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Exploring Team Familiarity: The Effect of Geographical Dispersion on Scrum Teams

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The authors declare that they are the sole authors of this thesis and that they have not used any sources other than those listed in the bibliography and identified as references. They further declare that they have not submitted this thesis at any other institution to obtain a degree.

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Abstract

Context: In recent years, software development teams have been adopting agile methodologies like Scrum to enhance productivity and collaboration. However, with the outbreak of COVID-19, remote working conditions have become the new norm. This shift has posed a challenge for software development teams as they struggle to maintain the same level of productivity and collaboration while working remotely. Agile methodologies like Scrum, which emphasize teamwork, communication, and collaboration, are particularly affected by remote work conditions. One critical factor that affects agile teams' effectiveness is team familiarity, which is the degree of mutual understanding among team members. High team familiarity can lead to better communication, coordination, and performance.

Objectives: The main aim of this research is to investigate the effects of geographical dispersion on team familiarity in Scrum teams due to pandemic restrictions. The research aims to identify the facets that contribute to the concept of team familiarity, investigate how geographical dispersion has affected team familiarity during the pandemic, and explore how the Scrum practices have been impacted by changes in team familiarity under remote working conditions.

Methods: The research employed a literature review as a research method and interviews as a data collection technique. The first phase involved conducting a comprehensive literature review by analyzing various research papers using the forward snowballing technique to identify the facets contributing to the concept of team familiarity. In the second phase, semi-structured interviews were conducted with 12 software professionals from various software companies who had experience working in Scrum teams during the pandemic. The interview questions focused on how remote working conditions had affected team familiarity and Scrum practices. The data collected during the interviews was analyzed using a deductive thematic analysis, which guided the identification of common patterns and themes.

Results: From the literature review, nine team familiarity facets were identified: *Shared work experience, Communication, Team coordination, Team cohesion, Interpersonal knowledge, Shared knowledge, Trust, Team collaboration, Member diversity*. The interview data revealed that the geographical dispersion did pose a few challenges due to the remote work setup and has negatively affected team familiarity. The correlation between team familiarity facets and the scrum practices was also explored along with how they were affected due to the geographical dispersion. However, the interviewees suggested several strategies to mitigate the challenges posed by geographical dispersion, such as regular communication and virtual team-building activities.

The results of the literature review were then compared with the interview results to determine the consistency of the findings. The comparison showed that most of the team familiarity facets identified in the literature review were also relevant to the interviewees' experiences. One important theme that emerged from the comparison of the literature review and interview findings is the interdependence of team familiarity facets, where a change in one facet could affect other facets as well. Trust and communication were found to be the most interconnected facets with links to other team familiarity facets.

Conclusions: This research highlights the importance of team familiarity in Scrum teams and the effect of geographical dispersion on team familiarity. The study identified nine facets that contribute to the concept of team familiarity and discussed their interdependence. The research findings suggest that mitigation strategies can help maintain team familiarity under remote work conditions. It was also concluded that maintaining team familiarity is crucial for effective Scrum practices and team performance. Organizations should consider these factors while implementing Scrum practices in geographically dispersed teams. The study recommends further research to explore the impact of team familiarity on other aspects of team performance. Moreover, the scope of the research could be expanded to include other agile methodologies apart from Scrum. Additionally, investigating the role of leadership in promoting team familiarity and collaboration in geographically dispersed Scrum teams is another potential avenue for future research.

Keywords: Team Familiarity, Geographical Dispersion, Agile Software Development, Scrum, Mitigation strategies, Interdependence, Literature review, Interviews.

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Chapter 1

Introduction

In today's rapidly evolving digital age, organizations strive to achieve their goals quickly and efficiently. Teamwork has been identified as a key factor in achieving these objectives as many studies have demonstrated that companies that value and promote teamwork are more likely to achieve their goals more rapidly, find better solutions, and increase productivity. The key to enhanced creativity and problem-solving in a team is open communication and collaboration, which leads to major industry innovations [1]. When team members support and assist one another while working towards a common goal, efficiency increases. Weimar et al. [2] explicitly stated that software quality depends on effective teamwork, team familiarity, and communication, in addition to traditional software engineering procedures and development methodologies.

Proper management and functioning of the team are crucial to improving the team's productivity and performance. Prior research has revealed that team familiarity and shared work experience play a critical role in the effective team and project performance [3, 4]. The degree to which the members of a team regard themselves as familiar can be characterized as *team familiarity*. It may also be described as the information or knowledge that members of a team possess or understand about each other's specific tasks and responsibilities. Team familiarity enhances the knowledge of fellow team members' areas of expertise, strengths, weaknesses, and personalities [5]. Many studies have shown that team familiarity has a positive effect on team efficiency, output, and productivity [6].

One of the core ideas of agile software development is the emphasis on iterative and collaborative work. Agile teams' work has been shifted remotely due to the rapid spread of the Covid-19 pandemic, resulting in geographical dispersion of team members [7]. This drastic shift of working remotely has hugely impacted how the teams collaborate and communicate [8]. Geographic separation between team members may also reduce the benefits of team familiarity in terms of knowledge sharing and also limits the effectiveness of communication [6]. The traditional approach to agile team management has been thrown into disarray as a result of this drastic shift to remote working. Prior study has revealed that team familiarity is one of the aspects that may have been impacted as a result of the distant working conditions imposed by pandemic restrictions [9].

The aim of this thesis is to investigate the effects of geographical dispersion on team familiarity in scrum teams as a result of pandemic restrictions. This research begins

with a literature review to identify the facets (i.e., the characteristics or aspects) that contribute to team familiarity, such as shared work experience, communication, team coordination, team cohesion, interpersonal knowledge, shared knowledge, trust, team collaboration, and member diversity. Then, using these 9 facets of team familiarity, we interviewed software professionals from various backgrounds to gather key information on their perspectives regarding team familiarity and geographical dispersion. The interviews provided us with qualitative data that we could analyze and explain the effects of team familiarity facets on Scrum teams.

In this study, it is noteworthy to mention that the results are based on the geographical dispersion of Scrum teams during the timeline of the COVID-19 pandemic. Therefore, the term "geographical dispersion" used in this study refers to the specific context of teams being physically separated due to the pandemic. Furthermore, terms such as "remote working", "geographical dispersion of team members", "distributed teams," and "dispersed teams" are used interchangeably in this study to refer to the same phenomenon. It is crucial to provide this context as the COVID-19 pandemic has significantly impacted the way teams collaborate and operate, and our findings are specific to this unique situation.

1.1 Thesis Structure/Outline

This thesis explores the effect of geographical dispersion on team familiarity in Scrum teams in the context of pandemic restrictions. The following sections present a detailed overview of the thesis structure and the research methodology employed.

1. In the *Introduction*, the background and significance of teamwork, team familiarity, and agile software development are discussed. The aim of the study is presented along with its objectives and research questions.
2. Chapter 2, *Related Work*, provides an overview of the existing literature on team familiarity and its facets, as well as relevant research on agile software development and geographical dispersion in software teams. The chapter also identifies gaps in the literature and provides a summary of the research papers that we selected for the literature review.
3. Chapter 3, *Research Design and Execution*, outlines the research methodology employed in the study. The chapter provides a detailed description of the data collection process and the research design, including the study participants, interview questions, and data analysis techniques for both the research methods in this study.
4. Chapter 4, *Results and Analysis*, presents the findings of the study, which are divided into two sections. The first section discusses the results of the literature review, focusing on the team familiarity facets identified, which answers the first research question, RQ-1. The second section of this chapter highlights the results of the interviews conducted with software professionals and the team familiarity facets reported by interview participants and how they were effected by geographical dispersion. This section also explores the relationship

between the identified team familiarity facets and Scrum practices, answering the research questions RQ-2 and RQ-3.

5. Chapter 5, *Discussion*, compares and contrasts the findings from the literature review and the interviews by highlighting the effect of geographical dispersion on the team familiarity facets. The chapter also examines the interdependence of team familiarity facets and discusses the challenges posed by geographical dispersion and the mitigation strategies that could be employed to overcome them. Additionally, the chapter highlights the practical implications of the study and identifies the potential validity threats to the research.
6. Chapter 6, *Conclusions and Future Work* summarizes the study's findings and answers the research questions. The chapter also highlights the limitations of the study and suggests areas for future research. Additionally, this chapter suggests ways in which the study's findings could be applied to improve team familiarity and collaboration in Scrum teams.

In conclusion, this research examines the effect of geographical dispersion on team familiarity in Scrum teams in the context of pandemic restrictions. The study provides valuable insights into the various team familiarity facets and also highlights the challenges posed by geographical dispersion and suggests mitigation strategies to overcome them. The study's findings have significant practical implications and could be applied to improve team familiarity and collaboration in Scrum teams.

1.2 Background

In this section, we will elaborate on the definitions and significance of teams, teamwork, Agile Software Development, Scrum Framework, etc, in the context of Team familiarity and distributed teams.

1.2.1 Teamwork and Team Familiarity

A team is a group of people who are brought together voluntarily to focus on achieving organizational goals and producing results [10]. The team members manage their relationships across organizational boundaries and are jointly responsible for the team's outcomes [11]. Teamwork involves the collaborative integration of individual skills and efforts, resulting in a collective outcome that surpasses the sum of its individual parts [12]. Effective teamwork is essential in many domains, including software development. Research has shown that teamwork is a critical factor in software development success [13]. Effective teamwork has been linked to better project outcomes, higher levels of quality, and increased productivity. In contrast, poor teamwork can lead to project failures, missed deadlines, and low-quality products. Therefore, it is important to understand the factors that contribute to effective teamwork in software development.

Teams that collaborate closely over an extended period of time can improve their ability to coordinate tasks and are shown to be more effective. Team members that

actively collaborate and combine their individual strengths to efficiently share high-level skills in order to finish a project on time and under budget are thought to be the most valuable asset to the organization. Recurring interactions between team members assist to create communication channels and a shared language. Open communication and cooperation offer increased learning opportunities, which may also develop an environment that promotes creativity and strengthened innovation. According to research, when teammates feel comfortable expressing themselves, new ideas, thoughts, and methods emerge that might not have developed when working independently [14]. As team members share their experiences, trust may develop, resulting in improved team performance [6].

The source of detail that team members have about each other, as well as the quantity of work that they have done together, are commonly used to describe *team familiarity*. Huckman et al. [4] define team familiarity as the average number of times each team member has collaborated with each other and emphasize that team familiarity is positively related with team performance. Team familiarity also includes the quality of the team's connections and team cohesiveness among members, as well as the team's communication [5]. Team familiarity allows team members to exchange information and interact efficiently, increasing their chances of aligning knowledge and developing meaningful and innovative solutions. According to Muskat et al. [5], the knowledge of each team member's technical competence, weaknesses, and backgrounds is improved by a high degree of familiarity. Especially in teams that work on repetitive and standardized activities are greatly benefited from team familiarity which is a major factor for team performance [9].

Team familiarity fosters a safe environment where team members can openly share their knowledge and experiences, which inspires creativity and development [6]. Research has shown that team familiarity can improve communication, reduce conflicts, and increase trust among team members [15]. In agile software development, team familiarity is particularly important due to the frequent interactions and close collaboration among team members [16]. Agile methodologies such as Scrum emphasize teamwork and collaboration, and rely on team members to self-organize and work together to deliver software products [17]. Therefore, understanding the impact of team familiarity on agile software development is essential.

1.2.2 Agile Software Development (ASD)

Agile software development (ASD) is an iterative project management approach in which requirements and solutions evolve through collaboration between self-organizing cross-functional teams. With increased face-to-face communication and less written documentation, it promotes cooperation, collaboration, and process adaptation across the project life cycle. ASD is based on the Agile Manifesto, which was introduced by a group of software practitioners in 2001 and has since become a guiding philosophy for Agile methodologies such as Scrum, Kanban, and Extreme Programming (XP) [18, 19]. These agile methods have gained popularity in the software industry due to their ability to quickly respond to changing customer needs and deliver high-quality software products. There are four core values of Agile software

development as stated by the Agile Manifesto [20]:

- *Individuals and interactions over processes and tools*
- *Working software over comprehensive documentation*
- *Customer collaboration over contract negotiation*
- *Responding to change over following a plan.*

One of the key principles of ASD is the emphasis on teamwork and collaboration among team members. Agile teams work closely together, often in the same physical location, and engage in frequent communication and interactions to ensure that the software product is developed effectively [18]. Team members in an ASD environment are encouraged to self-organize, make decisions collaboratively, and take ownership of the work they are responsible for [21]. The close collaboration and interdependencies among team members make team familiarity a critical factor in the success of agile software development projects. Research studies have shown that team familiarity significantly impacts the performance of agile teams. Higher levels of team familiarity lead to improved communication, coordination, and trust among team members, resulting in higher team productivity and reduced project risks [22]. Team familiarity also effects the effective implementation of agile practices and principles, such as continuous integration, daily stand-ups, and sprint reviews [13].

1.2.3 Agile Software Development (ASD) in Distributed Teams

In recent years, many software development teams have adopted distributed or remote work arrangements due to various factors such as globalization, cost-effectiveness, and access to a wider talent pool [22]. Distributed teams refer to teams whose members are located in different geographic locations, often across different time zones, and rely on communication and collaboration technologies to work together. While distributed teams offer several benefits, such as increased flexibility and access to diverse skill sets, they also face unique challenges related to communication, coordination, and team dynamics [13, 23].

The COVID-19 pandemic has further accelerated the adoption of distributed work arrangements in software development teams, as many organizations shifted to remote work to ensure the safety and well-being of their employees [24]. Agile methodologies can be applied in distributed teams as well, with some adaptations to address the challenges of geographical dispersion. For example, remote teams can use video conferencing, online collaboration tools, and project management software to facilitate communication and collaboration [22]. Agile practices such as daily stand-up meetings, sprint planning, and sprint reviews can also be adapted to ensure team alignment and transparent progress. Additionally, techniques like pair programming, continuous integration, and automated testing can be employed to maintain code quality and reduce integration issues [25].

Despite the potential benefits, applying Agile methodologies in distributed teams comes with challenges. Communication can be complex due to language barriers, time zone differences, and limited face-to-face interactions [22]. Coordination among

team members can also be challenging, as they may be working on different tasks at different times or may need to wait for inputs from other team members [26]. Moreover, team dynamics can be affected by the lack of informal interactions and shared context, which can impact team familiarity and cohesion [13]. These challenges need to be carefully managed to ensure the success of Agile software development in distributed teams, especially in the context of the COVID-19 pandemic.

1.2.4 Scrum Framework and Scrum Practices

Scrum is one of the most widely used Agile methodologies for software development, known for its iterative and incremental approach to product development [18]. Scrum is guided by a set of principles that provide a framework for Agile software development. These principles include empirical process control, self-organization, collaboration, time-boxing, iterative and incremental development, continuous improvement, visibility, focus on value, and flexibility. These principles enable Scrum teams to work collaboratively, deliver incremental value, and continuously improve their processes and products. By following these principles, Scrum teams can achieve success in Agile software development and deliver high-quality products that meet customer needs [17].

Scrum values are the guiding principles that shape the culture and behavior of Scrum teams. They include courage, focus, commitment, respect, and openness. These values promote collaboration, self-organization, transparency, and continuous improvement within the team. When practiced, Scrum values lead to effective teamwork, positive team culture, and successful Agile software development projects. Scrum teams are cross-functional, typically consisting of a Scrum Master, a Product Owner, and Development Team members [27]. The Scrum framework provides a set of roles, events, artifacts, and rules that guide the team's work. The Scrum framework includes several key roles in the team:

1. **Scrum Master:** The Scrum Master is responsible for facilitating the Scrum process, coaching the team on Agile principles and practices, and removing any obstacles that hinder team progress [27]. The Scrum Master acts as a servant-leader, promoting a culture of continuous improvement and collaboration within the team.
2. **Product Owner:** The Product Owner is responsible for defining and prioritizing the product backlog, representing the needs of the stakeholders, and ensuring that the team is working on the most valuable features and delivering value to the customers [27]. The Product Owner collaborates with the team to refine requirements, provides clarifications on user stories, and accepts the increment of the product at the end of each Sprint.
3. **Development Team:** The Development Team bears the responsibility of designing, developing, testing, and delivering the product incrementally in accordance with the principles of Scrum [27]. As a self-organizing and cross-functional unit, the Development Team possesses all the requisite skills to accomplish the tasks needed to produce a potentially releasable increment of the product by the end of each Sprint.

Scrum incorporates a set of practices that enable teams to work collaboratively, deliver high-quality software, and continuously improve their processes. These practices are designed to promote transparency, inspection, and adaptation throughout the development process, ensuring that the team can respond to changing requirements and deliver value to the customers. They also help teams deliver high-quality software incrementally, iteratively, and adaptively while enabling effective collaboration and communication among team members [28,29]. Some of the scrum practices along with their definitions have been listed below:

- ***Sprint:*** A Sprint is a time-boxed iteration in Scrum, typically lasting 1-4 weeks, during which the development team works to complete a set of product backlog items [27]. At the end of each sprint, the team holds a sprint review to demonstrate the increment of the product to stakeholders and receive feedback, and a sprint retrospective to reflect on the sprint and identify areas for improvement.
- ***Product Backlog:*** The Product Backlog is a prioritized list of items that represent the work to be done on the product, maintained by the Product Owner [27]. Product backlog items can be user stories, bug fixes, technical tasks, or other work items that add value to the product. The Product Backlog is continuously refined and updated based on feedback from stakeholders and the team.
- ***Sprint Backlog:*** The Sprint Backlog is the subset of the Product Backlog that the Development Team commits to completing during a Sprint [27]. The Sprint Backlog is created during the Sprint Planning and serves as a plan for the team's work during the Sprint. The development team self-organizes to determine how they will accomplish the sprint goal and select the items from the product backlog to include in the sprint backlog. The Sprint Backlog is a dynamic artifact that can be updated and adjusted throughout the Sprint as new information emerges or priorities change [28].
- ***Daily Stand-up:*** The Daily Stand-up, also known as the daily scrum is a short, time-boxed daily meeting where the scrum team members synchronize their work and plan for the day. It is an opportunity for team members to share updates on their progress, discuss any obstacles, and plan their work for the day [28,29].
- ***Sprint Planning:*** Sprint Planning is a collaborative meeting held at the beginning of each sprint to define the sprint's goal, select the items from the Product Backlog that will be worked on during the sprint, and create a plan for how the work will be done. It involves the Product Owner, the Development Team, and the Scrum Master, and is an opportunity for the team to clarify requirements, estimate effort, and create a shared understanding of the work to be done [28,29].
- ***Backlog Refinement:*** Backlog Refinement, also known as Backlog Grooming, is a Scrum practice that involves reviewing and refining the items in the Product Backlog. During Backlog Refinement, the Scrum Team works together

to clarify the requirements of the Product Backlog items, estimate their effort, and prioritize them based on their value and dependencies. This practice helps ensure that the Product Backlog is well-organized, understood, and ready for implementation in upcoming Sprints [27, 30].

