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TEAM FAMILIARITY AND TEAM INNOVATION IN THE BUSINESS SECTOR: ANTECEDENTS AND MODERATORS

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Abstract

This study explores how virtualization affects familiarity between team members and how this familiarity, in turn, influences team innovation. In increasingly digital and hybrid work environments, understanding these relational dynamics has become essential for promoting effective collaboration and innovation. Drawing on theories of team dynamics, trust, and knowledge sharing, this research proposes a conceptual model in which shared work knowledge, trust, and time working together are antecedents of team familiarity, which is expected to affect the team's innovation capacity. Additionally, the model examines the moderating roles of team typology, communication typology, and company innovation.

Data was collected through a structured online questionnaire and analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM), based on 158 valid responses from professionals across multiple sectors. The results support four main hypotheses: shared work knowledge and average time working together positively influence team familiarity, company innovation emerged as a strong predictor of team innovation and the effect of communication typology on team familiarity was confirmed. However, the hypothesized direct relationship between team familiarity and innovation and the effect of team typology on team familiarity were not statistically supported. A significant moderation effect showed that the positive influence of trust on team familiarity is weaker when communication is more asynchronous.

The findings contribute to the literature by clarifying the formation of team familiarity and its limited role in explaining innovative outcomes, particularly in virtual contexts. Practically, the study highlights the importance of fostering trust and shared knowledge in remote teams and suggests combining asynchronous and synchronous communication to support relational development. Finally, it offers avenues for future research into curvilinear relationships, contextual moderators, and the evolving role of familiarity in team innovation.

Key words: team familiarity, team innovation, trust, average time working together, shared work knowledge, company innovation, communication.

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1. Introduction

As we live the fourth industrial revolution, technology and innovation have increasingly been developing and spreading worldwide. Especially since the start of the 21st century, the number of means through which people can contact each other while being physically apart has augmented considerably. Companies took this opportunity to optimize their teams' work, implementing digital means in their employees' daily routines.

By turning some (or, in other specific cases, all) of their teams into virtual teams, these companies gained the possibility to hire qualified people regardless of their location (Gilson et al., 2015). Companies also have the option of hybrid teams, which combine virtual interaction with physical interaction between the team members. The COVID-19 pandemic was another factor responsible for an increase in remote work, severely augmenting the number of virtual teams all over the world (Kniffin et al., 2021).

However, several companies seem to require their collaborators to start going to the office again, at least on some workdays, proposing a hybrid work model. This requirement means that, although remote work has its benefits, it also brings disadvantages and problems, suggesting that face-to-face work has irreplaceable benefits and should not be discarded, as some of the authors mentioned further on in this study concluded. The hybrid model seems to be the consensual choice.

It is essential to acknowledge that this transition to virtual contact can affect the familiarity and the bond between the members of these virtual teams, because the interaction is very different when coworkers see each other and are physically close, and when they communicate through digital means (Maynard & Gilson, 2021). Thus, it is important not to discard studying team familiarity and how it differs when teams become virtual or hybrid, considering the increase in the number of virtual and hybrid teams. The concept of team familiarity includes, for example, what members know about each other (Huckman & Staats, 2011) and how long they have worked together (Huckman et al., 2008).

Furthermore, it is vital to understand if these concepts could be linked to innovation and how. Several definitions of innovation have been proposed in the last decades, even centuries. Joseph Schumpeter defined innovation as the invention of a technical or organizational novelty and its market introduction, meaning it is not enough to invent something new, but it is also

necessary to diffuse it and have agents adopt it for it to be considered innovation. Technology and innovation are clearly linked to one another, as both were responsible for the fourth industrial revolution we are currently living in, so it is important to understand if virtual teams (which became possible because of technology and depend on it) play an essential role in innovation and if it is enhanced or hindered by them. The results of a study by these authors indicated that virtual teams seem to experience a higher level of difficulty performing innovative tasks (Gibson & Gibbs, 2006). Another aspect to consider is the possibility of team familiarity, which is affected by the transition to virtual and hybrid teams, impacting the team's innovation capacity. Are familiar and bonded teams more or less capable of innovating? Muskat et al. (2022) concluded that bonded teams seem less capable of succeeding in innovative tasks.

Comparing the number of papers published in the Scopus database between 2014 and 2025, it is clear that there has been an increase in the number of papers that include the following keywords: 'virtual teams', 'remote work', 'team familiarity', and 'team innovation'. Additionally, studies addressing these topics mentioned several directions for future research to follow, as mentioned further in this report. The increase in the number of papers related to these topics and the variety of future paths to follow pointed out by researchers is evidence of the continuous rise of interest and importance surrounding virtual teams, team familiarity, and team innovation.

It seems to be possible to link two of these concepts, namely virtual teams and team familiarity, virtual teams and innovation, and team familiarity and innovation. However, is it possible to move further and link these three concepts? With this question in mind, the research questions my dissertation intends to answer are the following: "How does the virtualization of teams affect the familiarity between their members in companies? How does this affect the teams' capacity to innovate?".

Responding to these questions will hopefully contribute to diminishing the gap in the literature, which is the scarcity of papers directly linking virtual teams to innovation and team familiarity and innovation. Hopefully, it will also enable the possibility to establish a more direct relationship between virtual teams, team familiarity and team innovation, as I found relevant literature relatively dispersed. That shall be the main theoretical contribution of my dissertation to the knowledge on these topics. From a practical perspective, team managers will be able to bring their teams' capacity to innovate to a maximum level. To achieve that goal, those managers can use team familiarity, the typology of teams (hybrid or virtual), and virtual tools (synchronous

and asynchronous means of communication) to influence team innovation. Choosing to stimulate a higher or lower familiarity level in their teams, whether their teams should be hybrid or fully virtual, when to use synchronous and asynchronous communication and which specific means to use in each situation will be very important decisions to maximize team innovation capacity.

It is relevant to include teams that only work virtually, hybrid teams, and teams that don't work virtually at all, as well as the impact of different means utilized to interact virtually (for example, Zoom, E-mail, Google Docs, among others.). As mentioned in the research questions, I will also include companies with different levels of technological intensity and belonging to various sectors. Based on evidence found in previous studies, I illustrated my expectations with eight main hypotheses. I believe that the results of my research will reveal that synchronous communication brings more advantages to team innovation and team familiarity, when compared to asynchronous communication (Bell & Kozlowski, 2002). I expect to conclude that virtual teams' members develop a lower level of familiarity when compared to non-virtual teams' members (Carmody et al., 2022) and that less familiar teams are more successful performing innovative tasks than teams with higher levels of familiarity (Muskat et al., 2022). Another relevant aspect is discovering if some concepts, such as average time working together, shared work knowledge, friendship outside and at work, and trust between team members, contribute to developing a higher level of team familiarity. I intend to analyze the importance of these four factors and how much they contribute to team familiarity, comparing them, to understand which one(s) contribute more. The evidence about the relationship between these three topics and team familiarity is scarce.

2. Theoretical Framework

This chapter is divided into four sections, as displayed in Figure 1, to facilitate the distinction between the analyzed concepts.

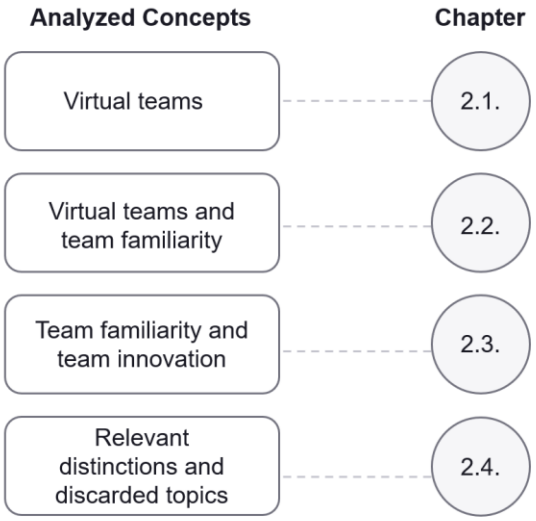

Figure 1 - Structure of the theoretical framework

2.1. Virtual Teams

Most of the existing definitions of virtual teams are based on the perspective that these teams depend on technology to interact and communicate, consistently breaking geographical and time-related barriers. These teams' members can be located in different parts of the world, distributed through different time zones and working for different companies. The first definitions of this concept focused on opposing virtual and face-to-face teams, prioritizing physical separation and communication based on technology. However, the level of technology-based communication needed for a team to be considered virtual was still unclear. Therefore, considering the most recent definitions, virtual teams can also be defined as "teams whose members use technology to varying degrees in working across locational, temporal, and relational boundaries to accomplish an interdependent task" (Martins et al., 2004, p. 808). Virtual teams can be linked to other concepts, such as team creativity, team interaction and performance, team relationships, team innovation and team familiarity. As for the link between virtual teams and creativity, a study investigated the possibility of virtual communication limiting the generation of ideas within those teams (Brucks & Levav, 2022). After laboratory and field experiments were concluded and the data were analyzed, the results showed that, when people work together, there

is a distinct cognitive advantage. This means that, when teams collaborate virtually, the generation of creative ideas is jeopardized. The authors who conducted this study also suggest that, in the case of hybrid teams, scheduling face-to-face meetings to generate creative ideas is likely to be advantageous. Concerning team interaction and performance, in a study regarding proximity and distance in work groups, after the authors reviewed relevant literature, the following conclusions were drawn: without the presence of coworkers' attention, social impact and familiarity seem to decrease; face-to-face communication is the most effective means for synchronizing an interdependent group's work, enhancing cooperation. Therefore, the authors pointed out communication technologies and structured management as possible solutions for physical separation and hypothesized that the efficacy of those solutions will be dictated by the group's level of distance or social cohesion. If the social cohesion level is high, communication technologies may represent an effective solution to physical separation. The authors also suggested that structured management, combined with technology, may be a necessary, but perhaps not sufficient, solution to physical separation when a group is not socially cohesive (Kiesler & Cummings, 2002). Focusing on team relationships, in another study, concerning the relational aspects of computer-mediated communication, the author hypothesized, for example, if: immediacy/affection is higher in initial face-to-face communication when compared to initial computer-mediated communication and increases and converges, in both types of communication, after many message exchanges; composure/relaxation is higher in initial face-to-face communication when compared to initial computer-mediated communication and if, in both types of communication, it increases and converges after many message exchanges; formality differs in initial computer-mediated communication and in initial face-to-face communication and decreases and converges, in both types of communication, after many message exchanges; in initial conversations, receptivity/trust is greater in computer-mediated communication and in face-to-face communication and increases similarly, in both types of communication, after many message exchanges. The results of this partially confirmed the hypothesis regarding formality, while the hypotheses regarding immediacy/affection, composure/relaxation and receptivity/trust were not confirmed (Walther, 1995). Also, regarding the concepts of trust and virtual teams, a study considered trust an antecedent and virtuality to be a moderator of knowledge sharing in teams. The evidence found suggested that, as trust between team members increases, those team members will share more and more knowledge,

