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Original Article

The state of the art on social interactions in virtual project teams

O estado da arte em interações sociais em equipes de projetos virtuais

Laurival Siqueira Calçada Junior[I], **Leonardo Vils**[I], **Marcírio Chaves**[II]

[I] Universidade Nove de Julho, SP, Brazil
[II] Pontificia Universidade Católica do Rio Grande do Sul, RS, Brazil

ABSTRACT

Purpose: This paper presents a better understanding of the state of the art of social interactions in virtual project teams based on comprehensive literature.
Methodology: This literature review comprises 125 articles from 2017 to October 2023.
Findings: We show that knowledge sharing, social identity, team cognition, psychological safety, and absorptive capacity are adopted to improve understanding of social interactions in virtual project teams.
Practical implications: The conclusions can help managers understand the factors that drive effectiveness in project management and their main barriers. The identified factors represent the focus of the research in the literature.
Originality: This study is original for integrating the themes of social interactions and virtual project teams and for the analysis at three levels: selected articles, most cited articles, and systematic reviews present in the sample. Knowledge sharing is emphasized as the only recurrent theme across all three levels of analysis and research agendas.

Keywords: Social interaction; Virtual teams; Project management; Team management; Organizational psychology

RESUMO

Objetivo: apresentar uma melhor compreensão do estado da arte das interações sociais em equipes de projetos virtuais com base em literatura abrangente.
Metodologia: esta revisão de literatura consiste em análise de 125 artigos coletados, abrangendo o período de 2017 a outubro de 2023.
Resultados: mostramos ser o compartilhamento de conhecimento, a identidade social, a cognição da equipe, a segurança psicológica e a capacidade de absorção adotados os construtos mais relevantes para melhorar a compreensão das interações sociais em equipes de projetos virtuais.

Implicações práticas: as conclusões podem ajudar gestores a compreenderem quais os fatores que impulsionam a eficácia na gestão de projetos e as suas principais barreiras. Os fatores identificados representam o foco da pesquisa na literatura. **Originalidade:** este estudo é original, tanto por integrar os temas das interações sociais e equipes virtuais de projetos quanto pela análise em três níveis: artigos selecionados, artigos mais citados e revisões sistemáticas presentes na amostra. Destacamos o compartilhamento de conhecimento como único tema recorrente nos três níveis de análise e agenda de pesquisa.

Palavras-chave: Interação social; Equipes virtuais; Gestão de projetos; Gestão de equipes; Psicologia organizacional

1 INTRODUCTION

Nothing will be the same as it was before the COVID-19 pandemic. However, the crisis presents us with opportunities. In the organizational context, digital communication has become a valuable and increasingly necessary tool, with remote work becoming essential (Gaudecker et al., 2020). Despite the increased reliance on remote work, the trend was already evident long before the pandemic, as global organizational expansion demanded flexible virtual teams (Peters, 1992; Stewart, 1994), offering low costs and quick response times, particularly in environments characterized by change, dynamic conditions, and turbulent markets (Mowshowitz, 1997; Snow et al., 1996).

Virtual teams use technology to interact with members across geographic and organizational boundaries, enhancing their effectiveness through repeated and shared social interactions (Jarvenpaa & Leidner, 2006). The transition from face-to-face to virtual work represents a procedural change that requires time for the team to adapt, with communication between members needing to be accurate, concise, and free from ambiguity (Bakshi & Krishna, 2008). Lin and Roan (2022) emphasize the importance of strengthening virtual team development, improving management practices, and fostering the creation of efficient and effective teams.

Given their inherent complexity, remote teams make high-quality project management crucial (Hooijberg et al., 1997), bringing together skills and knowledge to achieve project objectives (Fekry Youssef et al., 2023). Eftekhari et al. (2022) highlight

that interpersonal attributes and social skills are essential for project managers to build effective virtual teams and create cohesion among members (Kayworth & Leidner, 2000). Leaders must be adept at listening and recognizing the behaviors of all team members, facilitating collaboration and teamwork (Odenwald, 1993).

Social interactions refer to reciprocal relationships between individuals or groups that involve the exchange of information, ideas, and behaviors (De Felice et al., 2021), where knowledge is constructed (Piaget, 1972). Closely tied to the exchange of information between individuals, these interactions are crucial for the sharing of knowledge and experiences, allowing individuals to develop through their relationships with others (Vygotsky, 1978). The improvement of these interactions is linked to the formation of a team identity, which emerges from the interaction between the team's capabilities and the members' social identities (Mattarelli et al., 2017). Although Stoica et al. (2023) suggest that social identity is more difficult to establish in virtual teams, its development improves over time through increased interaction among members, even though such interactions are less frequent in virtual teams.

