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Exploring Challenges in Global Software Development

A Case Study of a Collaboration between a Korean and a Swedish Company

Bachelor of Science Thesis in Software Engineering and Management

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Challenges in a collaboration between a Korean and a Swedish Company

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Abstract—Global Software Development (GSD) is a growing trend in the field of software engineering. However, despite its numerous benefits, GSD often encounters challenges in collaboration, leading to compromised product quality. This study investigated the collaboration challenges and implemented strategies within a GSD environment, specifically from the perspectives of Swedish and Korean companies. Through a case study with interviews, the research identifies three areas of GSD challenges: geographical, temporal, and socio-cultural distance. Strategies such as proper communication tools, building personal relationships, increasing cultural awareness and maximizing synchronous work hours were implemented to address these challenges. While the study acknowledges the effectiveness of various strategies, the study highlights the enduring value of face-to-face interaction in GSD. This study contributes to a deeper understanding of collaboration between Sweden and Korea in GSD, providing insights for improving future collaboration and enhancing product quality.

Keywords—GSD, communication, collaboration, challenges, mitigation strategies, distributed

I. INTRODUCTION

The interest of Global Software Development (GSD) has been rapidly growing for the recent decade. GSD refers to the process whereby software is developed by different teams located in different geographic locations [1, 2]. The main benefit of GSD is that it helps companies to access skilled resources with cost efficiency [2]. In addition to its benefits GSD also produces challenges resulting from temporal, geographical, cultural, and language differences [3]. One of the critical challenges is the effective and efficient communication and collaboration between distributed teams and customers [4, 5]. Poor communication may lead to issues such as lack of team collaboration and poor understanding of the customer requirements. The result could be poor knowledge transfer, which can lead to a project failure [6]. There is a large amount of studies about GSD challenges between companies, but most of the research have focused on vendors or suppliers in developing countries, such as India [7]. Recently client companies have begun to expand their choice from India to various other

countries. I observed that Swedish companies have chosen South Korean (Korea) companies as vendors to respond to market demands in high technology areas, especially in automotive industries. Infrastructure, organizational culture, national culture, and the political situation can impact how a GSD project is managed and collaborated [8]. However, it is important to note that Korean practices in these areas differ from those in India. Furthermore, to my knowledge, there is a lack of research on collaboration in GSD from the perspectives of Korea in collaboration with Swedish companies. Therefore, the objective of this paper is to study challenges regarding collaboration and explore possible strategy that have been implemented from a Swedish and Korean perspective in a GSD environment. The term ‘strategy’ refers to any planned and deliberate activity undertaken to mitigate the effects of challenges.

The remaining sections of this paper are structured as follows. Section 2 provides an overview of related work in the field. Section 3 outlines the research methodology employed in this study. Section 4 presents the challenges identified during the research and discuss various strategies to mitigate these challenges. Section 5 presents a comprehensive discussion of our findings, while Section 6 provides a summary of the conclusions drawn from this research and suggest further research.

II. RELATED WORK

A. Characteristics of Global Software Development

1) *Geographical Distance*: Geographical distance is a crucial factor for collaboration and coordination [2]. It is a measure of the effort required for one member to visit members in other countries [1]. A larger geographical distance reduces the chance of face-to-face communication. This is especially true if the organization provides insufficient mechanisms to substitute for these interactions [5]. Lack of face-to-face communication can result in slow decision-making, cause difficulties in complex discussions and challenges in building personal relationships. These factors can potentially lead to project

delays and lower quality software outcomes [9]. Geographical distance is not measured in kilometers, but in ease of relocation. As an example, when two locations which are geographically close but lack enough transportation infrastructure between them, it is considered a high geographical distance. To increase the opportunity for periods of co-located teamwork, low geographical distance is preferred [10].

2) *Temporal Distance*: Temporal distance in GSD is a measure of the dislocation in time experienced by development teams. This can create challenges in coordinating team activities, communication, and collaboration, as team members may be working in different time zones and have different working hours. Temporal distance can affect a range of activities in global software development, including scheduling meetings, resolving issues, providing feedback and delivering project milestones. Therefore, researchers stated that time zone difference should be taken into consideration when organizing a development process to reduce temporal distance [1].

3) *Socio-cultural Distance*: Socio-cultural distance refers to the degree of difference between two cultures, societies or groups in terms of their values, beliefs, behaviours and norms. It can be thought of as the gap between two groups that can make communication and interaction challenging due to differences in their cultural backgrounds [1]. This can result in variations in work planning, decision-making approaches, negotiation styles, conversational patterns, and workload distribution [11]. Socio-cultural distance is a complex dimension since it is influenced by national culture, organizational culture, politics, language and work ethics. Language is pointed out as one of main cultural distinctions by many researchers [1]. Even using a standard language to communicate can cause problems due to lack of proficiency by some members and divergent semantic interpretations caused by different cultural backgrounds. Differences in understanding and interpretation of quality standards and requirements can lead to inconsistencies and variations in the delivered software product quality [12]. Great geographical distance, however, does not always imply great cultural distance. When two members with different nationalities and background have been working together for a long time within the same organizational culture, it is possible to have a low socio-cultural distance between them. In general, great geographical distance may imply high socio-cultural distance. However, it is important to note that there is no proportional relationship between geographical distance and socio-cultural distance [1].

B. Collaboration strategy

Collaboration is a core function when using distributed teams to accomplish a common goal. When development is distributed, it is common that dispersed members tend to feel lack of one team awareness, lack of involvement and lack of shared understanding [1]. Therefore, identifying and

implementing the optimal collaboration strategy is key to achieving effective coordination within distributed teams.