in all typologies of teams (regarding the level of virtuality) (Staples & Webster, 2008). A factor that can affect the communication in virtual teams is the decision of when team members should use synchronous means (such as video calls or chat messages) and asynchronous means (such as e-mails or discussion forums) to communicate. A message receiving a response immediately after being sent corresponds to a synchronous communication case. On the contrary, when people send a message and do not receive an immediate response, it is an asynchronous communication case (Seng et al., 2022). Frequently, when tasks involve a lower level of complexity, asynchronous communication can be more advantageous than synchronous communication. This advantage is caused by the elimination of the effects of a blockage in production, which occurs when only one person is able to talk at a time. Therefore, it is recommended that virtual teams choose synchronous means of communication when the high complexity of the task demands it (Bell & Kozlowski, 2002). As for virtual teams' capacity to innovate, a negative relationship between geographical dispersion and team innovation was found by a study that included conducting interviews and surveys. It was concluded that this dispersion restrains innovation by adding difficulty to coordinate the acquisition of resources, diminishing the efficiency of this process and obstructing productivity (Gibson & Gibbs, 2006). Future avenues of research pointed out by these authors include longitudinal intervention studies that analyze if adopting virtual elements increases or lowers innovation. My study will contribute to this research avenue because I will analyze whether virtual teams are more capable of innovating than non-virtual teams.

2.2. Virtual Teams and Team Familiarity

Another definition of familiarity is the specific knowledge people have about the configuration of machinery, physical environment, people, performance strategies, and jobs in their workplace (Goodman & Leyden, 1991). As previously mentioned, this transition from face-to-face communication to virtual communication can impact the familiarity between a team's members. A study about the importance of familiarity in virtual teams divides the concept of familiarity into two sub concepts: personal and professional. The authors describe personal familiarity by how well team members understand one another's individual preferences, values, interests, and personal backgrounds. In contrast, professional familiarity pertains to the degree to which colleagues are aware of each other's work-related abilities, limitations, and behavioral

traits, such as reliability and attention to detail (Maynard & Gilson, 2021). The results of the authors' research suggested that the impact of professional familiarity is more prominent than the one caused by personal familiarity on information elaboration, regardless of the type of team in question. Nevertheless, the more virtual teams are, the more personal familiarity becomes important. Familiarity in virtual teams can be associated with elaborating and disseminating information within those teams. In a study about the relationship between familiarity and information elaboration in global virtual teams, the authors also separated personal familiarity from professional familiarity. These authors hypothesized, for example, that: professional familiarity and information elaboration will have a positive relationship; personal familiarity and information elaboration will have a positive relationship; information elaboration will be more severely impacted by professional familiarity then by personal familiarity; when a team's level of virtuality is higher, the relationship between professional familiarity and information elaboration will be restrained; when a team's level of virtuality is higher, the relationship between personal familiarity and information elaboration will be improved. The results of this study confirmed all the hypotheses except the hypothesis mentioned in second place (Maynard et al., 2019). The dissemination of information topic is included in a study regarding the effect of co-location on human communication networks. This study concluded that teams whose members are physically dispersed are less likely to develop higher levels of familiarity, in contrast to what happens in physically close teams. Employees who are physically apart are less likely to form ties, jeopardizing information dissemination. The authors suggested that there's a need for technologies that recreate face-to-face interaction and communication to solve this problem. Another conclusion this study led to is that hybrid teams experience a lower loss of connections between members and, thus, should be favored over exclusively virtual teams (Carmody et al., 2022). On the contrary, in a study comparing virtual collaboration and face-to-face collaboration between teams of students, the authors concluded that familiarity and trust between team members are greater when those teams collaborate virtually. It is imperative to highlight that the values of trust and familiarity among teams regarding virtual and face-to-face collaboration were not significantly different, which suggests that the level of virtuality might not be a significant moderator to familiarity and trust (Singh et al., 2022). Team performance is another concept that, additionally to being related to virtual teams, can be associated with team familiarity. The authors that conducted a study about familiarity, complexity, and team performance in

geographically distributed software development hypothesized that, when team members' locations differ, there is a more powerful impact of team familiarity on team performance. The results found this hypothesis to be true (Espinosa, 2007).

2.3. Team Familiarity and Team Innovation

A team's level of familiarity can affect its ability to innovate, as was concluded by a study about these two topics, and has different effects on the performance of tasks associated with routine contexts and on the performance of innovative tasks. After reviewing relevant literature, the authors concluded that there is a lack of theoretical advances that surpass social cognition theories to illustrate the link between team familiarity and social aspects and how time is used by teams to stimulate familiarity (including time working together, time sharing experience, and friendship time). Average time working together, shared work knowledge, and friendship outside and at work are three of the team familiarity antecedents mentioned in this study. It is important to keep these antecedents in mind because two of the hypotheses of my study are focused on their impact on team familiarity. The following three gaps were found in the reviewed literature: the meaning of time is not discussed deeply enough; negative results and possible U-shaped developments in team performance are absent; discussion of insights of how social outcomes and individual well-being are benefited by positive cognitive outcomes and performance outcomes is lacking (Muskat et al., 2022). Regarding team familiarity and innovation, future avenues of research pointed out by these authors include developing research focusing on work contexts in which the levels of innovation, creativity, non-standardization, and ambiguity are high, to develop research regarding team familiarity. Another study, about the effect of familiarity on innovation outcomes regarding outsourcing settings, hypothesized, for example, that: innovation outcomes will probably be improved by a higher degree of client–supplier knowledge familiarity; innovation outcomes will probably be improved by a higher degree of supplier–client knowledge familiarity; innovation outcomes will probably be increased by a higher degree of relational familiarity. While the first hypothesis was confirmed, the second and the third hypotheses were not supported (Oshri et al., 2018). Weeks & Feeny (2008) consider trust to be a relationship enabler, concluding that the lack of trust can impede the progress of relationships between clients and suppliers. Although these two studies are not about team familiarity, the first one still links familiarity to innovation and the second one considers that

trust is important to strengthen relationships, meaning it could be important to increase familiarity. Those are the reasons why these studies should not be discarded, especially since the literature on these topics is scarce. Could these conclusions about clients and suppliers apply to teams as well? Trust can be defined as believing that other people's actions will benefit our interests and, therefore, being willing to demonstrate vulnerability towards those actions (Robinson, 1996). Trust was, then, linked to innovation by a study about the effects of geographic dispersion, electronic dependence, dynamic structure, and national diversity on team innovation. This study hypothesized if trust could minimize the negative consequences that virtuality has on teams. However, the evidence found no significant relationship between virtuality and trust, concluding the effect of trust on team Innovation was also not relevant (Gibson & Gibbs, 2006). The possibility of the relationship between intra-team trust and team innovation being curvilinear was pointed out by Hendarsjah et al. (2019). These authors' study also hypothesized that the complexity or simplicity of tasks performed by teams will cause the variation of this curvilinear relationship pattern. The results did not support this hypothesis. However, it was concluded that, as the level of task complexity increases, the level of team innovation also increases. These authors suggested that, when a new team is formed, meaning that members are not familiar with each other, a moderate level of familiarity should be stimulated before the team in question is required to perform a task that implicates a high level of innovation. Another explored possibility is the possibility that the relationship between a team's familiarity and its ability to innovate is curvilinear, forming an inverted U. The results of a study about this relationship corroborate the hypothesis that the relationship between team familiarity and team innovation has an inverted U shape. However, the authors found empirical evidence concerning this topic to be quite contradictory and suggested that an experimental study was needed to test the causal relationships involved in their theories (Xie et al., 2018).

2.4. Relevant Distinctions and Discarded Topics

2.4.1. Innovation and Creativity (Relevant Distinction)

An important distinction to make is the distinction between innovation and creativity, since some papers mention both of these concepts or mention the concept of creativity. In a paper regarding the routinization of innovation research, the authors concluded, based on the analysis of previous definitions, that idea generation and implementation are both included in the

concept of innovation. On the other hand, the concept of creativity may only include idea generation (or ideation) (Anderson et al., 2004). However, in papers, the authors concluded that researchers do not generally agree on the definitions of these concepts and that the boundaries between innovation and creativity are not so evident, as suggested by more recent literature (Anderson et al., 2014). Therefore, in my study, to avoid ambiguity, I will focus only on the concept of innovation, and not on the concept of creativity.

2.4.2. Friendship (Discarded Topic)

According to Nemiro (2002), friendship outside and at work is an antecedent of team familiarity, alongside average time working together and shared work knowledge. Initially, there was a hypothesis dedicated to this topic, to understand how it would affect team familiarity. However, the information that was found about measuring friendship in the work context was very scarce and would not provide sufficient foundation and evidence for me to explore it. Additionally, some of the questions found were very similar to the ones concerning the trust topic, which I also decided to investigate. Therefore, it would probably be redundant to include both topics.

2.5. Hypotheses and Conclusions

A few hypotheses arise based on the most critical findings that emerged from the analyzed literature. The typology of communication (synchronous or asynchronous communication), the typology of team (virtual or face-to-face interaction) and the average time working together will be the moderators of the analyzed relationships and the purpose of this study is also to understand how these different contextual factors affect the five main constructs (average time working together, trust, team familiarity, team innovation and company innovation).

Since average time working together is a team familiarity antecedent, is it possible that, when team members have worked together for more extended periods of time, the familiarity between them is higher?

- H1: Familiarity between team members increases as the average time their teams have worked together increases.

Since shared work knowledge is a team familiarity antecedent, is it possible that, when team members have a higher shared work knowledge, their familiarity is also higher?

- H2: Familiarity between team members increases as the shared work knowledge in those teams increases.

Since trust at work is a team familiarity antecedent, is it possible that, when team members trust each other in their professional context, the familiarity between them is higher?

- H3: Familiarity between team members increases as trust between those team members increases.

Since teams whose members are more familiar are less successful in innovative tasks and teams whose members are less familiar are more successful in routine and standardized tasks, is it possible that team familiarity negatively affects team innovation?

- H4: Teams whose members are less familiar with each other are more successful innovating than teams whose members are more familiar with each other.

Additionally, companies that stimulate innovation generate more creative teams than less innovative companies. Is it possible that company innovation positively affects team innovation? Prior research has established that organizations with a strong innovation orientation tend to foster team-level innovation. A supportive innovation climate at the organizational level provides resources, psychological safety, and strategic alignment, all of which enable teams to generate and implement new ideas (Anderson et al., 2014; Janssen, 2000; Scott & Bruce, 1994). Therefore, it is theoretically plausible to assume that company innovation positively affects team innovation.