- ***Sprint Review:*** The Sprint Review is a meeting held at the end of each Sprint to review and demonstrate the work done during the Sprint. It is an opportunity for the team to gather feedback from stakeholders, inspect the product increment, and adapt the product backlog based on the feedback received [17, 27].
- ***Sprint Retrospective:*** The Sprint Retrospective is a meeting held at the end of each Sprint to reflect on the team's performance and identify opportunities for improvement. It is a time for the team to inspect and adapt their processes, tools, and practices, and make adjustments for the next sprint [28, 29].
- ***Scrum of Scrums:*** Scrum of Scrums is a coordination practice in Scrum that is used to manage the work of multiple Scrum Teams working on a large or complex project. It involves representatives from different Scrum Teams coming together in a meeting to discuss progress, share information, address dependencies, and ensure the overall project is on track. Scrum of Scrums enables cross-team collaboration, alignment, and coordination, particularly in situations where teams are distributed or working on different components of the same product. This practice facilitates effective communication and coordination among teams, helping to ensure that the project progresses smoothly and that any inter-team dependencies are identified and resolved in a timely manner [17, 27].
- ***Definition of Ready (DoR):*** The Definition of Ready is a Scrum practice that defines the criteria that a product backlog item must meet before it can be considered ready for selection into a sprint. The Definition of Ready helps ensure that the product backlog items are adequately prepared and have enough information for the Scrum Team to start working on them. This practice helps prevent misunderstandings, delays, and rework during sprint planning and promotes a shared understanding among the Scrum Team about the work that needs to be done [30, 31].
- ***Definition of Done (DoD):*** The Definition of Done (DoD) is a shared agreement within the Scrum team on the criteria that must be met for a product increment to be considered complete and releaseable. It outlines the quality standards and expectations for the work done during a sprint and helps ensure that the team delivers a potentially deliverable increment of the product at the end of each sprint [17, 27].

Chapter 2

Related Work

This section outlines and summarizes some of the research papers that we studied in the context of team familiarity in order to carry out this research.

Bradley Staats' research [6], emphasized the benefits of team familiarity and also explored how the benefits of team familiarity vary when team members are in different locations. They mentioned that, team familiarity, or individuals' prior shared work experience, can improve team output efficiency and quality. This shared experience fosters good rapport and increases trust among team members. Team members who collaborate with one another on a regular basis may build social capital and improve their ability to coordinate actions. Moreover, with hierarchical team familiarity and frequent interactions, project managers can identify the team members' competence and can successfully allocate tasks based on their specialization. They also mentioned that, team familiarity gained when team members work together in the same Work-site has a significantly more positive effect on team performance compared with team familiarity gained while members were collaborating from different locations. When compared to different-location team familiarity, the higher frequency of interactions and fidelity of interactions of same-location team familiarity is expected to lead to greater knowledge identification within the team.

According to Avgerinos et al. [32], team familiarity will affect productivity more noticeably in environments with high levels of uncertainty. Benefits of team familiarity in situations like these include enabling members of the team identify more effective ways to collaborate without having to have extensive discussions with one another and cope with variation by using what they've learned from previous collaborations. Team familiarity also strengthens their bonds and interactions and makes it easier for them to collaborate on future tasks. Team familiarity aids managers in creating more effective strategies for team composition.

Nguyen et al. [33], performed a systematic literature review to summarize the empirical evidence on the impact of global dispersion dimensions on coordination, team performance and project outcomes. The authors discovered that when developers are geographically dispersed, the amount of time required to resolve modification requests increases. They also observed that geographical dispersion and team size had a detrimental effect on team performance, which could be mitigated by team familiarity. They stated that team coordination would be challenging for geographically scattered team members without team familiarity due to lack of situational

awareness, regular communication, and contextual reference.

Huckman et al. [3], in their research about the impact of diversity in experience and team familiarity on team performance, considered team familiarity to be one of the possible moderators of the concept of fluid teams. They characterized a team as "fluid" if its members bring their diverse experiences together to generate output. They mentioned that, as a result of prior work experience, team familiarity makes it simple to find knowledge within the group, communicate and share that knowledge, and accomplish goals. Team familiarity also enables members to specialize in various areas and aids in the development of a shared understanding of who understands what within the team. As individuals work together, they develop a shared language and communication channels. Team familiarity aids team functioning by helping members locate knowledge within a group, share knowledge with each other, and apply that knowledge to their work. This could help resolve a variety of issues resulting from interpersonal diversity without compromising any potential benefits. The authors' findings show that team familiarity improves team performance and is especially helpful for teams that are more interpersonally diverse.

Moving on from the broad backdrop of team familiarity to the introduction of multi-dimensional familiarity, Maynard et al. in [34], indicated two separate dimensions of familiarity in their research, namely professional familiarity and personal familiarity. They characterized professional familiarity as the extent to which team members are aware of one another's skills and limitations as they relate to their job, and personal familiarity as information about their personal lives, relationships, and so on. The authors contend that this type of professional familiarity among team members improves information elaboration, increasing team performance and viability.

Transitioning to the more specific focus of research on teamwork in distributed agile software development, Chaitanya et al. [35], in their research, considered team familiarity as one of the teamwork factors for distributed agile teams. They also mentioned how team familiarity might improve effective communication and coordination as global software development involves people from many cultures both at the national and corporate levels. According to a survey conducted as part of their research, they reported team familiarity was one of the teamwork factors that was found to be of the highest importance for quality analysts and people who are more involved in development over management when it comes to distributed software development. Team familiarity promotes greater coordination among team members because it improves interactions between team members who already know one another and prevents process loss since team members are aware of who to speak with and utilize the team's language. It insists on the way team members collaborate. In geographically dispersed software teams, familiarity is found to improve team performance.

By delving deep into the topic of team familiarity, Muskat et al. [5] in their research discussed the theoretical underpinnings of team familiarity using a systematic liter-

ature review and qualitative thematic analysis. The level of familiarity that team members have with one another and the amount of time they have collaborated together were both considered indicators of team familiarity in their research. High levels of familiarity within the team improve knowledge of each other's backgrounds, personalities, skills, and work habits. Sharing similar findings with Avgerinos et al. research in [32], the authors noted that teams that work on routine, standardized, and recurring activities function in an environment that greatly benefits from team familiarity. In the setting of recurring and standardized work, team familiarity is a key predictor of team effectiveness, performance, and productivity. Thus, in terms of inputs necessary to complete collective activities, team familiarity is considered crucial for teams that have a standardized workflow. High team familiarity has been shown in studies to have a favorable effect on team cognition, leading to improved and quicker collaborative learning capabilities, increased creativity, and enhanced creative performance. They did, however, mention one limitation: teams with high degrees of familiarity are more likely to rely on current methods and routines, which might interfere with the team's engagement in innovation and creative cooperation processes.

Addressing the Research Gap

In this section, an overview of existing research papers has been provided, summarizing the literature on team familiarity, team performance, remote working, geographical dispersion, and agile software development teams. However, despite the existing research, there is a noticeable research gap in understanding the specific impact of geographical dispersion on Scrum teams, particularly in the context of remote working during the COVID-19 pandemic. This research gap is significant and requires further investigation for several reasons. Firstly, the COVID-19 pandemic has brought unprecedented changes to work environments, with remote working becoming the new norm for many organizations. This sudden shift has forced teams to adapt to new ways of working, including geographically dispersed team members, virtual communication and collaboration, and unique challenges in maintaining team familiarity and effectiveness. Understanding the influence of geographical dispersion on Scrum teams in this remote working context is crucial for organizations to effectively manage their agile software development projects.

Secondly, agile software development methodologies, such as Scrum, emphasize teamwork, collaboration, and face-to-face interactions among team members. However, geographical dispersion can significantly impact the dynamics of Scrum teams, as team members may not have the same level of physical proximity and spontaneous interactions, which can affect team familiarity, communication, coordination, and ultimately, team performance [36]. Therefore, there is a need to investigate how geographical dispersion affects the dynamics of Scrum teams and whether specific practices or strategies need to be adopted to mitigate challenges and leverage opportunities presented by remote working.

Furthermore, the existing literature on this topic lacks a comprehensive exploration of the aspects of team familiarity and how it may be influenced by geographical dispersion. Team familiarity includes dimensions such as shared understanding and knowledge, trust, communication patterns, and team cohesion, etc which are crucial for the success of agile software development projects. However, the specific effects of geographical dispersion on these dimensions of team familiarity are not well understood. Therefore, conducting a study that specifically investigates the effect of geographical dispersion on Scrum teams, taking into account the remote working context during the COVID-19 pandemic, is vital to fill this research gap and contribute to the understanding of the dynamics of Scrum teams in geographically dispersed settings.

Chapter 3

Research design and execution

In this section, we present the main aim and objectives of the thesis, followed by the research questions that we established in order to attain the thesis's aim and objectives. The research methodologies and procedures for carrying out this research are also discussed in depth.

The main aim of this thesis is to investigate the effects of geographical dispersion on team familiarity in scrum teams as a result of pandemic restrictions. The objectives of this research have been outlined below:

O1 : To identify the facets that build the concept of team familiarity.

A literature review has been performed by studying and analyzing various research papers using the snowballing technique, which describes the concept of team familiarity. This aids in identifying and curating the facets that belong under the umbrella of team familiarity..

O2 : To investigate how geographical dispersion has affected team familiarity during the pandemic.

The facets of team familiarity were explored by studying various related literature and formulating the team familiarity facets which were later validated by the results of the interview.

O3 :To explore how the Scrum practices have been effected by changes in team familiarity under remote working conditions during the pandemic.

The effect of team familiarity has been studied in the context of the Scrum methodology practices such as Daily stand-up, Sprint Planning, and Sprint Review, under remote working conditions.

Our goal is to accomplish the thesis's aims and objectives by conducting research to answer the following research questions.

RQ1 : What are the facets that contribute to team familiarity?

RQ2 : How has geographical dispersion affected team familiarity facets during the pandemic?

RQ3 : How have the changes in team familiarity effected the scrum practices?

3.1 Research methodology

In this thesis, we adopted a qualitative approach to investigate and to gain a deeper understanding of team familiarity facets as it fits better in analyzing human behavior [37]. Qualitative research methods are ideal for investigating complex phenomena and comprehending subjective experiences [38, 39]. By adopting this approach, we aimed to gain a comprehensive understanding of the effects of geographical dispersion on team familiarity in the context of remote working conditions. The research methodology comprised a literature review as a research method and interviews as the data collection technique.

The literature review was used in the first phase of the research to analyze the existing literature and identify the facets that contribute to the idea of team familiarity. A literature review was chosen as a research approach because of its potential to provide a sound theoretical framework for the investigation [39, 40]. The snowballing approach was used to evaluate and analyze various research papers for the literature review. This strategy made it easier to identify and curate the facets that contribute to team familiarity. The literature study helped build a theoretical framework that guided the subsequent phases of the research by relying on existing information and theories [41].

In the second phase, we conducted interviews with professionals from various software companies, allowing us to collect real-world data on how remote working conditions had affected team familiarity. Interviews are a powerful source of qualitative data as they allow for an in-depth investigation of participants' opinions, experiences, and challenges [42, 43]. By engaging with participants in interviews, we aimed to capture their unique insights and gain a deeper understanding of how geographical dispersion had affected team familiarity during the pandemic.

Thematic analysis was used to evaluate the interview data in order to find patterns, themes, and categories [44]. This analytical technique enabled a systematic assessment of the interview data and aided in the extraction of important insights about the effect of team familiarity on Scrum practices such as daily stand-up, sprint planning, sprint review, etc under remote working conditions. The findings from the literature review were validated using the results obtained from the interviews. A thorough knowledge of the effects of geographical dispersion on team familiarity and its influence on Scrum practices was accomplished by comparing and contrasting the insights gathered from the literature review and the interview data.

Figure 3.1 depicts the two different phases of this research and how they have been combined to achieve the aim of the research.

3.1.1 Data Collection

This section outlines the specific steps we took to collect the relevant data that would be analyzed to present the findings of this study. We first reviewed the literature to summarize the scientific evidence regarding team familiarity facets. After that, we utilized the team familiarity facets to create an interview guide to collect data with practitioners.

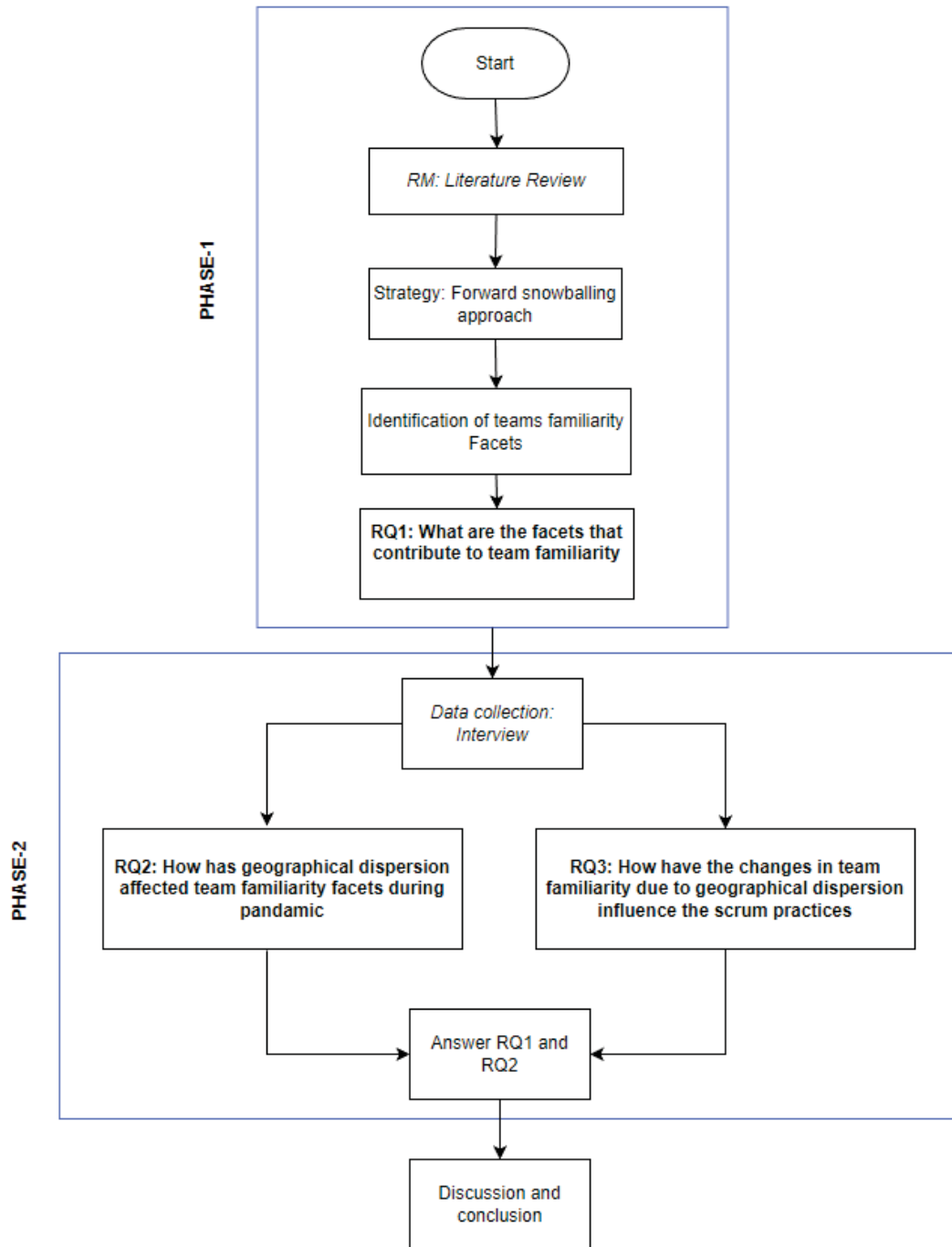


Figure 3.1: Research Design

3.1.1.1 Literature review procedure

A Literature Review is a comprehensive study and analysis of books, academic papers, and other sources related to a given topic that serves as a foundation of knowledge [40]. It gives an overview of existing knowledge, enabling the identification of appropriate ideas, techniques, and research gaps. To answer the first research question, we have studied and analyzed the literature in order to identify the facets that build up the concept of team familiarity.

For the literature review in this study, a forward snowballing technique was chosen to identify relevant research papers. Forward snowballing is the process of identifying new papers based on those that cite the current paper [45]. Forward snowballing involves starting with an initial set of papers and then systematically identifying and including papers that have cited the initial set of papers, allowing for a comprehensive exploration of the literature on the research topic [46]. There are several reasons why forward snowballing was chosen as the data collection approach for the literature review. Firstly, it allows for an inclusive and up-to-date coverage of the literature by capturing the most recent insights and developments in the field. This is particularly relevant for this study as the focus was on team familiarity in Scrum teams considering the timeline of the COVID-19 pandemic and the relevance of remote working and geographical dispersion in Scrum teams during this period. Including newer references through forward snowballing ensures that the literature review reflects the most current knowledge on the research topic.

On the other hand, backward snowballing, which involves identifying and including papers that have been referenced in the initial set of papers, was not chosen as the data collection approach for the literature review. There are several reasons for this decision, as backward snowballing has certain disadvantages that could affect the comprehensiveness and relevance of the literature review. Firstly, it may result in the inclusion of older references that are not directly related to the research questions of this study, potentially leading to a less up-to-date literature review. Additionally, backward snowballing includes sifting through a lot of references, some of which may not always be relevant, which can be time-consuming and labor-intensive [47].

Therefore, based on these considerations and the aim to capture the most recent insights related to remote working, geographical dispersion, and team familiarity in the context of the COVID-19 pandemic, forward snowballing was chosen as the data collection approach for the literature review in this study. The forward snowballing approach allowed us to acquire a thorough comprehension of the topic while also assisting us in answering the questions in a structured manner by identifying knowledge gaps. Snowballing has the advantage of starting with relevant studies and then using them to lead subsequent studies. Since most studies always include at least one publication from another relevant research or the systematic study already performed in the area, snowballing is extremely useful for producing a literature review. [48].

3.1.1.2 Interview procedure

In the second phase of our research, we aimed to conduct some interviews with industry practitioners from different agile software teams from various organizations.

Despite the growing popularity of internet surveys, face-to-face (in-person) interviews remain popular techniques of data collection [43]. We chose to conduct an interview because it provides a solid foundation for our research findings and allows us to collect real-world data on how team familiarity has been affected due to remote working conditions from a number of software professionals from different software companies. Interviews had a higher response rate and allowed researchers to learn more about the perspectives, behaviors, experiences, and phenomena of their research participants. We employed face-to-face interviews because they allow the researcher to evaluate nonverbal cues such as body language, facial expression, and eye contact, which may help the interviewer understand what is being expressed [49]. One-to-one interviews with professionals gave us access to their real-world experience-based responses, which helped us analyze and answer the research questions.

Due to the semi-structured nature of the interviews we conducted, we had the opportunity to probe further and learn more in-depth details about the participants' experiences. The majority of interview questions were open-ended, allowing for the collection of detailed information. The results from the interview could be used to validate the results of the literature review and answer the research questions. Furthermore, we determined the most common facets that fell under the umbrella of team familiarity after studying various literature based on team familiarity for the literature review. In the second phase of the research, we used these facets to construct an interview guide in order to obtain real-world data from industry practitioners in order to validate the literature review findings.

The following is a detailed description of how we conducted interviews in phase-2 of this research.

1. *Defining objectives*

The primary goal of the interview is to empirically validate the team familiarity facets derived from the literature review in phase 1 of this research. These interviews allowed us to explore and comprehend real-world data in the context of team familiarity, geographical dispersion, and scrum practices, based on the participant's opinions, behavior, experiences, phenomena, and so on, thereby answering RQ-2 and RQ-3 by analyzing the interview results.

2. *Designing interview guide*

With the objectives in mind, we created an interview guide that would allow us to thoroughly understand the topic of team familiarity and also includes particular questions based on participant experience working in a team. Since we already identified the team familiarity facets from the literature review, we had a predetermined list of variables that we wanted to explore in depth. The questions are written in a way that participants can understand them clearly and contribute to the research's findings.

