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The Impact of Mitigation Strategies on Geographical Distance Issues in GSD: An Empirical Evaluation

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Abstract

IGeographical distance is one of the most critical communication challenges in global software development projects; that significantly affects the projects' quality, cost, and schedule. Thus, it leads the project toward failure. Mitigation practices may help organizations overcome geographical distance challenges. In the past, the authors of this study conducted a systematic literature review to identify the geographical distance challenges and their relevant mitigation strategies to propose a conceptual framework. It is difficult to explain the exact relationship between geographical distance challenges and mitigation strategies without empirical analysis. Therefore, the main objective of this study is to empirically evaluate the proposed conceptual framework and to analyze the impact of identified mitigation strategies on geographical distance risks. The finding of this study shows that different mitigation strategies have a significant impact on different geographical distance risks with a p-value<0.01. Based on the results, this research can help software organizations to tackle geographical distance challenges by using appropriate mitigation strategies to reduce the software project's failure rate.

Keyword: Communication Challenges, Global Software Development, Distributed Software Development, Empirical Evaluation, Geographical Distance Risks, Mitigation Strategies.

1. Introduction

Over the last decade, many software organizations around the globe have started adopting global software development (GSD) due to its profound benefits such as low development cost and time, access to cheap skilled labor, etc. [1], [2]. GSD is carried out by knowledge team members in different geographical locations worldwide to develop commercially competitive software for organizations [3]. While working globally, GSD proved beneficial for software organizations [4]. Many developing countries including India, Afghanistan, Thailand, and Pakistan contribute to GSD activities to create a product

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for global market within quality, budget, and schedule constraint [5]. As a result, GSD has become an emerging paradigm for developing the software system in the IT industry. Despite these benefits, organizations are facing several challenges in GSD as well. The Communication challenge, the most critical one [1], is the primary cause of software project failure [2]. There are three type of communication challenges that threaten the incentives of the GSD. These challenges are Geographical distance, Temporal distance, and Cultural distance [1]. Temporal distance is the time zone difference between teams working at the distributed location. Cultural distance is the understanding of language, religion, and organizational culture of other team members working at remote locations, and geographical distance is defined as "effort required for one team member to visit another." Geographical distance risks occur because of the dispersion of team members over several distant locations [1],[6]. Among these communication risks, geographical distance is the most significant risk [6],[7],[8]. It has a ripple effect on other challenges such as cultural and temporal distance [9]. It causes delays and misunderstandings among distributed team members [10] because the amount of the information provided to dispersed team members is limited. Therefore, it is necessary to look for mitigation strategies to reduce the potential impact of these risks [11]. A few researchers also proposed different mitigation strategies to address geographical distance challenges [11],[12],[13].

Some of the effective communication strategies that will help reduce the negative impact of geographical distance issues are traveling between sites [14], Promoting informal communication [11], and Synchronous communication is, the most probable solution to alleviate the negative impact of communication risk. As team members have limited opportunities to meet face to face, usage of synchronous devices helps reduce misunderstandings between dispersed teams.

The author in [1] discusses communication issues and proposes a conceptual framework, but mitigation strategies are not discussed, and the framework is not empirically validated. In the study [8], the author gives strategies to address geographical distance challenges, but these guidelines are not empirically validated. The author in [15] identifies challenges posed by geographical distance and their relevant mitigation strategy through SLR and proposes a conceptual framework. However, to the best of our knowledge, no empirical study has been performed to evaluate the framework and analyze the impact of mitigation strategies on geographical distance issues. Therefore, the lack of empirical investigation leads to a gap in the existing literature. To fill the gap, the authors of this study proposed a conceptual framework in the past, and in this study, the proposed conceptual framework is empirically validated by small and medium-sized (SMEs) GSD organizations of Pakistan. The remaining section of this paper is organized as follows: In section 2 literature review is discussed, and section 3 discusses the research methodology, Section 4 discusses the result, and discussion of the current study is provided in section 5, Finally, in section 6 the conclusion and future work are discussed.

2. Literature Review

In the study [12], authors conducted an SLR to identify communication risks and discuss general solutions to overcome these challenges. In [7], authors surveyed to determine the effect of geographic distance on software development organizations. The survey results show that geographic distribution damages information sharing and communication channels among distributed software organizations. Another study conducted an SLR to identify risks for communication and provide solutions to overcome those challenges. However, the author did not propose any framework, and empirical evaluation was not performed[9]. Moreover, in [13], Communication risks and mitigation strategies during requirement change management in GSD are identified. The framework is also proposed, but the framework is not empirically validated. Furthermore, the author in [11] prioritized geographical issues and mitigation strategies with the help of the ANP algorithm. The author in [16],conducted an SLR to find out communication risk and mitigation strategies for the requirement engineering process in GSD. An author in [15], conducted a systematic literature review and identify eight issues that are caused by geographical distance and their relevant mitigation strategies. After that a conceptual framework is proposed. However, the framework is not empirically validated.

According to results of SLR, conducted in [15], most of the studies discuss that geographical distance risk is the most significant communication risk as compared to other risks [6], [7], and [8]. In a nutshell, we did not find any study that empirically evaluated the impact of mitigation strategies on geographical distance challenges in the GSD context. Table 1 shows a summary of the literature review.