Carmel [13] identifies six factors that increase global software teams' awareness and enhance their collaboration. These solutions comprise of telecommunication infrastructure, product architecture, team building, development methodology, managerial techniques, and collaborative technology. Telecommunication infrastructure and collaborative technologies help in reducing the negative effects of geographic dispersion, communication richness loss and coordination breakdown. Product architecture and development methodology provide coordination tools to guide task allocation and the software development cycle. Team building helps in creating awareness between team members and minimizing cultural differences. However, the most significant factor is managerial techniques, which holds a global team together. This involves designing team structure, managing conflicts, project management, metrics, rewards, compensation and selecting a global manager.

Holmström et. al. [1] found in their case study that agile practices could reduce the distance in GSD. In their study, the adoption of XP's pair programming practice has reduced the problem of missing time overlap in distributed teams, especially for the technical and coding aspects of the GSD project. When the developers had a program partner in distributed teams, they became more flexible and tried to spend as much time as possible with their pair programmer. This has led to an increase in individual responsibility to create temporal overlap, which reduces the negative impact of temporal distance on team communication and coordination. Their study also showed that Scrum practices have significantly improved team awareness and coordination among geographically dispersed teams. As an example, distributed team members shared work status and presented issues during daily scrum meetings. This allowed distributed team members to easily participate in project progress and improved the feeling of one team awareness. Both XP pair programming and Scrum can help increase communication, mutual understanding, and collaboration within distributed teams, resulting in a reduction of socio-cultural distance.

III. RESEARCH METHODOLOGY

The objective of this research is to find challenges regarding collaboration and explore possible solutions that have been implemented in a Global Software Development (GSD) environment. To achieve this objective, I have defined the following questions.

A. Research questions

RQ1: What are the challenges for team collaboration in Global Software Development between Korean and Swedish companies?

RQ2: What strategies are used to mitigate GSD challenges related to collaboration between Korean and Swedish companies?

B. Research Design

My research is based on an exploratory case study approach, which is appropriate for investigating "how" and "why" questions and providing a deeper understanding of

the subject matter [14]. Considering the objective to investigate collaboration challenges and how software project teams mitigate them in the specific context of Global Software Development (GSD), the exploratory case study method was well-suited for this study [15]. This study focused on a single development team in the GSD context, making it an appropriate unit of analysis. The process consisted of four phases: literature review, case design, data collection and data analysis. The first phase involved conducting a literature review to gather relevant findings from previous research related to the research questions. The second phase included selecting the case for the study. The third phase involved collecting data from the chosen case through an interview method. Finally, in the fourth phase, the collected data was analyzed to derive results.

C. Case and subject selection

To address the challenges in Global Software Development (GSD), data collection focused on the experiences of software development teams involved in a global project. For convenience sampling, I selected a company with which I had a personal connection through a team member. LG Electronics, based in Korea, was chosen as the company, as it is engaged in global projects with several other countries including Sweden, China, Germany and England. From the various teams within LG Electronics, I specifically chose a team involved in the development of Vehicle Information System as this team has a collaboration with Volvo Cars in Sweden.

The participants in this study were chosen based on their experience and relevance to the research objectives. All participants have been involved with GSD, with varying years of experience. However, all participants have experience in collaboration between Korean and Swedish teams. The selected participants in this study represent various roles and positions within the organizations, contributing to increased validity of the research finding [14]. Table 1 presents participants' roles and their respective locations.

Table 1 Interview participants

ID	Role	Location	Experience (Yr)
P01	Operation Technician	Sweden	12
P02	Test Engineer	Sweden	15
P03	Application Specialist	Sweden	5
P04	IT Team Manager	Sweden	17
P05	Application Developer	Korea	10
P06	Security Developer	Korea	6
P07	Project Manager	Korea	14

D. Data Collection

This study used qualitative interviews to gather data. This interview method allows researchers to acquire a deeper understanding of the subject that cannot be found by just using quantitative methods [14, 15]. The interviews were semi-structured, meaning that the questions were planned and defined before the interview, but they could be asked in any order during the interview depending on the

conversation. By using semi-structured interviews, the conversation was more improvisational which allows for the exploration of new ideas, connections and patterns that may emerge during the interview process. Researchers can follow up on interesting points raised by participants and probe deeper into specific areas. [14].

A pilot interview was conducted before the actual interview process to evaluate question quality and estimate interview duration. Irrelevant questions, such as those concerning challenges during different project processes, were eliminated based on feedback received during the pilot interview. The interview questions were also modified to be as neutral as possible, in order to avoid leading the participants. For example, the question "What difference have you noticed?" was modified to "Have you noticed any differences?".

Prior to starting the interviews, the interviewee was informed about the reasons, motivations and purpose of the interview following guidelines from current literature. This approach aimed to help the interviewees understand the purpose of the interview, which in turn facilitated obtaining meaningful answers to the questions [14].

Interviews were conducted either face-to-face or with online meeting tools such as Zoom or Teams depending on the respondent's location and preference. Each interview lasted between 40 and 60 minutes. In order to minimize any potential misinterpretation in the interview process and ensure effective communication, the interviews were done in the respondents' preferred languages, which in this case were Korean, Swedish or English. They were also recorded and transcribed into text for analysis purposes.

E. Data analysis

The interview data obtained from the participants was analyzed using a thematic analysis approach to identify and explore key themes related to the research questions. The software program Atlas was utilized to support the coding process. The transcription was reviewed multiple times in order to gain a better understanding of the collected data. Initial codes were generated to represent the relevant challenge areas. These codes were then compared and grouped into broader categories based on their similarities. As an example, the initial codes 'body language' and 'tone of voice' were categorized under the broader theme of 'non-verbal communication' though this phrase. The grouped codes were further analyzed to extract themes, which were derived from the research questionnaire, including geographical distance, temporal distance, and socio-cultural distance.