- H5: Team innovation increases as company innovation increases.

Since time working together is one of the main antecedents of familiarity, and familiarity is often linked with stronger relational ties such as trust, is it possible that spending more time together increases the level of trust among team members?

- H6: Teams whose members have worked together longer demonstrate higher levels of trust.

Because synchronous and asynchronous communication modes influence how relationships and information sharing develop in virtual teams, is it possible that the typology of communication affects the degree of familiarity between team members?

- H7: The typology of communication influences team familiarity, such that synchronous versus asynchronous modes lead to different levels of familiarity.

As teams may differ in their levels of familiarity depending on whether they operate face-to-face, in hybrid form, or virtually, it is possible that the typology of the team explains variations in team familiarity?

- H8: The typology of the team affects team familiarity, such that face-to-face teams versus hybrid teams versus virtual teams lead to different levels of familiarity.

Research suggests that different communication modes (face-to-face versus computer-mediated) can influence relational dimensions such as immediacy, affection, receptivity and trust. Is it, therefore, possible that the influence of trust on team familiarity varies depending on whether communication is synchronous or asynchronous?

- H9: The typology of communication moderates the relationship between trust and team familiarity, such that synchronous versus asynchronous communication changes the influence of trust.

The literature indicates that synchronous communication is preferable for tasks with higher complexity, while asynchronous communication can be more advantageous for simpler tasks. Since knowledge sharing contributes to familiarity, is it possible that the mode of communication shapes how effectively shared work knowledge enhances team familiarity?

- H10: The typology of communication moderates the relationship between shared work knowledge and team familiarity, with communication mode shaping the extent to which knowledge sharing enhances familiarity.

Because professional familiarity was shown to positively influence information elaboration, but its effect is restricted in more virtual teams, is it possible that the relationship between shared work knowledge and team familiarity depends on the degree of virtuality?

- H11: The typology of the team moderates the relationship between shared work knowledge and team familiarity, with the effect of shared knowledge differing according to the level of virtuality.

Finally, since trust was found to be an antecedent of knowledge sharing across all levels of virtuality, is it possible that the effect of trust on team familiarity varies depending on whether teams are more virtual or face-to-face?

- H12: The typology of the team moderates the relationship between trust and team familiarity, such that the impact of trust differs according to the level of virtuality.

Figure 2 presents the research model developed for this study, followed by a brief description of each item measured in the analysis. Directional arrows represent hypothesized relationships between constructs. Green hypotheses indicate a positive influence, meaning that an increase in the first construct is associated with an increase in the second one. In contrast, red arrows represent a negative influence, suggesting that higher levels of the first construct are associated with lower levels of the second. The assumptions of positive or negative relationships between moderators and variables are based on the conclusions found in the literature. Solid arrows represent the 8 main hypotheses (H1-H8), and dashed arrows represent the moderation hypotheses (H9-H12).

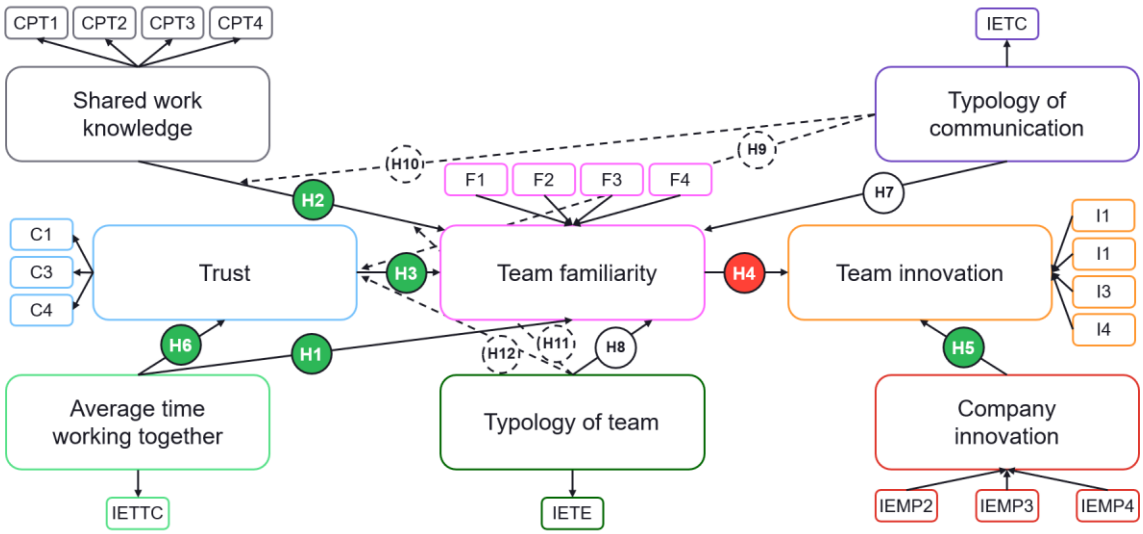

Figure 2 - Research model

CPT1 – Level of comfort in suggesting ideas or changes to the team leader

CPT2 – Level of comfort in suggesting ideas or changes to team members

CPT3 – Extent to which team members keep each other informed about work-related matters

CPT4 – Extent to which team members with specialized knowledge are willing to help others

C1 – Level of willingness to speak openly to the team leader, even when at fault

C3 – Level of confidence that team members will follow through on their commitments

C4 – Extent to which team members help each other when facing difficulties at work

F1 – Level of comfort in expressing work-related opinions to the team leader

F2 – Extent to which team members feel comfortable discussing personal matters

F3 – Prior acquaintance with team members before joining the team

F4 – Level of familiarity with team members' working styles and competencies

I1 – Extent to which a team seeks external information on markets, products, and technologies

I2 – Extent to which a team has a defined innovation strategy and goals

I3 – Frequency of team engagement in research and development (R&D)

I4 – Frequency of team-generated products or services resulting in patents

IEMP2 – Extent to which employees actively seek innovative approaches to problem-solving

IEMP3 – Frequency of company efforts to develop new solutions

IEMP4 – Frequency of company-developed products, processes, or services that are new to the market or sector

IETTC – Average time the team has been working together

IETE – Team typology (in-person, hybrid, or virtual)

IETC – Typology of communication most frequently used by the team (synchronous, asynchronous or a combination of both)

Although the quantity of papers linking virtual teams to team familiarity is higher, papers linking virtual teams to innovation are scarce. Adding to the fact that the quantity of literature that directly analyzes the relationship between team familiarity and team innovation is relatively scarce, the conclusions drawn by academics are not always consistent in these fields. No papers were found linking virtual teams to team familiarity and team innovation. As expected, as the number of topics increases, the quantity of available literature that analyzes the relationships between them decreases. It would be interesting to compare pre-pandemic and post-pandemic papers to understand if the results and conclusions changed after this phenomenon. However, the scarcity of papers linking these topics is even higher when the goal is to find recent papers. I hope it will be possible to compare both contexts regarding virtual teams, team familiarity and team innovation. The quantity of papers directly analyzing the impacts of trust, average time working together and shared work knowledge on team familiarity is also very scarce. Therefore, there is a clear need to advance in the research of these relationships, so that the quantity and homogeneity of the knowledge on these topics can be increased. I expect that this study will contribute to reducing this uncertainty.

3. Methodology

Following the examples of some of the papers I analyzed (Table 1), the methodology chosen for my study is a quantitative approach, through a questionnaire. It is a deductive methodological approach, because the foundation is theory and, based on that theory and hypotheses, the collected data is analyzed to draw conclusions. Team familiarity and team innovation shall be the dependent variables and virtual and face-to-face-interaction, synchronous and asynchronous communication, company innovation, average time working together, shared work knowledge and trust between team members shall be the independent variables. Table 1 presents examples of studies that successfully applied quantitative methods to investigate similar constructs and relationships, supporting the methodological choice for this research.

Table 1 - Examples of quantitative studies mentioned in the theoretical framework

Authors	**Title**	**Period**	**Countries**	**Sector/ Industry**	**Methodology**	**Number of respondents**	**Journal**
Melanie Brucks, Jonathan Levav	"Virtual Communication Curbs Creative Idea Generation"	2020	Finland, Hungary, India, Israel, Portugal	Engineering	Quantitative	1,490 respondents (field experiment) 602 (laboratory experiment)	*Nature*
Daniel Carmody, Martina Mazzarello, Paolo Santi, Trevor Harris, Sune Lehmann, Timur Abbiasov, Robin Dunbar, Carlo Ratti	"The Effect of Co-location on Human Communication Networks"	2019-2020	USA	Technology	Quantitative	2,834 respondents	*Nature*

Travis Maynard, John Mathieu, Lucy Gilson, Diana Sanchez, Matthew Dean	"Do I Really Know You and Does It Matter? Unpacking the Relationship Between Familiarity and Information Elaboration in Global Virtual Teams"	Not specified	China, Ireland, Japan, Mexico, Taiwan, United States and others	Technology	Quantitative	363 respondents	*Sage journals*
Harshika Singh, Gaetano Cascini, Christopher McComb	"Virtual and Face-to-face Team Collaboration Comparison Through an Agent-based Simulation"	2019-2020	Italy	Design	Quantitative	25 teams	*Journal of Mechanical Design*
Sandy Staples, Jane Webster	"Exploring the Effects of Trust, Task Interdependence and Virtualness on Knowledge Sharing in Teams"	Not specified	Not specified	Technology	Quantitative	985 respondents	*Information Systems Journal*

I started by developing a pilot questionnaire, further explained in Annex 3A, to test if the questions were clear and if the general definitions and presentation could be improved. I distributed the questionnaire to ten people, belonging to different genders and age groups. Based on the received feedback, the final questionnaire was improved (Table 15).

In order to measure the shared work knowledge, trust, team familiarity, team innovation and company innovation variables, a 5-point Likert-scale was used, presenting the following levels: 1. Strongly disagree; 2. Disagree; 3. Neither agree or disagree; 4. Agree; 5. Strongly agree.

The first group of questions is the "shared work knowledge" group. Questions one, two, and three were retrieved from a paper about measuring psychological safety in healthcare teams.