This research analyzes and synthesizes the constructs and recurring research proposals across three levels: the entire sample, the most cited papers, and systematic reviews. We identify the authors who focus on understanding the dynamics of social interactions in virtual project teams, their theoretical frameworks, and their research proposals. Additionally, we highlight current research topics and the gaps identified by scholars. Walther (1997) emphasized the need for a deeper understanding of team social dynamics, and Weigel et al. (2020) underscore the importance of this understanding for virtual teams. Based on this, we pose the following research question: What is the state of the art regarding social interactions in virtual project teams?

To address this question, we employed the systematic literature review (SLR) methodology, which generates academic knowledge through an objective approach while ensuring transparency and replicability (Tranfield et al., 2003). In October 2023, we conducted searches in the Scopus and Web of Science databases for works

published between January 2017 and October 2023. After applying inclusion and exclusion criteria, we selected 125 relevant publications from a total of 511, focusing on topics related to this study.

2 THEORETICAL FRAMEWORK

2.1 Virtual teams

"A team is a collection of individuals who are interdependent in their tasks, share responsibility for results, see themselves and are seen by others as an intact social entity embedded in one or more larger social systems, and manage their relationships across organizational boundaries" (Cohen & Bailey, 1997, p. 241). Although broad, this definition sufficiently encompasses both virtual and traditional teams by identifying key team-defining factors: a common purpose, identity as a social structure, and shared responsibility among participants (Powell et al., 2004).

As the world becomes more interconnected and the geographic scope of many organizations expands, there has been a rise in "distributed," "dispersed," or "virtual" teams (Kerrissey et al., 2020). The concept of virtuality introduces the idea of permeable boundaries and connections (Mowshowitz, 1997; Kristof et al., 1995), as project teams are rapidly formed, reorganized, and dissolved. Miles and Snow (1986) note that virtual teams are a progression of networked organizations made possible by advances in information and communication technologies, enabling individuals with diverse skills to collaborate across time, space, and cultures (Jarvenpaa & Leidner, 2006). Schulze and Krumm (2017) go further, suggesting that virtual teams are becoming the standard way of working in organizations.

These teams offer flexibility, responsiveness, cost-effectiveness, and optimized resource usage to meet growing demands and adapt to changing task requirements in highly turbulent and dynamic global business environments (Mowshowitz, 1997; Snow et al., 1996). Members of hybrid teams can prioritize which colleagues to meet with and when, across different platforms (Gilstrap et al., 2022).

Research on virtual teams has increased significantly in recent years. Lin and Roan (2022) underscore the relevance of this research by examining how communication mediated by information systems affects team relationships. Complementing this, Rogers et al. (2021) emphasize that social interactions are fundamental to creating positive experiences among team members. However, Alsharo et al. (2017) reveal that interactions within virtual teams often lack strong social ties.

2.2 Social interactions

In sociology, social interaction is the most elementary partition, and it is committed to studying the organization of individuals, although Turner (1988) indicates no appropriate conceptualization of the construct. Since social interaction is closely linked to positive social identity (Dutton et al., 1994), such relationships promote increased productivity and efficiency in information sharing (Chiu et al., 2006). Their connections are like rivers for torrents of resources and knowledge (Tsai & Ghoshal, 1998). Their strength is a combination of emotional intensity, amount of time and mutual trust (Granovetter, 1973), associated with social capital and the dynamics of social networks, strengthening individual bonds (Santos et al., 2021).