3. *Validating and optimising the interview guide*

We've made a number of optimizations based on the supervisor's feedback on the draft interview guide and online research of other interview guide instances. We

intended the interviewees to understand the questions as precisely as possible while eliminating any ambiguity so that they could contribute to our research findings. Additionally, we made sure that these questions were actually in line with the goals and could aid in producing the best results possible in support of our research goals. The final interview guide that we've used to conduct the interviews can be seen in Appendix A.

4. *Selecting participants and scheduling the interview*

In order to ensure the relevance and credibility of our research, we specifically targeted participants from the software engineering field, as the setting of our study was the software industry. We utilized a combination of availability sampling and quota sampling strategies to recruit our interview participants. This approach allowed us to conveniently access participants who were readily available and willing to participate in the study. We were able to access participants whom we knew and also expand our sample through referrals from initial participants, while also ensuring that our sample included individuals from different roles as per our predefined quotas/roles such as product owners, scrum masters etc. This sampling approach was chosen to maximize the diversity and representativeness of our sample and to obtain a comprehensive understanding of the research topic in the context of different roles within the target population. Table 3.1 represents the specific details about each participant, their role in different organizations along with years of working experience in the software industry respectively.

We introduced ourselves and the project we were working on to each of the 12 representatives by phone and email. We also gave them a brief explanation of the interview's goal, our research objectives, and the significance of their participation and schedule an appointment with each of the participants. The process of scheduling appointments and conducting interviews took almost a month to complete, considering the logistical complexities involved. Despite these challenges, we successfully obtained interview results from all the participants. It is worth mentioning that the participation of software professionals with diverse backgrounds and perspectives enriched the data collection process, contributing to the robustness and validity of our findings.

Participant ID	Role	Years of Experience
P1	Junior Software Developer	1.4 years
P2	Junior Software Developer	1.8 years
P3	Senior Software Developer	4.2 years
P4	Senior Software Developer	6 years
P5	Senior Software Developer	9.5 years
P6	Team Manager	4.8 years
P7	Team Manager	11 years

P8	Scrum Master	4.7 years
P9	Scrum Master	7 years
P10	Product Owner	11 years
P11	Product Owner	13 years
P12	Software Architect	14 years

Table 3.1: Specific statistics based on Participants, Roles, Years of Experience

5. *Conducting the interview*

We made sure that the participants were informed about consent and how their personal data would be used before beginning the interview. We aimed not to reveal any personal information or the names of the organizations in order to protect their privacy and avoid potential bias. To be respectful of their time and adhere to the time limit, we have made clear the interview's format as well as the anticipated duration. In order for the participants to submit their responses within the context of the research, we made sure they were fully informed of the aim and objectives of the research. In addition, with the signed consent of the participants, we recorded a few of the interviews for future reference in analyzing and reporting the findings. Due to the semi-structured nature of the interviews we conducted, we had the opportunity to ask the participants additional questions spontaneously about their experiences that might be relevant to our research and to gain more clarity.

6. *Analysing and reporting results*

The data and patterns from the interviews were analyzed using a *deductive thematic analysis*. We employ the predetermined topics from the existing theory to direct the analysis in a deductive thematic analysis [44]. We have used the pre-identified team familiarity features from the literature review in this research as the themes to direct our analysis of the interview. In this research, the following section 3.1.2 gives more insights on deductive thematic analysis and section 4.2.1 shows how deductive theme analysis was explicitly used in this research to analyze the data and report the results.

3.1.2 Data Analysis

In this study, we chose to employ thematic analysis as the data analysis method for several reasons. Thematic analysis is a widely used qualitative analysis technique that allows for a comprehensive exploration of data, identification of patterns, and generation of solid insights [50]. It may be used on a collection of texts like an interview or transcripts. Using this strategy, we carefully evaluate the data to uncover common themes like subjects, ideas, and patterns of meaning [51]. This technique makes use of the data to apply what we believe are the most relevant insights, key themes, or patterns obtained from research. Given that our research primarily aimed to investigate subjective and context-dependent variables related to team familiarity

facets, thematic analysis was chosen as the most suitable approach. This method allowed for a flexible and systematic examination of the interview data, enabling us to identify and analyze key themes, patterns, and meanings specifically pertaining to team familiarity within the context of geographical dispersion [52].

When examining and analyzing patterns of meaning across datasets, the term *Thematic Analysis* applies to a variety of qualitative research techniques [53]. In thematic analysis, there are two approaches for identifying themes and patterns: inductive and deductive [44].

In *inductive thematic analysis*, themes emerge directly from the data without being pre-established. It involves a bottom-up process of carefully analyzing the data, identifying meaningful units, and grouping them into themes based on observed patterns and similarities. This iterative coding and categorization process allows for the discovery of new themes and sub-themes that may not have been discovered initially [44]. The inductive approach is especially appropriate when there is minimal existing theory or information about the phenomenon being studied, or when the goal of the research is to develop new ideas for subsequent study [50].

However, in this study, we used *deductive thematic analysis*, in which the analysis is guided by pre-established themes or an existing theory. This method may also be referred to as the "top-down" approach or "theoretical" thematic analysis. The complexity of qualitative data makes it crucial to develop a plan that will keep us focused on the research questions. We can maintain focus on the objective of the study by employing the technique of deductive analysis [54]. This approach stands in contrast to inductive thematic analysis, which lets the themes be determined by the data [44, 51].

Deductive thematic analysis is more explicitly analysis-driven since it is typically motivated by the researcher's theoretical or analytical interest in the subject. This frequently entails applying predetermined codes to the data in qualitative analysis. The codes may be developed as purely organizational tools, or they may be developed using ideas taken from theories, literature, or the researcher's own formed propositions [54]. This method offers a thorough investigation of the data aspect that we are interested in studying. The deductive method allows for a more focused and organized study, which is especially helpful when the researcher has a keen theoretical or analytical interest in the subject [55].

In this research, the deductive approach was more appropriate as we analyzed the interview data in relation to the pre-defined themes that were derived from the team familiarity facets identified in the literature review. By utilizing these pre-defined themes, we ensured an in-depth analysis of each team familiarity facet we aimed to investigate, thereby enabling us to delve into how these identified themes were expressed within the interview responses. This approach facilitated the examination of the presence and significance of these themes within the data, thereby enhancing our understanding of their implications for team familiarity in the context of geographical dispersion. In Chapter 4, we will discuss each theme that we have discovered, with the goal of graphically depicting the themes derived from thematic analysis as well as the findings of the interviews for better comprehension.

Chapter 4

Results and Analysis

In this section, we present and analyze the findings of the literature review conducted in Phase 1, as well as the conclusions drawn from the interviews conducted in Phase 2 of the research.

4.1 Literature Review results

The primary goal of the literature review is to identify the facets that contribute to the concept of team familiarity, thereby answering RQ-1. The literature review has been performed by studying various existing literature on the concepts of team familiarity, geographical dispersion, scrum teams and practices etc. This investigation provided us with a description, summary, and critical evaluation of works related to the research problem and also added to the overall knowledge of the topic of the research. This qualitative research method established a solid foundation of the topic and its interconnections while also assisting us in identifying research gaps and inconsistencies in previous studies. It also provided a broad overview of the topic, enabling relevant approaches, methods, and research gaps to be identified.

4.1.1 Team Familiarity

The initial research papers that we applied forward snowballing to are "Unpacking Team Familiarity: The Effects of Geographic Location and Hierarchical Role" [6] and "Team familiarity—boon for routines, bane for innovation? A review and future research agenda" [5] to ensure a broader coverage of the literature, and because they directly address the concept of team familiarity, which is a critical aspect of this research. These papers specifically explore how geographic location and hierarchical role impact team familiarity, which aligns with the research focus on the effect of geographical dispersion on Scrum teams. Additionally, these papers are published in reputable journals and are cited by other relevant research papers, indicating their significance and relevance to the field. Moreover, these papers further included references to other relevant research papers like [3, 4, 9, 56, 57]. This helped us to expand our literature search and identify additional sources that were related to our research topic.

The forward snowballing approach was selected for data collection because the initial papers were systematic literature reviews, implying that they had already captured relevant information from previous studies. Therefore, conducting backward snowballing would have been unnecessary and inefficient since it would involve going

through literature that had already been included in the systematic review. This decision was made to avoid redundancy and save valuable time during the data collection process. From the forward snowballing approach for literature review, 27 papers related to this research have been identified, 17 of which focus on team familiarity, 10 on geographical dispersion, and scrum practices. Each research paper's authors have defined team familiarity differently, but the meaning was similar. The following is an overview of how various authors in the research papers we considered for our literature review defined team familiarity:

Definition of Team Familiarity	Reference of the research paper
<i>"The degree to which two members of a team regard themselves as acquainted based on previous work experience, coworkers, and work environment."</i>	[5]
<i>"It refers to knowledge of the team's other members as well as an understanding of the work at hand."</i>	[9, 35]
<i>"It can be defined as the team members' prior experience working with one another."</i>	[3, 4, 6]
<i>"Familiarity here is referred to as the state of acquaintance between the two individuals."</i>	[58]

Table 4.1: Definitions of Team familiarity in different research publications.

We have noticed that majority of the authors addressed the benefits of team familiarity in their research papers, some of which are:

- Team members' comprehension of each other's expertise, strengths, weaknesses, and background is enhanced by a high level of team familiarity [5].
- Team familiarity may have a beneficial impact on project team performance when combined with interpersonal team diversity. Familiarity improves teamwork by allowing individuals to locate and exchange information inside a group, as well as apply that knowledge. It may also help teams adapt better to task change by providing a single platform for learning and action [3].
- Team familiarity contributes to better team collaboration and team performance. It also increases conformity in team decision-making [58].
- Team familiarity aids in the creation of high-quality task outputs, increases team cognition and is also important in the management of uncertainty and knowledge. Team familiarity is a crucial driver of team effectiveness, favorably stimulating the task and social elements of individual team members [5].
- Team familiarity helps managers to more efficiently assign assignments based on their specialized roles and coordinate activities, which improves the overall

project quality. This enhances team cohesion, and performance and improves the quality of knowledge sharing. Furthermore, team familiarity fosters trust and a comfortable atmosphere in which team members may share mistakes and take risks, leading to increased experimentation and innovative thinking [6].

- When the team has to share knowledge among itself, team familiarity might help the group function more cohesively. Individuals can develop team human capital due to shared experiences, which boosts performance. [4].
- Team familiarity creates greater coordination and improves the quality of interactions among team members. Familiarity has been shown to increase team performance in geographically distributed software teams [35].
- Team familiarity contributes to minimizing the negative effects of geographical dispersion and the team size on team performance [33].
- Team familiarity may affect the capacity of the team to exchange and assimilate information communicated among the team members. Communication and team performance benefit from team familiarity [34].

The following Table 4.2 illustrates the most often discussed benefits of team familiarity among the research papers chosen for literature review.

Identifier	Benefit	References
B1	Positively effects team performance and team coordination	[3–6, 33–35, 59]
B2	Increases quality of knowledge sharing and management	[3, 4, 6, 33, 34, 59–61]
B3	Increases trust and fosters a safe and environment	[6, 61–64]
B4	Develops team human capital	[4, 6, 65–67]

Table 4.2: Team Familiarity Benefits

4.1.2 Team Familiarity Facets

To acquire a comprehensive understanding of the impact of geographic dispersion on team familiarity, we must first identify and define what are the factors that fall under the category of team familiarity, and then we will explore each factor, as well as geographical dispersion and scrum practices in this section. These factors that contribute to team familiarity are referred to as *team familiarity facets (or TF facets)* in this research. We discovered the team familiarity facets by studying and analyzing the significant research articles identified in the forward snowballing approach in Phase-1 of this research. We started by outlining the common patterns/themes that contribute to team familiarity in general, then categorizing them into team

familiarity facets. Table 4.3 shows the team familiarity facets that were identified through the literature review. The frequency of occurrence of each team familiarity facet and the number of research papers that mentioned each facet is depicted in Figure 4.1.

Team familiarity facets	Identifiers	Reference identified
Shared work experience	SWE	[3–6, 34, 58, 65, 68]
Communication	COM	[3, 5, 6, 33, 34, 57, 59, 65, 69, 70]
Team Coordination	TCR	[3, 33, 34, 65, 71]
Team Cohesion	TCH	[2, 5, 57, 69]
Interpersonal knowledge	IK	[5, 9, 33, 34, 57, 58]
Shared Knowledge	CK	[3, 5, 59, 65–68, 70]
Trust	TR	[6, 32, 34, 57, 58, 62, 68–70]
Team Collaboration	TCL	[5, 6, 56, 58, 70–72]
Member Diversity	MD	[3, 57]

Table 4.3: Team Familiarity Facets identified through Literature Review

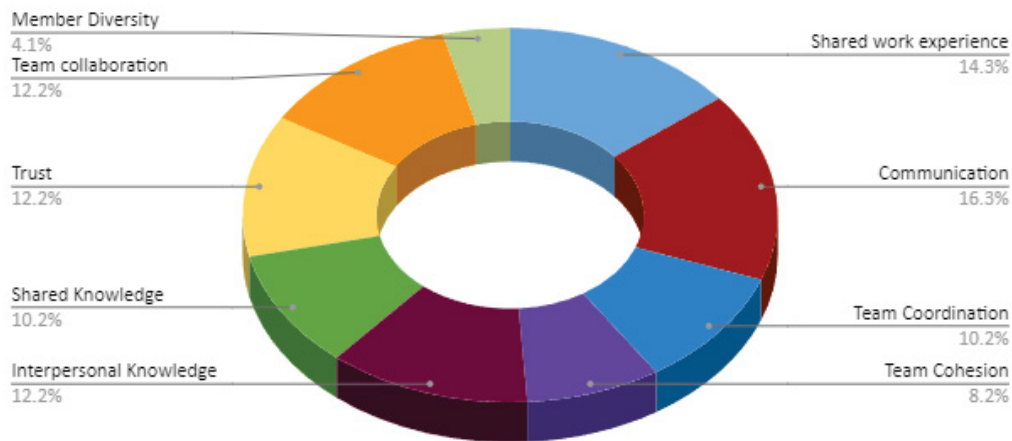


Figure 4.1: Frequency Distribution of TF Facets in Literature Review

These are the team familiarity facets that we identified through studying various research papers as part of the literature review in order to answer RQ-1. In accordance with the objectives and research questions of this research, we intend to analyze each team familiarity facet in regards to geographical dispersion and explain why we represented it to be a team familiarity facet based on the literature review.

Shared work experience

As formerly noted in the previous section 4.1.1, some definitions of team familiarity in research publications studied for the literature review [3, 4, 6], include the team members' prior experiences working with one another, which we refer to as the *Shared work experience (SWE)*. Shared experiences are a potent tool that managers may use to create high-performing teams. They aid in forming the perceptions, customs, and conduct that enable individuals to operate more productively and successfully [73]. Teams that have shared experiences tend to be more emotionally intelligent since everyone can learn from one another and see one another's emotions, behaviors and perceptions. As a result, the team's EQ is increased, and this emotional intelligence is one of the key factors to boost the team's performance, as mentioned in a study by Hillary Elfenbein et al. in [74]. According to research findings of [34, 75], the relationship between shared work experience in the team and transactive memory systems (TMS) discovers that understanding the competence of one's teammates is strengthened to the extent individuals have previously worked together.

Prior work experience undoubtedly leads to professional familiarity. Shared work experience also helps team members understand one other's work-related strengths and weaknesses so that when they need assistance with anything, they know who to approach. Due to better coordination, familiarity in the form of prior work experience has been found to predict individual and overall performance [34]. Individuals that work together for an extended period of time with frequent interactions can build team familiarity. Teams with more socially diverse members may gain from prior work experience because they are better able to monitor and identify knowledge within the group, effectively communicate their knowledge, and use this knowledge to meet their goals. People establish a common language and communication methods when they collaborate. The significance of shared work experience in achieving team success has been recognized by fluid teams. This shared experience may offer a strong framework for teams to respond to changing tasks since shared prior work experience permits implicit coordination between members [3]. Thus, we identified *shared work experience* as one of the important team familiarity facets, just as it was given significant importance in the majority of the research papers that we've studied [3-6, 34, 58, 65].

Communication

Team communication is one of the most fundamental components of collaboration. While working effectively is necessary, team communication is much more critical. It makes it possible for team members to learn from one another and exchange expertise. Additionally, it improves morale, encourages teamwork, and helps employees stay engaged in the workplace [76]. Communication within the team can help to create strong work relationships and develop trust among team members [77]. However, in a remote teamwork setting, poor communication can harm working relationships. As people collaborate, they establish a common language and means of communication. Effective communication is essential for a team to respond to changing tasks and unplanned work, which is relatively common [3]. Team familiarity can aid in efficient

cooperation and communication. It has been found that communication and knowledge sharing are important factors in team performance [34]. Team familiarity can facilitate communication and collaboration, which can improve knowledge-sharing and decision-making within the team [59].

In any team context, especially in software teams where the majority of work is done through human interaction, it is impractical to execute any of the collaboration behaviors without communication [35]. The ability of team members to locate knowledge inside the team is compromised by poor communication and inconsistent interactions, especially when the team members are geographically distributed. Team familiarity improves communication and information exchange within the group, which enhances team performance [6]. In fact, we've found that communication is crucial for fostering any other facet of team familiarity mentioned in this research. The importance of communication has been mentioned in various studies in the literature review [3, 5, 6, 33, 34, 57, 65].

Team Coordination

Team Coordination (TCR) refers to the procedures and strategies that organizations use to allow their teams to collaborate more effectively on individual and collective goals. Coordination is known as the "essence of management," as it serves as a thread to synchronize various management tasks and ensure that the organization runs smoothly. Coordination is essential from the initial planning stage until the end, as it could help to reduce disputes, rivalries, delays, and other organizational difficulties, thereby improving relations within the organization. As a result, with the help of coordination, an organization can meet its objectives on time [78].

Nguyen et al. [33], in their research, defined team coordination as the "actions necessary to maintain consistency within a work product or to manage dependencies within the workflow." Effective team coordination is critical for the success of global software projects. Individuals who work with familiar team members on a regular basis may develop social capital, which improves team coordination [65]. Research focusing on the culture of firefighters [79], discovered that a stronger culture of joviality was associated with reduced coordination time or faster response times in a high-pressure environment, and hence jovial relationships between team members can boost cooperation and coordination. Personal familiarity can imply that team members understand what is being stated before it is said, which could help with team coordination [34]. This form of team coordination established by team familiarity may greatly benefit the software industry, which frequently has a lot of unexpected work and pressure and must respond to changes rapidly. Hence, we considered *TCR* as one of the team familiarity facets in this research providing evidence for the team familiarity benefit B1 from Table 4.2.

Team Cohesion

Team cohesiveness measures how successfully team members collaborate with one

another. When a team is cohesive, it means that everyone understands their roles, is confident in their abilities, and is thus committed to the overall team goals [80]. A cohesive workplace helps individuals to work effectively together and feel they contribute to the overall success of the group in a team environment. When employees operate in a cohesive work environment, they are driven by the team's efforts rather than their own accomplishments [81]. People that operate as part of a cohesive team communicate better, create a positive work environment, and actively pursue the company's objectives and goals. A higher level of team familiarity in the team serves to strengthen team cohesion.

Weimar et al. [2], in their research, identified team cohesiveness as one of the main teamwork quality factors for software development teams, stating that team cohesion could enhance a sense of belonging in the team, which is associated with morale inside the group and motivates individuals to accomplish organizational goals and objectives. Teams that are made up of familiar individuals are more likely to show stronger interpersonal attraction and, consequently, are more cohesive than groups made up of unfamiliar members [57, 82]. Cohesion helps members of the group successfully communicate and resolve any disagreement. Strong team cohesiveness helps with successful conflict resolution by ensuring that all team members are heard and feel safe and secure sharing their thoughts and ideas. The more cohesive a team is, the better its members are at resolving conflicts and avoiding significant disagreements in the workplace [83]. Therefore, we regarded team cohesion as one of the important TF facet.