Table 1: Summary of Literature Review

Reference	Description	Methodology	Evaluation	Limitation
[9]	Communication risks and Mitigation strategies are discussed.	SLR	NOT	Empirical evaluation is required.
[13]	Framework is proposed for communication risks during requirement change management process and their relevant mitigation strategies.	SLR	NOT	Empirical evaluation is required.
[16]	Communication risk and their mitigation strategies are discussed.	SLR	NOT	Empirical evaluation is missing.
[15]	Framework is proposed for geographical distance risks and their relevant mitigation strategies.	SLR	NOT	Empirical evaluation is missing.

3. Research Methodology

This section explains the research methodology of the current study. The Overall research design is shown in Figure 1. Given below are the steps used to conduct the study.

A. Systematic Literature Review

In our previous study, SLR was conducted to extract geographical distance issues for communication and their relevant mitigation strategies from literature. A total of eight geographical distance issues were identified and nine common strategies were extracted for their respective risks. These mitigation strategies resolve more than one issue. After competing SLR a conceptual framework was proposed [15]. Figure 2 shows the proposed conceptual framework.

The proposed conceptual framework is a second-order formative model. To evaluate the proposed conceptual framework, suggested formative measures were applied. There are two-second order formative constructs, i.e., Mitigation practices for geographical distance issues in GSD and Geographical Distance issues. Both second-order constructs are further composed of 8 different first-order constructs. Each first-order construct has unique properties different from others, so removing any item is omitting a part of the construct.

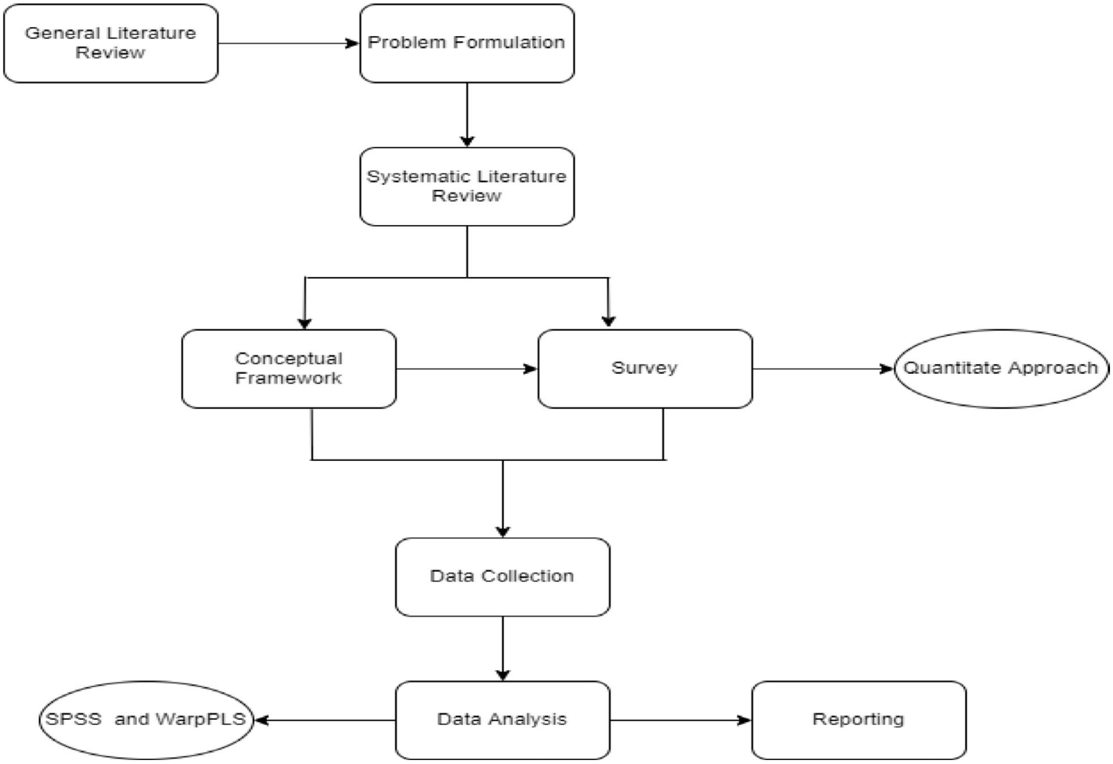

Figure 1: Research Methodology

B. Hypothesis Development

Following the proposed conceptual framework, a total of 9 hypotheses are hypothesized and given below.

H1: Lack of trust mitigation strategies (MSLOT) positively impacts geographical distance issues in GSD.

H2: Lack of team cohesiveness mitigation strategies (MSLOC) positively impacts geographical distance issues in GSD.

H3: Lack of informal communication mitigation strategies (MSLFFM) positively impacts geographical distance issues in GSD.

H4: Lack of interpersonal relationship mitigation strategies (MSLIC) positively impacts geographical distance issues in GSD.

H5: Loss of communication richness mitigation strategies (MSLIR) positively impacts geographical distance issues in GSD.

H6: Communication frequency reduced mitigation strategies (MSLCR) positively impacting geographical distance issues in GSD.

H7: A Communication effort increase mitigation strategy (MSCEI) positively impacting geographical distance issues in GSD.