F. Limitations

1) *Internal Validity*: Internal validity in the context of interview methods refers to the extent to which the observed relationships or findings can be attributed to the intended variables or factors being studied and not influenced by confounding variables or biases [14]. In this case, the results are based on my subjective interpretation and classification of the collected data, which may introduce bias. In order to enhance internal validity, the transcription was thoroughly reviewed multiple times to ensure accuracy and reliability of the emerged data.

Another potential threat could be the relationship between the interviewer and interviewee. Since the participants were all acquainted with me, there is a possibility that their responses might have been influenced by their expectations derived from our personal relationship.

2) *External Validity*: External validity refers to the extent to which the results of a research study can be generalized to a larger population beyond the specific sample that was used in the study [14]. To ensure external validity I carefully selected participants from various roles, considering their diverse experiences in GSD and thereby aiming to improve the generalizability of the findings.

However, due to the relatively smaller sample size compared to surveys, the generalizability of the findings in this research becomes somewhat limited. Therefore, the finding should be viewed from its specific context.

3) *Construct Validity*: The construct validity could be threatened if the interview questions or data analysis techniques used did not accurately capture the experiences and perspectives of individuals involved in GSD projects. As an example, it is possible that the interview questions were not interpreted in the same way by the researcher and the interviewees. To mitigate this threat, participants were encouraged to use their preferred languages during the interviews, which helped ensure clear communication and reduced the risk of misinterpretation. In addition, the interview transcripts were read repeatedly to ensure that same result were derived each time. A pilot interview was also conducted to assess the quality and effectiveness of the interview questions, ensuring they were suitable for gathering the desired information. These steps collectively contributed to ensure construct validity in the study.

IV. RESULT

This section presents the result of the interviews according to the research questions presented in section 3. Table 2 summarizes the findings.

Table 2 Challenge and Mitigating Strategies

Distance type	Challenge	Strategy
Geographical Distance	Inefficient communication	Travel to other sites
	Difficulty in building personal relationships	Regular team meetings
	Misinterpretation of requirement	Multiple Collaboration tools
Temporal Distance	Limited synchronous working hours	Flexible working hours
	Difficulty in scheduling meetings	Identifying overlapping hour
	Delayed response	Setting up communication protocol
Socio-cultural distance	Strict hierarchy	Develop cultural awareness
	Difficulty of expressing 'disagreement'	Assign local liaison Safe atmosphere

A. *RQ1: What are the challenges for team collaboration in Global Software Development between Korean and Swedish companies?*

1) *Geographical distance related challenges*

a) *Inefficient Communication*: The most prominent challenge identified by the participants was the lack of efficient communication between distributed teams. According to the participants, a face to-face meeting was the most effective way to communicate as people could rely on non-verbal cues from their partners to understand them better. Non-verbal cues including facial expressions, body language, gestures, tone of voice and other subtle signals convey emotions, intentions and attitudes in communication [5]. Therefore, non-verbal cues often provide valuable context and additional information to enhance communication and understanding. However, the big geographical distance between Korea and Sweden restricts the opportunity of a face-to-face meeting between teams. The travel time is almost 24 hours and the cost of travel is also quite high. In situations where individuals have difficulty expressing themselves or understanding the spoken language, non-verbal communication can bridge the gap and convey meaning effectively. A respondent from the Korean site expressed the difficulty to understand their partners intention in online meetings, stating *"You can't really tell if a person likes or dislikes what you are saying until you see their face, so it's a lot of one-sided explanations in a tele meeting. They can say that your proposal is interesting without having any real interest"*. One respondent from the Swedish site also mentioned the importance of non-verbal communication, saying that *"Sometimes the Korean team say they understand, when they clearly have not. However, when we have a face-to-face meeting, I can tell if they really understand by seeing their face or gestures"*. This was reiterated by a Korean respondent who mentioned that *"I feel more confident to use English in a face-to-face meeting than during an online meeting. It seems that they understand me better"*.

b) *Personal relationships*: The limited opportunity for face-to-face meetings gave rise to a challenge in building personal relationships within the distributed teams. Face-to-face meetings provide an environment where individuals can engage in informal communication as 'chit chat' which facilitates the exchange of non-work-related information. It strengthens relationships, promotes teamwork, and enhances productivity within the team. However, in this study, it was found that team members between the two sites sometimes had very limited opportunities to meet face-to-face, with some reporting no meetings at all or only one or two meetings per year. The occasions for face-to-face meetings differed between the sites. In the Swedish site, joint reviews where both distributed teams participate to review the product were planned as part of the project process, providing a regular opportunity for in-person interaction. On the other hand, the Korean team didn't plan their visits but rather visited Sweden when there were serious issues that needed to be

resolved. The priority during the visit was to address and resolve the specific issues at hand, which took precedence over engaging in casual or informal conversations which contribute to building relationships. One respondent described his experience of visiting Sweden and mentioned that "...due to limited time and high cost, I was required to solve all issues during my visit, forcing me to work late instead of going out and socialize with the Swedish team in the evenings."

c) *Requirement misinterpretation*: In the software project process, the requirement engineering process typically requires rich communication due to the frequent presence of ambiguities in requirements and conflicts between stakeholders. To clarify ambiguities and resolve conflicts, effective communication is essential. However, due to geographical distance, the frequency of communication is reduced, and face-to-face communication is limited. The issue of understanding requirements was raised by a Korean team member, "*It became evident that the interpretations of the specifications did not align, leading to discrepancies and issues. The Swedish and Korean teams developed the software based on the same specifications, but they had developed different components based on their own understanding, so it failed the integration test*". Similar concerns were raised by another Korean respondent, who stated that "*The specification is a living document. A small change can have a big effect on the final product, but they are easier to miss than a large change. Therefore we need to communicate constantly to ensure that we understand each other correctly*".

