finally, 10 responses were considered. The survey questionnaire was used to obtain an expert judgment for a pairwise comparison of mitigation strategies. For pairwise comparison, the Saaty scale is used as given in [42].

All respondents are considered equally important, so they have equal weight. GMM is applied using Equation 3 to aggregate individual comparison matrices to calculate the group judgment matrix. The group judgment matrices were arranged based on individual matrices obtained from expert

TABLE 12. Measurement model evaluation.

Constructs	Full Collinearity	Beta Value	R-Square Value	Items	Loadings	Weights	Significance	VIF
MSCD	1.615	-0.68	0.46	MSCD1	0.819	0.118	< 0.01	3.003
				MSCD2	0.828	0.119	< 0.01	2.995
				MSCD3	0.832	0.12	< 0.01	3.163
				MSCD4	0.817	0.118	< 0.01	2.918
				MSCD5	0.871	0.125	< 0.01	3.953
				MSCD6	0.846	0.122	< 0.01	3.405
				MSCD7	0.801	0.115	< 0.01	2.503
				MSCD8	0.828	0.119	< 0.01	2.744
				MSCD9	0.862	0.124	< 0.01	3.313
				MSCD10	0.825	0.119	< 0.01	2.665
MSLD	1.491	-0.66	0.43	MSLD1	0.822	0.289	< 0.01	1.977
				MSLD2	0.849	0.299	< 0.01	2.158
				MSLD3	0.846	0.298	< 0.01	2.223
				MSLD4	0.854	0.3	< 0.01	2.267
MSLMU	1.572	-0.73	0.53	MSLMU1	0.831	0.298	< 0.01	2.127
				MSLMU2	0.824	0.296	< 0.01	2.104
				MSLMU3	0.846	0.303	< 0.01	2.318
				MSLMU4	0.839	0.301	< 0.01	2.286
MSDTU	1.496	-0.66	0.43	MSDTU1	0.836	0.232	< 0.01	2.328
				MSDTU2	0.871	0.241	< 0.01	2.738
				MSDTU3	0.849	0.235	< 0.01	2.457
				MSDTU4	0.856	0.237	< 0.01	2.498
				MSDTU5	0.834	0.231	< 0.01	2.215
MSLOBLS	1.389	-0.64	0.41	MSLOBLS1	0.869	0.392	< 0.01	1.939
				MSLOBLS2	0.844	0.381	< 0.01	1.747
				MSLOBLS3	0.865	0.39	< 0.01	1.902
MSNFFE	1.529	-0.60	0.36	MSNFFE1	0.911	0.549	< 0.01	1.774
				MSNFFE2	0.911	0.549	< 0.01	1.774

opinion. The comparison matrices with criteria weights are presented in Tables 14, 15, 16, 17, 18, 19, and 20.

TABLE 13. Group judgement matrix of mitigation strategies (MS-SCD).

	MS CD	MS LD	MS LMU	MS DTU	MS LOBLS	MS NFFE
MSCD	1.00	0.79	2.40	0.95	2.53	3.00
MSLD	1.26	1.00	2.36	3.44	2.98	2.13
MSLMU	0.42	0.40	1.00	0.94	0.70	2.03
MSDTU	1.06	0.29	1.07	1.00	1.05	1.64
MSLOBLS	0.39	0.34	1.43	0.95	1.00	0.83
MSNFFE	0.33	0.47	0.49	0.61	1.21	1.00

TABLE 14. Normalized matrix with CW for MS-SCD.

	MS CD	MS LD	MS LMU	MS DTU	MS LOBLS	MS NFFE	CW
MSCD	0.22	0.24	0.27	0.12	0.27	0.28	0.23
MSLD	0.28	0.30	0.27	0.44	0.31	0.20	0.30
MSLMU	0.09	0.12	0.11	0.12	0.07	0.19	0.12
MSDTU	0.24	0.09	0.12	0.13	0.11	0.15	0.14
MSLOBLS	0.09	0.10	0.16	0.12	0.11	0.08	0.11
MSNFFE	0.07	0.14	0.06	0.08	0.13	0.09	0.10

The consistency of the MS-SCD matrix is accessed using Equations 1 and 2. So, λ_{max} is calculated from the normalization of new priority weights, which are calculated by multiplying each row-element given in Table 13 by the initial criteria weights provided in Table 14 and adding them.