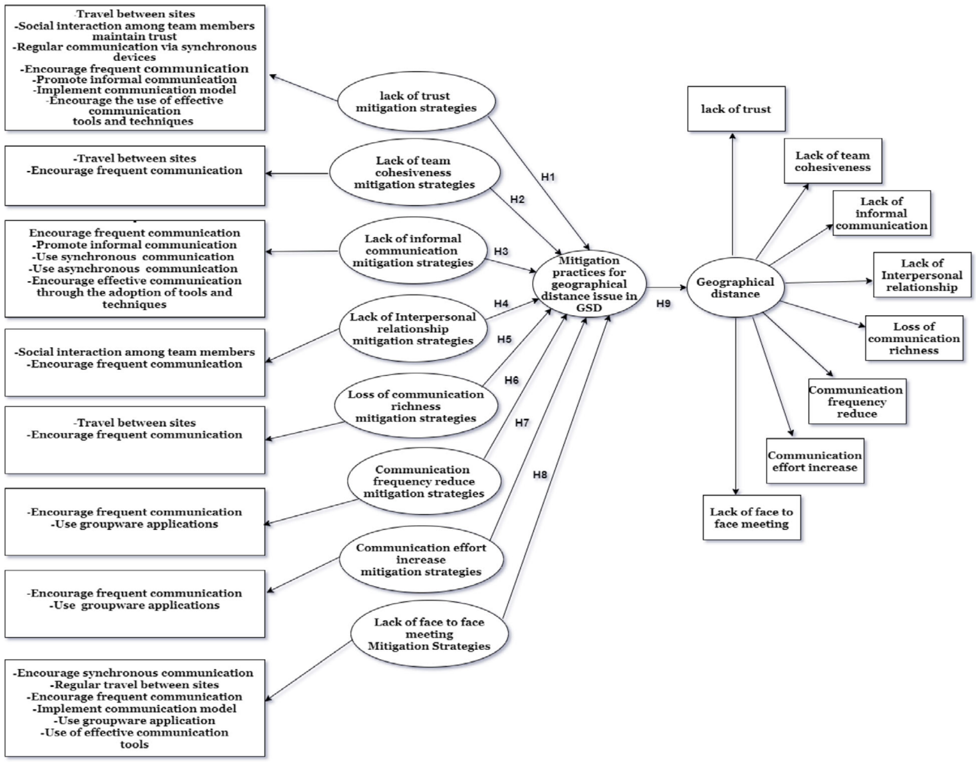

Figure 2: Conceptual Framework for Geographical Distance Issues and their Mitigation Strategies in GSD

H8: Lack of face-to-face meeting mitigation strategies (MSLCFR) positively impacts geographical distance issues in GSD.
H9: Mitigation practices have a positive impact on geographical distance issues.

C. Empirical Analysis of Conceptual Framework

This section, presents the empirical analysis of the conceptual framework.

Measure and Procedure for Data Collection

A quantitative research method was used in this study to investigate the geographical distance issues in GSD. A closed-ended questionnaire was developed and used to obtain GSD-based organization's data to evaluate and test the conceptual framework. The questionnaire consists of 3 main sections shown in Figure 3. The ordinal scale is used to understand the relative rank of variables. The option include in scale are starting from 0 = "No contribution at all", 1= "slightly contributive", 2 = "Moderately contributive",

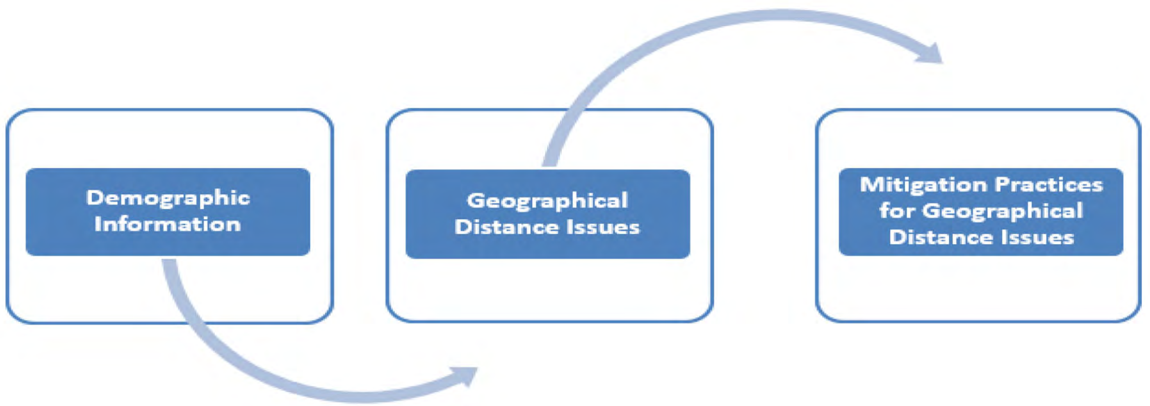

Figure 3: Survey Design

1). Participants

After pilot study the convenience sampling technique was used in this research study because all organizations in Pakistan are not GSD-based. Only GSD-based organizations have been targeted for data collection. Data was collected from April 11 to May 7, 2021. The survey was distributed online using the LinkedIn platform to 400 people, out of which 212 people replied and filled the survey. A total of six questionnaire were discarded as they were not filled correctly. A total of 206 responses received, yielding a 51 percent of response rate in final study.