In this paper, I found a questionnaire in which the questions are divided in three sections: questions related to the team leader, questions related to the peers and questions related to the team as a whole (O'Donovan et al., 2020). I used the authors' division in this group of questions, as well in the other groups of questions - I adapted some of the questions, changing or adding terms, so every group would include at least one question of every section. The first, second and third questions, "I feel comfortable giving suggestions and ideas for new projects to my team leader", "I feel comfortable giving suggestions and ideas for new projects to team members" and "In my team, members keep each other informed about work-related matters" aim to understand how individuals assess psychological safety in a restricted group (Detert & Burris, 2007). The aim is to measure participative safety (West & Anderson, 1994) and psychological safety (Edmondson, 1999) as well. Question one also examines how the respondents perceive their team leaders concerning the support level. Question four, "Members with more knowledge are willing to help the rest of the team", was retrieved from a questionnaire included in a paper about the effects of trust, task interdependence and virtualness on knowledge sharing in teams. This question was found in the section that aimed to measure knowledge sharing (Staples & Webster, 2008).

The second group of questions is the "trust" group. Question six, "If my team leader asked why a problem occurred, I would speak openly, even if partially at fault" was adapted from a paper about trust in management and performance (Mayer & Gavin, 2005). The original question did not include the team leader, it was added, so every section mentioned on the last paragraph was represented. Question seven, "I frequently rely on team members to handle important matters on my behalf", was adapted from the "Handbook of research methods of Trust", from the sub-section of "Cross-sectional Surveys" (Lyon et al., 2015). The original question included the leader, instead of the peers. Questions eight and nine were retrieved from a paper about the measures of trust, organizational commitment and personal need non-fulfilment. Both questions, "I can trust that most team members will do what they said they would do" and "If someone in the team were having difficulties, others would try to help", were found in section nine of this paper's questionnaire - "Interpersonal Trust at work" (Cook & Wall, 1980).

The third group of questions is the "team familiarity" group. Questions ten and eleven were adapted from the same paper as questions one, two and three (O'Donovan et al., 2020).

The tenth and eleventh questions, "I can express my opinions about work-related matters to my team leader" and "Team members feel comfortable discussing personal matters with each other" aim to measure participative safety (West & Anderson, 1994) and psychological safety (Edmondson, 1999). Question ten also aims to examine how the respondents perceive their team leaders concerning the support level. The twelfth question was adapted from a paper concerning familiarity, complexity, and team performance in geographically distributed software development (Espinosa, 2007). In this paper, the authors state that previous knowledge of peers within the team was used to measure team familiarity (Gruenfeld et al., 1996). With this information, I formulated question twelve, "I already knew some or most of my team members before working with them". The thirteenth question is based on two papers, the first one concerning the relationship between teamwork and performance in healthcare teams and the second one concerning the relationship between familiarity and information elaboration in global virtual teams. In the first paper, in the sub-section dedicated to team familiarity, the authors mention that the familiarity people experience with their other team members' working styles increases when they have worked together before (Schmutz et al., 2019). In the second paper, the authors infer, based on previous research, that the familiarity between team members is likely to increase when they are familiar with each other's work and skills. Channeling this knowledge, question thirteen, "I am familiar with the working styles and individual competencies of my team members", was formulated (Maynard et al., 2019). The fourteenth question is also based on a paper about team familiarity, role experience and performance. In this paper, team size is used in the formula that measures team familiarity, implying it has an influence on the relationship shared by team members. In the formula, team size is represented by the letter N and appears only in the denominator, meaning that, as team sizes increase, Team familiarity shall decrease (Huckman et al., 2009). Thus, question fourteen, "How many people are there in your team?" allows the respondents to provide that information, through the following scale: 2-4 people; 5-9 people; 10-14 people; 15 or more people.

The fourth group of questions is the "team innovation" group. Question fifteen, "My team frequently seeks external information about new markets, products, or technologies" was retrieved from a paper concerning innovation by teams in Shanghai, China. It is presented in the "Rating of innovation by team" section, meaning it is used by the authors to measure team innovation (Wong et al., 2009). Question sixteen was adapted from a paper focused on

measuring firm innovativeness, which divides the innovation indicators in input-oriented measures, process-oriented measures and output-oriented measures (Carayannis & Provance, 2008). Based on this division, I assured that this group of questions had at least one question for each typology of measures. The fifteenth question belongs to the input-oriented measures, as the information searched by the team is an input to the product, process or service that is being developed. The innovation strategy indicator is presented in the process-oriented measures section of the paper I based the sixteenth question, "My team has a clear strategy and defined goals for innovation", on. Although this paper is focused on firms, I adapted the question so it could be related to teams. The seventeenth question was based on a paper that presents a methodology to measure innovation in the European Union (Carvalho et al., 2015). This question, "Research and development (R&D) is frequently carried out by my team", belongs, as the fifteenth question does, to the input-oriented measures, as R&D is an input to be used in the development of a product, process or service. The eighteenth question, "The products or services developed by my team often lead to patents", was also based on this paper and belongs to the output-oriented measures, as a patent is associated with the final product, process or service developed by the team. Both these variables, R&D and patents, are presented in the paper as measurements of firm innovation. Similarly to what was opted for in question sixteen, I changed the focus from firms to teams.

The fifth group of questions is the "company innovation" group. Questions nineteen, twenty and twenty-one were retrieved from a paper about measuring the perceived support for innovation in organizations. All of these questions were listed on table 2, "Items and Factor Loadings of the Siegel Scale of Support for Innovation" (Siegel & Kaemmerer, 1978). The questions are the following: "There is not much room for change in my company"; "People in the company are constantly looking for innovative ways to solve problems"; "The company continuously moves towards developing new responses". Question twenty-two, "The company frequently develops products, processes, or services that are new to the market", was based on the same paper as question sixteen, as "new to the industry" is one of the indicators listed to measure innovation (Carayannis & Provance, 2008).

The seventh, eight and ninth groups are focused on collecting information about the respondent, the respondent's team and the respondent's company. In the "team information group", it is asked if the team is virtual, non-virtual or hybrid, because the virtual interaction is

a moderator and the objective was to include these three typologies of teams. The next question aims to understand if the communication within the team is mostly synchronous, asynchronous or if both forms of communication are used equally. As synchronous communication is also a moderator, it is important to include teams that use different forms of communication. The third question of this group, "How long has the majority of the team you are part of been working together?", is based on the same paper as question thirteen. In this paper, the authors mention that previous work experience regarding the team seems to increase familiarity between team members (Goodman & Leyden, 1991; Kanki et al., 1989). Thus, it is important to include teams that have been working together for different periods of time. In this question, the following scale is used: Less than 1 year; 2-4 years; 5 years or more. In the "company information" group, the first question aims to collect information about the sector that the company belongs to or, alternatively, the name of the company. The goal is to include companies belonging to different sectors. With the answers to the following question, "What do you consider to be the level of technological intensity of the company you work for?", it was possible to include highly technological companies, somewhat technological companies and to low-tech companies. In this question, the respondents answered according to the following scale: Low; Medium-low; Medium; Medium-high; High.

For the analysis of the questionnaire's results, I used the partial least squares structural equation model (PLS-SEM). SEM (Structural Equation Model) combines exploratory factor analysis and structural path analysis, making it possible to simultaneously assess the measurement and structural models (Lee et al., 2011), explaining several statistical relationships. Due to its flexibility, this model is universally used to analyze experimental and non-experimental data (Mueller & Hancock, 2018; Ullman & Bentler, 2012). PLS-SEM, is adequate if the research is based on exploratory research, testing an established theory and confirming it (Hair Jr et al., 2017; Sarstedt et al., 2014). Recently, the number of published papers regarding research in which PLS-SEM was used has substantially increased (Hair et al., 2017). It is also important to refer that the application of the PLS-SEM model in several social science disciplines has been notably increasing (Hair et al., 2019). These include: organizational management (Sosik et al., 2009), international management (Richter et al., 2016), human resource management (Ringle et al., 2020), management information systems (Ringle et al., 2012), operations management (Peng & Lai, 2012), marketing management (Joe F Hair et al., 2012), management accounting (Nitzl,

2016), strategic management (Joseph F Hair et al., 2012), hospitality management (Ali et al., 2018) and supply chain management (Kaufmann & Gaeckler, 2015). PLS-SEM should be chosen by researchers (among other cases):

- If the purpose of the research is to test a theory based on predictions;
- If the structural model is substantially complex, including several constructs, indicators and/or relationships;
- If they intend to explore the extensions of existing theories in order to develop their own incremental theory;
- If their research is based on a small sized population sample (Hair et al., 2019).

Since my research's purpose is to explore a theory that is an extension of existing theories, based on predictions, has several indicators and relationships and was tested using a small sample (158 people), it is clear that the PLS-SEM model was a very adequate choice.

4. Data Analysis

4.1. Descriptive statistics

Before presenting the results of the Measurement and Structural Models, this section begins by characterizing the sample used in this study, based on the 158 valid responses collected. Although a total of 289 responses were initially collected, only 158 were complete and, therefore, retained for analysis. IBM SPSS was used for initial descriptive analysis, while SmartPLS 4 was used for model estimation and hypothesis testing using PLS-SEM.

As shown in Table 2, regarding gender, 62% of the respondents were females, 37% were males and 1% did not identify with either of these genders.

Concerning age, most respondents were between 18 and 29 years old (53%) and the average age was 32 years old.

In terms of typology of teams, 53% of respondents belonged to hybrid teams, 41% belonged to non-virtual teams, 4% belonged to virtual teams and 2% did not respond to this question.

Concerning the typology of communication, most respondents belonged to teams that usually mix synchronous and asynchronous communication (67%). 20% of respondents usually communicate with their teams synchronously, 11% usually communicate with their teams asynchronously and 2% did not provide an answer to this question.

Regarding average time working together, 54% of respondents belonged to teams that have been working together from 1 to 4 years, 29% belonged to teams that have been working together for 5 or more years, 15% belonged to teams that have been working together for less than 1 year and for 2% of respondents this information was not provided.

In terms of opinion about the level of technological intensity of their company, the results were very heterogeneous: 28% of respondents consider their company's level of innovation to be medium-high, 27% consider it to be high, 23% consider it to be medium, 13% consider it to be medium-low, 13% consider it to be low and 3% did not respond.

Finally, concerning the sector of the respondents' company, and according to CAE-Rev.3's division, most companies belonged to Section J - Information and Communication Activities (23%).