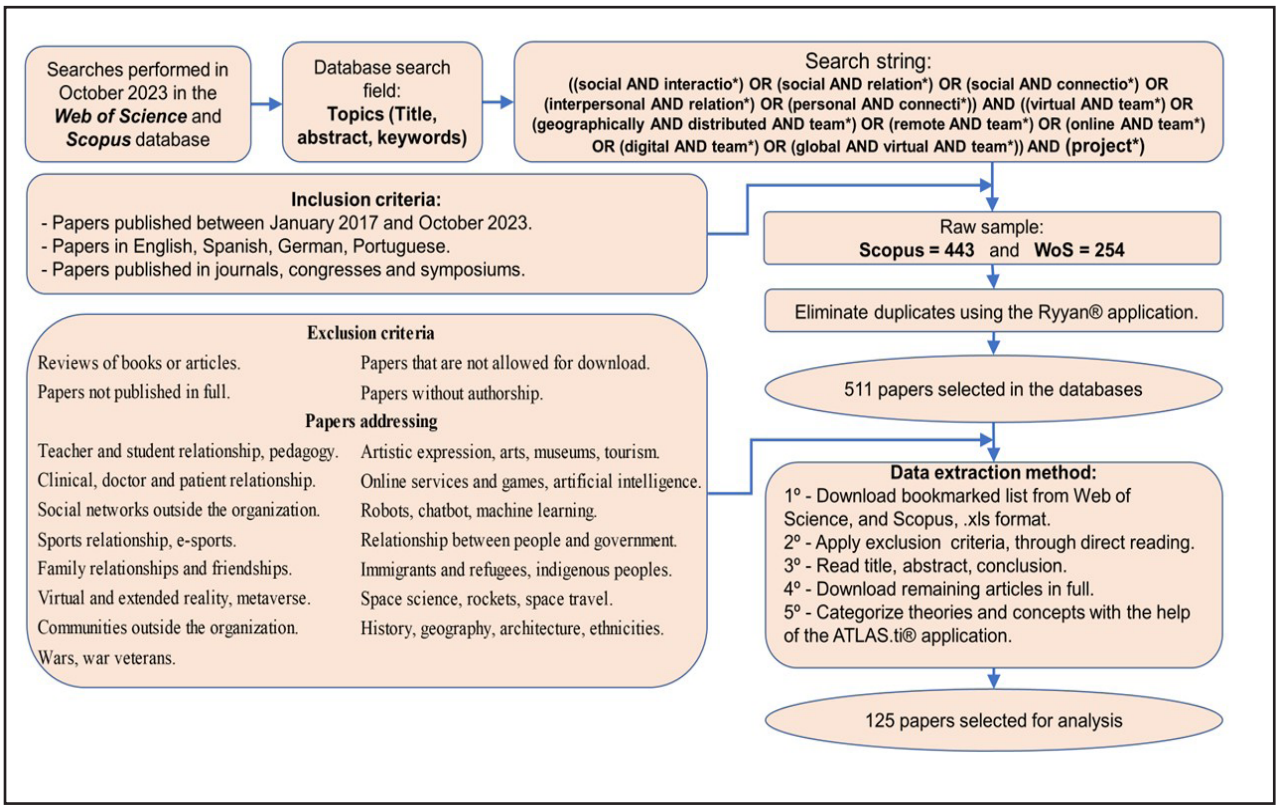
Organizations must recognize the differences between virtual and co-located teams, or they risk reduced efficiency, lower performance, and decreased member satisfaction (Holding Eagle, 2020). Schröder et al. (2021) support this idea by emphasizing that teams must integrate members' diverse cultures, which, when absent, can become a missed development opportunity. Team leaders can address this deficiency (Enrique & Joel, 2020) by actively promoting progressive improvements in intercultural relations.

3 METHOD

The systematic literature review (SLR) allows the construction of academic research based on metadata without the need for empirical data (Kraus et al., 2020). This research followed the guidelines of Okoli and Schabram (2010). We searched by papers with full access allowed free of charge in the ISI Web of Knowledge® and Scopus® databases. The search string was as follows: ((social AND interactio*) OR (social AND relation*) OR (social AND connectio*) OR (interpersonal AND relation*) OR (personal AND connecti*)) AND ((virtual AND team*) OR (geographically AND distributed AND team*) OR (remote AND team*) OR (online AND team*) OR (digital AND team*) OR (global AND virtual AND team*)) AND (project*).

Figure 1 details the protocol for this research, based on Pollock and Berge (2018).