2). Data Analytical Approach

After the Cronbach's alpha test, correlation analysis, we used the PLS-SEM method to test the hypotheses as it helps to analyze second-order formative construct. The PLS-SEM method consists of two sub-model, i.e., the structural and measurement model. The structural models show the relationship between dependent and independent variables. On the other hand, the measurement model depicts the relationship between variables and data collected with the help of a survey [17].

4. Result of an Empirical Analysis

This section presents the finding of the empirical investigation. We examined each hypothesis and also analyzed its outcome.

1). Demographic Profile of Respondent

The suggested sample for PLS-SEM use is 200 or above [18]. Therefore, a total of 206 responses were collected in this research study. Table 2 lists respondent's demographic information.

Table 2: Summary of Respondent demographic information

Demographics	Respondent	Frequency	Percentage
Gender	Male	198	96.1%
	Female	8	3.9%
Total	-	206	100%
Education	Diploma	0	0
	Bachelor's	152	73.8%
	Master's	54	26.2%
Total	-	206	100%
Work experience	1-4 years	134	65%
	5-9 years	48	23.3%
	More than 10 years	24	11.7%
Total	-	206	100%
Role	Developer	130	63.1%
	Analyst	3	16%
	Tester	33	5.9%
	Test Manger	12	10.2%
	Project Manager	21	0
	Designer	0	0.4%
	EO	1	2.9%
	Others	6	1.5%
Total	-	206	100%

No of employees	Between 10-25	13	6.3%
	Between 26-50	6	2.9%
	Between 51-100	21	10.2%
	Between 100-250	166	80.6%
Total	-	206	100%

1). Reliability Analysis of Questionnaire

Cronbach alpha test was applied to test the reliability of the questionnaire i,e. to check internal consistency among the variable of the questionnaire. According to [18], the minimum value of 0.6 is acceptable. Table 3 shows the results of the Cronbach alpha test.

Table 3: Cronbach Alpha Result

Construct	Items	Cronbach Alpha
MSLOT	7	0.875
MSLOC	2	0.620
MSLIC	5	0.862
MSLIR	2	0.668
MSLCR	2	0.660
MSCEI	2	0.673
MSCFR	2	0.68
MSLFFM	6	0.881

2). Correlation Analysis

In this section, correlation analysis among the construct was analyzed and discussed. Correlation analysis was conducted between dependent and independent variables using SPSS before performing PLS-SEM analysis. According to [19], for correlation analysis coefficient value must lie between +1 and -1. If the value of correlation is greater than 0.8, then a strong correlation exists between variables [20]. Table 4 summarizes the proposed conceptual framework's correlation analysis among independent and dependent variables. According to the results, a strong correlation exists between variables. Because of that, the estimated level of collinearity is very high. Collinearity is a serious threat in a formative model. In the formative model, there should be no high intercorrelation between variables. High collinearity between variables affects the significance of overall results [21]. According to [22], the acceptable value of collinearity should be less than 3.3. After analyzing our model by using WarpPLS version 6.0, the collinearity between variables is 7.041. Because of that overall significance of the result has been compromised. To test the framework and to check the impact of independent variables on dependent variables, we split a conceptual framework into eight models and checked the significance of each mitigation strategy against their relevant geographical distance issue. These Models are shown in Figures starting from 4, to 11.

Table 4: Correlation Analysis

	GDI	MS LOT	MS LOC	MS LFFM	MS LIC	MS LIR	MS LCR	MS CEI	MS CFR
GDI	1								
MSLOT	0.901**	1							
MSLOC	0.803**	0.780**	1						
MSLFFM	0.915**	0.844**	0.781**	1					
MSLIC	0.906	0.785**	0.687**	0.855**	1				
MSLIR	0.839	0.781**	0.704**	0.782**	0.770**	1			
MSLCR	0.815	0.724**	0.739**	0.740**	0.705**	0.741**	1		
MSCEI	0.847	0.758**	0.631**	0.771**	0.777	0.743**	0.717**	1	
MSCFR	0.615	0.455**	0.396**	0.475**	0.517	0.494**	0.438**	0.568**	1