$$\begin{aligned}
MSCD &= (1.00 * 0.23) + (0.794 * 0.30) + (2.40 * 0.12) \\
&\quad + (0.946 * 0.14) + (2.53 * 0.11) + (3.00 * 0.10) \\
MSLD &= (1.259 * 0.23) + (1.00 * 0.30) + (2.35 * 0.120) \\
&\quad + (3.44 * 0.14) + (2.98 * 0.11) + (2.134 * 0.10) \\
MSLMU &= (0.42 * 0.23) + (0.40 * 0.30) + (1.00 * 0.12) \\
&\quad + (0.94 * 0.14) + (0.70 * 0.11) + (2.03 * 0.10) \\
MSDTU &= (1.06 * 0.23) + (0.29 * 0.30) + (1.069 * 0.12) \\
&\quad + (1.00 * 0.14) + (1.05 * 0.11) + (1.64 * 0.10) \\
MSLOBLS &= (0.4 * 0.23) + (0.34 * 0.3) + (1.4 * 0.12) \\
&\quad + (0.95 * 0.14) + (1 * 0.11) + (0.83 * 0.10) \\
MSNFFE &= (0.33 * 0.23) + (0.5 * 0.3) + (0.49 * 0.12) \\
&\quad + (0.6 * 0.14) + (1.2 * 0.11) + (1 * 0.10)
\end{aligned}$$

The normalized weight for each mitigation strategy is:

$$\begin{aligned}
MSCD &= 1.46/0.23 = 6.198 \\
MSLD &= 1.89/0.30 = 6.272 \\
MSLMU &= 0.74/0.12 = 6.218 \\
MSDTU &= 0.88/0.14 = 6.251 \\
MSLOBLS &= 0.68/0.11 = 6.252 \\
MSNFFE &= 0.59/0.10 = 6.198
\end{aligned}$$

So that the mean λ_{max} is:

$$\lambda_{max} = (6.20 + 6.27 + 6.22 + 6.25 + 6.25 + 6.20)/6 = 6.23$$

Using Equation 1, the consistency index (CI) is calculated as follows:

$$CI = (6.232 - 6)/(6 - 1) = 0.046$$

Using Equation 2, the consistency ratio (CR) is calculated as follows:

$$CR = 0.046/1.24 = 0.037$$

As specified by Saaty [42], since $0.07 < 0.10$, the paired ratings are acceptable. Similarly, we have calculated the criteria weight (CW) to find out the priority of each mitigation technique and calculate the value of the consistency ratio (CR) of all other mitigation strategies (MSCD, MSLD, MSLMU, MSDTU, MSLOBLS, MSNFFE) in Table 15, 16, 17, 18, 19, and 20.

The local rank illustrates the contribution of a mitigation technique in its particular strategy. Based on the local weights provided in column 5 of Table 21, the local ranking of the mitigation techniques in a particular strategy was determined and illustrated in column 6 of Table 21. The global weight determines the contribution of a particular mitigation technique to the overall objective. The global weight of each mitigation technique is the product of local weight and weight of their respective strategy.

The summarized results given in Table 21 present that MSLD is the highest priority mitigation strategy with a weight value of 0.30. We further noted that MSCD is declared the second most crucial mitigation strategy that could reduce the negative effect of the socio-cultural distance issues in GSD. The taxonomy of mitigation strategies is presented in Figure 17. The given ranking presents the degree of importance to which the mitigation strategies help to minimize the potential effect of socio-cultural distance issues.

V. DISCUSSION

This study identifies communication as the most significant challenge in GSD [12], [52]. The recent literature presented that ineffective communication is the leading cause of software project failure in GSD [6], [11]. Moreover, the communication challenges are divided into three main categories; Socio-Cultural Distance, Geographical D1istance, and Temporal Distance [12]. Authors in different studies [13], [14] discussed that socio-cultural distance is the most critical issue that affects communication among dispersed teams. Moreover, in recent studies, several authors suggested different mitigation strategies that reduce socio-cultural distance issues' potential effect in GSD. However, no one had empirically evaluated and prioritized those mitigation strategies. Therefore, this study identifies and evaluates socio-cultural distance risk mitigation strategies in GSD-based organizations. A total of six socio-cultural distance issues and their mitigation strategies are extracted by conducting SLR. In order to empirically evaluate the impact of mitigation strategies on socio-cultural distance issues, a conceptual framework has been proposed. Several GSD-based software organizations in Pakistan have been approached to collect information on mitigation strategies for socio-cultural distance issues.