Interpersonal Knowledge

Interpersonal knowledge is one of the key factors along which groups of members who are acquainted with one another are expected to vary from groups of members who are unfamiliar. Interpersonal knowledge also means having a deeper understanding of one another's abilities, perspectives, strengths, and weaknesses. Familiar group members are more likely to have a better understanding of one another on an individual level and perform well in interactive tasks. Greater interpersonal knowledge among familiar group members makes them more predictable when compared to unfamiliar group members [57]. This predictability might be useful for teams working on standardized tasks in high-pressure environments. Additionally, this makes it easier for managers to assign responsibilities to the group appropriately and empowers the team to adapt quickly to changes in an uncertain environment.

According to Greer et al. in [84], interpersonal knowledge of the team members is correlated with effective group behavior. The development of trust among team members could be facilitated by interpersonal knowledge. This enables them to predict one other's activities, coordinate actions, and communicate more effectively and with less ambiguity [9]. Team familiarity promotes a safe space and trust among interpersonally knowledgeable individuals, reducing the fear of criticism and exclusion while also allowing for a greater willingness to contribute and welcome the ideas of others [34]. Therefore, we have regarded *interpersonal knowledge* as one of the key

TF facets.

Shared Knowledge

Employees have a plethora of knowledge that is beneficial to both the organization and their teammates. It would be unfortunate if it simply remained in their minds. The benefit of knowledge sharing in organizations is that knowledgeable employees may teach others what they know. By doing so, they turn it into a resource that everyone can utilize, as well as their coworkers can use in their work. The highest level of learning is when knowledge is shared [60]. Employees may help one other develop new skill sets and fill up knowledge gaps by exchanging expertise on certain topics [85]. Sharing information is just as important as having it when it comes to producing advancements in the industry.

When people exchange knowledge, communication is more effective and familiarity is increased. Teams that are more interpersonally diverse may benefit from shared past job experience. Members who have previously collaborated are better able to precisely identify information inside a group, effectively communicate the knowledge they hold, and then can use this knowledge to achieve the desired objective. However, team members must effectively find, share, and apply knowledge for their knowledge base to convert into increased performance. When individuals collaborate, they establish a common understanding of who on the team possesses which expertise. Individuals can get the information required to tackle certain challenges by knowing who the competent team members are [3]. This familiarity leads to the development of human capital, which refers to the knowledge, skills, and abilities of individuals in the team [67]. As team members become more familiar with each other, they are better equipped to collaborate effectively, share knowledge, and utilize each other's strengths to achieve common goals. This can lead to higher productivity, better decision-making, and improved performance [66]. Researchers discovered that teams with a high level of familiarity learn at a faster rate than unfamiliar teams, are proficient at communicating, and effectively apply their knowledge from prior experience to the present situation [65]. Thus, we considered *shared knowledge* as one of the TF facets, providing evidence for the team familiarity benefits B2, B4 from Table 4.2.

Trust

Trust can be defined as the “reliance on the character, ability, strength, or truth of someone or something” and it is essential to create an effective team and provide significant outcomes since it creates a feeling of safety [86]. Team members are more likely to be candid, take calculated risks, reveal weaknesses, and be vulnerable when they feel secure with one another. Team members are more inclined to trust one another if they know one another personally. As team members exchange experiences, trust may develop, improving performance [87]. It fosters close relationships among the team members, which could result in more innovative problem-solving [6]. These days, especially when working remotely, trust in the workplace has a significant effect on how employees interact and work together on the same project.

Prior shared working experience can help to create rapport and trust within a team, increasing the possibility that team members will seek and get assistance from the most qualified individual available. This would aid project teams in developing informal, advice-seeking networks while also improving formal processes such as peer review and testing [6,88]. Members of a familiar group trust one another more than members of an unfamiliar group [89]. Trust is based on the belief that one will find what one wants from another without fear of being judged. It is strengthened by strong communication capabilities and increases the tendency to take others' words at face value [90]. When this happens, the interchange and consideration of critical information, as well as trust among group members, may increase the quality of group output [57, 87, 90]. Team familiarity can help to build trust among team members, which is essential for effective teamwork [62]. Interpersonal knowledge, effective communication, and enhanced team familiarity can be key strategies to build trust at a workplace, which in turn contributes to increased team performance and productivity. Hence, we considered *trust* to be one of the significant TF facets in this research, providing evidence for the team familiarity benefit B3 from Table 4.2.

Team Collaboration

Collaboration enhances a team's ability to function as a unit and solve problems. This results in more innovation, more efficient processes, greater success, and better communication. When teams learn to work well together and have a clear knowledge of their purpose, they become more adaptable. Teams and organizations must evolve at a rapid speed, and when the team collaborates actively and effectively, it allows the team to anticipate, be prepared for, and adapt to any changes that occur within the company [91]. When team members collaborate with one another, they will constantly have the chance to learn from each other's accomplishments and failures, which fosters effective skill-sharing within the team. The organization stays aligned with its long-term or short-term goals when duties are allotted to individuals or a collaborative team who would be able to meet the established targets [92].

Each team member's investment in a common, shared goal promotes team collaboration. A crucial component in creating cooperative teams appears to be time [93]. Prolonged shared working experience and communication create efficient team collaboration. Establishing trust, building shared values and attitudes, empowering team members, successfully managing team meetings, and providing feedback on team functioning are all components of an effective collaborative team [72,93]. The key to active team collaboration is effective interprofessional team communication, which leads to efficient knowledge and skill sharing within the team. High-performing teams are distinguished by their ability to collaborate effectively [58]. Team members who collaborate often may build social capital and enhance their capacity to coordinate actions [6,56]. Team familiarity promotes successful group collaboration, improves team communication, and aids in the reduction of knowledge gaps in geographically distributed teams [5,70]. Hence, we regard *team collaboration* to be one of the essential TF facets in this research.

Member Diversity

A diverse team is an organization's group of people from various backgrounds and skill sets that collaborate to accomplish the organization's goals. They may differ in age, nationality, religious background, personal and professional experience, talents, gender etc [57,94]. These distinctions may help companies develop innovative solutions and methods to improve workflow and achieve operational goals [95]. In this research, we define member diversity as diversity based on technical skills and work experience. Experiential diversity among team members may aid in a team's ability to adapt to evolving tasks. As team members with diverse backgrounds interact, they could find new applications and combinations of their varied skill sets [3,96].

When a team works together, members may more effectively filter new information and come up with strategies to share and expand their collective knowledge [3]. Diverse experience and skill sets can be advantageous for group problem-solving when the heterogeneity increases the probability that one person (or more) shall be right. Additionally, because the expression of different viewpoints can result in fresh ideas, diverse groups outperform homogeneous ones on tasks requiring creative problem-solving and creativity [57]. Bringing together several sets of team members with diverse skill sets to collaborate on a project is one straightforward and effective technique to improve cohesiveness within the team. Software development teams all across the world are a good illustration of this technique since they combine engineers with diverse technical skills to work together on projects [97].

Team familiarity boosts group cohesiveness as a result of interpersonal attraction. Members of familiar groups will express disagreement more naturally and with less discomfort than members of unfamiliar groups [57]. Team familiarity allows the exploration, exchange, and application of knowledge that is present inside a team, which enhances the coordination of team activities and may mitigate a variety of challenges caused by interpersonal diversity without compromising the potential benefits. Additionally, as interpersonal diversity highlights the coordination benefits of team familiarity, team familiarity, and interpersonal diversity may interact favorably in terms of performance [3]. Therefore, we chose *member diversity* as one of the TF facets in this research.

4.2 Interview Results

In order to empirically evaluate the findings of the literature review performed in phase-1 of the research and to provide answers to RQ-2 and RQ-3, we conducted semi-structured interviews with real-life software engineering professionals from a variety of software organizations across the world. We utilized interviews as a research strategy to learn about participants' experiences, perspectives, and opinions on geographical dispersion and its impact on team familiarity. As mentioned in section 3.1.1.2, we employed a combination of availability sampling and quota sampling

strategies to recruit the interview participants. The combination of availability sampling and quota sampling allowed us to access participants whom we knew and had easy access to, while also ensuring that we included individuals from senior roles to capture a diverse range of perspectives. This sampling strategy was chosen to enhance the credibility and rigor of our research and to ensure that our findings were based on a comprehensive and diverse sample of participants.

Furthermore, we purposefully included participants in roles such as product owners, scrum masters, and developers in our sampling strategy. These roles are key components of the Scrum framework, which is a widely used agile project management methodology. By including individuals in these roles, we aimed to capture their specific experiences, perspectives, and insights related to the topic of our research. Product owners, scrum masters, and developers have distinct responsibilities and perspectives within the Scrum framework, and their insights can provide valuable information on various aspects of agile software development processes, team dynamics, and project management practices. Therefore, their inclusion in our sample was intentional, as we sought to gather data from individuals with firsthand experience in these roles, which could enrich our understanding of the research topic and contribute to the credibility and relevance of our findings. The interview results were further analyzed using thematic analysis, where we identified relevant patterns that help us answer the researched questions.

4.2.1 Data Analysis and Results

As part of our research, we interviewed a total of 12 software professionals. All of the participants were from different organizations, worked on distributed agile projects, and had varying levels of experience in the software sector. It can be seen that the members' various responsibilities included Junior software developers, Senior software developers, Team Managers, Scrum Masters, Product Owners, and Software Architects.

According to statistics of the selected participants for the interviews, it is evident that we have recruited more senior software engineers and managers with extensive experience in the software industry to participate in the interview, which boosts the credibility of our study conclusions. In this case, we have considered people with 5 to 10 years of experience which made up 33.3%, and people with more than 10 years of experience making up to 25% of the overall participation respectively. Nevertheless, we have also interviewed junior software developers with less than 2 years of experience constituting 16.6% and participants in the mid-senior level (with 2 to 5 years of experience) which constituted another quarter of the total participants, to gain a fresh perspective on the opinions that make our research findings authentic.

Although it was vital to be aware of the participants' job experiences, it wasn't sufficient. Additionally required were the participants' professional experiences with agile approaches, in particular the scrum methodology. Prior to the interview, we verified this to ensure that the participants could understand the questions and provide reliable answers. Figure 4.2 illustrates the statistics based on participants' experience with Agile and Scrum methodologies (Note: It is assumed that all participants

who used Scrum are also considered as Agile practitioners since the Scrum Framework is a subset of Agile methodology). In the interviews conducted, we reported a broad range of agile approaches, including Scrum, Kanban, Scaled Agile Framework (SAFe), and Extreme Programming (XP). Among these techniques that were reported in the interview, research primarily focuses on the scrum framework and how changes in team familiarity brought on by geographic dispersion affect the scrum practices, which will be detailed in the next sections of this chapter.

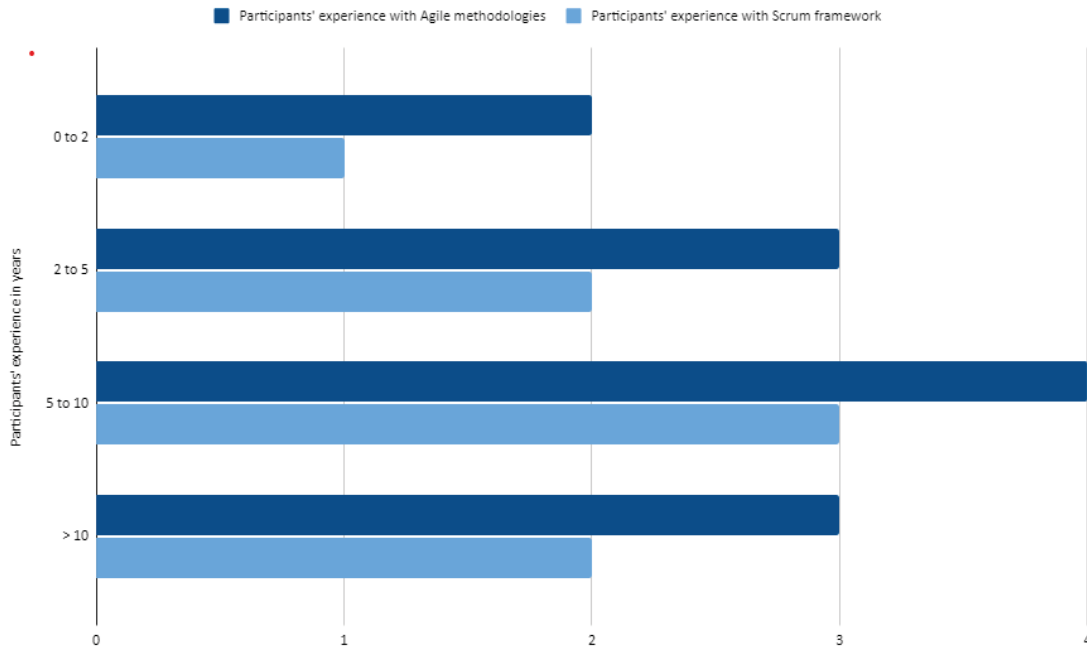


Figure 4.2: Statistics based on participant's experience with Agile methodologies and Scrum framework.

4.2.1.1 Team Familiarity and Team Size

In this section, we examine the relationship between team familiarity facets and team size. We draw upon the findings from the interviews with 12 software professionals from different organizations globally, with different scrum team sizes, as described in Table 4.4.

Team size	No. of Participants
0-10	3
10 - 15	4
15 - 20	2
20- 25	2
> 25	1

Table 4.4: Statistics Based on Participants' Team Size

During the interviews, participants were asked to share their opinions on how team familiarity facets can vary based on the size of the team. The interviews revealed interesting insights into how the prominence of team familiarity facets differ in large and small teams which can be observed in Figure 4.3.

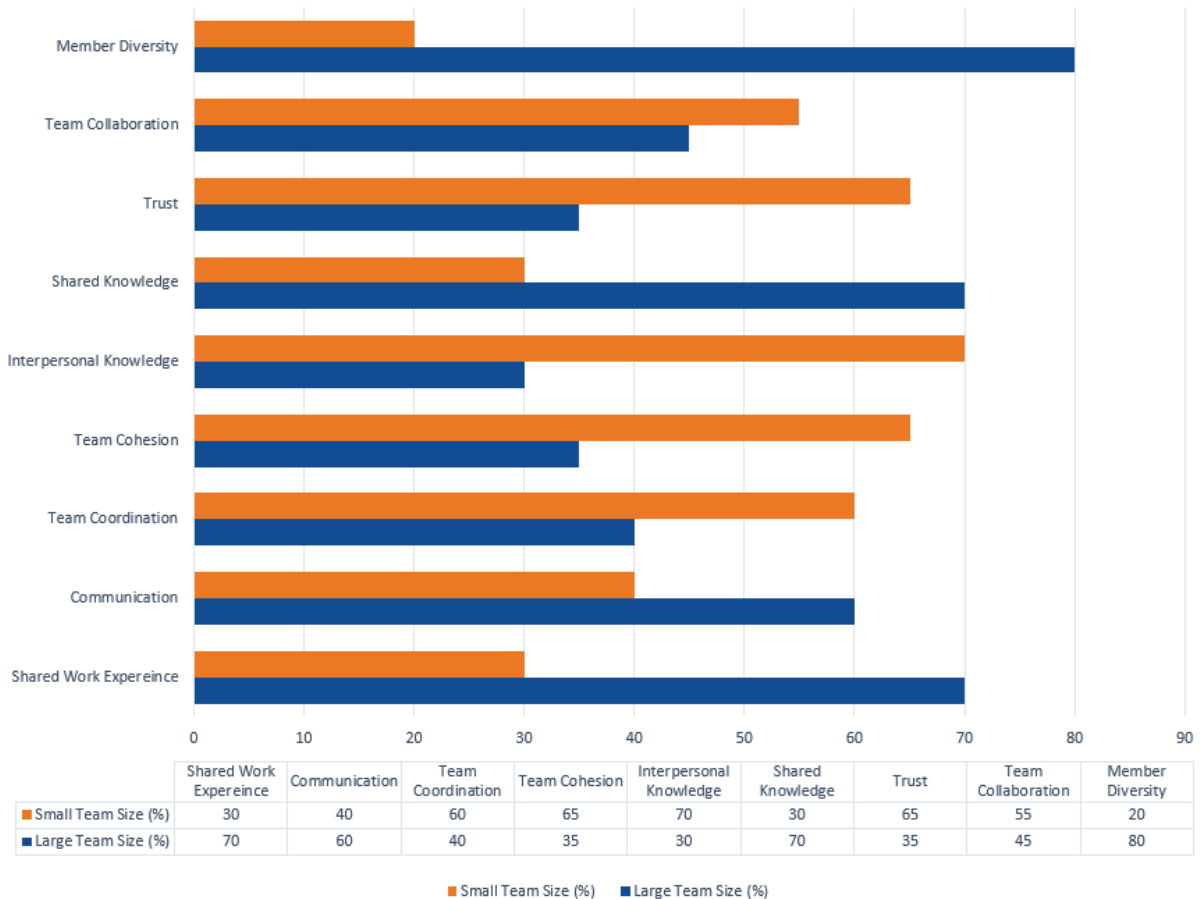


Figure 4.3: Prominence of Team Familiarity facets based on Team Size.

Prominence of team familiarity facets in larger teams:

- Around 70% of interviewees responded that shared work experience is more prominent in larger teams. The interviewees mentioned that shared experience helps team members to better understand each other's strengths and weaknesses, leading to a higher level of collaboration and task allocation based on the team member's expertise.
- Communication is crucial for effective collaboration, regardless of team size. However, it is more prominent in larger teams, as per 60% of the interviewees. Larger teams often consist of members from different locations, and effective communication is crucial for task coordination and maintaining a shared understanding of project objectives. Without clear and frequent communication, team members can easily become siloed and disconnected, which can negatively impact overall team performance. In contrast, it was also noted by 40% of the

participants that communication could be more prominent in smaller teams where communication can be more direct and effective.

- Shared Knowledge refers to the extent to which team members share common knowledge and skills related to the task or project at hand. It is more prominent in larger teams, where it is more likely that team members will have different areas of expertise according to 70% of the interviewees.
- Member Diversity concerns the extent to which team members have diverse backgrounds, skills, and perspectives. In larger teams, member diversity may be more common due to the increased number of team members. In contrast, in smaller teams, member diversity may be less common, making this facet less prominent.

Prominence of team familiarity facets in smaller teams:

- Team Coordination refers to the ability of team members to work together and coordinate their efforts towards achieving a common goal. In larger teams, coordination may be more difficult due to the increased number of team members and the potential for conflicting viewpoints. Therefore, this facet may be more prominent in smaller teams where coordination can be more streamlined according to 60% of the interviewees.
- Team Cohesion refers to the level of unity and cooperation within the team. In larger teams, team cohesion may be more difficult to achieve due to the increased number of team members and the potential for conflicting viewpoints. Therefore, this facet may be more prominent in smaller teams where team members can develop stronger relationships and work more closely together according to 65% of the interviewees.
- Interpersonal Knowledge refers to the amount of personal knowledge team members have about one another. In larger teams, it may be more difficult for team members to develop personal relationships, and therefore this facet may be less prominent. In contrast, in smaller teams, team members may have more opportunities to interact and develop interpersonal knowledge about one another, making this facet more prominent according to 70% of the interviewees.
- Trust is characterized by a belief in the reliability and competence of team members. It is essential for effective collaboration and can be more prominent in smaller teams, where personal relationships, and shared experiences through repeated interactions can foster trust according to 65% of the interviewees.
- In larger teams, collaboration may be more difficult due to the increased number of team members and the potential for conflicting viewpoints. Therefore, this facet may be more prominent in smaller teams where team members can collaborate more easily according to 55% of the interviewees.