** Correlation significant at 0.01 level

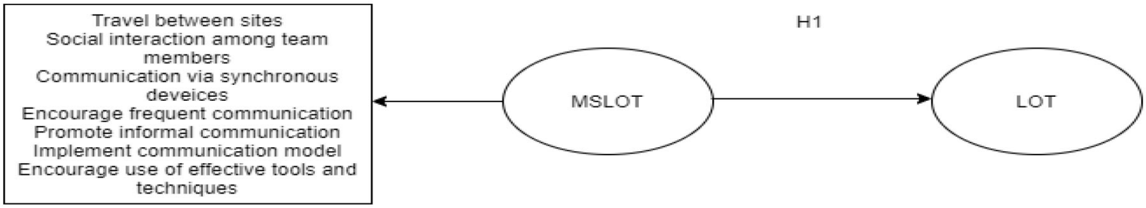

Figure 4: Model for MSLOT

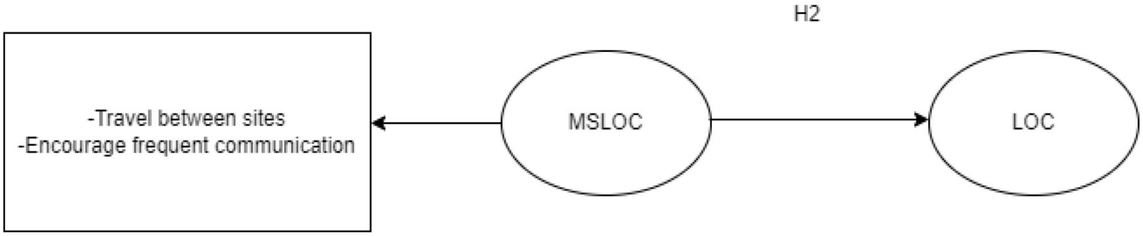

Figure 5: Model for MSLOCS

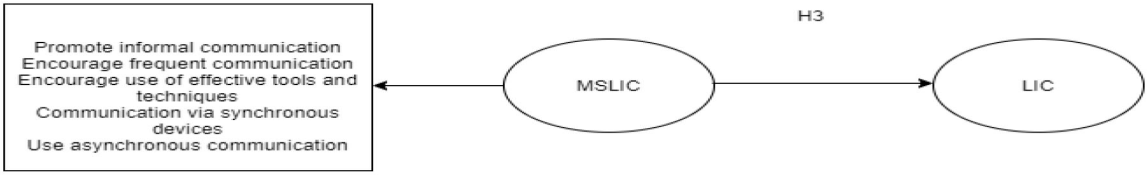

Figure 6: Model for MSLIC

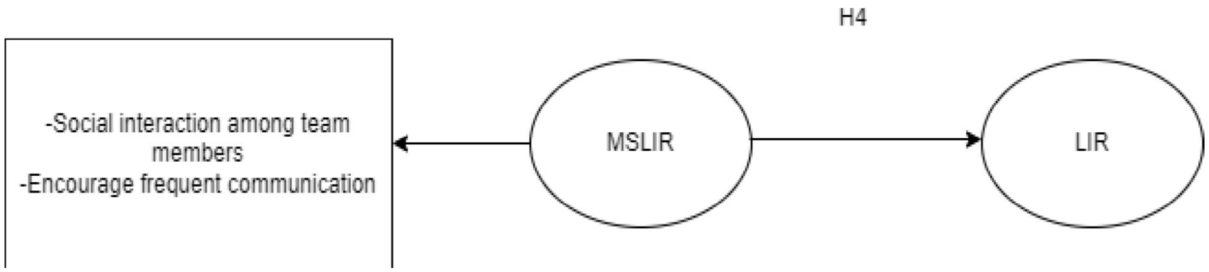

Figure 7: Model for MSLIR

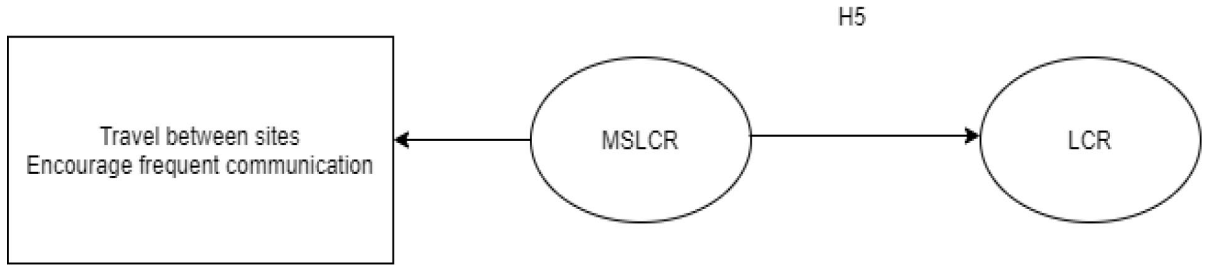

Figure 8: Model for MSLCR

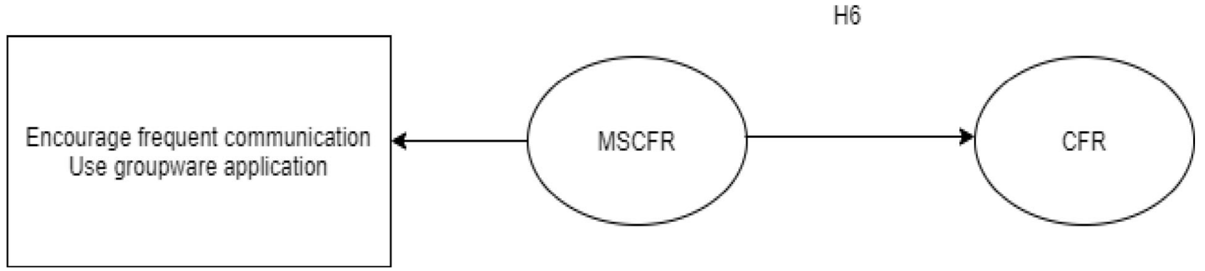

Figure 9: Model for MSCFR

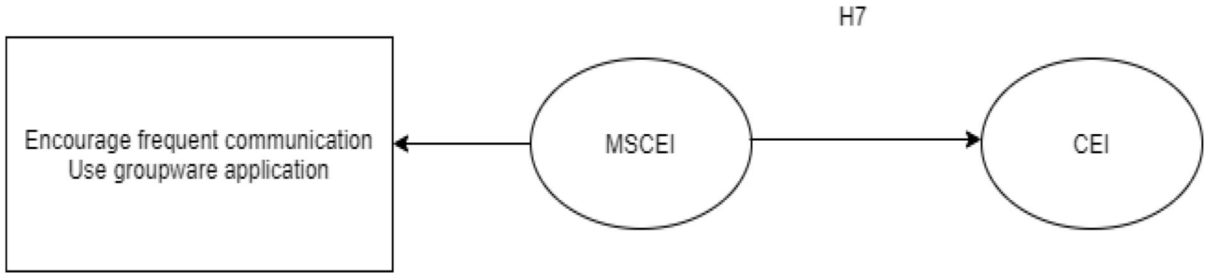

Figure 10: Model for MSCEI

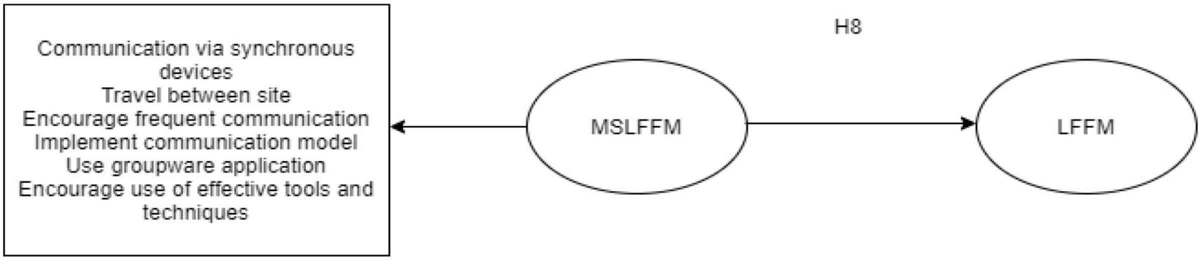

Figure 11: Model for MSLFFM

4). Model Assessment

PLS-SEM was applied in this study. Initially, to describe the accuracy and authenticity of the construct measurement model was accessed. Then, a structural model was accessed that describes the significance of the relationship or association between the constructs.

A. Assessment of Measurement Model

PLS Mode B algorithm is more suggested for formative measurement assessment [22]. Therefore, the PLS Model B algorithm was used in this study. Firstly, the variance inflation factor (VIF) is used to evaluate the construct's validity. After that R-square, beta coefficient, loading, weight and P-value was acquired.

- VIF is acceptable if its value is less than 5 and ideal if, its value is less than 3.3 [21].
- Loading, weight, VIF, full collinearity, and significant level of items was accessed to check the reliability of the formative construct.
- All items were acceptable if their loading value is greater than 0.5 [21].
- "R-Square represent the percentage of variance in independent variable caused by dependent variable "[23].