The SLR was performed to address the RQ1. A total of 53 primary studies were selected for SLR, from which 6 critical issues were extracted from the literature that impacts socio-cultural distance. Based on SLR findings, 28 mitigation strategies were identified and classified into their respective categories to answer the RQ2. Furthermore, operationalization was performed to refine the socio-cultural distance issues and their mitigation strategies. Finally, the extracted 28 mitigation strategies were classified into six categories: Cultural differences, Language differences, Lack of mutual understanding, Different terminology usage, Lack of business language skills, and No frequent feedback exchange.

In this study, a formative second order framework is proposed to identify the impact of mitigation strategies on socio-cultural distance issues. The qualitative analysis had been performed to evaluate the hypotheses of the proposed framework. As the mitigation strategies are repeating, a strong correlation exists between variables($r>0.85$). The existence of a strong correlation among more than two exogenous variables is called multicollinearity. Multicollinearity is a serious issue in the formative model [49]. There should be no intercorrelation between variables in the formative constructs. High collinearity between variables affects the significance of overall results [48]. Therefore, the primary conceptual framework was divided into six sub-frameworks to investigate the impact of mitigation strategies on their relevant issue. Furthermore, the Analytical Hierarchy Process (AHP) was applied to prioritize the mitigation strategies based on their significance.

The results and findings of the empirical analysis illustrated that MSCD has a significant role in measuring overall mitigation practices for Socio-Cultural distance for GSD. In [50], the authors suggested that conducting group exercises provide opportunities for team members to know about each other cultural norms. The authors of another study [35] highlight that providing cultural training to distributed team members and encouraging frequent visits among distributed sites helps to decrease cultural differences. The results of this study present that the MSCD has a negative impact on CD, which satisfy our proposed hypothesis H1. Our findings seconds the results of [34], that implementing MSCD helps to improve communication in GSD teams.

The MSLD assists in decreasing the LD issue among dispersed team members working in a GSD environment [38]. In recent studies [28], [36], the researchers discussed the influence of asynchronous communication and language tools. They argue that the usage of language tools has decreased the language differences in distributed team members. Several studies claim that communication becomes effective as the language difference becomes reduced between GSD teams. Our research results show that the MSLD has a negative impact on the LD, which satisfies our proposed hypothesis H2. The above-discussed result

TABLE 15. Group judgment matrix for MSCD along with CW.

	MSCD1	MSCD2	MSCD3	MSCD4	MSCD5	MSCD6	MSCD7	MSCD8	MSCD9	MSCD10	CW
MSCD1	1.00	0.67	0.76	1.31	0.90	0.78	2.53	2.12	0.62	1.50	0.11
MSCD2	1.48	1.00	1.46	1.34	1.63	0.28	2.54	0.86	0.40	1.37	0.11
MSCD3	1.31	0.68	1.00	0.60	0.93	1.37	0.60	1.31	2.37	1.91	0.10
MSCD4	0.76	0.75	1.59	1.00	1.65	2.20	0.63	1.65	2.57	0.72	0.12
MSCD5	1.12	0.61	1.07	0.58	1.00	0.65	1.53	2.08	1.68	1.97	0.10
MSCD6	1.28	3.62	0.73	0.46	1.46	1.00	0.75	0.95	3.50	1.12	0.12
MSCD7	0.40	0.39	1.68	1.58	0.66	1.27	1.00	0.77	0.58	1.63	0.09
MSCD8	0.47	1.16	0.76	0.61	0.48	1.05	1.30	1.00	0.92	1.42	0.08
MSCD9	1.62	2.50	0.42	0.39	0.60	0.29	1.73	1.08	1.00	0.83	0.09
MSCD10	0.67	0.73	0.52	1.38	0.59	0.76	0.61	0.70	1.21	1.00	0.07
Note: λ_{max} = 11.265, CI = 0.141, CR = 0.090											

TABLE 16. Group judgment matrix for MSLD along with CW.