Table 2 - Distribution of respondents by business sector, based on CAE-Rev.3 classification

Section	Frequency	Percent
Section C – Manufacturing industries	17	11
Section E – Water collection, treatment and distribution; sanitation waste management and depollution	5	3
Section F – Construction	2	1
Section G – Wholesale and retail trade; repair of motor vehicles and motorcycles	18	11
Section H – Transport and storage	2	1
Section I – Accommodation, restaurants and similar	4	3
Section J - Information and Communication Activities	36	23
Section K - Financial and insurance activities	13	8
Section L – Real Estate activities	2	1
Section M – Consultancy, scientific, technical and similar activities	18	11
Section N - Administrative activities and support services	1	1
Section O - Public Administration and Defense; Mandatory Social Security	4	3
Section P – Education	10	6
Section Q – Human health and social support activities	6	4
Blank	20	13
Total	158	100

To ensure the robustness of the data used in this study, descriptive statistics and outlier detection were conducted using SPSS. Standard deviations were calculated for all survey items, revealing moderate to high variability across responses, which is typical in Likert-scale questionnaires. For example, the items related to shared work knowledge presented standard deviations ranging from 0.803 to 0.940, indicating consistent but diverse perceptions among respondents. Trust-related items showed slightly higher dispersion, with standard deviations of 0.937 and 0.759. Team familiarity items also displayed moderate variability, with standard deviations between 0.754 and 0.856, except for the item "I already knew some or most of my team members before working with them" (F3), which had a notably higher standard deviation of 1.258, indicating a wide range of prior familiarity among team members.

Team innovation items revealed the highest dispersion among all constructs and the available data suggest substantial differences in innovation practices across teams, which aligns with the theoretical expectation that innovation is context-dependent and influenced by team dynamics. Notably, the item "Research and development (R&D) is frequently carried out by my team" (I3) presented the highest standard deviation observed in the dataset - 1,291 - indicating substantial variability in how teams approach exploratory and developmental activities.

Company-level innovation items also displayed considerable variability. The item "The company frequently develops products, processes, or services that are new to the market" (IEMP4) showed the highest standard deviation of 1.273, reflecting significant differences in innovation culture across organizations.

4.2. Empirical analysis

4.2.1. Measurement Model Assessment

Table 3 presents the list of questionnaire items (possible answers listed in Annex 4A) used in the Measurement Model, including the construct to which each item belongs, its corresponding code, and its inclusion status in the final model.

Table 3 - Measurement Model: Constructs, indicators, questionnaire items, and indicator inclusion

Construct	Indicator code	Questionnaire item	Status
Shared work knowledge	CPT1	I feel comfortable giving suggestions and ideas for new projects to my team leader.	Included
	CPT2	I feel comfortable giving suggestions and ideas for new projects to team members.	Included
	CPT3	In my team, members keep each other informed about work-related matters.	Included
	CPT4	Members with more knowledge are willing to help the rest of the team.	Included
Trust	C1	If my team leader asked why a problem occurred, I would speak openly, even if partially at fault.	Included
	C2	I frequently rely on team members to handle important matters on my behalf.	Excluded
	C3	I can trust that most team members will do what they said they would do.	Included
	C4	If someone in the team were having difficulties, others would try to help.	Included
Team familiarity	F1	I can express my opinions about work-related matters to my team leader.	Included
	F2	Team members feel comfortable discussing personal matters with each other.	Included
	F3	I already knew some or most of my team members before working with them.	Included
	F4	I am familiar with the working styles and individual competencies of team members.	Included
	F5	How many people are in your team?	Excluded
Team innovation	I1	My team frequently seeks external information about new markets, products, or technologies.	Included
	I2	My team has a clear strategy and defined goals for innovation.	Included
	I3	Research and development (R&D) is frequently carried out by my team.	Included
	I4	The products or services developed by my team often lead to patents.	Included

Company innovation	IEMP1	There is not much room for change in my company.	Excluded
	IEMP2	People in the company are constantly looking for innovative ways to solve problems.	Included
	IEMP3	The company continuously moves towards developing new responses.	Included
	IEMP4	The company frequently develops products, processes, or services that are new to the market.	Included

In this study, shared work knowledge and trust were modeled as reflective constructs because their indicators were conceptualized as manifestations of the underlying latent variable. That is, changes in the latent construct were expected to cause variation in the observed measures, and the indicators were assumed to be interchangeable and highly correlated. In contrast, the remaining constructs - team familiarity, team innovation, company innovation, average time working together, typology of communication and typology of team were modeled as formative. These constructs are composed of distinct indicators that collectively define the latent variable, such that each indicator contributes a unique aspect to the construct, and removal of an indicator could alter the meaning of the construct itself (Hair Jr et al., 2021).

The construct team familiarity was conceptualized as formative, since its indicators represent distinct facets rather than interchangeable reflections of a single latent dimension. Familiarity was understood as a broad construct encompassing both cognitive aspects (e.g., prior acquaintance with colleagues, time spent working together, awareness of competencies and working styles) and relational aspects (e.g., openness to discussing work or personal matters). These indicators are not necessarily correlated, but together they capture the richness of what familiarity entails in team contexts. A potential limitation is that some items may overlap with related constructs, such as team cohesion or relational trust. Nevertheless, their inclusion was theoretically relevant, as interpersonal openness and shared history are central to operationalizing familiarity in organizational settings.

Similarly, team innovation and company innovation were also specified as formative constructs. Their indicators capture multiple, complementary manifestations of innovation rather than reflective expressions of a single dimension. For instance, team innovation was measured through the pursuit of external information, the presence of strategic clarity, engagement in research and development, and innovation outputs, such as patents. Company-level innovation included dimensions such as the search for new solutions, capacity for rapid

adaptation and proactive response, and the development of novel products or services. These facets represent different ways in which innovation materializes in practice, and omitting any of them would lead to an incomplete representation of the construct. Formative modelling thus ensured a more comprehensive conceptualization of innovativeness at both team and organizational levels.

The construct trust, in contrast, was measured reflectively, but it combined items referring to both vertical trust (in the leader) and horizontal trust (among peers). While these can be considered distinct subdimensions, in this study they were analyzed together to capture a generalized perception of team-level trust. The rationale was that trust within teams functions as an emergent climate phenomenon: members' willingness to rely on both the leader and their colleagues contributes to a shared sense of reliability and psychological safety. Therefore, trust was retained as a unified reflective construct, in line with the study's focus on overall team dynamics rather than on separating leader- and peer-focused trust.

In order to evaluate the adequacy of the measurement model, several criteria were examined, namely the reliability and validity of the latent constructs. This included the analysis of indicator reliability (outer loadings), internal consistency reliability (Composite Reliability), convergent validity (Average Variance Extracted - AVE), discriminant validity (HTMT ratio) and variance inflation factor (VIF).

As a first step, the reliability of each indicator was assessed through its outer loading on the respective latent variable. According to Hair Jr et al., (2021), loadings above 0.70 are considered acceptable, as they indicate that the construct explains more than 50% of the indicator's variance. In this study, three indicators - F5 (team familiarity), C2 (trust), and IEMP1 (company innovation) - were excluded from the model due to poor performance in the initial analysis. These items portrayed either very low or negative outer loadings, which suggested that they did not contribute meaningfully to their respective constructs and would reduce the overall measurement quality if retained.

After removing these problematic indicators, the reliability of the reflective construct's items was reassessed. Most indicators met the recommended loading threshold. As portrayed in Table 4, two indicators, CPT3 and C1, presented loadings between 0.51 and 0.70. Although these indicators fall slightly below the ideal value, they are considered acceptable when supported by

sufficient Composite Reliability and Average Variance Extracted (Hair Jr et al., 2021). No indicators fell below the critical minimum of 0.40, and thus no further exclusions were made.

Table 4 - Measurement Model: Outer loadings of indicators

Construct	Indicator	Loading
Shared work knowledge	CPT1	0.770
	CPT2	0.805
	CPT3	0.653
	CPT4	0.777
Trust	C1	0.672
	C3	0.762
	C4	0.778

Composite Reliability (CR) and Average Variance Extracted were then used to assess internal consistency and convergent validity. As presented in Table 5, both reflective constructs achieved CR values above the 0.70 threshold. Additionally, AVE values surpassed the recommended minimum of 0.50, confirming adequate convergent validity (Hair Jr et al., 2021).

Table 5 - Measurement Model: Composite reliability and average variance extracted

Construct	Composite Reliability (CR)	Average Variance Extracted (AVE)
Shared work knowledge	0.839	0.568
Trust	0.782	0.546

To assess discriminant validity, the Heterotrait-Monotrait ratio (HTMT) was applied. HTMT values below 0.85 (conservative threshold) or 0.90 (liberal threshold) suggest that constructs are empirically distinct (Henseler et al., 2015). As presented in Table 6, the majority of HTMT values fall below the conservative threshold, indicating satisfactory discriminant validity across most constructs. However, one pair of constructs exhibits HTMT values above 0.90: Shared work knowledge - Trust (HTMT = 1.079). These results suggest a potential lack of discriminant validity between these specific constructs. However, both constructs were retained for three main reasons. Firstly, despite their empirical overlap, shared work knowledge and trust capture distinct conceptual dimensions that are consistently distinguished in the literature on team dynamics and innovation. Secondly, further item removal was not feasible without compromising the minimum indicators required per construct. Thirdly, complementary psychometric indicators - such as composite reliability and average variance extracted - remained

within acceptable thresholds. Therefore, the decision to retain both constructs is theoretically and empirically justified, and the overall robustness of the measurement model is preserved.

Table 6 - Measurement Model: Discriminant validity (HTMT Matrix)

				Typology of					
	Average time working together	Shared work knowledge	Trust	Communication	Team	Team x Trust	Communication x Trust	Communication x Shared work knowledge	Team x Shared work knowledge
Average time working together	-	-	-	-	-	-	-	-	-
Shared work knowledge	0.179	-	-	-	-	-	-	-	-
Trust	0.075	1.079	-	-	-	-	-	-	-
Typology of communication	0.040	0.141	0.110	-	-	-	-	-	-
Typology of team	0.113	0.115	0.091	0.098	-	-	-	-	-
Typology of team x Trust	0,046	0,043	0,020	0,059	0,136	-	-	-	-
Typology of communication x Trust	0,025	0,109	0,159	0,035	0,068	0,131	-	-	-
Typology of communication x Shared work knowledge	0,069	0,086	0,098	0,225	0,002	0,129	0,537	-	-
Typology of team x Shared work knowledge	0,031	0,201	0,057	0,001	0,169	0,763	0,106	0,139	-

To assess potential multicollinearity among the indicator variables in the outer model, the Variance Inflation Factor (VIF) was examined for each reflective and formative constructs' indicator. Multicollinearity can adversely affect the stability and interpretability of the model estimates by inflating standard errors and undermining the individual contribution of each indicator.

The obtained VIF values (for reflective and formative constructs' indicators) ranged from 1.072 to 2.268, as presented in Table 7. Specifically, the lowest value was observed for reflective indicators was 1.089, while the highest value corresponded to 1.771. All values are well below the commonly accepted threshold of 5 (Hair Jr et al., 2021), which indicates that multicollinearity is not a concern within the measurement model.