- Beta value compare the strength of each individual variable on dependent variable. The higher the value of beta coefficient the higher is the effect [23].
- P-value shows relationship significance if its value less than 0.05. We can say that relationship among variables is significant [23].

Table 5 shows the result for measurement model assessment. Items(column) represent list of all mitigation's strategies against each issue. Evaluation of the measurement model indicates that all constructs are statistically significant.

Table 5: Evaluation of Formative Measurement Model

Construct	Items	Loading	Weight	Significance	Full-Collinearity	Beta	R-square	VIF
MSLOT	M1LOT	0.491	0.042	<0.01	1.380	0.53	0.28	1.328
	M2LOT	0.832	0.362	<0.01				1.921
	M3LOT	0.862	0.347	<0.01				2.471
	M4LOT	0.800	0.172	<0.01				3.112
	M5LOT	0.571	0.241	<0.01				2.306
	M6LOT	0.795	0.136	<0.01				3.121
	M7LOT	0.852	0.318	<0.01				2.961
MSLOC	M1LOC	0.961	0.801	<0.01	1.625	0.63	0.39	1.330
	M2LOC	0.719	0.321	<0.01				1.330
MSLFFM	M1LFM	0.803	0.281					
	<0.01	2.307	0.75	0.57	1.817			
	M2LFM	0.669	0.245	<0.01				1.344
	M3LFM	0.869	0.286	<0.01				2.945
	M4LFM	0.820	0.188	<0.01				2.500
	M5LFM	0.774	0.240	<0.01				2.046
	M6LFFM	0.781	0.029	<0.01				2.887
MSLIC	M1LIC	0.790	0.274	<0.01	1.858	0.68	0.46	2.175
	M2LIC	0.682	0.201	<0.01				2.514
	M3LIC	0.857	0.373	<0.01				2.389
	M4LIC	0.849	0.414	<0.01				2.019
	M5LIC	0.773	0.322	<0.01				1.699
MSLIR	M1LIR	0.897	0.581	<0.01	1.875	0.70	0.48	1.506
	M2LIR	0.881	0.544	<0.01				1.506
MSLCR	M1LCR	0.741	0.428	<0.01	2.062	0.72	0.52	1.217
	M2LCR	0.922	0.741	<0.01				1.217
MSCEI	M1CEI	0.866	0.529	<0.01	1.713	0.65	0.42	1.456
	M2CEI	0.899	0.603	<0.01				1.456
MSCFR	M1CFR	0.937	0.861	<0.01	1.515	0.59	0.34	1.049
	M2CFR	0.542	0.356	<0.01				1.049