Figure 1 – Protocol application



Source: the authors (2024)

4 ANALYSIS OF THE RESULTS

Table 1 – Main outlets publishing about social interaction in projects with virtual teams

Amt	Journals, Conferences, Symposia	H index[a]	Subject area[a]
4	ASEE Annual Conference and Exposition	39	Computer Science & Engineering
4	International Journal of Project Management	167	Business, Management and Accounting
4	Team Performance Management	40	Business, Management and Accounting
3	Int. Journal of Environmental Research and Public Health	167	Environmental Science & Medicine
3	Technological Forecast and Social Change	155	Business, Management and Accounting
2	Advances in Intelligent Systems and Computing	58	Computer Science & Engineering
2	Clean Technologies and Environmental Policy	68	Business, Management and Accounting
2	Communications in Computer and Information Science	62	Computer Science & Mathematics
2	Computers and Education	197	Computer Science & Social Sciences
2	Construction Management and Economics	105	Business, Management and Accounting
2	IEEE Access	204	Computer Science & Engineering
2	Information Technology and People	71	Computer Science & Social Sciences
2	Int. Journal of Construction Managment	39	Construction Economics
2	International Journal of Information Management	152	Business, Management and Accounting
2	Journal of Universal Computer Science	56	Computer Science & Mathematics
2	Lecture Notes in Computer Science	446	Computer Science & Mathematics
2	ARCOM Conference	12	Engineering
2	Society of Petroleum Engineers	115	Earth and Planetary Sciences
2	Sustainability	136	Computer Science & Energy
2	VINE Journal of Informat. and Knowledge Manag. Syst.	33	Business, Management and Accounting

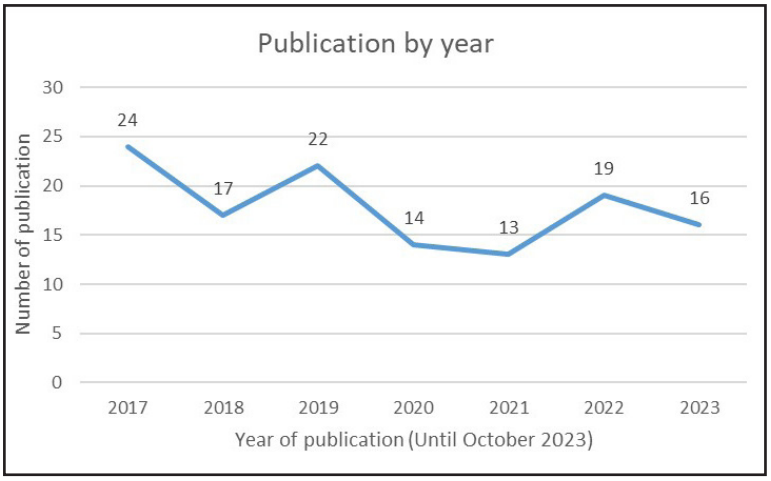
Source: Web of Science® and Scopus® databases, compiled by the authors

After compiling the studies, we identified that the publications are dispersed across several journals and conferences/symposia. Table 1 lists journals that published more than one study in the period analyzed. The sample comprises 79 (63.2%) studies published in journals and 46 (36.8%) conferences/symposia spread across various areas of knowledge. Publications related to Information Systems (18%)

and Management (16%) account for more than 30% of the total, indicating interest in the search for understanding social relationships in virtual teams.

Figure 2 shows the evolution of publications from 2017 to 2023, indicating a decline in the number of papers accepted by journals. Horbach (2020) offers a partial explanation for the fluctuations in publication numbers over the years. Horbach observed that journals accelerated their peer review and publication processes, enabling the faster dissemination of research related to COVID-19.

Figure 2 – Evolution of publications



Source: Web of Science and Scopus, compiled by the authors

Table 2 – Method, nature of research and scientific approach

Amt	Methodology	Amt	Nature of Research	Amt	Scientific Approach
39	Survey	54	Qualitative	85	Deductive
30	Experiment	39	Quantitative	14	Descriptive
12	Single case study	23	Not applicable	10	Exploratory
10	Theoretical article	6	Mixed methods	4	Inducive
9	Others	2	Grounded-Theory	5	Abductive
7	Not applicable	1	Action-research	4	Not applicable
5	Systematic literature review			3	Explanatory
4	Mixed methods				
3	Multiple case studies				
2	Ground Theory				
2	Action search				
2	Delphi				

Source: the authors (2024)

The search for understanding social interactions in virtual teams is indicated by 55% of methodologies adopting questionnaires and experiments to develop research. Reinforcing this idea, 43% of studies are qualitative, a typical approach for perceiving factors, and studying causes and agents in the phenomena (Creswell, 2010). Studies that adopt deductive, descriptive, or exploratory approaches (87%) demonstrate the investigative nature of the research (Table 2).