These findings suggest that team size can play a crucial role in the development of team familiarity, and organizations should consider the size of their teams while implementing Scrum practices.

4.2.2 Effect of geographic dispersion on team familiarity

While conducting the interviews based on the team familiarity aspects, we discussed the idea of team familiarity and asked the participants how much they believed the facets we identified contributed to team familiarity based on their past experiences working in a team. Figure 4.4 illustrates the team familiarity facets reported in the interview according to their ranking. The highest number in the bar graph represents the most voted facet that contributes to team familiarity and vice-versa. In this case, it can be observed that *communication* was ranked as the most important team familiarity facet followed by *shared work experience* and *team coordination*.

We posed specific questions to the interview participants to determine the extent to which each team familiarity facet has been effected by geographical dispersion. Figure 4.5 displays the most affected facets of team familiarity as a result of geographical dispersion as reported in the interviews. The highest number in the graph represents the most affected team familiarity facet due to geographical dispersion and vice-versa. In this case, it is evident that *communication* and *interpersonal knowledge* were the most affected team familiarity facets by the geographical dispersion.

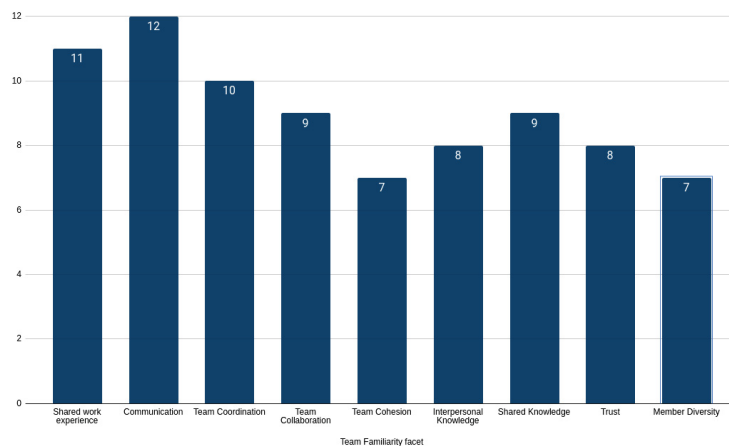


Figure 4.4: Team familiarity facets reported through the Interview

Based on these findings from figures 4.4 and 4.5, we can answer RQ-2 in this research by analyzing the interview results using a deductive thematic analysis. We will analyze these findings and categorize them according to each team familiarity facet, which serve as the pre-established themes in the deductive approach to thematic analysis.

Shared work experience

During the interviews conducted in phase-2 of this study, the participants were asked about the role of *shared work experience* in team familiarity. The majority of the participants, 91.6%, agreed that shared work experience could be considered a team familiarity factor. According to some of the participants, having previous professional relationships with team members allowed them to better understand each

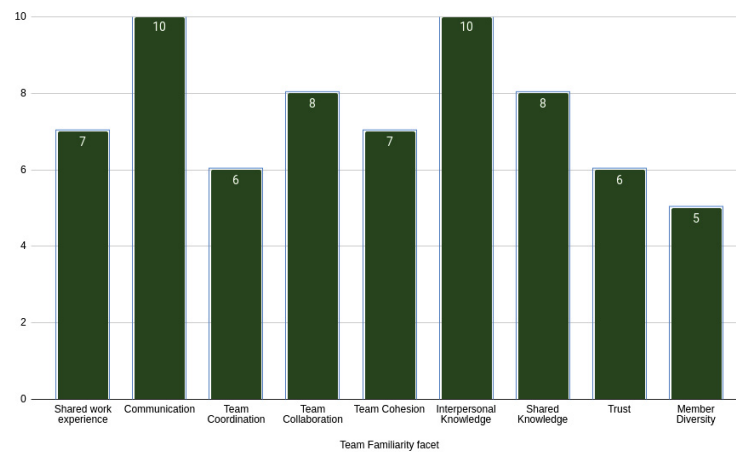


Figure 4.5: Most affected team familiarity facets due to geographical dispersion reported through the Interview

other's areas of expertise and made it easier to approach them for specific queries. However, despite having a good working connection in the past, 7 out of 10 respondents reported that geographical dispersion had a negative impact on their shared work experience.

One of the participants (P1) elaborated on this issue and stated that they used to approach their previous colleagues for task-related advice. However, after starting to work remotely, they would think twice before posing a question as they were unsure about the person's current situation and tasks. Another participant (P3) mentioned that the approachability of team members also plays a crucial role in shared work experience. They added that while working onsite, they would prefer to consult a familiar person for task-related assistance, which would save a lot of time. However, while working remotely, they often had to restrain their questions and either conduct their own research or ask another employee who was more reachable onsite.

These responses indicate that shared work experience can play an essential role in promoting team familiarity, but its effectiveness may be limited by the challenges posed by geographical dispersion. Organizations should consider implementing strategies to mitigate these challenges and promote shared work experience among team members, such as providing opportunities for team members to work together in person or organizing team-building activities that foster stronger relationships among geographically dispersed team members.

Communication

According to the interviews, *communication* was identified as the most critical facet that positively affects team familiarity, as depicted in the figure 4.4 with a 100% positive response rate. All participants agreed that communication is essential for effective collaboration in Scrum teams. Due to the significance placed on "communication," it was also one of the aspects of team familiarity that was most negatively affected by geographic dispersion, as observed by 83.3% of participants in the in-

terviews. Many participants observed that communication while working remotely often resulted in misunderstandings and ambiguity, particularly in messaging and emails.

It was noted that there were miscommunications or incorrect understandings of the task among the team members. One of the participants (P4) further stated, "I work in a team where our workload frequently consists of impromptu or unplanned assignments. Due to unclear communication between team members while working remotely, it was often unclear as to who was actually leading a particular task, which was one of the reasons behind the delayed deliveries to the customer". Participants also highlighted other communication challenges while working remotely, such as the irregular operation of certain communication tools at times, lack of availability of key team members due to time-zone differences, lack of a common language, and limited direct and emotional communication. The challenges of communication in geographically dispersed teams indicate the need for implementing effective communication strategies and tools to maintain effective collaboration and team familiarity.

During the interviews, several participants mentioned that it was difficult to reach out to a colleague via email for a second time when they had doubts, and it felt awkward. This issue was more pronounced when working remotely, as communication delays in replies were common. Participants also mentioned that working on-site facilitated a much easier and faster communication flow, eliminating such delays. One of the participants (P6) stated, "When working remotely, the communication process is not as smooth as it is when working on-site. Sometimes, people may not be able to respond as quickly, which can lead to frustration and delay in project completion." Another participant mentioned, "Working remotely requires more formal and structured communication, which can be time-consuming and lacks the spontaneity of in-person communication." These responses highlight the challenges posed by remote communication and the importance of finding strategies to facilitate effective communication in geographically dispersed teams.

Team Coordination

During the interviews, 10 out of 12 participants acknowledged the importance of *team coordination* in promoting team familiarity. Almost half of the participants highlighted that geographical dispersion had an impact on team coordination. Participants expressed that lack of team coordination resulted in deviating from the common objectives of the sprint, lack of commitment to team goals, and poor attendance in remote meetings. They also mentioned that a lack of coordination made it difficult to share a common vision of the goals, and expectations and priorities were not clear enough to be completed on time.

Most of the participants who reported that "team coordination" was impacted by remote working conditions pointed out that individual goals were more important, and they were unable to coordinate with the team adequately. As one of the participants (P5) highlighted, "Due to everyone being preoccupied with their own tasks and you not knowing what the other people are doing, remote working has a clear negative effect on team collaboration and team coordination. As a result, there was a lack of

common responsibility, as well as a lack of discussions and ideas." The pattern was consistent as 50% of those who reported team coordination challenges belonged to larger teams of more than 12 persons.

Participants further elaborated on the challenges of team coordination in remote work environments, such as misaligned priorities, difficulty in establishing accountability, and delays in decision-making due to communication barriers. The challenges of team coordination were also effected by the size of the team, the complexity of the project, and the frequency of interactions between team members. Overall, the interviews indicated that team coordination is an essential facet of team familiarity, and the impact of geographical dispersion on team coordination requires careful consideration for geographically dispersed Scrum teams.

Team Collaboration

The interview results provide valuable insights into the role of *team collaboration* in team familiarity as well as the impact of geographical dispersion on this aspect of team familiarity. Nearly 75% of the participants believed that team collaboration is one of the most crucial elements of team familiarity, underlining its importance in establishing and maintaining team familiarity in Scrum teams. When asked about the impact of geographical dispersion on team collaboration, 7 out of 12 participants reported that it had a negative effect, while the others indicated that it had little to no impact. One of the developers (P5) from the interview mentioned that "Geographical dispersion definitely presents both advantages and challenges for our team collaboration. On one hand, we have access to diverse skill sets and flexible work arrangements, which is great. But on the other hand, communication can be impacted by time zone differences, language barriers, and cultural disparities."

However, some participants mentioned that they used collaboration tools such as Microsoft Teams and Slack to collaborate online, which helped to mitigate the impact of geographical dispersion. They reported sharing their screens and connecting one-on-one in a virtual environment, which helped them work together more effectively and find solutions faster. One of the team managers (P7) noted that "we heavily rely on technology for communication and collaboration to address these challenges, which can lead to the adoption of new tools and techniques, but also increases the need for documentation." Additionally, the use of these tools helped them develop professional relationships, which further strengthened their team collaboration. Providing more insights regarding the impact of team size and team collaboration when working remotely, one of the scrum masters (P9) mentioned that "Larger teams face more communication challenges but also have a diverse skill set, whereas, smaller teams may have fewer communication challenges but limited resources. Organizations must consider these factors for successful collaboration in dispersed teams."

The results of the interviews provide evidence to support the argument that team collaboration is a crucial aspect of team familiarity and that geographical dispersion can have an impact on team collaboration. These findings have important implications for organizations that rely on Scrum teams, highlighting the need to consider the impact of geographical dispersion on team collaboration and the role of collabo-

ration tools in mitigating this impact.

Team Cohesion

The interview data revealed that *team cohesion* was considered a crucial aspect of team familiarity by a majority of the participants (58.3%). However, seven out of the twelve respondents reported that geographical dispersion had impeded team cohesiveness. These respondents noted that a lack of cohesiveness could lead to chaos, ambiguity, and misalignment with goals. Furthermore, participants (P6, P8) mentioned that promoting team cohesiveness and coordination among members was particularly challenging due to pandemic-induced constraints and remote work arrangements. This manager's observations were supported by the experiences of other team members who reported that remote working conditions had a negative impact on team performance.

One of the main reasons cited for this decline in performance was a lack of team cohesion. Participants noted that limited face-to-face interactions hindered the development of trust and collaborative work, while cultural and language differences led to misunderstandings and conflicts. Additionally, time zone differences made it difficult to schedule meetings and coordinate work effectively, resulting in delays, missed deadlines, and a sense of disconnection among team members. To address these challenges, some teams scheduled more meetings than usual to ensure everyone was in sync while working remotely. However, this approach could also further burden distant teams and hamper the development of team cohesiveness. Despite these challenges, it is noteworthy that eight out of twelve respondents did not believe that geographical dispersion had adversely affected the unity of the team during difficult times.

Interpersonal Knowledge

According to the interview findings, a majority of the respondents considered interpersonal knowledge to be a crucial aspect of team familiarity. Specifically, 8 out of 12 respondents (66.6%) believed that building strong relationships and fostering interpersonal knowledge were key factors in building effective teams, highlighting the high value placed on interpersonal knowledge within Scrum teams as essential to project success. However, the majority of respondents also acknowledged that geographical dispersion posed a significant challenge to the development of interpersonal knowledge. As many as 10 out of 12 respondents (83.3%) believed that geographic dispersion made it more difficult for team members to build strong relationships and interpersonal knowledge, indicating that geographic dispersion negatively impacted the team's ability to work effectively.

Reduced in-person and informal interaction presents a challenge to building strong interpersonal relationships in geographically dispersed Scrum teams, as noted by one interviewee who felt that they were missing out on the subtle cues that come from in-person communication and also made it harder to gain knowledge about each other's areas of expertise. Another interviewee (P2) pointed out that casual conversations and informal interactions are less frequent when working remotely and stated that

"We don't have those coffee breaks or the small talk where we can casually get to know each other. It sometimes makes it harder to build rapport and trust." The heavy reliance on technology was also noted as a recurring theme throughout the interviews. One participant (P11) stated, "While technology helps us communicate, it's not the same as being in the same room. Video calls and instant messaging just don't capture the same emotional depth as face-to-face interactions."

The interview results revealed that people in smaller geographically dispersed teams felt they had more interpersonal knowledge compared to those in larger teams. This could be attributed to the fewer team members in small teams, which may make it easier to establish personal connections and coordinate communication despite geographical dispersion. However, both small and large teams still face these challenges, with larger teams potentially experiencing these challenges more prominently due to the increased complexity of communication and coordination.

Shared knowledge

Based on the interview results, shared knowledge was recognized as an important aspect of team familiarity by 8 out of 12 respondents (66.6%). However, a majority of respondents also believed that geographical dispersion can have a negative impact on shared knowledge. However, the majority of the respondents also believed that geographic dispersion can hinder effective knowledge sharing, with 7 out of 12 respondents (58.3%) expressing this view. This suggests that geographic dispersion poses a significant challenge for Scrum teams and can impact their ability to work effectively.

The interviewees agreed that knowledge sharing was more prevalent when working on-site and that this has been significantly and adversely impacted by the shift to remote working. One junior developer (P1) noted that it was more difficult to reach out to people, there were fewer knowledge transfer sessions, and people seemed to be more preoccupied with their own work, making it feel like a burden to ask questions in the initial stages of starting at the company. Other interviewees also shared similar experiences and mentioned that the amount of interaction while sharing knowledge had been reduced due to geographical dispersion.

The interviews also highlighted that geographical dispersion can make team members less comfortable seeking help from colleagues in areas outside of their expertise, which may lead to knowledge silos and hinder effective collaboration. Furthermore, 11 out of 12 respondents mentioned that they had looked into other sources of information before seeking assistance from team members, indicating decreased reliance on interpersonal knowledge sharing. This could be attributed to the challenges of remote working, such as increased barriers to communication, which make it more difficult to share knowledge effectively. Some interviewees also emphasized the importance of creating a culture of openness and transparency that encourages team members to share their knowledge and ideas freely.

Trust

Trust is a crucial element for achieving team familiarity and successful collaboration in Scrum teams, as indicated by the majority of the participants (8 out of 10) during the interviews. However, despite this importance, only a minority of the participants (4 out of 12) believed that remote work did not affect their trust in team members they already knew and worked with. From the interviews, it was evident that while geographical dispersion did not have a significant impact on maintaining trust, building trust was more challenging when working remotely. One of the Scrum Masters interviewed explained that working remotely can lead team members to feel isolated and less aware of what others are working on, which can affect visibility and accountability. This lack of awareness can make it more challenging to build trust, especially in regard to ensuring that team members are meeting their commitments.

Additionally, a few participants believed that casual conversations and social interactions are essential for fostering a sense of familiarity and trust within a team. However, these are often more challenging to facilitate remotely. Communication can also be more difficult in a remote working environment, especially when team members are in different time zones or using different communication tools. This can lead to misunderstandings, delays, and a lack of clarity, which can erode trust within a team.

According to one manager (P7) interviewed, fostering creativity in the team was essential, as team members have unique perspectives to offer in problem-solving. However, low levels of trust can discourage team members from suggesting new or unconventional ideas due to fear of criticism or rejection. This can lead to a silo mentality, where team members work independently and withhold valuable information, ultimately impeding effective collaboration and decision-making. Similarly, a product owner interviewed stated that in a low-trust environment, team members may be hesitant to make bold decisions or take risks, fearing blame or failure. This can create a risk-averse culture, where conventional solutions are favored over potentially more effective alternatives.

Overall, the interviews conducted revealed that the shift to remote work has had a significant impact on trust-building within Scrum teams. Though building trust is possible in a remote environment, it requires intentional efforts to facilitate communication, establish clear expectations, and foster familiarity within the team. The findings of this study suggest that trust-building should be prioritized in remote work to ensure effective collaboration and project success. To overcome the negative impact of low trust on decision-making, Scrum teams should focus on building and maintaining trust through open communication, mutual support, shared goals, and a culture of psychological safety.

Member Diversity

According to the interview results, member diversity is a crucial factor that affects both positive and negative aspects of team dynamics. Out of the 12 respondents, 5 emphasized the importance of member diversity in promoting team familiarity. They highlighted the positive effects of member diversity on team creativity, innovation, decision-making, and adaptability. As one interviewee (P12) noted, "Having diverse

members in the team definitely helps to improve team familiarity, as it brings in different perspectives and ideas that would not have been considered otherwise." Another interviewee added that diverse skill sets and backgrounds enable teams to approach problems from different angles, increasing problem understanding and fostering creative solutions.

Regarding diversity in technical experience, some participants stressed its importance, with one interviewee expressing that having team members with different experience levels enables learning from one another, identification of blind spots, and the creation of better solutions. Teams with diverse members are often more adaptable to change, as they have a broader range of experiences and skills to draw upon when faced with new challenges or shifting circumstances. Teams with diverse members tend to make more informed decisions, as they can consider various viewpoints and avoid groupthink. By integrating different perspectives, team members can challenge each other's assumptions and reach more comprehensive conclusions.

However, there are negative aspects of member diversity, such as communication challenges, particularly language and cultural barriers. These barriers can hinder the smooth flow of information and collaboration within the team. Potential conflicts might also arise from misunderstandings rooted in differences in values and beliefs. In terms of technical experience diversity and its relation to geographical dispersion, interviewees acknowledged that attaining the right balance of experience levels in a team can be challenging, especially when a project demands specialized knowledge. One participant (P10) during the interview commented, "Diverse teams generally require more time to establish team familiarity, as members may need additional time to understand and appreciate each other's backgrounds, experiences, and perspectives. Given the remote working environment, I don't expect much communication, which could result in difficulties understanding peers and, in turn, negatively affect team collaboration."

In summary, the Table 4.5 represents the team familiarity facets and the effect of geographical dispersion on these facets, in response to RQ-2.

TF Facet	Definition	Effect of Geographical Dispersion
Shared Work Experience	The extent to which team members have worked together previously, and have established a professional relationship and understanding of each other's areas of expertise.	Geographical dispersion can negatively impact shared work experience, as team members may hesitate to approach each other for task-related advice, and may have to rely on alternative sources of information or research.
Communication	The exchange of information and ideas between team members, including both formal and informal communication channels.	Geographical dispersion can negatively impact communication, resulting in misunderstandings, ambiguity, and delays in replies. This can lead to a lack of clarity on task ownership and delays in project completion, indicating the need for effective communication strategies and tools.