2) Temporal distance related challenges

a) *Delay in response*: When there is a significant geographical distance between two locations, it often results in different time zones. In the conducted interviews, participants in both the Swedish and Korean sites agreed that the temporal distance posed a challenge regarding synchronous collaboration. The time difference between the sites is 7 hours in the summer and 8 hours in the winter, resulting in very limited overlapping working hours. Due to this, delayed response times are described as the biggest challenge according to the participants. By the time one site starts working, the other site is about to finish their work which gives a delay in responses. This is highlighted by one Swedish respondent, saying "*Meetings are always before work, which is morning for us, but in Korea it's four o'clock. If you need to ask something important after the meeting, they've already left work, so you have to wait until tomorrow to ask the question, halting our progress*".

b) *Synchronous communication*: The limited overlapping working hours necessitate the reliance on asynchronous communication tools for the teams. This means that opportunities for synchronous communication, such as phone calls, direct messages or online meetings, may be reduced. This issue was highlighted by one member from the Swedish team by stating, "*You have to communicate everything via email after 10 o'clock with the Korean team, but sometimes it is much more efficient to talk*

via phone to clear up any issues". Another Swedish team member mentioned that the ambiguity of email conversations sometimes requires complementary synchronous communication. He explained, "*Whenever a certain message is not clear to me in a received email, I make a call to figure it out. It works better that way*". This highlights the need for synchronous communication methods to increase communication efficiency.

c) *Scheduling meeting time*: The time zone difference also added challenges in scheduling meetings and requires the team to be extra attentive to the limited time they have for overlap working. One member of the Swedish team highlighted that "*All meetings with the Korean team have to be early. Preferably first thing in the morning*". Likewise, one respondent from the Korean site mentioned that "*All meetings have to be planned for the afternoon and we often have to stay late after the meeting to do follow up actions*".

3) Socio-cultural difference related challenges

a) *Hierarchical culture*: The challenge related to cultural and social differences in team collaboration was mostly raised by the Swedish team. A major challenge was the hierarchical culture present in the Korean organization. The Swedish team felt that this could sometimes affect the project negatively. According to the participants, the organizational culture in Sweden is characterized as flat, meaning there is a less pronounced hierarchy compared to the Korean site. There is less emphasis on hierarchical levels and more emphasis on collaboration and equality. One Swedish respondent described the organizational culture difference "*Asian suppliers and LG, where we worked, are very hierarchical. There is a top-down management, and you only communicate with your immediate boss. That's not as common in Sweden, where the organization is much flatter. It was very important to maintain communication with the manager*". On the other hand, the Korean site has a strong hierarchical structure, where there is a clear chain of command and decision-making authority. This process often resulted in the wrong or incomplete information being conveyed as one Swedish respondent explained that "*Due to the strict hierarchy a manager has to know everything. Even if he doesn't personally have anything to do with the issue, you still have to go through him to get to the person you really want to talk to. And since he usually is not as knowledgeable as the specialist, he will often give the wrong information to them, instead of you being able to contact them directly and provide the correct information. This causes more problems*".

One Korean respondent expressed concerns about the hierarchical nature of decision-making in Korea and how it affected the team members turnover from the Swedish site "*Korea has a vertical organization whereas the culture of working in Sweden is horizontal. For example, in Sweden, the opinion of the person in charge is important when making decisions, but in China or Korea, a decision is made at the top management level. That sometimes caused*

the person in charge to become frustrated and, as a result, people kept changing”.

b) Ambiguous expression : Another cultural challenge faced by the Swedish site, was the issue of expressing disagreements within the Korean team. Particularly, the Korean cultural tendency to say 'yes' when they mean 'no' was identified as a challenge. This issue was raised by several participants highlighting the difficulty of accurately gauging the true intentions and opinions of their Korean counterparts.

One respondent mentioned, *“It could be a cultural thing too. They are kind and don't dare to ask follow-up questions, saying yes to everything.”* This was repeated by another Swedish respondent saying, *“You don't want to say something and raise a red flag in front of your boss in Korea”*. Without noticing this cultural behavior and taking it into account, it can have a big impact on the quality of the project, as one respondent mentioned *“People will not say no until it is too late, but by that time the damage has already been done.”*

This challenge reflects the importance of understanding cultural differences in communication styles and expressions of disagreement to foster effective collaboration and avoid misunderstandings between the Swedish and Korean teams.

4) General perception of GSD challenge

At the end of the interviews, the participants were asked to share their general perceptions of working on a GSD project. Despite the challenges experienced by the participants shown in table 2, the overall perception from the interviews suggests that the participants viewed the challenges of GSD as manageable. Most interviewees expressed that geographical distance was no longer a significant problem in today's globalized work environment. They mentioned how technology had enabled remote collaboration and the establishment of teams in different locations without the need for physical offices. They highlighted the ease of working globally and the availability of meeting tools that facilitate remote work. *“Generally speaking, with today's technology, working globally works quite well. I haven't experienced any major negative effects.”* and *“I think it's getting easier in Korea now too. There was a point where they didn't know what tools to use but now, they've gotten a lot of experience, and the tools have gotten easier to use as well.”* One tester mentioned that *“People can sit at home connected to the cloud in a test environment. You can upload the software, run it in the test suite and then you get the result the following day, all from home. You don't have to be in the same place anymore”*.