B. Assessment of Structural Model

To evaluate the structural model, hypotheses of the proposed conceptual framework were tested, and the significance of the construct was evaluated using WarpPLS version 6.0. The acceptable p-value is <0.05. Table 6 shows the assessment of the structural model. The table shows that lack of trust (LOT) mitigation practices has a significant impact on geographical distance issues with a p-value less than 0.01. Moreover, lack of team cohesiveness (LOC) mitigation practices significantly impacts geographical distance issues with a p-value less than 0.01. The Lack of face-to-face meeting (LFFM)mitigation practices significantly impacts geographical distance issues with a p-value less than 0.01. Similarly, Lack of informal communication (LIC) mitigation practices significantly impacts geographical distance issues with a p-value less than 0.01. Lack of interpersonal relationship (LIR) mitigation practices significantly impacts geographical distance issues with a p-value less than 0.01. Also, Loss of communication richness (LCR) mitigation practices significantly impacts geographical distance issues with a p-value less than 0.01. Moreover, Communication effort increase (CEI) mitigation practices significantly impact geographical distance issues with a p-value less than 0.01. Communication frequency reduced (CFR) mitigation practices significantly impact geographical distance issues with a p-value less than 0.01. Overall, mitigation practices significantly impact geographical distance issues with a p-value less than 0.01. The hypotheses proposed in the Hypothesis development section are supported and approved based on the results.

The more the organization uses these mitigation strategies in their GSD projects, the negative impact of issues will be reduced.

Table 6: Evaluation of Formative Structural Model

Hypothesis Testing	P-value	Results
H1: MSLOT→LOT	<0.01	Supported
H2: MSLOC→LOC	<0.01	Supported
H3: MSLIC→LIC	<0.01	Supported
H4: MSLIR→LIR	<0.01	Supported
H5: MSLCR→LCR	<0.01	Supported
H6: MSCFR→CFR	<0.01	Supported
H7: MSCEI→CEI	<0.01	Supported
H8: MSLFFM→LFFM	<0.01	Supported
H9: MS→GDI	<0.01	Supported

5. Discussion

In the current study, it has been observed that communication between distributed team members is hampered because of geographical distance risks. Geographical distribution influences the essence of team interactions and provides fewer opportunities for spontaneous interaction and team knowledge acquisition. Communication among dispersed team members becomes more complex as geographical distance increases. In our previous study [15], a conceptual framework was proposed, which was formative and empirically evaluated in this study. For empirical evaluation, a survey was conducted in which more than 200 participants from GSD SMEs participated.

PLS_SEM is used to perform statistical analysis. According to the result of correlation analysis shown in table 4, a strong correlation exists between variables (r>0.85); because of that, the estimated level of collinearity is very high. Collinearity is a severe threat in a formative model, as in formative model, there should be no intercorrelation between variables. High collinearity between variables affects the significance of overall results. After analyzing our model using WarpPLS version 6.0, the collinearity between variables is 7.041. Because of that overall significance of the result has been compromised. To test the framework and check the impact of independent variables on dependent variables, we split it into eight models and check the significance of each mitigation strategy against their relevant geographical distance issue. Nine hypotheses were developed to examine the impact of independent variables on dependent variables. Hypothesis testing was done with the help of PLS-SEM. Initially to check authenticity and accuracy of each construct measurement model was accessed. To describe the significance of relationship between dependent and independent variable structural model was accessed. There result is shown in, table 5 and table 6. Each hypothesis is addressed and discussed separately, which is given below.

- **H1**

LOT is the leading risk that affects communication in GSD. Mitigation practices help to reduce the potential effect of these issues. The beta value for MSLOT is obtained as 0.53, R square is 0.28 with items loading greater than 0.5. The P-value of the overall construct is less than 0.01, which is statistically significant. This implies that MSLOT helps to minimize LOT issues in the GSD environment. Therefore, H1 is supported in this research.

- **H2**

The relationship between mitigation strategies and LOC issues could be shown by beta value, and R-square value obtains as 0.63, 0.39 with items loading greater than 0.5. The P-value for construct is <0.01 (<0.05), showing the significant impact of MSLOC on LOC geographical distance risk. Therefore, H2 is supported in this research based on the above relationship result.

- **H3**

The beta value and R-square value of MSLIC are obtained as 0.68 and 0.46, with items loading >0.5. The obtained p-value <0.0.1 (p <0.05), which shows a positive impact of MSLIC on the LIC issue. Therefore, H4 is supported in this research.

- **H4**

The relationship between mitigation strategies and LIR issues could be shown by beta value and R-square value obtained as 0.70 and 0.48 with items loading greater than 0.5. P-value is obtained as <0.01 (<0.05), which shows significance. Hence, H6 is supported in this research.

• **H5**

The relationship between mitigation strategies and LCR issues could be shown by beta value and R-square value obtained as 0.72 and 0.52 with items loading greater than 0.5. P-value is obtained as <0.01 (<0.05), showing the significant impact of MSLCR on LCR. Therefore, result H5 is supported in this research based on the above relationship.

• **H6**

The relationship between mitigation strategies and CFR issues could be shown by beta value and R-square value obtained as 0.59 and 0.34 with items loading greater than 0.5. P-value is obtained as <0.01 (<0.05), showing the significant impact of communication frequency reduced mitigation strategies on CFR geographical distance risk. Therefore, H8 is supported in this research.