These results suggest that the indicators included in the model do not exhibit problematic levels of collinearity, thereby supporting the adequacy of the outer measurement model in terms of discriminant and convergent validity. Consequently, the estimation of path coefficients and other model parameters can be considered reliable and unbiased by multicollinearity issues.

In conclusion, the collinearity statistics confirm that the indicators function independently enough to justify their simultaneous inclusion in the model, providing a robust foundation for subsequent structural model analysis.

Table 7 - Measurement Model: Variance inflation factor (VIF) values

Indicator	VIF
Reflective	
CPT1	1.644
CPT2	1.771
CPT3	1.415
CPT4	1.621
C1	1.089
C3	1.393
C4	1.327
Formative	
F1	1.095
F2	1.102
F3	1.072
F4	1.121
I1	1.416
I2	1.944
I3	1.790
I4	1.422

IEMP2	1.935
IEMP3	2.268
IEMP4	1.504

In addition to the reflective constructs, the adequacy of the formative measurement models was also assessed. For formative constructs, the evaluation focuses on the significance and relevance of the indicator weights as well as the assessment of potential collinearity among indicators (Hair Jr et al., 2021; Henseler et al., 2015).

As presented in Table 8, the outer weights of the indicators were examined using bootstrapping. Most indicators displayed significant weights, especially F1, I1, I2, and IEMP4, confirming their relative contribution to the respective construct. For indicators with non-significant weights, the outer loadings were inspected to evaluate their absolute contribution. In cases where indicators showed non-significant weights but outer loadings above the recommended threshold of 0.50, they were retained due to theoretical relevance and their meaningful absolute contribution to the construct.

Table 8 - Measurement Model: Outer loadings and weights of formative constructs' indicators

Construct	Indicator	Loading	Weight
Team familiarity	F1	0,813	0.637
	F2	0,510	0.265
	F3	0,534	0.323
	F4	0,563	0.311
Team innovation	I1	0,856	0.545
	I2	0,878	0.561
	I3	0,616	-0.023
	I4	0,540	0.101
Company innovation	IEMP2	0,825	0.412
	IEMP3	0,833	0.244
	IEMP4	0,860	0.531

To further assess collinearity among formative indicators, the Variance Inflation Factor (VIF) values portrayed in Table 7 were analyzed. The VIF values ranged between 1.072 and

2.268, all of which are below the conservative threshold of 3.3 and well below the more liberal threshold of 5.0 (Hair Jr et al., 2021). These results indicate that multicollinearity is not a concern and support the adequacy of the formative measurement models.

Overall, the formative constructs demonstrate satisfactory measurement properties, thereby justifying their retention for the structural model assessment.

In summary, the measurement model demonstrates adequate reliability and validity across constructs, despite some weaker indicator loadings and a discriminant validity concern between shared work knowledge and trust. These limitations are outweighed by the theoretical justification and robustness of the psychometric properties overall. Therefore, the measurement model can be considered sound, providing a solid foundation for the subsequent evaluation of the structural model and the hypothesized relationships between constructs.

4.2.2. Structural Model Assessment

After confirming the reliability and validity of the measurement model, the following step in the Partial Least Squares Structural Equation Modeling (PLS-SEM) process is the assessment of the Structural Model. This step involves examining the hypothesized relationships between latent variables in order to determine whether the data support the theoretical assumptions.

The evaluation of the structural model included several key indicators. Firstly, collinearity among predictor constructs was assessed using the inner VIF values. Furthermore, before analyzing the individual path coefficients, the model's overall fit was assessed using global fit indices. Specifically, the Standardized Root Mean Square Residual (SRMR), d_ULS, and d_G were examined. Subsequently, the path coefficients were analyzed to assess the strength and direction of the relationships between constructs. The significance of these coefficients was tested through a bootstrapping procedure, which provided p-values for hypothesis testing. Furthermore, the model's explanatory power was assessed through the coefficient of determination (R^2), which indicated the proportion of variance explained in the endogenous constructs. Additionally, the effect size (f^2) was examined to determine the individual contribution of each predictor variable. Finally, predictive relevance (Q^2) was assessed using the blindfolding procedure, with Q^2 values above zero indicating that the model had predictive relevance for a given endogenous construct (Hair Jr et al., 2021). This section presents the results

of the structural model, organized by hypothesis, and discusses whether each theoretical relationship is supported by the empirical data.

To ensure that multicollinearity did not bias the estimation of path coefficients, collinearity diagnostics were conducted using the inner VIF values (Table 9). All VIF values ranged between 1.000 and 2.651, which are well below the conservative threshold of 5 (Hair Jr et al., 2021). This indicates that collinearity among predictor constructs is not a concern in the model. The lowest VIF value was observed for the relationship between average time working together and trust (VIF = 1.000), suggesting a completely independent contribution of this predictor. On the other hand, the highest VIF values were found for the interactions typology of team × shared work knowledge → team familiarity (VIF = 2.651) and typology of team × trust → team familiarity (VIF = 2.518). Although these are the strongest collinearity indicators in the model, they still remain comfortably below the critical cut-off, confirming that all predictor variables contribute uniquely to the explanation of their respective endogenous constructs.

Table 9 - Structural Model: Variance inflation factor (VIF) values

Indicator	VIF
Company innovation → Team innovation	1.171
Shared work knowledge → Team familiarity	2.294
Average time working together → Team familiarity	1.034
Typology of communication × Trust → Team familiarity	1.464
Trust → Team familiarity	2.156
Typology of communication → Team familiarity	1.098
Team familiarity → Team innovation	1.171
Typology of communication × Shared work knowledge → Team familiarity	1.530
Average time working together → Trust	1.000
Typology of team → Team familiarity	1.087
Typology of team × Trust → Team familiarity	2.518
Typology of team × Shared work knowledge → Team familiarity	2.651

Global model fit was then assessed using SRMR, d_ULS, and d_G. The SRMR for the saturated model presented a value of 0.086, slightly above the recommended threshold of 0.08, while the SRMR for the estimated model presented a value of 0.146, suggesting a moderate

global fit. Although d_ULS and d_G values indicate some discrepancy between observed and estimated covariance matrices, the model is considered sufficiently adequate to interpret path coefficients and predictive relevance (Table 10) (Hair Jr et al., 2021; Henseler et al., 2015).

Table 10 - Structural Model: Global model fit

Index	Saturated Model	Estimated Model	Interpretation
SRMR	0.086	0.146	Moderate global fit; saturated model near threshold
d_ULS	1.717	4.956	Some discrepancy between observed and estimated covariances
d_G	0.468	0.682	Minor geodesic discrepancy

The structural model was further evaluated by analyzing the path coefficients between constructs, as well as the significance levels obtained through the bootstrapping procedure. The results for the main hypotheses (H1 to H8) are presented below:

- H1 predicted that the longer team members have worked together, the higher their familiarity. This hypothesis was supported by the data ($\beta = 0.176$, $p = 0.002$);
- H2 suggested that shared work knowledge contributes positively to team familiarity. This was the strongest predictor of team familiarity in the model ($\beta = 0.512$, $p < 0.001$), confirming the hypothesis;
- H3 posited a positive relationship between trust and familiarity. The path was not statistically significant ($\beta = 0.176$, $p = 0.069$), therefore H3 was not supported;
- H4 hypothesized a negative relationship between team familiarity and innovation. The relationship was positive ($\beta = 0.129$) but not statistically significant ($p = 0.190$), and thus, H4 was not supported.
- H5 hypothesized a positive relationship between company innovation and team innovation. The relationship was positive ($\beta = 0.550$) and statistically significant ($p < 0.001$), and thus, H5 was supported;
- H6 suggested a positive relationship between average time working together and trust. The relationship was positive ($\beta = 0.060$) but not statistically significant ($p = 0.479$), and thus, H6 was not supported;

- H7 hypothesized a relationship between typology of communication and team familiarity. The relationship was negative (β = -0.112) and statistically significant (p = 0.043), and thus, H7 was supported;
- H8 hypothesized a relationship between typology of team and team familiarity. The relationship was negative (β = -0.018) but not statistically significant (p = 0.724), and thus, H8 was not supported.

Furthermore, one significant moderating effect was found:

- The interaction between typology of communication and trust had a significant negative effect on team familiarity (β = -0.197, p = 0.017), confirming H9, and indicating that the influence of trust on team familiarity may weaken in more virtual communication contexts.
- All other interaction effects tested in the model (moderations) were not statistically significant and therefore not interpreted further.

Table 11 presents the standardized path coefficients and significance levels resulting from the Structural Model assessment, including the main hypotheses tested (H1-H8) and additional relationships and moderation effects (H9-H12).

Table 11 - Structural Model: Path coefficients, significance levels and hypothesis confirmation

Hypothesis/Path	Relationship	Path coefficient (β)	p-value	Supported?
H1	Average time working together → Team familiarity	0.176	0.002	Yes
H2	Shared work knowledge → Team familiarity	0.512	<0.001	Yes
H3	Trust → Team familiarity	0.176	0.069	No
H4	Team familiarity → Team innovation	0.129	0.190	No
H5	Company innovation → Team innovation	0.550	<0.001	Yes
H6	Average time working together → Trust	0.060	0.479	No
H7	Typology of communication → Team familiarity	-0.112	0.043	Yes
H8	Typology of team → Team familiarity	-0.018	0.724	No

H9	Typology of communication × Trust → Team familiarity	-0.197	0.017	Yes
H10	Typology of communication × Shared work knowledge → Team familiarity	0.108	0.188	No
H11	Typology of team × Shared work knowledge → Team familiarity	0.003	0.967	No
H12	Typology of team × Trust → Team familiarity	-0.049	0.608	No

The coefficient of determination (R^2) indicates the proportion of variance in the endogenous constructs that is explained by their predictors. According to (Hair Jr et al., 2021), R^2 values of 0.75, 0.50, and 0.25 are considered substantial, moderate, and weak, respectively. Adjusted R^2 values account for the number of predictors and sample size, providing a more conservative estimate of explanatory power.

As presented in Table 12, the construct team familiarity achieved an R^2 of 0.525 (adjusted $R^2 = 0.496$), indicating a moderate level of variance explained by its antecedents (average time working together, shared work knowledge, trust, typology of team, and communication-related variables). The construct team innovation had an R^2 of 0.373 (adjusted $R^2 = 0.365$), suggesting a weak-to-moderate level of variance explanation, acceptable within social sciences research. Finally, the construct trust presented an R^2 of 0.004 (adjusted $R^2 = -0.003$), which indicates virtually no explanatory power from its predictors.