Furthermore, both team leaders in Korea and Sweden emphasized the benefits of having a global team, mentioning *“You get different ideas and different perspectives from your global teams”*.

The impact of the pandemic is mentioned as a catalyst for increased remote work. *“Now that we're past Covid, people*

are more or less used to working from home. There are also a lot more meeting tools available”.

The overall sentiment is that working globally has become more accessible and convenient, with fewer obstacles and a cultural shift towards remote work. While there were mentions of cultural and communication challenges, the participants expressed a positive outlook, indicating that with time and experience, they were able to learn and adapt to the cultural differences. They emphasized the importance of understanding and respecting different working styles and communication norms across cultures.

B. RQ2 - What strategies are used to mitigate GSD challenges related to collaboration between Korean and Swedish companies?

1) Overcoming geographical distance

a) Collaboration tools: To mitigate communication challenges within a GSD context, the use of tools to facilitate team communication is essential. One frequently used tool in this study is Microsoft (MS) Teams, along with WebEx. MS Teams serves as the primary tool for team collaboration, both internally and externally, at the Swedish site. Users working with Teams expressed their positive experiences, highlighting its numerous functions. Especially, Teams has proven highly beneficial for facilitating easy access to other team members by seeing a status of availability, eliminating the need for phone calls that may or may not reach the partner. Teams is able to send instant messages and have personal video meetings from the users' workplace instead of having to book a conference room. Additionally, the integrated SharePoint function within Teams enables distributed teams to share all project related statuses, which further solidified its status as the primary tool in the Swedish site. One respondent highlighted the comprehensive capabilities of Teams, stating, *“Teams is the only tool you need today because the entire Office 365 is embedded in the ecosystem and there you can link with everything you need to know about the project history. You can also collaborate with anyone in the world at any time”*. Another Korean participant mentioned his positive experience in knowledge sharing through Teams. *“After COVID, Teams has become a commonly used tool where we update documents or collaborate while having discussions. As a result, the issue of missing information from merging with other sites has been significantly reduced”*. However, in contrast to the Swedish site, the utilization of Microsoft Teams in Korea was not as common or widespread. Instead, the primary tool used in Korea is WebEx. Additionally, access to Teams was limited and required approval from the relevant authorities. Furthermore, the Korean team are using separate collaboration tools for internal and external purposes in contrast to Sweden, where both internal and external collaboration occurred within the same unified tool. One participant from Korea expressed concern about the use of separate tools, stating *“When working on multiple projects, there are times when I can't keep up with all the issues due to different tools, and it's hard because I'm not familiar with the tools”*.

To reduce misinterpretation of communication, the Korean respondents have expressed a preference for using asynchronous communication tools, such as email. One respondent emphasized an advantage of using email, noting that, *“I prefer email over Teams meetings since things tend to get lost if there is no meeting of minutes. It's also easy to lose focus in the middle of a conversation in Teams and forget what the exact request was”*. Another Korean respondent mentioned the value of having information in written form, *“Sometimes I don't understand things in the meeting but if I get the same information in an email I can understand. In a mail the information is more formally structured. The message is concrete and clearer than with verbal communication”*. These responses shed light on the preference for using email as an effective asynchronous communication tool among the Korean respondents, especially when there are language barriers.

b) *Travel to on-site*: Despite the benefits of using tools in the GSD context, they cannot fully replace the advantages of face-to-face communication. In this study, it has been found that travel to other sites serves as an effective mitigation strategy.

One Korean participant mentioned that *“Business trips are always time limited, so in order solve the issues, I become more goal oriented, which in turn often lead to increased communication and real time feedback”*. Another Korean participant mentioned that *“Sometimes, miscommunications still occur despite many online meetings. As a last solution, we then travelled to the Swedish site and sat together and worked”*. By working in collocation, the Korean participants aimed to address the communication challenges. Since the issue of not building relationships stems from a lack of face-to-face interaction, traveling to another site facilitates the development of personal relationships with the other site's team members which allows for a better understanding of communication. Several respondents from both the Korean and Swedish sites emphasized that visiting each other's sites resulted in improved communication by building stronger personal connections. One respondent from a Swedish company mentioned the value of meeting in person *“When you had met them in Korea, and you had kind of built up a relationship with them it was much easier for him to open up to me and tell me what was happening down there. Even if it wasn't official information”*. Another stated that *“Once we had met them and you have an established relationship it was easier to understand them even if they sometimes said the wrong thing”*. Likewise, another respondent mentioned that *“If you go to Korea and see your partner's face, or if a Korean developer comes to our Swedish office, it becomes much easier to work together. If you don't see each other and only talk remotely, you don't work as well because you don't know the person you're asking. But once you see each other and work together, your requests are answered quickly”*. Overall, traveling to other sites and working together in person served as an effective strategy to overcome the persistent challenges. This approach not

only facilitated clearer communication but also played a significant role in building personal relationships among team members.

c) *Building relationships*: The practice of building relationships varied among the participants and sites. Some participants made special efforts to interact more personally with remote team members. For example, one respondent mentioned, *“I always take the opportunity when I'm driving to the office in the morning to call him so that even if there was nothing really important that required a meeting, we could still just talk a bit and see if anything new has happened”*. Another example of an effort made to foster personal relationships was the intentional inclusion of informal conversations. One participant mentioned, *“I tried to join the meeting a bit early so that I had more time to engage in chit-chat with the Korean teams before the official meeting began”*.

Another practice implemented for building relationships on a team level is the establishment of regular team meetings. This approach was highlighted by one respondent who stated, *“We have weekly meetings together, so you don't just settle for email conversations, but you really gather the teams from both sides. You can have the meeting with or without a camera, usually you may not need it if you have met once, but you make sure that you involve everyone in the meeting and have the discussion with all of them”*. Likewise, one participant described that *“We have a meeting every 3 days with the development team in Sweden. When we talk that often, we get closer to each other”*.