Team Coordination	The ability of team members to work together and align their efforts towards common goals and objectives.	Leads to misaligned priorities, difficulty in establishing accountability, and delays in decision-making. This impact can be more pronounced in larger teams, complex projects, and when team members have limited interactions with each other.
Team Collaboration	The degree to which team members work together and share knowledge, skills, and resources to achieve common goals.	Heavy reliance on technology to communicate with others. communication can be impacted by time zone differences, language barriers, and cultural disparities. Misunderstandings and delays can occur, which can affect the quality and speed of collaboration.
Team Cohesion	The degree to which team members are united and work together towards common goals, with a sense of mutual trust and commitment.	Cultural and language differences can also lead to misunderstandings and conflicts, while time zone differences can result in delays, missed deadlines, and a sense of disconnection among team members, hindering the development of trust and collaborative work.
Interpersonal Knowledge	The degree to which team members possess knowledge about each other's strengths, weaknesses, and areas of expertise, as well as their interests and personalities.	Reduced in-person and informal interactions make it difficult to build strong relationships and establish personal connections. Video calls and instant messaging are insufficient substitutes for face-to-face interactions.
Shared Knowledge	The degree to which team members possess and utilize common information and knowledge to achieve team goals.	Communication barriers can result in challenges in sharing knowledge effectively, due to reduced interaction and spontaneous knowledge transfer sessions among team members, potentially causing team members to feel less comfortable asking for help from colleagues outside their area of expertise. This may result in knowledge silos.
Trust	Refers to the belief in the reliability, integrity, and competence of team members	Building trust is more challenging when working remotely due to the lack of awareness, visibility, and accountability, and difficulty in establishing personal relationships. Low levels of trust can discourage team members from suggesting new or unconventional ideas, ultimately impeding effective collaboration and decision-making.

Member Diver- sity	The range of differences in skills, experience, backgrounds, and perspectives among team members.	Teams with diverse technical experiences may have difficulty achieving the right balance of experience levels, which can lead to difficulties in understanding peers and negatively impact team collaboration, particularly in a remote working environment. Cultural and language barriers can lead to misunderstandings and conflicts that can impede effective collaboration and decision-making.
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Table 4.5: Effect of Geographical Dispersion on Team Familiarity facets.

4.2.3 Team Familiarity and Scrum practices

In this section, we explore the relationship between Scrum practices and team familiarity facets, building on the findings from the previous section that investigated the impact of geographical dispersion on each team familiarity facet. Scrum, being an agile methodology, places significant importance on effective team dynamics for successful implementation. For instance, team familiarity facets like communication and team cohesion are essential for Scrum practices such as daily stand-ups and sprint planning, etc. Therefore, understanding how team familiarity facets influence Scrum practices is crucial for optimizing team performance in Scrum teams. Additionally, this section provides a synopsis of the interview results concerning how participants have responded to the impact of geographical dispersion on Scrum practices, consequently answering RQ-3. During the interview, several mitigation strategies were discussed to counteract the negative impact of geographical dispersion on Scrum practices and teams. These strategies have been summarized below, categorized under each respective facet.

Shared Work Experience:

Teams that have worked together before and share a common work experience tend to have a more profound understanding of each other's strengths, weaknesses, and working styles. This familiarity can be highly beneficial when implementing Scrum practices, as it can lead to more effective task allocation during Sprint Planning. Team members who are familiar with each other's strengths and weaknesses are better equipped to assign tasks to the right person based on their individual skill sets.

Moreover, understanding each other's working styles helps in smoother communication during Daily Stand-ups, as team members know how to approach and communicate with their colleagues. This familiarity also contributes to faster issue resolution during Sprint Retrospectives, as team members can work together efficiently to identify and address issues that may arise during the sprint. Overall, team familiarity is a crucial factor that can significantly impact the success of Scrum projects.

Geographical dispersion can make it difficult for team members to accumulate shared work experience. It can be harder for them to observe each other's work styles and

build an understanding of each other's strengths and weaknesses. Teams might need to rely on virtual platforms or occasional face-to-face meetings to develop shared work experiences.

Communication:

Communication is a crucial aspect of Scrum team dynamics, as it enables effective coordination of tasks, sharing of information, and resolution of issues. Familiarity with each other's communication styles and preferences can enhance the productivity of Scrum teams, resulting in more focused updates during Daily Stand-ups, productive discussions during Sprint Planning, and effective conflict resolution during Sprint Retrospectives. Good communication practices are especially important for remote or geographically dispersed teams, where communication barriers such as time zones, language differences, and reduced non-verbal cues can pose significant challenges. These barriers can hinder effective communication and reduce opportunities for casual interactions that can build team familiarity.

To overcome communication barriers and maintain open communication, Scrum teams should consider using both synchronous and asynchronous communication tools such as video-conferencing to facilitate real-time interactions and email, messaging respectively. Effective communication practices and tools are essential for Scrum teams to succeed, especially for remote or geographically dispersed teams facing communication barriers. By developing familiarity with each other's communication styles and preferences and leveraging synchronous and asynchronous communication tools, Scrum teams can maintain alignment, engagement, and collaboration to achieve project success.

Team Coordination:

Familiarity with each other's roles, responsibilities, and working styles is crucial for Scrum teams to coordinate their efforts efficiently. This understanding helps team members to better plan, prioritize, and execute tasks within the Sprint, resulting in higher productivity and a greater likelihood of meeting Sprint goals. Effective team coordination also supports the Scrum principle of self-organization, enabling team members to manage their work autonomously.

For geographically dispersed Scrum teams, coordinating tasks and responsibilities can be more challenging due to time zone differences and reduced face-to-face interactions. As a result, teams may need to adapt their Scrum practices to improve coordination. For example, scheduling overlapping working hours for Daily Stand-ups can help align schedules and ensure that team members are up-to-date on the progress of the Sprint. Similarly, using collaboration tools such as shared task boards and online project management tools can help keep the team aligned and focused on Sprint goals.

Moreover, Scrum teams may also consider defining clear roles and responsibilities for team members to help them manage their work autonomously. This can include establishing guidelines for task ownership, setting expectations for deliverables and

deadlines, and establishing communication protocols for reporting progress and addressing issues.

Team Cohesion:

Cohesion in Scrum teams is crucial as it fosters a strong sense of unity and shared purpose among team members. High team cohesion often leads to increased motivation, commitment, and satisfaction, positively influencing the team's overall performance. Cohesive teams are also more likely to support each other during challenging situations, fostering resilience and adaptability in the face of change or setbacks.

Building team cohesion can be more challenging for geographically dispersed teams, as they have fewer opportunities for social bonding and face-to-face interactions. Therefore, it is crucial for these teams to find alternative ways to build cohesion. Virtual team-building activities, such as online games, virtual brainstorming sessions, and remote team-building exercises, can help team members build rapport and connect with each other despite the distance.

Moreover, regular video calls can help team members stay connected and maintain a sense of togetherness, while occasional in-person meetings can provide valuable opportunities for face-to-face interaction and social bonding. For example, Scrum teams can consider arranging occasional team-building events or offsite meetings to help foster stronger bonds and strengthen the team's sense of unity.

Interpersonal Knowledge:

Familiarity with each other's personality traits, preferences, and tendencies is essential for effective collaboration in Scrum teams. This knowledge enables team members to anticipate potential conflicts and address them proactively, contributing to a positive team atmosphere where members feel valued and supported. Interpersonal knowledge plays a crucial role in conflict resolution during Sprint Retrospectives. By understanding each other's personality traits and tendencies, team members can approach conflicts more empathetically and effectively. This can help maintain a positive team atmosphere and foster resilience and adaptability in the face of change or setbacks. Understanding individual limitations and strengths also helps team members work together more effectively, ultimately leading to better performance and outcomes.

For geographically dispersed Scrum teams, gaining interpersonal knowledge of each other's personality traits, preferences, and tendencies can be more challenging due to limited face-to-face interaction. Encouraging virtual social interactions and informal communication can help team members get to know each other on a personal level and build familiarity. This can include virtual coffee breaks, online team-building games, and other informal communication channels that provide opportunities for social bonding and casual conversation.

Additionally, Scrum teams can also consider using personality tests or assessments to gain a better understanding of each other's working styles and preferences. These assessments can provide valuable insights into team members' strengths, limitations,

and communication styles, enabling them to work together more effectively.

Shared Knowledge:

Scrum teams with shared knowledge of the project, domain, and technical aspects are better equipped to make informed decisions, reducing the need for extensive clarification and rework. This shared knowledge also supports collective problem-solving and innovation, as team members can build upon each other's expertise and ideas. Additionally, a shared understanding of the project's goals and requirements helps the team maintain focus and prioritize tasks effectively during Sprint Planning.

However, geographical dispersion can make it harder to establish shared knowledge among Scrum team members, as they might have limited opportunities for spontaneous knowledge sharing and learn from each other. To bridge this gap, teams can leverage collaboration tools, document repositories such as confluence, Google Drive and SharePoint, and regular knowledge-sharing sessions to ensure that everyone has access to the same information.

Collaboration tools such as shared task boards, online document repositories, and video conferencing can facilitate remote knowledge sharing, making it easier for team members to access and contribute to project information. Regular knowledge-sharing sessions, such as virtual brainstorming sessions, can also help team members stay informed and learn from each other despite the distance. Furthermore, Scrum teams can consider using pairing or mentoring programs to help team members learn from each other and build expertise. For example, pairing experienced team members with less experienced team members on a task can help the less experienced team members gain knowledge and skills from the more experienced team member.

Trust:

Trust is crucial for fostering open communication and collaboration within Scrum teams. When team members trust each other, they are more likely to share ideas, ask for help, and admit mistakes. This openness contributes to a culture of continuous improvement and learning, which is essential for Scrum teams to adapt and grow. Trust also enables team members to hold each other accountable, reinforcing the Scrum value of commitment.

Trust is especially useful in various Scrum practices, such as Sprint Planning, Daily Stand-ups, Sprint Retrospectives, Pair Programming, and Refinement Sessions. During these practices, team members need to trust each other to make informed decisions, provide honest progress updates, provide constructive feedback, work effectively together, and make informed decisions about what work should be included in the next Sprint.

Building trust among geographically dispersed team members can be challenging, as face-to-face interactions and casual conversations that foster trust are limited. To build trust within the team, even when members are not co-located, teams should encourage open communication, transparency, and accountability by establishing clear communication protocols and guidelines that promote honesty and respect. Teams

should also ensure that all team members have equal opportunities to participate in discussions and decision-making processes. By building trust among team members, Scrum teams can create a more positive and productive work environment, ultimately leading to better project outcomes.

Team Collaboration:

Effective collaboration is essential in Scrum practices such as Sprint Planning, Daily Stand-ups, and Sprint Retrospectives. Collaborating effectively enables team members to distribute workloads evenly, support each other during challenging tasks, and share knowledge and expertise, driving project success. Familiarity among team members enhances collaboration as it promotes understanding and respect for each other's opinions and ideas. In a collaborative environment, team members can leverage each other's skills and expertise to identify problems, generate ideas, and find effective solutions. In a collaborative environment, team members can leverage each other's skills and expertise to identify problems, generate ideas, and find effective solutions. This collaboration is strengthened when team members have familiarity with each other, including each other's strengths, weaknesses, and work styles.

However, geographical dispersion can pose challenges to effective collaboration due to time zone differences, language barriers, and reduced face-to-face interactions. To address these challenges, Scrum teams should use collaboration tools and platforms to facilitate teamwork and ensure that all team members can contribute effectively, regardless of their location. Collaboration tools such as video conferencing and messaging applications can help team members work together on tasks, share documents and files, and communicate in real time.

To ensure successful collaboration, Scrum teams should establish clear communication protocols, guidelines, and expectations for each team member's responsibilities and deliverables. Team members should have a clear understanding of their roles and responsibilities and be accountable for meeting commitments and deadlines. Building familiarity among team members can also enhance collaboration by fostering a more comfortable work environment where team members feel confident sharing their opinions and collaborating effectively. Scrum teams can build familiarity through team-building activities, such as virtual games or shared learning experiences, promoting personal connections beyond their professional roles. By creating a collaborative and familiar environment, Scrum teams can achieve their goals and unlock their full potential.

Member Diversity:

Member diversity in Scrum teams can bring fresh perspectives, skills, and expertise that can enhance decision-making, problem-solving, and innovation. During Sprint Planning, diverse team members can propose creative solutions and identify potential issues. During Daily Stand-ups, diverse skills and knowledge can lead to higher productivity and faster progress. During Sprint Retrospectives, diverse perspectives and experiences can help identify areas for improvement and propose effective solutions. By leveraging diverse backgrounds and experiences, Scrum teams can unlock

their full potential and achieve their goals effectively.

However, diversity can also create challenges in terms of communication and coordination. Familiarity among team members can help mitigate these challenges, allowing the team to leverage the benefits of diversity while maintaining effective collaboration and coordination. Geographically dispersed Scrum teams often have increased diversity in terms of culture, language, and skill sets. This diversity can be both an asset and a challenge, as it can lead to innovative solutions while also creating potential communication and coordination difficulties.

To overcome these challenges, teams should actively work to build familiarity among members, fostering understanding and appreciation of each other's backgrounds and expertise. This can be achieved through regular team-building activities, knowledge-sharing sessions, and open communication. By building familiarity among team members, Scrum teams can unlock the full potential of their diverse backgrounds and achieve their goals effectively.

The table below lists the Scrum practices along with their definition and the most important team familiarity facets associated with each practice.

Scrum practice	Definition	Most Important Team Familiarity Facets
Daily Stand-up	A daily 15-minute meeting for the team to synchronize activities, discuss progress, and address obstacles.	Communication, Team coordination, Shared work experience, Interpersonal knowledge, Trust
Sprint Planning	A meeting to define the Sprint goal, select items from the product backlog, and plan the work to be completed in the upcoming Sprint.	Communication, Team coordination, Shared knowledge, Trust, Member diversity
Backlog Refinements	Regular sessions to review, refine, and prioritize items in the product backlog, ensuring that the backlog remains organized and clear.	Communication, Shared knowledge, Team collaboration, Member diversity, Interpersonal knowledge
Sprint Retrospective	A meeting held after each Sprint to discuss what went well, what could be improved, and what actions should be taken to improve the process.	Communication, Team cohesion, Trust, Interpersonal knowledge, Shared work experience
Scrum of Scrums	A meeting for multiple Scrum teams working on the same project to coordinate, share information, and address cross-team dependencies.	Communication, Team coordination, Shared knowledge, Trust, Team Collaboration

Sprint Review	A meeting to review and demonstrate the work completed during the Sprint, gather feedback, and update the product backlog accordingly.	Communication, Team collaboration, Shared knowledge, Trust, Interpersonal knowledge
Definition of Ready (DoR)	A shared understanding of the criteria that must be met for a product backlog item to be considered ready for inclusion in a Sprint.	Communication, Shared knowledge, Team collaboration, Trust, Member Diversity
Definition of Done (DoD)	A shared understanding of the criteria that must be met for a product increment or backlog item to be considered complete.	Communication, Shared knowledge, Team collaboration, Trust, Member Diversity

Table 4.6: Scrum practices and team familiarity facets

In summary, the Table 4.7 represents how the changes in team familiarity facets due to geographical dispersion affects the scrum practices, in response to RQ-3.

TF Facet	Effect of Geographical Dispersion on Scrum Practices
Shared Work Experience	Geographical dispersion can lead to a lack of shared work experience among team members, which can make it challenging to develop a shared understanding of the project's objectives and requirements. This can lead to delays in completing user stories, as team members may not have a clear understanding of each other's work or be able to resolve blockers efficiently.
Communication	Communication can be more difficult in a remote environment, particularly due to challenges like working in different time zones, cultural and language barriers, misunderstandings, delays, and a lack of clarity can occur, which can erode trust within a team. Lack of in-person interaction can result in a lack of awareness of others' work, leading to isolation and less accountability. This can impact visibility and communication, making it challenging to maintain alignment and shared understanding.
Team Coordination	Geographical dispersion can lead to coordination challenges among team members, making it difficult to align goals and schedules, monitor progress, and address issues in a timely manner. This can affect the team's ability to deliver value incrementally and to adapt to changing requirements. It can also lead to difficulties in coordinating work, particularly when dependencies are involved, resulting in missed deadlines and increased technical debt.

Team Cohesion	Geographical dispersion can reduce team cohesion by limiting opportunities for social interactions and casual conversations among team members. This can result in a lack of shared understanding and trust among team members, making it more challenging to collaborate effectively and achieve project goals. It can negatively impact the team's motivation, communication, and collaboration. This can lead to a lack of engagement in Scrum ceremonies and decreased productivity.
Interpersonal Knowledge	Geographical dispersion can limit opportunities for interpersonal knowledge development, such as getting to know each other's personalities, interests, and working styles. This can lead to communication challenges, misunderstandings, and a lack of alignment among team members. This can make it more challenging to build and maintain relationships within the team and can lead to a lack of trust and psychological safety within the team.
Shared Knowledge	Geographical dispersion can make it challenging to share knowledge and information effectively among team members. This can result in silos and information asymmetry, leading to reduced collaboration, decision-making, and innovation. This can lead to difficulties in resolving technical issues and impediments and can result in a lack of clarity around project goals and requirements.
Trust	Geographical dispersion can affect trust-building among team members, making it more challenging to establish and maintain trust. This can result in communication breakdowns, missed commitments, and a lack of accountability. This can lead to a silo mentality, where team members work independently and withhold valuable information, ultimately impeding effective collaboration and decision-making.
Team Collaboration	Geographical dispersion can reduce opportunities for team collaboration, making it more challenging to work together to achieve project goals. This can lead to reduced creativity, innovation, and effectiveness, as well as missed deadlines and increased costs. This can also lead to communication challenges and misunderstandings.
Member Diversity	Geographical dispersion can increase the challenges of building familiarity and trust among team members with diverse backgrounds, skill sets, and experiences. This can lead to communication challenges, misunderstandings, and conflicts, as well as reduced innovation, creativity, and adaptability.

Table 4.7: Effect of Geographical Dispersion on Scrum Practices

In this chapter, we aim to analyze and interpret the findings from our two-phase study that explores the effect of geographical dispersion on team familiarity in Scrum teams, with a focus on the pandemic period. The study is guided by three primary research questions mentioned in chapter 3, including the facets that contribute to team familiarity, the effects of geographical dispersion on team familiarity facets during the pandemic, and how changes in team familiarity have effected Scrum practices.

By conducting an extensive literature review, we identified key facets of team familiarity, including shared work experience, communication, team coordination, team cohesion, interpersonal knowledge, shared knowledge, trust, team collaboration, and member diversity. In the second phase of our study, we conducted interviews to better understand how geographical dispersion has impacted these facets and, in turn, effected the effectiveness of Scrum practices.

Through this discussion section, we aim to provide a comprehensive analysis of the various facets of team familiarity, examining their interrelationships and the effect of geographical dispersion during the pandemic. Additionally, we will explore the practical implications of our findings for Scrum teams operating in geographically dispersed contexts, providing potential strategies for overcoming challenges and leveraging opportunities in this new working landscape.

5.1 Comparison of Literature Review and Interview Results

In this section, we aim to compare and contrast the findings from the literature review and the interviews conducted to gain a deeper understanding of the team familiarity facets in geographically dispersed Scrum teams. The objective is to identify similarities and differences between the findings of these two research methods, evaluate their significance, and discuss potential explanations for any discrepancies. This comparison will help to address the research questions, provide insights into the practical and theoretical implications of the study's findings, and identify future research directions. We shall individually compare each team familiarity facet from the results of the literature review and interview results respectively. By examining the interplay between the literature review and interview findings, we aim to contribute to a more comprehensive understanding of the impact of geographical dispersion on team familiarity and its effect on Scrum practices.

Communication and collaboration were identified as the most important facets in both the literature review in research papers [3, 5, 6, 33, 34, 57, 65, 69, 70] and interview

results. Effective communication and collaboration are essential for building team familiarity and promoting trust and psychological safety. Team coordination was also emphasized in both the literature review in research papers [3, 33, 34, 65, 71] and interviews, with geographical dispersion posing challenges to effective coordination. Trust and communication were found to be the most interconnected facets in both literature reviews according to research papers [6, 34, 57, 69, 70] and the interview results, with several relationships to other factors. The comparison highlights the need for organizations to recognize and address the challenges posed by geographical dispersion and develop strategies to promote team familiarity.