Table 12 - Structural Model: Coefficient of determination (R^2 and Adjusted R^2) for endogenous constructs

Endogenous Construct	R^2	Adjusted R^2	Interpretation
Team familiarity	0.525	0.496	Moderate
Team innovation	0.373	0.365	Weak to moderate
Trust	0.004	-0.003	None

The f^2 effect size values provide insight into the individual contribution of each exogenous construct on its respective endogenous variable. As shown in Table 13, large effect on team innovation ($f^2 = 0.412$), while shared work knowledge had a medium effect on team

familiarity (f^2 = 0.241). Several predictors showed small effects (f^2 between 0.02 and 0.15), including the effect of average time working together on team familiarity (f^2 = 0.063), the effect of trust on team familiarity (f^2 = 0.030), the effect of typology of communication × trust on team familiarity (f^2 = 0.041), the effect of typology of communication on team familiarity (f^2 = 0.024), and the effect of team familiarity on team innovation (f^2 = 0.023). All other effects were negligible (f^2 < 0.02).

Table 13 - Structural Model: f^2 effect sizes of predictors on endogenous constructs

Relationship	f^2 Effect Size	Interpretation
Company innovation → Team innovation	0.412	Large
Shared work knowledge → Team familiarity	0.241	Medium
Average time working together → Team familiarity	0.063	Small
Typology of communication × Trust → Team familiarity	0.041	Small
Trust → Team familiarity	0.030	Small
Typology of communication → Team familiarity	0.024	Small
Team familiarity → Team innovation	0.023	Small
Typology of communication × Shared work knowledge → Team familiarity	0.012	Negligible
Average time working together → Trust	0.004	Negligible
Typology of team → Team familiarity	0.001	Negligible
Typology of team × Trust → Team familiarity	0.000	Negligible
Typology of team × Shared work knowledge → Team familiarity	0.000	Negligible

In PLS-SEM, the Stone–Geisser Q^2 value obtained through the blindfolding procedure has traditionally been used to assess the predictive relevance of the model for endogenous constructs (Table 14). Q^2 values above zero indicate that the model has predictive relevance for a given endogenous construct (Hair Jr et al., 2021). However, recent methodological developments highlight that Q^2 values derived from blindfolding can sometimes be misleading, particularly when models include formative constructs or when the focus is on predictive performance (Shmueli et al., 2019). For this reason, SmartPLS also offers the PLSpredict procedure, which generates Q^2 Predict values based on out-of-sample prediction. This approach provides a more robust assessment of the model's predictive power, as it compares the prediction errors of the PLS model against a simple linear benchmark. In this study, instead of relying on blindfolding-based Q^2 values, the Q^2 Predict procedure was adopted, as recommended for models that include formative constructs and aim to evaluate out-of-sample prediction.

The Q^2 predict values indicate that the model possesses meaningful predictive power for team familiarity (Q^2 predict = 0.383) and team innovation (Q^2 predict = 0.312), both above the threshold of 0, thus confirming that the model outperforms a naïve benchmark (Hair Jr et al., 2021; Shmueli et al., 2019). By contrast, trust shows a negative Q^2 predict value (-0.011), suggesting that the model is unable to generate predictive accuracy for this construct, and that its performance is not superior to a simple linear model baseline.

In terms of predictive error metrics, the RMSE and MAE values further support these conclusions. For team familiarity (RMSE = 0.800, MAE = 0.620) and team innovation (RMSE = 0.840, MAE = 0.673), the relatively lower error values are consistent with their positive Q^2 predict, indicating a satisfactory predictive ability. On the other hand, trust displays higher error levels (RMSE = 1.022, MAE = 0.793), aligning with its negative Q^2 predict value.

Overall, the PLSpredict results confirm that the model demonstrates substantial out-of-sample predictive power for the core constructs of team familiarity and team innovation, while the construct trust does not benefit from predictive accuracy. This supports the practical usefulness of the model for predicting team dynamics, despite its limitations in explaining the drivers of trust.

Table 14 – Structural Model: PLSpredict results at the latent variable (LV) level

Indicator	Q^2 predict	RMSE	MAE
Team familiarity	0.383	0.800	0.620
Team innovation	0.312	0.840	0.673
Trust	-0.011	1.022	0.793

Taken together, the assessment of the structural model demonstrates that the proposed relationships explain a moderate proportion of variance in team familiarity and a weaker, yet acceptable, proportion of variance in team innovation, while almost no variance was explained for trust. The predictive relevance analysis (Q^2 predict) further supports the model's ability to generate meaningful out-of-sample predictions for most indicators, despite some weaker or negative results in a few items. Overall, these findings suggest that the model provides a theoretically consistent and empirically valid explanation of how familiarity and communication dynamics shape innovation in teams, while also highlighting areas where predictive power remains limited and further refinement may be necessary.

5. Discussion of Results

This section discusses the findings obtained from the measurement and structural model assessments, with the aim of interpreting the empirical evidence in light of the theoretical framework and research hypotheses. By integrating the reliability, validity, and predictive performance of the constructs with the analysis of path coefficients and effect sizes, this discussion highlights the key mechanisms through which team familiarity, trust, shared work knowledge, and communication dynamics influence innovation at both the team and organizational levels. Furthermore, the implications of the observed relationships, including their significance, explanatory power, and predictive relevance, are considered to provide a comprehensive understanding of the factors that shape team innovation processes.

The assessment of the measurement model indicated adequate reliability and validity across constructs, providing a sound foundation for structural analysis. Most reflective indicators demonstrated satisfactory outer loadings, with a few slightly below the ideal threshold but retained due to theoretical relevance and acceptable composite reliability (CR) and average variance extracted values. Specifically, all constructs achieved CR above 0.70 and AVE above 0.50, confirming internal consistency and convergent validity.

Discriminant validity was generally supported by the HTMT ratios, with the exception of the shared work knowledge - trust pair, which exceeded the conservative threshold. Despite this, both constructs were retained due to conceptual distinctiveness and sufficient psychometric support. Formative constructs also demonstrated adequate indicator weights and low collinearity, ensuring that each construct contributed meaningfully to the structural model. The overall measurement model thus provided reliable and theoretically consistent estimates for subsequent hypothesis testing.

The structural model revealed nuanced relationships among the constructs. Collinearity diagnostics indicated no serious multicollinearity issues, with inner VIF values comfortably below the critical threshold of 5.

Regarding the global model fit, the SRMR for the saturated model (0.086) was near the recommended threshold, while the estimated model (0.146) suggested moderate fit. Although the d_ULS and d_G values indicated some discrepancies between observed and estimated covariances, the model was considered adequate to interpret path coefficients and predictive relevance.

Path coefficient analysis revealed that shared work knowledge was the strongest positive predictor of team familiarity ($\beta = 0.512$, $p < 0.001$), highlighting the central role of knowledge sharing in fostering interpersonal familiarity. Average time working together also contributed positively to familiarity ($\beta = 0.176$, $p = 0.002$), whereas trust did not have a statistically significant effect ($\beta = 0.176$, $p = 0.069$): contrary to theoretical expectations, the relationship between trust and team familiarity was not statistically significant. One possible explanation lies in the operationalization of the construct: in this study, trust was measured as a reflective construct encompassing both vertical trust (towards the team leader) and horizontal trust (among peers). While this approach aimed to capture a generalized perception of team-level trust, it may have obscured more nuanced effects that each dimension could exert individually on familiarity. Furthermore, in increasingly virtual or hybrid work environments, trust may develop through functional mechanisms - such as reliability and task competence - without necessarily fostering interpersonal closeness or shared understanding. In such contexts, trust may exist without contributing meaningfully to the cognitive or relational dimensions of familiarity. This suggests that trust and familiarity, although related, may not always co-evolve, particularly in teams where interactions are more transactional than relational.

Additionally, the lack of a significant relationship between average time working together and trust among team members requires reflection. While it is often assumed that prolonged collaboration naturally fosters trust, the findings of this study suggest that time alone may be insufficient to do so. In virtual or hybrid teams, extended periods of working together do not necessarily translate into meaningful interpersonal experiences or opportunities for trust-building. Factors such as limited face-to-face interaction, asynchronous communication, and the absence of informal social exchanges may hinder the development of trust, even in long-standing teams. This highlights the importance of intentional trust-building practices and structured opportunities for interpersonal engagement, rather than relying solely on time as a proxy for relational depth. It also reinforces the idea that trust is shaped more by the quality and context of interactions than by their duration.

Interestingly, team familiarity did not significantly predict team innovation ($\beta = 0.129$, $p = 0.190$), suggesting that familiarity alone may not directly drive innovation outcomes.

Company-level innovation had a strong positive effect on team innovation ($\beta = 0.550$, $p < 0.001$), indicating that organizational innovation climate strongly influences team-level

innovative behaviors. Typology of communication showed a small negative effect on team familiarity (β = -0.112, p = 0.043), which was further reinforced by a significant negative moderating effect of the interaction between communication typology and trust (β = -0.197, p = 0.017). These results suggest that more asynchronous or virtual communication may weaken the positive influence of trust on familiarity among team members.

Explanatory power was moderate for team familiarity (R^2 = 0.525, adjusted R^2 = 0.496) and weak-to-moderate for team innovation (R^2 = 0.373, adjusted R^2 = 0.365). Trust showed almost no explained variance (R^2 = 0.004), highlighting its limited role as predicted by the model. Effect size analysis (f^2) further confirmed that shared work knowledge had a medium impact on team familiarity, while company innovation had a large impact on team innovation. Other effects were small or negligible.

Predictive relevance assessed via Q^2 predict indicated that the model generated meaningful out-of-sample predictions for team familiarity (Q^2 predict = 0.383) and team innovation (Q^2 predict = 0.312), while predictive accuracy for trust was not achieved (Q^2 predict = -0.011). RMSE and MAE metrics were consistent with these findings, supporting the model's practical usefulness for forecasting team dynamics and innovation potential.

These findings underscore the importance of shared work knowledge as a central mechanism driving familiarity within teams. While familiarity alone did not significantly influence team innovation, the organizational innovation climate and knowledge resources provided the strongest impetus for team-level innovative outcomes. The moderating effect of communication typology highlights the complex interplay between virtual interactions and trust, suggesting that organizations may need to manage communication channels carefully to maintain strong team cohesion.

Furthermore, the limited explanatory and predictive power of trust in this model points to the need for future research to explore additional antecedents or contextual factors that influence trust dynamics and their translation into innovation performance. Overall, the results provide a theoretically coherent and empirically grounded account of how knowledge sharing, team interactions, and organizational innovation contribute to team innovation in business settings.

6. Conclusions

This study aimed to explore the relationships between virtualization, team familiarity, and team innovation, seeking to understand how team familiarity was formed and whether it contributed to innovative outcomes. Through a Partial Least Squares Structural Equation Modeling (PLS-SEM) analysis of 158 valid responses to a structured questionnaire, the study tested eight main hypotheses, alongside several additional relationships and moderation effects.