Participants in the study demonstrated their commitment to building relationships by actively creating opportunities for informal conversations and fostering a sense of one team awareness through regular team meetings.

d) *Addressing Language Barriers*: To mitigate the challenges of requirement misinterpretation, respondents explained that they use visual aids and collaborative requirement engineering *“Many times, we use visual aids. Drawing on the whiteboard helps to enhance understanding”*. Another respondent highlighted the effectiveness of sitting together in the same location to discuss requirements, stating, *“To reduce the gap in understanding requirements, sitting in the same place and discussing brings us the best results”*. Furthermore, these strategies can be incorporated as part of face-to-face meetings facilitated through onsite visits.

2) *Overcoming temporal distance*

a) *Maximizing synchronous work*: In order to overcome the challenges posed by temporal differences, both the Swedish and Korean sites focused on a common strategy: identifying and utilizing overlapping work hours. By increasing the amount of time the team members shared, they were able to facilitate real-time communication and collaboration among their distributed teams. One effective solution that emerged from the interviews conducted was the implementation of adjusted schedules or flexible

working hours. For instance, one team member mentioned, *“Some members in our team come to work after lunch and finish later in the evening to be able to work more synchronously with the Swedish team”*. This adaptive approach allowed for maximizing overlap in working hours between the teams.

Another interviewee shared their experience in dealing with different time zones, stating, *“When I talk to Asian companies, I usually schedule morning meetings for myself, so that it's not too late for them. If I interact with colleagues or suppliers on the other side, such as in the US, Mexico, and so on, I arrange afternoon meetings to accommodate their early morning hours. Constant adaptation is necessary to ensure that it works well for both sides”*. The interviews also highlighted the importance of synchronizing meetings within normal working hours for all parties involved. As one interviewee explained, *“You try to synchronize the meetings so that they are within normal working hours for both parties, so to speak. This way, all team members can actively participate”*. By maximizing overlapping work hours and employing strategies such as adjusted schedules and synchronized meetings, the Swedish and Korean teams aim to foster effective collaboration and coordination across temporal distance.

b) Setting up communication guidelines: To address the challenge of delayed response, the Korean site established a clear communication protocol to enhance team collaboration. This protocol set explicit communication deadlines and established clear expectations for task completion. As a result, team members were made fully aware of their responsibilities for responding and the requester can expect a relatively quick responding time.

One respondent explained that *“We have a protocol where we respond within 24 hours. However, depending on priority, we can set different review times and then provide a comprehensive response within a week”*. By establishing clear expectations and response times, the Korean site effectively minimizes the impact of temporal differences on collaboration and maintains efficient communication.

3) Overcoming socio-cultural distance

a) Acknowledging the differences: To mitigate the cultural differences, particularly in terms of hierarchy, the participants in the study implemented a non-concrete solution. Rather than implementing a specific solution, participants facilitated open discussions and acknowledging the differences. One participant mentioned that *“We talk a lot about the culture differences when we have a chance. While we cannot change their hierarchical structure, we try to understand it. At the same time, the Korean team needs to understand our flat culture”*. To help the team to acknowledge the difference between the teams, the Swedish site organized more deliberate sessions, including cultural training and workshops for the team members, aimed at increasing their awareness and understanding of different cultural norms and communication styles. One respondent from the Swedish site mentioned *“We do a lot of different culture workshops*

and team building workshops, but they need to be done on a regular basis”. Another participant from the Swedish site stated that *“What is OK in one place is not necessarily OK in another. Highlighting and teaching those differences are things that should be done through a workshop”*. However, it's worth noting that none of the interviewees from the Korean site mentioned receiving such culture training internally. It appears that the awareness of cultural differences is less emphasized in the Korean site.

b) Assigning a local liaison: Even though there was no concrete mitigation plan to overcome specific culture differences, there has been a similar strategy to embrace cultural differences between both the Swedish and the Korean sites. They have hired a liaison person at each site who can speak the language of the other site and has knowledge of cultural norms. This individual served as a bridge between the teams, ensuring smooth and effective communication across locations. One Swedish participant stated that *“In the beginning of the project, we hired a Korean person who could speak Swedish and she was in charge of communicating with Korean teams in Korean. It was very effective and helped us a lot since it was the first project we worked on with Korea”*. Similarly, the Korean company hired one Swedish engineer, allowing him to work in the Swedish site. The importance of having a liaison was emphasized by one participant who stated, *“As a project manager, the most important thing was to have a local engineer because we were developing in Korea and traveling back and forth a lot. When you hire a local, you don't have to travel as much because they know the local culture and they don't have any communication issues”*. According to this respondent, the liaison's deep understanding of the local culture and context allowed for efficient collaboration, reducing the need for extensive travel, and improved problem-solving capabilities during conference calls with the Swedish team.

c) Safe atmosphere: In response to the challenge of people not expressing disagreements in the Korean teams, one of the respondents from the Swedish site emphasized the importance of creating an environment that encourages team members to open up and address concerns or issues transparently. In that environment, it is easily acceptable to express differing opinions or to say *“No”* respectfully. One respondent stated that *“People will not say no until it is too late. We need to build trust and a team environment for them to open up about different issues”*. Another Swedish respondent noted that as he spent more time with the Korean team members, he developed a deeper understanding of their communication style. He explained, *“I felt that over time when you got to know them, you understood what they really meant. You understood that even though they said ‘yes’ they hadn't really understood and then you made sure they got the information they needed anyway”*. This further highlights the significance of building relationships, enabling better comprehension and effective communication even in situations where there may be cultural or linguistic differences.