The literature review and interview results both underscore the importance of team coordination in achieving team goals, but the interviews also suggest that geographical dispersion can negatively impact team coordination. The majority of those who reported challenges in team coordination attributed it to individual goals being prioritized over team goals. The findings from the literature review [6, 35, 69–71] and interviews highlight the challenges posed by remote working conditions and the importance of team coordination in successful project outcomes. The importance of effective communication, interpersonal knowledge, team cohesion, and shared knowledge in promoting team familiarity is highlighted in both the literature review and interview results. From the literature review and interviews, it was evident that the facets that are specific to Scrum teams include Shared work experience, Team coordination, Team cohesion, Shared knowledge, and Team collaboration. These facets highlight the importance of shared experiences, effective coordination, strong team cohesion, knowledge sharing, and collaboration. These facets are particularly relevant in Scrum teams as they align with the iterative and collaborative nature of the Agile methodology.

One important theme that emerges from the comparison of the literature review and interview findings is the interdependence of team familiarity facets. For example, effective communication is essential for promoting team coordination and collaboration, which in turn fosters team cohesion and shared knowledge. Similarly, member diversity can positively impact team creativity, innovation, and decision-making, but only if effective communication and interpersonal knowledge exist within the team to overcome potential barriers to collaboration and communication. The importance of trust is also highlighted as a critical aspect of team familiarity, as it is essential for promoting effective collaboration and knowledge sharing, but it can only be built through intentional efforts to establish clear expectations, facilitate communication, and foster familiarity within the team.

Trust and communication appear to be the most interconnected facets, with various links to other TF facets. Trust is heavily reliant on interpersonal knowledge, and efficient communication for effective team familiarity. Communication is essential for establishing and sustaining trust, and a lack of communication may destroy trust within a team. Moreover, communication is a critical component of team coordination, cooperation, and knowledge sharing, making it critical for the success of geographically distributed Scrum teams. Additionally, team cohesiveness is linked to effective communication and trust, and it can affect team coordination and collaboration. In Section 5.2, we will explore these interdependencies in greater detail

and provide recommendations for organizations to improve team familiarity in geographically dispersed Scrum teams.

The comparison also revealed that geographical dispersion can negatively impact all of these team familiarity facets, emphasizing the need for organizations to recognize and address these challenges. Communication tools, time-zone differences, lack of common language, and lack of emotional communication were the main challenges identified by interviewees in promoting effective communication. The heavy reliance on technology was also mentioned as a recurring theme throughout the interviews.

Geographical dispersion makes it more challenging for team members to build strong relationships and interpersonal knowledge, hindering effective knowledge sharing. For example, effective communication is critical for collaboration, knowledge sharing, and teamwork, but time-zone differences, irregular communication tool operation, lack of common language, and emotional communication barriers can impede effective communication in geographically dispersed Scrum teams. Working remotely can also make it more challenging to build trust among team members, which is based on interpersonal knowledge, effective communication, and enhanced team familiarity.

Overall, the comparison between the literature review and interview findings provides valuable insights into the impact of geographical dispersion on team familiarity in Scrum teams. It emphasizes the importance of considering contextual factors such as geographical dispersion and highlights the need for organizations to develop strategies to address the challenges posed by remote work arrangements.

5.2 Interdependence of Team Familiarity Facets

Upon examining the results from both the literature review and the interviews, it was discovered that each team familiarity facet was interconnected with one or more other facets. This section delves into the intricate relationships among the various team familiarity facets and their collective effect on the overall effectiveness and performance of Scrum teams. The interdependencies between team familiarity facets were discovered through a thorough analysis of the interview results and were further cross-validated by examining the interconnections mentioned in various literature review papers referenced in this research. The detailed description of the interdependencies between team familiarity facets, along with the corresponding citations to the corresponding relevant literature review papers below, provides a comprehensive understanding of these relationships. Understanding these interdependencies is crucial in developing targeted strategies to improve team familiarity, especially in geographically dispersed contexts.

The interdependencies between team familiarity facets create a complex and dynamic system that impacts the overall effectiveness of Scrum teams. By addressing these interdependencies, organizations can establish more resilient, adaptable, and high-performing geographically dispersed Scrum teams. The interdependencies between the team familiarity facets listed below are considered the most important due to their significant impact on team dynamics, performance, and overall effectiveness. These relationships shape how team members interact, collaborate, and make deci-

sions, which are critical aspects of functioning teams. The conceptual map presented in Figure 5.1 illustrates the inter-dependencies among each team familiarity facet identified through the comparison of literature review findings and interview data. Each relationship in the concept map represents a direct or indirect dependency between these facets and is accompanied by a unique relation number. These relation numbers are referenced next to each description of the dependency relationship below. This allows readers to easily locate and cross-reference the specific relationships discussed in the text with their corresponding numbers on the concept map.

1. **Communication and Trust:** (*Relation number 3 in Figure 5.1*)

Communication and trust are strongly interrelated in the context of teamwork. In the context of teamwork, effective communication is essential for building trust among team members, as it helps establish a shared understanding and facilitates cooperation and collaboration [98]. Trust is built through consistent, open, and transparent communication that demonstrates honesty, integrity, and respect for team members' perspectives. When team members communicate openly and transparently, they can build trust by demonstrating honesty, integrity, and respect for one another [76, 77, 86, 88].

In contrast, poor communication, such as withholding important information or failing to communicate clearly, can erode trust and lead to misunderstandings and conflicts [99]. Effective communication can foster trust by providing opportunities for team members to express their ideas, concerns, and feedback. When team members feel heard and valued, they are more likely to trust their colleagues and work collaboratively towards shared goals.

2. **Shared work experience and Interpersonal Knowledge:** (*Relation number 2 in Figure 5.1*)

When team members work together on multiple projects or tasks, they develop a sense of familiarity with one another's abilities, preferences, and communication styles [100]. This familiarity leads to the development of interpersonal knowledge, which helps team members anticipate each other's needs and adjust their actions accordingly, leading to better team performance [101].

Interpersonal knowledge can enhance the benefits of shared work experience by providing a deeper understanding of team members' perspectives, motivations, and values. This knowledge can promote empathy and mutual respect among team members, leading to improved collaboration and better outcomes [3, 4, 6, 84, 102]. It is essential for effective communication and collaboration in teams and can affect the way team members work together and allocate tasks. Therefore, team leaders and managers should encourage opportunities for team members to work together and develop shared work experiences to foster the development of interpersonal knowledge and improve team cohesion and performance.

3. **Team Cohesion and Trust:** (*Relation number 7,10 in Figure 5.1*)

Team cohesion and trust are two interconnected and interdependent facets of team familiarity that significantly impact team performance and effectiveness. These two elements have a reciprocal relationship, supporting and reinforcing

each other in various ways. Team cohesion refers to the degree to which team members are united in pursuing shared goals, fostering a sense of belonging, and commitment to their team. Cohesive teams tend to exhibit higher levels of satisfaction, motivation, and engagement, which can lead to better team performance [80,81,103]. Trust, on the other hand, is the belief in the reliability, integrity, and competence of one's teammates. Trust is essential for promoting open communication, collaboration, and the willingness to take risks, which are all critical for effective teamwork [86,87,99]).

The interdependency between team cohesion and trust becomes evident when considering that trust is a crucial factor in fostering cohesion within teams. When team members trust each other, they are more likely to collaborate effectively, share information openly, and support one another during challenging times. This mutual support and cooperation can strengthen the bonds between team members, leading to greater team cohesion [89,104]. Conversely, a cohesive team environment can facilitate the development of trust by promoting a sense of safety, belonging, and shared values among team members. When team members feel united in their goals and have a strong sense of camaraderie, they are more likely to develop trust in their teammates' abilities, intentions, and reliability [63].

4. **Communication and Team Coordination:** (*Relation number 9,12 in Figure 5.1*)

Communication and team coordination are interconnected and interdependent facets of team familiarity that play a crucial role in the overall performance and effectiveness of teams. These two aspects have a symbiotic relationship, supporting and reinforcing each other in various ways. The interdependency between communication and team coordination is evident when considering that effective coordination is heavily reliant on clear and open communication. Effective team coordination involves organizing and synchronizing team members' efforts to achieve a common goal [9,56,78]. It requires a clear understanding of individual roles and responsibilities, effective communication, and the ability to adapt to changing circumstances. When team members communicate regularly and transparently, they are better able to understand each other's needs, priorities, and progress, which in turn enables them to coordinate their efforts more effectively and efficiently [105]. Without clear and open communication, team members may not understand their roles and responsibilities, and tasks may not be synchronized effectively [4].

Conversely, effective communication requires team coordination. When team members are well-coordinated, communication can be more streamlined and focused on achieving the team's goals. When team members understand their roles and responsibilities and are working together towards a shared objective, they are better equipped to communicate effectively. Moreover, effective communication can facilitate team coordination by promoting a shared understanding of goals, roles, and responsibilities [6,34]. When team members communicate openly and honestly, they can identify potential issues early and work together to find solutions, leading to better team coordination and outcomes.

This shared understanding helps to minimize misunderstandings, conflicts, and miscommunications, which can hinder team performance [106].

5. **Trust and Shared Knowledge** : (*Relation number 14,16 in Figure 5.1*)

The relationship between shared knowledge and trust is mutually reinforcing, as they are interdependent components of effective teamwork. The act of sharing knowledge among team members fosters a sense of competence and reliability, which in turn promotes trust. Conversely, trust promotes knowledge sharing and collaboration, resulting in improved team performance and outcomes [64]. Employees' willingness to share knowledge is effected by their trust in the recipient. When employees perceive a higher level of trustworthiness in the recipient, they are more likely to share knowledge [59–61].

Organizations that promote both trust and knowledge sharing have a competitive advantage over those that do not. These organizations are more effective at problem-solving, decision-making, and innovation, leading to improved organizational performance [107]. Trust and knowledge sharing are particularly important in diverse teams, where cultural differences and communication barriers can negatively impact collaboration. Fostering trust and promoting knowledge sharing can help overcome these challenges and enhance team performance [108].

6. **Team coordination and Team collaboration** : (*Relation number 6, 11 in Figure 5.1*)

Team collaboration and Team Coordination are two critical facets of team familiarity that significantly impact team performance. Both aspects are crucial for effective functioning within teams, and they often support and reinforce each other in various ways. Team collaboration involves team members working together cooperatively towards a common goal, and sharing knowledge, resources, and expertise. It requires active participation, open communication, and mutual support among team members, enabling them to combine their skills and knowledge effectively [4, 9]. Team coordination, on the other hand, involves organizing and synchronizing team members' efforts to ensure smooth and efficient task execution [76, 78]. It involves managing the interdependencies between tasks, roles, and resources, as well as monitoring and adjusting team activities as needed to achieve the desired outcomes [109].

The interdependency between team collaboration and team coordination is apparent when considering that effective collaboration relies on well-coordinated efforts [34, 57]. When team members can coordinate their tasks and responsibilities efficiently, it creates a supportive environment that fosters collaboration by minimizing conflicts, reducing duplicated efforts, and ensuring that resources are used optimally [110]. Conversely, a collaborative team environment can facilitate better coordination by promoting open communication, trust, and shared understanding among team members. When team members feel comfortable sharing their ideas, concerns, and expertise, they are more likely to develop a shared mental model of the tasks and goals at hand, enabling them to anticipate each other's needs and coordinate their efforts more effectively [111].

7. Shared Knowledge and Member Diversity: (*Relation number 13 in Figure 5.1*)

Shared knowledge and member diversity are interdependent and significantly impact group performance. On one hand, member diversity enriches shared knowledge. The collaboration of individuals from diverse backgrounds, experiences, and perspectives in sharing knowledge brings unique insights and a broad pool of knowledge that can lead to better-informed decisions and innovative solutions to challenges [3, 65, 67]. Conversely, member diversity can also challenge shared knowledge, enabling a more nuanced understanding of a topic and preventing flawed decisions based on incomplete or biased information [57]. Despite challenges posed by cultural and social identity differences, shared knowledge can bridge these differences and foster a sense of commonality among group members [112].

In terms of technical experience, member diversity can bring distinct skills and expertise that can contribute to the development of new knowledge and more creative solutions to challenges. This means that the team should comprise individuals with varying levels of technical proficiency, which enables knowledge sharing within the team. For instance, a junior team member with less technical experience can collaborate with a senior team member who has more experience and learns from their shared knowledge. Therefore, knowledge sharing is essential for employees with varying backgrounds and experiences to learn from each other and develop a shared understanding of the organization's goals and values. To leverage the benefits of diversity, organizations must create an environment that values knowledge sharing and prioritizes diversity [113].

8. Team coordination and Team Cohesion : (*Relation number 17 in Figure 5.1*)

Effective team coordination and team cohesion are important components of successful teamwork. Coordination involves the synchronization of team members' efforts towards a common goal, while cohesion refers to the sense of unity, trust, and shared purpose among team members. Effective team coordination is necessary for promoting team cohesion [3, 4, 80, 109]. When team members are able to coordinate their efforts seamlessly, it helps to create a sense of unity and shared purpose, fostering a cohesive team environment [114]. This cohesion helps to build a foundation of trust and mutual respect among team members, leading to improved collaboration and communication.

Team cohesion can enhance team coordination by promoting a positive team environment where team members feel comfortable communicating and sharing information [81]. When team members feel a sense of belonging and trust among each other, they are more likely to coordinate their efforts effectively, leading to improved team performance. Effective coordination is necessary for promoting cohesion, while cohesion enhances coordination by promoting open communication and trust among team members.

9. **Trust and Team Collaboration** : (*Relation number 4,5 in Figure 5.1*)

In the context of team familiarity, team collaboration and trust are interconnected and interdependent factors that play a crucial role in team performance and effectiveness. These two aspects support and reinforce each other in various ways. Effective team collaboration involves members working together to achieve shared goals by leveraging their skills, knowledge, and resources to solve problems and complete tasks efficiently [77, 86, 87, 91]. This requires cooperation, open communication, and mutual support among team members. Trust is a critical enabler of open communication, collaboration, and risk-taking, all of which are vital for effective teamwork [99].

The interdependence of team collaboration and trust becomes apparent when considering that trust is a crucial factor in facilitating effective collaboration among team members. When team members trust each other, they are more likely to share information openly, seek feedback and input from others, and cooperate to solve problems and achieve common goals [89]. This mutual support and cooperation can lead to more efficient and productive collaboration [115]. On the other hand, effective team collaboration can promote trust development by demonstrating the reliability, competence, and integrity of team members [57, 58, 70]. When members collaborate successfully, they have opportunities to observe and evaluate each other's abilities, intentions, and dependability, which can increase trust among team members [116].

These interdependencies are crucial for understanding the complex relationships between team familiarity facets, as they directly impact team dynamics, performance, and effectiveness. By recognizing and addressing these interdependencies, organizations can develop strategies to enhance team performance and create more cohesive, collaborative, and high-performing teams.

5.3 Challenges and Mitigation Strategies Posed by Geographical Dispersion

In the previous section, we compared and contrasted the findings from the literature review and interviews to gain a deeper understanding of the team familiarity facets in geographically dispersed Scrum teams. This comparison helped to identify interdependencies between the different facets and highlighted the challenges posed by remote work arrangements.

In this section, we aim to explore the challenges posed by geographical dispersion on team familiarity and provide strategies for improving team familiarity and creating an ideal team in geographically dispersed Scrum teams. These challenges and strategies are based on the findings from the literature review and interviews. These challenges will be mapped to their corresponding mitigation strategies in Table 5.1.

Challenge	Mitigation Strategy
Limited opportunities for face-to-face interaction	Plan periodic face-to-face meetings, use video conferencing tools for virtual meetings, and encourage team members to share personal information to build interpersonal connections.
Limited opportunities for knowledge sharing	Establish a centralized knowledge repository, encourage team members to share their expertise and insights, and use collaboration tools that facilitate knowledge sharing.
Time-zone differences	Schedule regular meetings that accommodate all time zones, establish common work hours and use collaboration tools that allow asynchronous communication.
Lack of trust	Establish clear expectations and guidelines for working together, foster familiarity and rapport through informal interactions, and use communication tools that facilitate trust-building.
Differences in work culture	Establish clear expectations and guidelines for working together, provide cultural training to team members and encourage open communication and respect for diverse work styles.
Cultural differences	Foster an inclusive team culture that values and respects diversity. Provide cultural training to team members to increase cross-cultural awareness and understanding.
Technical difficulties	Provide technical support to team members to troubleshoot issues and ensure that all team members have access to necessary tools and software.
Lack of team cohesion	Establishment of team-building activities, such as virtual social events, to build relationships and strengthen team bonds. Encourage informal communication and collaboration to promote teamwork.
Lack of visibility	Use project management tools to provide visibility into team progress and individual contributions

Table 5.1: Mapping of Challenges and Mitigation Strategies

It is important to note that these are just a few of the discussed challenges due to geographical dispersion during the interviews. These challenges are mapped to possible mitigation strategies for improving team familiarity. By identifying and

addressing these challenges, organizations can create more effective and collaborative geographically dispersed Scrum teams. We recognize that different organizations and teams may have unique needs and constraints, and therefore, the strategies outlined here should be adapted to suit individual circumstances. Expanding on the mitigation strategies for the challenges posed by geographical dispersion and fostering team familiarity in Scrum teams, here are a few recommendations provided during the interviews which have been cross-validated with the existing literature review papers:

- **Promote effective communication:** Communication is critical for promoting collaboration, knowledge sharing, and teamwork [3, 4, 6, 34, 59, 76]. To mitigate communication challenges, organizations should use a combination of synchronous and asynchronous communication methods and encourage team members to communicate regularly. Organizations should also establish communication guidelines, such as preferred communication channels and expected response times, to ensure clarity and reduce ambiguity.
- **Build interpersonal knowledge:** Interpersonal knowledge is essential for building trust, promoting team cohesion, and effective collaboration [56, 57, 84]. To build interpersonal knowledge, organizations should encourage team members to share information about their backgrounds, experiences, and interests. Additionally, team members should be encouraged to socialize and participate in team-building activities.
- **Foster team cohesion:** Team cohesion is essential for effective collaboration and achieving organizational goals [9, 35, 80, 81]. To foster team cohesion, organizations should establish a clear team identity and purpose, promote team-building activities, and encourage team members to support each other. Organizations should also provide opportunities for team members to meet in person or virtually and establish regular team meetings.
- **Establish clear expectations:** Clear expectations are essential for building trust and promoting effective communication [63, 76, 77, 86, 89, 90]. Organizations should establish clear guidelines for team members, such as roles and responsibilities, expected work hours, and expected response times. These guidelines should be communicated clearly to all team members.
- **Develop a shared understanding of team goals:** A shared understanding of team goals is essential for promoting team cohesion, collaboration, and effective communication [4, 59, 61, 77, 80]. Organizations should establish clear team goals and objectives and ensure that all team members understand and are committed to them. Additionally, organizations should provide opportunities for team members to collaborate on projects and make decisions together.
- **Encourage diversity and inclusivity:** Diversity can promote team creativity, innovation, and decision-making, but it can also pose challenges [57, 61, 65, 85, 96]. Organizations should promote diversity and inclusivity by hiring individuals from different backgrounds and experiences and providing opportunities for team members to learn about and appreciate each other's differences.