The findings showed that shared work knowledge and average time working together were significant predictors of team familiarity, with shared work knowledge emerging as the strongest influence. These results reinforced the importance of both cognitive and relational mechanisms in the development of familiarity within teams. In contrast, the relationship between team familiarity and team innovation was not statistically significant, suggesting that the impact of familiarity on innovation was more nuanced than initially hypothesized. Company innovation exhibited a strong positive effect on team innovation, highlighting the role of organizational culture and strategy in fostering innovative behavior at the team level. Among the contextual factors examined, typology of communication showed a small but significant negative effect on team familiarity, indicating that more virtual or asynchronous communication environments could hinder relationship-building. A significant moderating effect was also identified: the interaction between typology of communication and trust, which suggested that the positive influence of trust on team familiarity weakened in virtual communication contexts.

Taken together, these findings provided partial support for the proposed theoretical framework and contributed to the growing literature on team familiarity and innovation in digital work environments. By integrating antecedents, outcomes, and contextual moderators, this study offered a more holistic understanding of how teams function under varying levels of virtuality and how relational mechanisms such as familiarity and trust shaped these dynamics.

While some hypothesized relationships were confirmed, the lack of significance in others - particularly the direct effect of familiarity on innovation - highlighted the need for further research. Future studies could examine curvilinear relationships, task complexity, or sector-specific dynamics, and could benefit from longitudinal or experimental designs to capture causal mechanisms more precisely.

In practical terms, the results suggested that managers should invest in fostering trust and shared knowledge among team members, especially in virtual and hybrid settings, while

recognizing that relational dynamics alone may not automatically lead to innovation without additional structural and cultural support.

The findings of this study carried several practical implications for organizations operating in increasingly digital and hybrid environments. Firstly, the results highlighted the importance of shared work knowledge and interpersonal trust as key foundations for fostering team familiarity. This suggested that managers should actively promote knowledge-sharing practices and trust-building mechanisms, particularly in teams that collaborate remotely. Strategies may include the implementation of collaborative platforms, peer mentoring, and team-building activities, even in virtual settings.

Secondly, the small but significant negative impact of virtual communication on team familiarity underscored the need to balance asynchronous tools with opportunities for synchronous interaction, such as video calls or, when feasible, in-person meetings. Managers of hybrid or remote teams should therefore strategically schedule real-time engagements to support relational development.

Thirdly, the strong effect of company innovation on team innovation emphasized the role of organizational culture and leadership. To enhance innovation outcomes, efforts should go beyond the team level and include clear innovation goals, openness to experimentation, and recognition systems that reward creativity and initiative across all organizational levels.

As with any empirical research, this study presents certain limitations. Firstly, the data were collected through self-reported questionnaires, which may be subject to common method bias or social desirability effects. Secondly, the study employed a cross-sectional design, which limits the ability to infer causality between constructs. Thirdly, although the sample was sufficiently large for PLS-SEM, it was drawn mainly from professionals working in Portugal, which may limit the generalizability of the results to other cultural or organizational contexts.

Furthermore, in terms of measurement and model results, some limitations emerged. The construct trust showed very low explained variance ($R^2 = 0.004$) and a negative predictive relevance (Q^2 predict = -0.011), indicating that the model did not capture well the factors influencing this variable. Additionally, the relationship between team familiarity and team innovation was not significant, suggesting that familiarity alone may not be sufficient to drive innovative outcomes in teams. The HTMT value between shared work knowledge and trust (1.079) indicated a potential issue with discriminant validity, although both constructs were

retained for theoretical and empirical reasons. While they were retained as distinct variables in line with prior literature, this finding suggests that they may partly capture the same underlying phenomenon. It is possible that both constructs are intertwined dimensions of a broader latent concept, such as team climate or psychological safety, which encompasses informational exchange, as well as relational reliability and support. Future studies could, therefore, test alternative specifications, for instance by modeling shared work knowledge and trust as subdimensions of a higher-order construct, in order to capture this overlap more explicitly.

Finally, the SRMR for the estimated model (0.146) indicated only a moderate global fit, suggesting that the overall model may not fully capture all aspects of the covariance structure.

Despite these limitations, the study provided valuable insights into the antecedents and outcomes of team familiarity in virtual and hybrid environments, and the results remain useful for guiding both theory and practice.

Building on these findings and limitations, several avenues for future research are proposed. Firstly, longitudinal studies could better capture the development of team familiarity over time and its causal impact on innovation outcomes. Secondly, experimental designs may test the effectiveness of different communication strategies (e.g., synchronous versus asynchronous) on trust and team familiarity. Thirdly, future research could examine non-linear or curvilinear relationships - for example, whether excessive familiarity may lead to groupthink and hinder innovation. Fourthly, task complexity or industry-specific factors could be explored as potential moderators of the familiarity-innovation link. Finally, future studies could refine the conceptualization of team familiarity by differentiating between its personal and professional components, particularly in hybrid and virtual team contexts. Integrating qualitative methods, such as interviews or case studies, could provide richer insights into how familiarity develops and operates within diverse organizational environments.

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Annexes

Annex 3A

This annex describes the evolution of this research's questionnaire until its final version. The first version of the questionnaire had two questions that were not clear to every respondent and had to be adapted. The first question was related to the activity of the respondents' company. I used INE's CAE-Rev.3 division to classify the respondents' companies and had originally decided to limit the companies' types of activities, obliging the respondents to choose between some of the CAE-Rev.3 categories. I had selected types of activities that were considered to be somewhat innovative or considerably innovative. However, several problems emerged: the selection was too restrictive and it would be difficult to collect a high number of answers; there would be a lack of non-innovative companies in comparison to the somewhat innovative companies and considerably innovative companies; some respondents thought it was difficult to fit their company into one type of activity, frequently having doubts between two types. Therefore, I altered the division from types of activities to sectors. Nevertheless, the respondent could, even so, find it difficult to fit the company into a sector, possibly having to access the internet to find the answer to the question. Thus, it would be important to have the simple and comfortable alternative of simply writing the company's name, making it my task to, posteriorly, fit it into the correct sector. At this point, another problem emerged: writing the company's name would have to be optional, due to identity protection of the respondent. The solution was to let the respondent choose between writing the sector and/or the company's name. The final question turned out to be the following: "What is the name of the company you are employed at, or alternatively, the sector?".

Other aspects that have been modified regarding the original questionnaire consisted of adding a group of questions, inserting new questions and adapting an existing question. In the pilot questionnaire, there was a group named "innovation". This group covered the topic of team innovation and was the only part of the questionnaire where the innovation topic was approached. In the final questionnaire, this group's name changed to "team innovation" and a new group, named "company innovation" was added and the question "The team frequently develops products or services that are a novelty to the company, sector or market" was changed to "The company frequently develops products, processes, or services that are new to the

market". This question was moved to the "company innovation" group, in which three other questions were added. The term "processes" was added, so it would be possible to include companies that develop processes, instead of merely products or services.

After these slight modifications, the final version of the questionnaire, presented in Table 15, was stabilized.

Table 15 - Final questionnaire

Construct/Group	Indicator code	Questionnaire item	Possible answers
Shared work knowledge	CPT1	I feel comfortable giving suggestions and ideas for new projects to my team leader.	Likert Scale *
	CPT2	I feel comfortable giving suggestions and ideas for new projects to team members.	Likert Scale *
	CPT3	In my team, members keep each other informed about work-related matters.	Likert Scale *
	CPT4	Members with more knowledge are willing to help the rest of the team.	Likert Scale *
Trust	C1	If my team leader asked why a problem occurred, I would speak openly, even if partially at fault.	Likert Scale *
	C2	I frequently rely on team members to handle important matters on my behalf.	Likert Scale *
	C3	I can trust that most team members will do what they said they would do.	Likert Scale *
	C4	If someone in the team were having difficulties, others would try to help.	Likert Scale *
Team familiarity	F1	I can express my opinions about work-related matters to my team leader.	Likert Scale *
	F2	Team members feel comfortable discussing personal matters with each other.	Likert Scale *
	F3	I already knew some or most of my team members before working with them.	Likert Scale *
	F4	I am familiar with the working styles and individual competencies of my team members.	Likert Scale *
	F5	How many people are there in your team?	2-4; 5-9; 10-14; 15 or more; No answer
Team innovation	I1	My team frequently seeks external information about new markets, products, or technologies.	Likert Scale *
	I2	My team has a clear strategy and defined goals for innovation.	Likert Scale *
	I3	Research and development (R&D) is frequently carried out by my team.	Likert Scale *
	I4	The products or services developed by my team often lead to patents.	Likert Scale *
Company innovation	IEMP1	There is not much room for change in my company.	Likert Scale *

	IEMP2	People in the company are constantly looking for innovative ways to solve problems.	Likert Scale *
	IEMP3	The company continuously moves towards developing new responses.	Likert Scale *
	IEMP4	The company frequently develops products, processes, or services that are new to the market.	Likert Scale *
Personal information	-	What age range are you in?	18-29; 30-39; 40-49; 50-59; 60 years old or more; No answer
	-	What is your gender?	Masculine; Feminine; Other; No answer
Typology of team	IETE	What typology does your team belong to belong to?	Fully in-person; Hybrid (virtual and in-person); Fully virtual; No response
Typology of communication	IETC	What type of communication is used most frequently by your team?	Asynchronous (email, chat messages, google docs, etc.); Asynchronous and synchronous; Synchronous (video call, phone call, face-to-face interaction, etc.); No response
Average time working together	IETTC	How long has the majority of the team you are part of been working together?	Less than 1 year; 1-4 years; 5 years or more; No response
Company information	-	What is the name of the company you are employed at, or alternatively, the sector?	Open response
	-	What do you consider to be the level of technological intensity of the company you work for?	Low; Medium-low; Medium; Medium-high; High; No answer

Note: Likert Scale *: Totally disagree; Disagree; Neither agree nor disagree; Agree; Totally agree; No answer

Annex 4A

During the measurement model assessment, three items were excluded due to poor psychometric performance. The criteria for exclusion were based on recommendations from Hair et al. (2022), who suggest that outer loadings below 0.40 indicate insufficient contribution to the construct and can undermine the reliability and validity of the model. The removed items and the rationale for their exclusion are summarized in Table 16.

Table 16 - Items excluded from the measurement model

Item Code	Construct	Item (paraphrased)	Outer loading	Reason for exclusion
C2	Trust	Relying on others to handle important issues	-0.006	Negative and non-significant loading
F5	Team familiarity	Team dimension	0.419	Below 0.40 threshold
IEMP1	Company innovation	Resistance to change in the company	-0.419	Negative loading; reversed meaning issue

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