V. DISCUSSION

This section provides a discussion of the findings presented in the previous section. Additionally, the findings are compared to previous related work.

A. Geographical challenges and strategies

Due to the large geographical distance between Korea and Sweden, the identified challenges were inefficient communication, difficulty in building personal relationships and misinterpretation of requirements.

1) *Inefficient communication:* The most effective form of communication, face-to-face meetings, was hindered by the significant geographical distance between the Korean and Swedish teams. This communication challenge is commonly observed in a GSD context and has been reported in previous studies as well [5],[16]. To enhance communication efficiency between distributed teams, both the Korean and Swedish teams utilize multiple communication tools. The adoption of multiple communication modes is supported by previous research findings as well [4]. While Korean respondents prefer to use asynchronous communication tools to ensure clear understanding, Swedish respondents have a preference for synchronous tools. The benefits of asynchronous tools, which provide individuals more time to comprehend and compose a response, are supported by previous research findings [17, 18]. This finding suggests that recording important synchronous communication could be considered a useful practice to increase communication efficiency to Korean teams. This practice allows team members to refer back to the recordings, ensuring accurate information capture and minimizing misunderstandings.

2) *Building personal relationships:* The lack of opportunities to build personal relationships in distributed teams was identified as another challenge arising from geographical distance. To address this challenge, the most effective strategy found was to travel to another site. This approach aligns with the findings of a previous case study, where it was observed that visits to on-site locations played a crucial role in overcoming communication and relationship-building challenges [19]. The on-site visits facilitated opportunities for informal communication, which has been found to be effective in building personal relationships. The importance of informal communication in strengthening personal relationships is also emphasized in previous research [18]. In face-to-face meetings, the objective is to foster personal connections and establish a social network that cultivates trust, respect, and commitment. This, in turn, facilitates collaborative work across diverse geographical sites [20]. Due to the high cost of travel, the on-site travel strategy is limited. Therefore, it is important for project management to incorporate planned visits into the project plan, specifically during the early stages of the project, to maximize their impact. While face-to-face interactions may be limited, it is important for remote teams to recognize the value of personal relationships and actively work towards building them [17]. In this study, the effort to do so was mainly seen from

the Swedish site members. When the question was asked regarding the personal effort to build relationships, there were no concrete answers provided by the Korean team. The observed difference might indicate that the importance of personal relationships in collaboration might be underrated in the Korean team in GSD context. Therefore, it is important for the Korean team to also prioritize efforts in fostering personal relationships.

I would also like to note that all of my respondents were men. Since men and women usually have different ways of communicating, with women tending to emphasize relationship-oriented communication and empathy, while men lean towards directness and task-oriented communication [21], this could have affected my results.

3) *Misinterpretation of requirements:*

Misinterpretation of requirements was identified as one of the main issues arising from geographical distance in this study.

This issue was also highlighted in previous research [22]. However, it is important to note that the misinterpretation of requirements is not solely attributed to the chosen language [22]. According to [13], different domain understanding within specific domains can also influence the interpretation of requirement. However, the strategies identified in this study primarily focused on ensuring clear information transfer, such as the use of visual aids. Therefore, it is crucial to make concerted efforts to minimize misunderstandings in requirement engineering, taking into account not only language barriers but also cultural differences, within collaboration of the Swedish and Korean sites [17, 22].

B. Temporal challenge and strategies

The challenges identified in relation to temporal distance were delayed responses and the limited availability of synchronous working hours, as well as optimizing meeting hours.

1) *Delayed response:* Delayed response of asynchronous communication is very frequently observed in previous research. For instance, in a distributed context, the average response time to comments posted on a forum was found to be over half a day longer compared to a co-located context [18]. Likewise, delays in receiving answers to an inquiry in a distributed context was over two-and-a-half times longer compared to a co-located context [23]. To address this challenge, a clear communication protocol was implemented. A clear communication protocol can address the challenge of delayed response by providing guidelines and expectations for communication within the team. Previous studies similarly expressed the benefits of having clear communication protocols, including defining the responsibilities of team members and establishing effective communication processes [16]. Based on this finding, it is crucial to strike a balance between synchronous and asynchronous methods to optimize the communication between the Korean and Swedish teams. The Korean team's preference for asynchronous communication, which results in delayed responses, can be addressed by incorporating

more synchronous communication. This shift can help reduce the negative effects of delayed responses, enhance collaboration, and mitigate potential project delays.

2) *Limited overlap working hours* : Due to the temporal difference between Sweden and Korea, there are only a few hours of overlap in working hours. To address this issue, adjusted schedules or flexible working hours was implemented. By adapting their work hours to start earlier or later in the day, team members were able to maximize the limited overlapping time for effective collaboration. These measures have been recognized in previous research as effective solutions for managing temporal differences in global collaboration. [3] [24].

3) *Optimizing Meeting Schedule*: Furthermore, the interviews revealed the importance of synchronizing meetings within normal working hours for all parties involved. By scheduling meetings that accommodated the time zones of the distributed teams, active participation from team members was encouraged. This finding corroborates previous research that emphasizes the significance of coordinating meeting times to foster effective communication in distributed teams [13].

C. Socio-cultural challenges and strategies

The challenge of cultural and social differences in team collaboration was predominantly raised by the Swedish team. The challenges related to socio-cultural difference were hierarchical organization culture and ambiguous expression of disagreement.