- **Use collaboration tools:** Collaboration tools can help mitigate the challenges posed by geographical dispersion by facilitating communication, knowledge sharing, and collaboration [4, 34, 35]. Organizations should identify and implement collaboration tools that best suit their team's needs and encourage team members to use them regularly.
- **Establish regular team meetings:** Regular team meetings are essential for promoting effective communication, building interpersonal knowledge, and fostering team cohesion [4, 76, 80, 88, 103]. Organizations should establish regular team meetings and encourage team members to attend them.

Overall, by implementing these strategies, organizations can mitigate the challenges posed by geographical dispersion and foster team familiarity in Scrum teams, hence improving team performance and resulting in project success.

5.3.1 Practical Implications of the study

The findings of this study hold practical implications for organizations seeking to enhance team familiarity and collaboration in geographically dispersed Scrum teams. As more and more organizations adopt remote working arrangements, understanding the impact of geographical dispersion on team familiarity and its effect on Scrum practices has become increasingly important. First and foremost, organizations should recognize the importance of effective communication and trust in promoting team familiarity and achieving project success in geographically dispersed Scrum teams. To this end, organizations should implement strategies to promote effective communication, such as establishing clear communication guidelines, encouraging regular communication, and promoting emotional communication. Organizations should also work to build trust among team members by promoting interpersonal knowledge and providing opportunities for team members to collaborate and make decisions together.

Team coordination and collaboration are essential for achieving team goals, and organizations should identify strategies to promote team coordination in geographically dispersed Scrum teams. This may involve identifying and implementing collaboration tools that best suit the team's needs, establishing clear team goals and objectives, and providing opportunities for team members to meet in person or virtually. Team cohesion should also be promoted by establishing a clear team identity and purpose, encouraging team-building activities, and providing opportunities for team members to support each other. In addition, organizations should encourage diversity and inclusivity by hiring individuals from different backgrounds and experiences and providing opportunities for team members to learn about and appreciate each other's differences.

Furthermore, it is essential to recognize the challenges posed by geographical dispersion on team familiarity and Scrum practices and develop strategies to address them. Mitigation strategies mentioned in Table 5.1, such as using collaboration tools, establishing regular team meetings, and promoting effective communication and trust can help to overcome these challenges. In conclusion, this study provides valuable insights into the impact of geographical dispersion on team familiarity and its effect

on Scrum practices. By developing strategies to address the challenges posed by geographical dispersion, organizations can enhance team familiarity and collaboration, promote project success, and achieve success in geographically dispersed Scrum teams.

5.4 Validity Threats

The validity of any research study is crucial to ensuring the accuracy and reliability of its findings. In this study, we aimed to explore the effect of geographical dispersion on team familiarity in Scrum teams and identify strategies to promote team familiarity and collaboration. To ensure the validity of our research, we took several measures to mitigate potential threats to its validity.

The validity of this research study may be effected by several threats to its internal and external validity. Internal validity refers to the extent to which the findings of a study are accurate and free from bias, while external validity refers to the extent to which the findings of a study can be generalized to other settings and populations [117].

In phase 1 of our research, we used the snowballing technique to identify relevant literature. While this technique can be effective in identifying additional sources, it may also result in a biased sample of literature, as it relies on the recommendations of others. To mitigate this risk, we attempted to ensure that our literature search was comprehensive and included a variety of sources in multiple databases, such as peer-reviewed articles, books, etc. The study may have been limited by the availability and quality of the literature on team familiarity in geographically dispersed Scrum teams. While we used a comprehensive search strategy to identify relevant literature, it is possible that some relevant studies were missed. Additionally, the quality of the studies included in the review may have varied, which could have affected the reliability of the results. To mitigate this threat, we used a rigorous screening and selection process and only included studies that met our predefined criteria.

One potential threat to the validity of the study was the use of self-reported data obtained from the interviews. Self-reported data can be subject to response bias, where participants may provide socially desirable answers or over/under-report their experiences. To mitigate this threat, we used a semi-structured interview format and encouraged participants to provide honest and detailed responses. Additionally, we used a deductive thematic analysis method to analyze the data obtained from the interviews. This method involves using a predefined set of themes or codes to analyze the data, which reduces the risk of introducing bias into the analysis [44,118]. There is a risk of social desirability bias in the interviews, as participants may have provided answers they believed were socially desirable rather than their true opinions. To mitigate this risk, we ensured the anonymity and confidentiality of our participants, emphasized the importance of honest and open feedback, and used probing questions to encourage deeper reflection and discussion. As the interviews were semi-structured, we had the flexibility to incorporate additional questions beyond those provided in the interview guide in the Appendix A. This allowed us to gain a deeper

understanding of the participants' perspectives and opinions. Additionally, we triangulated the interview data with the results of the literature review to increase the reliability of the findings [38].

One more potential threat to the validity of the study was the potential for selection bias. We recruited participants from organizations with experience in geographically dispersed Scrum teams, which may have limited the generalizability of the findings. To mitigate this threat, we purposefully sampled participants from a diverse range of organizations and industries to increase the representativeness of the sample. While efforts were made to recruit participants with diverse backgrounds and experiences, the sample size was relatively small, which could have resulted in limited generalizability of the findings. However, previous research has shown that even small sample sizes can provide valuable insights into complex phenomena [119]. Additionally, the interviews were conducted online, which could have limited the depth of the data collected compared to face-to-face interviews. To mitigate this threat, the interview questions were carefully designed to ensure that they were open-ended and allowed for in-depth exploration of the research questions. Moreover, we ensured that participants were given enough time to share their perspectives and experiences.

Another potential threat to the validity of the findings is the interpretation of nonverbal cues, such as facial expressions and body language. Different researchers may interpret these cues differently, introducing subjectivity. Additionally, relying solely on nonverbal cues may provide limited context and may not fully represent participants' true emotions or intentions [120]. The potential modification of behavior in the presence of an interviewer further adds to this threat [121]. To mitigate these issues, efforts were made to ensure consistency in interpretation and to triangulate nonverbal cues with other data sources, such as verbal responses and overall interview context.

In conclusion, while this study provides valuable insights into the impact of geographical dispersion on team familiarity in Scrum teams, several validity threats were identified and addressed to ensure the rigor and reliability of the research process. By acknowledging and addressing these validity threats, we were able to increase the validity and reliability of the study's findings. We can ensure that our findings are valid, reliable, and useful for organizations seeking to improve team familiarity and collaboration in geographically dispersed Scrum teams. Future research can build on this study by addressing some of these limitations and using larger sample sizes, triangulating multiple data sources, and employing alternative analysis methods.

Chapter 6

Conclusions and Future Work

This study aimed to explore the impact of geographical dispersion on team familiarity in Scrum teams and identify strategies to promote team familiarity and collaboration. By conducting a comprehensive literature review and interviews with professionals experienced in geographically dispersed Scrum teams, we have gained valuable insights into the challenges and mitigation strategies that can contribute to successful project outcomes.

6.1 Answers to research questions

The following is the summary to the answers of the research questions of presented in this research.

RQ1: What are the facets that contribute to team familiarity?

Through the literature review conducted in phase-1 of this research, we have identified 9 team familiarity facets such as *Shared work experience, Communication, Team coordination, Team cohesion, Interpersonal knowledge, Shared knowledge, Trust, Team collaboration, Member diversity*. All of these facets were found to be essential in promoting team familiarity and collaboration in geographically dispersed Scrum teams. In Phase-2, we compared the theoretical results from the literature review with the practical perspectives obtained from the interviews.

RQ2: How has geographical dispersion affected team familiarity facets during the pandemic?

In Phase-2 of this research, we conducted semi-structured interviews involving 12 software engineering professionals from different organizations to better understand the practical perspectives of this objective. We found that the pandemic has amplified the challenges posed by geographical dispersion on team familiarity facets. Communication, team coordination, and team cohesion were among the most affected facets during the pandemic due to the increased reliance on remote communication tools and lack of in-person interaction. Specifically, communication was hindered by technological issues, lack of common language, and reduced opportunities for informal communication, team coordination was challenged by difficulties in aligning work due to different time zones and managing dependencies, and team cohesion was impacted by reduced social interaction and increased reliance on virtual communication. However, suggestions for organizations to implement several mitigation strategies to address these challenges, such as promoting emotional communication

and using collaboration tools to enhance communication and coordination were also discussed.

RQ3: How have the changes in team familiarity due to geographical dispersion effected Scrum practices?

We have illustrated the correlation between the implementation of Scrum practices and team familiarity facets and specifically identified the most crucial facets required for each Scrum practice commonly utilized today. Our research findings indicate that the impact of geographical dispersion on team familiarity facets can significantly affect the implementation of Scrum practices. From the interview results, we have discussed how changes in team familiarity due to geographical dispersion can impact Scrum practices. Reduced communication, coordination, team cohesion, etc can lead to inefficiencies during Scrum practices such as daily stand-ups and sprint retrospectives, resulting in misunderstandings and poor sprint planning. Organizations need to be aware of these challenges and consider these factors while implementing Scrum practices in geographically dispersed teams.

6.2 Limitations of the study

In this research, we aimed to explore the effect of geographical dispersion on team familiarity and identify strategies to promote team familiarity and collaboration in Scrum teams. While the findings of this study provided valuable insights into the impact of geographical dispersion on team familiarity and its effect on Scrum practices, several limitations should be acknowledged as with any research study.

Firstly, the study relied on self-reported data obtained from interviews with participants, which could be subject to response bias and social desirability bias. Despite efforts made to mitigate these threats, such as using a semi-structured interview format and ensuring the anonymity and confidentiality of participants, it is still possible that some of the responses were effected by these biases. Additionally, the study used a relatively small sample size of participants, which may limit the representativeness of the findings. While the study attempted to ensure a diverse range of participants, a larger sample size could have increased the generalizability of the findings. Future research could address this limitation by using larger sample sizes and including additional data sources to validate the findings.

Another limitation of this study is that the interviews were conducted online, which may have limited the depth of the data collected compared to face-to-face interviews. Additionally, the study focused exclusively on Scrum teams in the software development industry, which may limit the generalizability of the findings to other industries and contexts. Other industries may use different methodologies and face different challenges when working in geographically dispersed teams. Therefore, future research could expand the scope of the study to include other industries and contexts to increase the generalizability of the findings.

Furthermore, this study was conducted during a specific period, and its findings may not be entirely relevant or applicable in the current context. As the business environment continues to evolve rapidly, the strategies identified in this study may

become outdated or require modification. The study did not consider the impact of cultural differences on team familiarity and collaboration. Although the study encouraged diversity and inclusivity among team members, cultural differences may still pose challenges that were not addressed. Future research could explore the role of culture in team familiarity and collaboration and identify strategies to promote cross-cultural understanding and communication.

Finally, the study focused on the challenges posed by geographical dispersion and identified strategies to mitigate them. However, the study did not investigate the potential benefits of geographical dispersion, such as increased diversity or access to a broader talent pool. Future research could explore the potential benefits of geographical dispersion and identify strategies to leverage them for better project outcomes. Despite these limitations, the study has provided valuable insights into the impact of geographical dispersion on team familiarity and identified several strategies to promote team familiarity and collaboration in Scrum teams. By acknowledging these limitations, future research can build upon the findings of this study and contribute to a more comprehensive understanding of the challenges and opportunities of geographically dispersed teamwork.

6.3 Future work

This study provides valuable insights into the impact of geographical dispersion on team familiarity and its effect on Scrum practices. However, there is still much room for future research to build on this study and expand the knowledge in this area. Future research could investigate the role of leadership in promoting team familiarity and collaboration in geographically dispersed Scrum teams. While this study acknowledged the importance of effective communication, coordination, and trust in promoting team familiarity, the role of leadership in fostering these aspects was not specifically investigated. Future research could explore how different leadership styles and approaches can contribute to team familiarity and collaboration in geographically dispersed Scrum teams.

Additionally, future research could explore the impact of different collaboration tools and technologies on team familiarity and collaboration in geographically dispersed Scrum teams. This study identified communication and coordination as essential facets for promoting team familiarity and collaboration, but the specific tools and technologies used to achieve these goals may vary across teams and organizations. A more in-depth investigation of the most effective tools and technologies for promoting team familiarity and collaboration could provide valuable guidance for organizations seeking to enhance their remote work capabilities.

Another direction for our future research could be to investigate the impact of team familiarity on other aspects of team performance, such as productivity and innovation. While this study focused primarily on the effect of team familiarity on Scrum practices and project outcomes, team familiarity may have broader implications for team performance in general. Investigating the relationship between team familiarity and other performance measures could provide valuable insights into the benefits of promoting team familiarity in geographically dispersed Scrum teams.

Finally, future research could expand the scope of the study to include other agile methodologies, other industries, and contexts beyond software development. While Scrum is widely used in software development, other industries may use different methodologies and face different challenges when working in geographically dispersed teams. Investigating the challenges and strategies for promoting team familiarity in other industries could provide valuable insights for organizations operating in a variety of contexts.

Overall, future research could build on the findings of this study and contribute to a better understanding of the challenges and opportunities associated with geographical dispersion in Scrum teams. By addressing the limitations of this study and exploring new areas of inquiry, future research can provide valuable guidance for organizations seeking to enhance their remote work capabilities and achieve success in geographically dispersed Scrum teams.

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Appendix A

Interview Guide

Gathering basic information to get started

- Can you tell me about your current position and responsibilities within the company?
- How long have you been working in the software industry, and what is your area of specialization?
- Have you had experience working with agile practices in the past? If so, which ones have you utilized, and for how long?
- Can you tell me about your experience working with Scrum Framework?
- How long have you been employed at this company, and have you held any other positions within the organization?
- What is the size of your current team, and how does this impact the dynamics of your work?
- Are you currently working remotely or onsite, and how has this arrangement affected your work?
- How many members of your team are working remotely, and how does this impact team collaboration and communication?
- Can you tell me about the diversity of your team members, particularly in terms of technical experience and geographical location?

Shared Work Experience

- How important do you think shared work experience is in promoting team familiarity? Can you give an example?
- Have you ever worked with any of your current team members before joining this company? How did that affect your familiarity with them?
- Do you both work remotely or on-site? How do you think this affects shared work experience?
- How likely are you to go to your team seeking task-related advice? Have you noticed any difference in this behavior since transitioning to remote work?
- Have you faced any challenges in maintaining shared work experience with geographically dispersed team members? How did you address those challenges?

<p><i>Communication</i></p> <ul style="list-style-type: none"> • How do you rate the importance of communication in promoting team familiarity? • How do you prioritize communication in your daily work, especially while working remotely? Do you feel that you are able to communicate effectively with your team members? • How did the geographic dispersion impact the amount of interactions? Were they same or did they reduce? • Have you faced any challenges while communicating with team members who are geographically dispersed? If so, could you please provide an example? • What communication tools does your team use to facilitate collaboration? How effective are these tools in promoting effective communication? • Have you noticed any differences in communication styles between team members who work remotely versus those who work on-site? If so, could you please elaborate on these differences? • What strategies do you think organizations can implement to mitigate the challenges of communication in geographically dispersed Scrum teams?
<p><i>Team Coordination</i></p> <ul style="list-style-type: none"> • How do you feel about the importance of team coordination in promoting team familiarity? Can you give an example of when team coordination helped your team achieve its goals? • How has geographical dispersion impacted your team's ability to coordinate effectively? Can you provide an example of a time when geographic distance made it challenging to achieve team goals? • Have you experienced any challenges with team coordination in remote working conditions? If so, can you describe these challenges and how they impacted your team's productivity? • How do you establish accountability and prioritize goals when working remotely with a team? Have you found any strategies or tools that have been particularly effective in facilitating coordination? • How do the size of the team and the complexity of the project impact your team's ability to coordinate effectively? Can you provide an example of a time when these factors affected team coordination and how the team worked to overcome them?
<p><i>Team Collaboration</i></p> <ul style="list-style-type: none"> • Can you describe your understanding of team collaboration and its role in promoting team familiarity? • How do you think geographical dispersion affects team collaboration in Scrum teams?

- Have you experienced any challenges related to team collaboration while working remotely? If yes, can you describe how you have overcome them?
- How do you think team size and complexity of the project can impact team collaboration in remote work environments?
- Do you use any collaboration and communication tools while working remotely? If so, how do you use them to mitigate the impact of geographical dispersion on team collaboration?

Team Cohesion

- How do you rate the importance of team cohesion in promoting team familiarity?
- Does your team adhere to a common goal/purpose?
- Do you think your team works according to the sprint goal while working remotely? Has it been the same as while working on-site or has it changed? If yes, how?
- What challenges did remote work arrangements pose for promoting team cohesiveness? How did your team work to mitigate the negative impact of geographical dispersion on team cohesion?
- What are the consequences of a lack of team cohesion in a remote work environment?
- What strategies do teams use to build and maintain team cohesion when working remotely?
- Do you think cultural and language differences can affect team cohesion? If yes, what can a team do to address them?

Interpersonal Knowledge

- Do you consider interpersonal knowledge as an important facet that promotes team familiarity? If yes, why?
- How well do you know team members working remotely when compared to those working on-site?
- Have you noticed any changes in the level of interpersonal knowledge among team members since the shift to remote working conditions?
- How would you describe your familiarity with the areas of expertise of your fellow team members?
- Have you experienced any challenges in building strong relationships and fostering interpersonal knowledge within your team?
- In what ways has technology helped or hindered the development of interpersonal knowledge in your team?
- Have you found any effective ways to overcome the challenges of building interpersonal knowledge in geographically dispersed teams?

<ul style="list-style-type: none"> • How do you think the size of a team affects the development of interpersonal knowledge, and have you noticed any differences between small and large teams in this regard?
<p><i>Shared Knowledge</i></p>
<ul style="list-style-type: none"> • How important is shared knowledge in the success of your Scrum team and in promoting team familiarity? • Can you describe how knowledge sharing takes place within your team when working on-site? • How has the pandemic affected the frequency and effectiveness of knowledge sharing within your team? Have you noticed any changes in the number of interactions? • Did you start to look more into other sources of information than talking to people about specific knowledge/information? • Can you describe any specific challenges you have faced while trying to share knowledge with your team members in a remote setting? • How important do you believe creating a culture of openness and transparency is for effective knowledge sharing within the team? • How do you think the team can overcome the challenges posed by geographical dispersion to improve knowledge sharing and collaboration? • How does team size affect the development of team familiarity and the ability to effectively share knowledge within the team?
<p><i>Trust</i></p>
<ul style="list-style-type: none"> • In your opinion, how important is trust in achieving team familiarity and successful collaboration? • Have you noticed a difference in your ability to build trust with team members when working remotely compared to when working on-site? • Have you found it more challenging to have casual conversations and social interactions with team members when working remotely? • How do you foster a sense of familiarity and trust within a remote team environment? Are there any specific practices that you follow? • Do you think low levels of trust can hinder creativity or risk-taking in your team? If yes, How do you encourage team members to suggest new ideas or take risks in a low-trust environment? • How do you ensure that team members are meeting their commitments and that there is accountability within the team when working remotely? • How does team size impact trust-building within Scrum teams, especially in a remote work environment?

<i>Member Diversity</i>
<ul style="list-style-type: none">• What are your thoughts on member diversity and its impact on team familiarity?• How diverse in your team based on technical experience? How do you believe diversity in technical experience affects team creativity, innovation, and decision-making?• Can you share an example of how diverse team members have helped in problem-solving and decision-making?• What challenges have you faced in working with team members who have different backgrounds or come from different cultures?• Do you face any difficulties communicating with another team member of a different age or technical experience? If yes, could you please elaborate?• In your experience, how does geographical dispersion affect team familiarity and communication within the team?• How do you establish and maintain trust in a team with diverse members?• How does team size affect the potential benefits and challenges of having member diversity in a Scrum team?

Table A.1: Interview Guide