	MSLD1	MSLD2	MSLD3	MSLD4	CW
MSLD1	1.00	1.33	2.62	1.06	0.32
MSLD2	0.75	1.00	3.16	2.33	0.35
MSLD3	0.38	0.32	1.00	1.06	0.14
MSLD4	0.94	0.43	0.94	1.00	0.19
Note: λ_{max} = 4.156, CI = 0.052, CR = 0.058					

TABLE 17. Group judgment matrix for MSLMU along with CW.

	MSLMU1	MSLMU2	MSLMU3	MSLMU4	CW
MSLMU1	1.00	1.09	2.88	1.33	0.33
MSLMU2	0.92	1.00	2.20	2.52	0.35
MSLMU3	0.35	0.46	1.00	0.94	0.14
MSLMU4	0.75	0.40	1.06	1.00	0.18
Note: λ_{max} = 4.069, CI = 0.023, CR = 0.025					

TABLE 18. Group judgment matrix for MSDTU along with CW.

	MSDTU1	MSDTU2	MSDTU3	MSDTU4	MSDTU5	CW
MSDTU1	1.00	0.75	2.53	1.38	3.00	0.27
MSDTU2	1.34	1.00	2.20	2.76	3.24	0.34
MSDTU3	0.40	0.43	1.00	1.08	0.74	0.12
MSDTU4	0.72	0.36	0.93	1.00	1.05	0.14
MSDTU5	0.33	0.31	1.35	0.95	1.00	0.12
Note: λ_{max} = 5.080, CI = 0.020, CR = 0.018						

TABLE 19. Group judgment matrix for MSLOBLS along with CW.

	MSLOBLS1	MSLOBLS2	MSLOBLS3	CW
MSLOBLS1	1.00	1.96	2.61	0.52
MSLOBLS2	0.51	1.00	2.36	0.32
MSLOBLS3	0.38	0.40	1.00	0.16
Note: λ_{max} = 3.022, CI = 0.011, CR = 0.019				

highlights that GSD organizations must pay attention to MSLD to minimize the language barrier.

The author in [52] discussed that in the GSD environment, team members engaged from various cultural backgrounds with their individual views and thoughts. Mutual understanding among team members in GSD may suffer due to misinterpretation of communication and lack of knowledge sharing [37]. The authors in [34] emphasize that team-building exercises help to reduce the lack of mutual understanding among team members. The findings of this study depict that the MSLMU decreases the potential effect of LMU. Therefore, the proposed hypothesis H3 is significantly supported.

TABLE 20. Group judgment matrix for MSNFFE along with CW.

	MSNFFE1	MSNFFE2	CW
MSNFFE1	1.00	2.10	0.68
MSNFFE2	0.475	1.00	0.32
Note: λ_{max} = 2.0, CI = 0, CR = NA			

In GSD based environment, developers belong to different countries and have different working cultures. According to [32], different terminologies usage between GSD teams creates critical technical problems and inconsistencies in requirements. In [38], the authors argue that terminology issues can be decreased by developing a special terminology dictionary. Similarly, the findings of our study present that MSDTU negatively affects the DTU issue, supporting hypothesis H4.

According to [16], business language skills are required to make profitable business deals among globally dispersed teams. LOBLS creates many communication issues in the GSD environment. The results of this study present that the MSLOBLS negatively impacts LOBLS. So the proposed hypothesis H5 is supported in this study.

In recent studies [32], [39], the authors claimed that coordination among team members in a GSD environment does not work well when there is limited feedback from remote locations. Lack of frequent feedback leads to project failure. In [27], the authors discussed that groupware applications enhance the frequency of feedback exchange rate. Moreover, the authors in [28] argue that informal communication improves the frequency of feedback exchange between team members. This study's results show that MSNFFE negatively impacts NFFE. Therefore, the proposed hypothesis H6 is statistically satisfied.

Based on the above discussion, socio-cultural mitigation practices significantly impact the socio-cultural distance among team members in GSD. Therefore, hypothesis H7 is significant. Authors in different studies [32], [35], [50] second that mitigation strategies for socio-cultural distance

TABLE 21. AHP based ranking of mitigation strategies.