1) *Hierarchical organization culture*: The Swedish team encountered significant difficulties in communication due to the hierarchical nature of the Korean site's culture. This hierarchical culture sometimes resulted in the transmission of inaccurate or incomplete information. Moreover, it contributed to longer communication times. A similar issue has been reported in a previous study, which examined the differences in organizational hierarchy between a Finnish and a Central European country. In the previous case study, team members were unable to disregard the conversational rules imposed by the hierarchical layers [25]. One mitigation solution to reduce communication time is to flatten the communication hierarchy [19, 26]. However, in this study, no effort to flatten the hierarchy could be found. Instead, the Swedish team embraced an understanding of Korean culture and adopted it to improve communication and collaboration. To bridge the cultural gap, a liaison was hired who possessed a comprehensive understanding of the cultures on both sites. Individuals with relevant technical and domain knowledge who can effectively connect between cultures serve as natural facilitators for managing and mediating communication [27]. Similarly, the significance of providing education and training for qualified local GSD project managers has been highlighted in previous research, a sentiment that was echoed by one of the respondents in this study [28].

2) *Ambiguous expression of disagreement*: Another challenge encountered by the Swedish team was the ambiguous expression of disagreement from the Korean team. It was observed that Korean team members often responded with "Yes" even when they did not fully understand the agenda or had objections, especially when interacting with individuals in higher hierarchical positions. This behaviour was also attributed to their kindness. Saying "No" directly can be seen as impolite or offensive in Korean culture. A previous study has highlighted a similar concern, where the polite expressions of acknowledgement used by Asian engineers could potentially be misconstrued and misinterpreted as an agreement by European engineers [29]. To address this challenge, it is crucial to foster open communication and cultivate a mutual understanding between both teams [30]. One respondent in this study emphasized that creating an environment that encourages team members to openly express their concerns is an important factor in overcoming this challenge. One other solution identified in this study is the provision of culture training. By offering training programs that focus on cultural awareness and sensitivity, team members can gain a better understanding of each other's communication styles, norms, and values. Culture training has been recognized as one of the most important best practices for global teams in the previous study [31]. It has been shown to be an economically efficient route to achieving a better understanding and collaboration among team members from different cultural backgrounds.

VI. CONCLUSION

The objective of this paper was to investigate the challenges faced by collaborations between Sweden and Korea in GSD projects and explore practical solutions that have been implemented. Through an exploratory case study approach, both challenges and strategies were identified. The main challenges were categorized into three areas: geographical distance related challenges, temporal distance related challenges and socio-cultural related challenges. The identified challenges under geographical distance were inefficient communication, requirement miscommunication, and difficulty in building personal relationships. Challenges related to temporal distance included limited overlapping working hours and delayed responses. Furthermore, cultural differences were observed, particularly within the Korean team, involving hierarchical communication and ambiguous expression of disagreement. Strategies to mitigate these challenges included the use of proper collaboration tools, regular team meetings, flexible working hours, and the establishment of clear communication protocols. To address cultural-related issues, the development of cultural awareness was practiced within the participant group, and a liaison was assigned. The identified issues and mitigation plan in this study were also observed in several previous studies. However, this study did not observe practical solutions to flatten communication hierarchy. Additionally, the specific implementation of agile practices, such as scrum, was not

observed or discussed in detail, diverging from previous research.

These challenges in GSD are not standalone. Instead, they are interconnected. When there is a good interpersonal relationship, individuals feel more comfortable opening up and gain a better understanding of others' culture, resulting in improved collaboration efficiency. Therefore, it is necessary to implement a mitigation plan from the early stages of the project to minimize the negative effects of these challenges.

In this study, participants expressed feeling less challenged while working in a GSD environment due to today's technical advancements. However, it is important to keep in mind that the most effective collaboration tool is not fully functional if personal relationships within a distributed team are not established. This suggests that both individual efforts and management-level initiatives are required to facilitate the development of personal relationships and increase success in global projects. By recognizing the interdependence of technical development and interpersonal relationships, we can effectively address the challenges associated with GSD. Early implementation of a mitigation plan, combined with efforts to foster personal connections, will contribute to smoother collaboration and improved project outcomes.

Considering the importance of personal relationships in Global Software Development (GSD) teams, further research on team dynamics in GSD is of significant interest. Therefore, I suggest conducting a further study that investigates the correlation between team member dynamics and GSD success. By examining how the interpersonal dynamics, communication patterns, and relationship quality among team members impact the overall success of GSD projects, valuable insights can be gained to inform best practices and strategies for building high-performing GSD teams.

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[Appendix] Interview Questions

General Questions

- What is your role in the company?
- How long have you worked as a software engineer/ Global Software Development (GSD) projects?
- Which countries were the teams located in?

Communication

- How do you communicate with colleagues at your own office and at other offices?
- Have you noticed any differences in how you communicate with different colleagues?
- Are there certain tools/method that you prefer/work better for you?
- Have you experienced any challenges in communication with colleagues from other offices?
- If so, have you made any changes to improve communication?
- How did communication affect the GSD project quality?
- Are there any policies regarding communication in a project?

Geographical distance

- How often have you visited another site?
- What is the purpose of the visit?
- Has being at a different site affected you in a more positive or negative way?

Socio-cultural distance

- Have you noticed differences of culture between your site and other sites?
- Have cultural differences had negative or positive effects on the project?
- How do you build teamwork with members from other sites?

Temporal distance

- Does difference in time zones present any issues or challenges with your work?
- If so, how do you try to solve these problems?

Agile

- Are you familiar with the 'Agile' method?
- Have you used any agile practice during the GSD project?
- If so, what contribution did the agile practices make to the project?

Role specific

- What kind of challenges are there related specifically to your role during a project?
- What challenges do you think need to be solved first?

Finally, is there any experience regarding globally distributed development that you want to share or anything else you wish to add?

Thanks for your participation!