• **H7**

The beta value and R-square value of MSCEI were obtained as 0.65 and 0.42, which show a positive impact of mitigation strategy on a dependent variable with items loading greater than 0.5 with a p-value <0.01 that show a significant relationship. Therefore, H7 is supported in this research.

• **H8**

According to the result, the beta and R-square values were obtained as 0.75 and 0.57, showing a positive impact of MSLFFM on LFFM risk. As LFFM is one of the important risks that cause GSD communication issues, it is necessary for the organization to choose a suitable mitigation strategy to cope with this issue. The loading value of all MSLFFM items is greater than 0.5. The significant impact of lack of face-to-face mitigation strategy on the LFFM issue was shown by p-value <0.01. Hence, H3 is supported.

• **H9**

To check the impact of mitigation strategies on geographical distance issues, hypothesis H9 was tested. The result shows that p-value is less than 0.01, which shows the significant impact of mitigation strategies on geographical distance issues. Hence, based on the above relationship, result H9 is supported in this research.

Travel between sites help team members to know each other, their culture and have informal communication and, to maintain trust among them. mitigation strategy alleviates the lack of face-to-face communication issue though socialization and create a feeling of team-ness. Social interaction among teams help to reduce interpersonal relationship issue and help to establish trust. Synchronous and asynchronous communication among team members help to reduce lack of face to face and informal communication issue. Trust-building takes time usually require frequent communication between parties. This strategy helps resolve any misunderstanding that might occur because of cultural and language diversity among dispersed team members. It also helps to develop team cohesion, interpersonal relationships among team members, which results in the improvement of informal communications among teams. Promote informal communication mitigation strategy is helpful to improve cohesion and interpersonal relationship among teams. In a GSD environment, informal communication can be done with the help of asynchronous and synchronous communication channels. The remote team must communicate with each other and share their best practices, expertise, and knowledge by using efficient communication tools. This strategy is helpful to prevent the chance of schedule delays and to resolve cuticle problems which result in building trust among teams, to increase communication among team members, encourage effective use of groupware applications such as project management tools, wiki, Mendeley, drop box, Microsoft exchange etc.

In a nutshell, the current study contributes to the empirical evaluation of mitigation strategies for geographical distance risks. Moreover, the frameworks and their hypothesis has been tested that specify the impact of mitigation strategies on geographical distance risks. The survey is conducted from small and medium-size GSD organizations of Pakistan. These organizations made the project for the global market. Because of the distance involved, they face the same issues as other international GSD organizations face. The results of the study will be helpful to overcome the geographical distance risks that cause communication issues in the GSD environment, and it ultimately reduces the failure rate of a software project in Pakistan.

6. Conclusion and Future Work

GSD practice has been increasingly emerging in the software industry in recent years. Existing literature has observed that geographical distance is a crucial risk that hinders GSD projects' communication and leads projects toward failure. The geographic distance between dispersed teams cannot be reduced, but the potential effect of these risks can be minimized by applying different mitigation strategies. In a previous study, an SLR was conducted to identify geographical distance issues and their relevant mitigation strategies, and a conceptual framework was proposed but not empirically validated.

In this study, an empirical evaluation is performed. An online survey is conducted from the small and medium-sized GSD-based organizations of Pakistan to gather data and validate the hypothesis of the framework. As correlation among variables is pretty much high (>0.80), and collinearity is 7.041. So, to test the framework, we split it into eight frameworks and tested each mitigation strategy against its relevant issue. The finding of our study shows that all mitigation strategies have a significant impact on geographical distance issues with a p-value less than 0.01. So, we conclude that if organizations use mitigation strategies, the effect of geographical distance challenges will be reduced, and the study's finding is helpful in avoiding software project failure that occurs due to geographical distance risks.

In the future, an Analytic network process algorithm (ANP) can be used to prioritize the most critical strategy and geographical distance challenges. Moreover, a survey is conducted among small and medium-sized GSD organizations.

Like all other studies, this study also has a few limitations. The result of the study cannot be generalized. Therefore, to generalize the results, it is recommended to conduct a similar study in some other countries. A few other electronic databases can be included in further studies to identify more issues and relevant mitigation strategies. The survey can also be conducted on the respondents of large GSD organizations in the future. In addition, the Analytical Hierarchical Process (AHP) approach may help the software industry prioritize the issues and mitigation strategies.

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Appendix

Table 7: List of Mitigation Strategies and Risks

Risks	Mitigation Strategies
Lack of trust	-Travel between sites -Social interaction among team members maintain trust -Regular communication via synchronous devices -Encourage Frequent Communication -Promote informal Communication -Implement communication model -Encourage the use of effective communication tools and techniques
Lack of team cohesiveness	-Travel between sites -Encourage Frequent Communication
Lack of face-to-face meeting	-Travel between sites -Encourage synchronous communication -Encourage Frequent Communication -Promote informal Communication -Use groupware application -Use Effective communication tool
Lack of informal communication	-Promote informal interaction -Encourage frequent communication -Encourage effective communication through the adoption of tools and techniques -Use synchronous communication -USE asynchronous communication (instant messaging)
Lack of interpersonal relationship	-Social interaction among team members -Encourage frequent communication
Loss of communication Richness	-Travel between sites -Encourage frequent communication
Communication effort increase	-Encourage frequent communication -Use groupware application
Communication Frequency Reduced	-Encourage frequent communication -Use groupware applications