Mitigation Strategy	Weights	Ranks	Items	Local Weight	Local Ranking	Global Weight	Global Ranking
MSCD	0.23	2	MSCD1	0.106	4	0.0243	16
			MSCD2	0.110	3	0.0254	15
			MSCD3	0.104	5	0.0239	18
			MSCD4	0.120	2	0.0277	14
			MSCD5	0.104	5	0.0237	17
			MSCD6	0.125	1	0.0287	13
			MSCD7	0.091	5	0.0208	20
			MSCD8	0.079	8	0.0181	23
			MSCD9	0.089	7	0.0204	21
			MSCD10	0.073	9	0.0167	28
MSLD	0.30	1	MSLD1	0.323	2	0.0969	2
			MSLD2	0.351	1	0.1054	1
			MSLD3	0.138	4	0.0413	8
			MSLD4	0.188	3	0.0564	5
MSLMU	0.12	4	MSLMU1	0.334	2	0.0400	9
			MSLMU2	0.347	1	0.0416	7
			MSLMU3	0.143	4	0.0172	25
			MSLMU4	0.176	3	0.0212	19
MSDTU	0.14	3	MSDTU1	0.273	2	0.0383	10
			MSDTU2	0.344	1	0.0482	6
			MSDTU3	0.123	4	0.0172	26
			MSDTU4	0.138	3	0.0193	22
			MSDTU5	0.122	5	0.0170	27
MSLOBLS	0.11	5	MSLOBLS1	0.517	1	0.0568	4
			MSLOBLS2	0.320	2	0.0352	11
			MSLOBLS3	0.163	3	0.0180	24
MSNFFE	0.10	6	MSNFFE1	0.678	1	0.0678	3
			MSNFFE2	0.322	2	0.0322	12

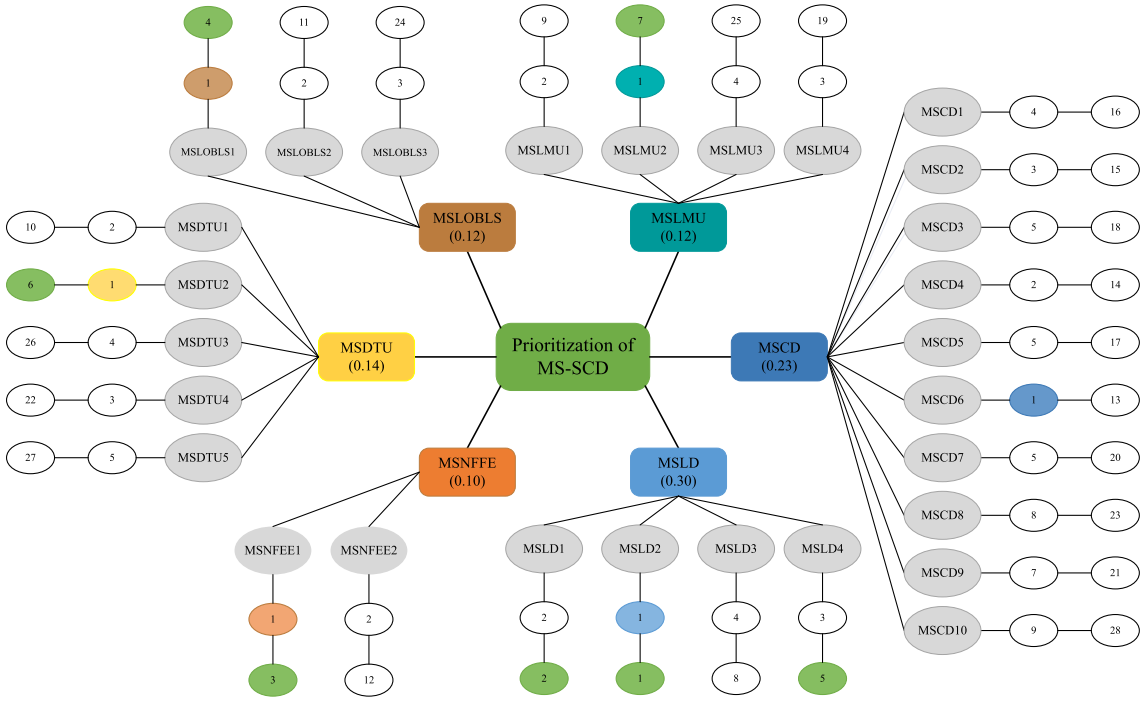

FIGURE 17. Taxonomy of mitigation strategies.

issues facilitate the GSD organization to reduce the negative impact of socio-cultural distance issues and ultimately increase the success rate of software projects.

Furthermore, the identified mitigation strategies are prioritized by applying AHP. The prioritization procedure determines the local and global weights of mitigation strategies. The local weight illustrates the ranking of each mitigation strategy in its particular category, while the global ranking presents the overall priority of a certain strategy. Based on rank order, the practitioners can implement the most appropriate and relevant strategies for socio-cultural distance issues.

This study contributes to the existing literature by identifying and empirically evaluating the six socio-cultural distance issues and their twenty-eight mitigation strategies. Moreover, an AHP approach is applied to prioritize the

significant mitigation strategies. This prioritization illustrates that out of twenty-eight mitigation strategies, seven are the most influential, which may help practitioners reduce project failure.

VI. STUDY LIMITATIONS

Generally, all research studies have limitations. This study also has a few limitations. First, we cannot generalize the results of the study. However, as the survey participants worked in the GSD environment, i.e., on projects outsourced from foreign countries, similar results may be produced when a similar study is conducted in different countries. Secondly, this study was cross-sectional as in surveys, data was collected at a single point in time, which may cause issues in measuring changes in the population. However, before conducting a survey, the issues and their mitigation strategies were identified from the literature. During the analysis of data, it was observed that there was no significant difference between researchers and practitioners. Another built-in limitation of a survey is missing data due to respondent failure to complete the survey. To prevent it from happening, we make each question mandatory in the online survey form.

Last, we identified the issues and mitigation strategies from existing literature. The primary studies were selected from a few electronic databases to determine characteristics that may cause significant articles to be absent. As earlier research [30] has shown, it is not a systematic problem. Further, we have used google scholar also to identify the maximum relevant studies.

VII. CONCLUSION AND FUTURE WORK

For the last two decades, GSD has been a common practice for software companies to reach the global market. However, it is reported that socio-cultural distance issues significantly reduce communication in GSD and cause project failure. This study extracts six socio-cultural distance issues and their relevant mitigation strategies from the existing literature through SLR. To empirically identified the role of issues and the significance of mitigation strategies, a conceptual framework has been proposed and evaluated through an online survey. The results of this study illustrate that all mitigation strategies can significantly reduce the negative impact on socio-cultural distance issues. Finally, an AHP approach was applied to prioritize the identified mitigation strategies to assist the SME's GSD-based organization focus on the most effective strategies. According to the results of the AHP approach, a language difference mitigation strategy is the most effective strategy. Other than this, cultural difference mitigation and different terminology mitigation strategies are also effective strategies. This study has theoretical and practical implications. This study enriches the body of knowledge by identifying all socio-cultural distance issues and their mitigation strategies. This may help practitioners reduce the potential effect of socio-cultural distance issues faced by distributed team members working in a GSD environment. Therefore, this study's findings may help practitioners increase the project's success.

In future there is a need to conduct similar studies in different countries to apply the results of this study to a broader context. In addition, the researchers may identify more mitigation strategies from GSD-based organizations through interviews. It would be helpful for GSD-based organizations to overcome the socio-cultural distance issues.

Furthermore, future researchers may conduct similar studies for large-size GSD-based organizations. Its benefits will be two folded. On the one hand, it would help the practitioners of large-size GSD-based organizations to overcome the socio-cultural distance issues; on the other hand, it would be helpful to do a comparative analysis of issues and mitigation strategies of SMEs and large size GSD-based organizations.

In this study, only AHP is used for prioritization. While in the future, the Fuzzy Analytic Hierarchy Process can be used to prioritize the mitigation strategies for socio-cultural distance issues. Moreover, common mitigation strategies for geographical, temporal, and socio-cultural distance issues will be needed to identify and prioritize. The practitioners may adopt a common mitigation strategy which is more convenient to implement than individual strategies for all the communication issues of GSD, as mentioned above.

APPENDIX

The below link is the main questionnaire that we adapted to validate the extracted mitigation strategies for the socio-cultural distance issues: https://drive.google.com/file/d/1cIyHwYeI0e3Ag3EmlPIiXV8RhqMLpPtP/view?usp=sharing

ACKNOWLEDGMENT

The authors would like to thank the Qatar National Library for providing all the necessary support and open-access funding to conduct this research work.

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