To understand which concepts and theories about interpersonal relationships in virtual teams are favored in studies, we used the VOSviewer® application to identify the co-occurrence of terms. Table 3 presents the focus of this research and lists the cited authors from the sample. We only include theories and concepts related to social interactions, social relationships, social connections, interpersonal relationships, and personal connections mentioned in the selected studies. The authors initially developed these constructs for face-to-face teams, and subsequent research has adapted them for virtual teams.

Table 3 – Constructs

Amt	Constructs	Cited authors
23	Knowledge sharing	Nonaka and Takeuchi (1995)
17	Social Identity	Tajfel (1972); Erikson (1968)
16	Team cognition	Hansen et al. (2012; Hollan et al. (2000)
7	Psychological Safety	Edmondson (1999)
4	Absorptive capacity	Duffield e Whitty (2016); Ali et al. (2019)

Source: the authors (2024)

We describe how the theories and concepts are used in the listed papers, highlighting the main foundations of each one.

Knowledge sharing: Fauzi (2022) claims that in the twentieth century, competition is natural in business. Competition combined with digitized globalization demands synergy between team members and knowledge sharing in companies. Knowledge is a crucial asset in companies, as it promotes competitive advantages in virtual teams, directly relating to the understanding and awareness of social connections conceived

and negotiated through social interactions (Olaisen & Revang, 2017). The construct represents action and development, and Nonaka (1994) conceptualizes it as dynamic, personal, and subjective of a socially constructed nature and, even with limited social ties, it is relevant for knowledge sharing (Granovetter, 1973).

Social identity: In 1972, Henri Tajfel proposed an understanding of identity through sociology, demonstrating that it is a component of the self-concept defined by our belonging to social groups (Akhilesh et al., 2013). Tajfel (1972, p. 292) defines social identity as an "individual's knowledge that he belongs to certain social groups, along with some emotional and value meaning for him as a member of that group." Thus, social identity can be described as a configuration that gradually integrates personal data, specific needs, favored capacities, meaningful identifications, effective defenses, successful sublimations, and consistent roles (Erikson, 1968). Group identification can be particularly significant in virtual teams (Walther, 1997). Weigel et al. (2020) highlight the leader's role in this process, emphasizing that it is their responsibility to foster a culture of belonging, listening, and empathy. Managers within the team must develop skills in communication, internal conflict resolution, and goal awareness (Lin & Roan, 2022). More broadly, human resource management must plan and prepare remote teams effectively for projects (Gallego et al., 2021).

Team cognition: Describes the patterns of knowledge structures maintained among team members, allowing them to anticipate each other's needs and coordinate their actions (Niler et al., 2021). The sharing of project team knowledge among team members, along with their processes and task-specific information, directly impacts team performance (Fiore & Salas, 2004). Oliveira, Marques, and Machado (2020, p. 80) highlight the importance of team cognition in efficiency in virtual teams, defined as "the set of knowledge, beliefs, values, norms and expectations shared by team members that influence how the team processes information and makes decisions." Sharari et al. (2022) concluded that fragmented information is a source of divergence and cognitive limitation,

limiting team members from making safe decisions. However, trust and strong ties are resources to minimize misunderstandings and eliminate cognitive gaps in teams.

Psychological safety: Edmondson (1999, p. 354) presents psychological safety as: "a belief shared by team members that the team is safe to take interpersonal risks". This concept has helped researchers study organizational learning behavior (Nembhard & Edmondson, 2006). It is a collective event in which team members can think independently and feel protected from taking risks because there is trust and mutual respect in the team (Edmondson, 2004). Effective virtual teams develop and maintain trust and psychological safety, enhancing connections between colleagues and providing determination that the task can be completed and any doubts can be raised (Sumathipala, 2020).

Absorptive capacities: Absorptive capacity (AC) refers to a company's ability to absorb knowledge from various sources and apply it to manage upcoming projects (Duffield & Whitty, 2016). Agostineto et al. (2022) demonstrate that an organization's AC is the sum of the individual absorptive capacities of each team member, with individual development contributing to the organization as a whole. The importance of AC is evident in strategic management (Lane & Lubatkin, 1998; Nahapiet & Ghoshal, 1998), technology management (Schilling, 2001), and global markets (Glass & Saggi, 1998). Despite its increasing use, the AC construct remains ambiguous in its definitions (Zahra & George, 2002). Joglekar et al. (1997) support this view by calling for a deeper understanding of the domain and its operationalization. Gao et al. (2021) investigated the relationship between absorptive capabilities and efficiency in virtual teams, finding that AC is positively related to team efficiency. They further suggest that open communication and collaboration among team members are crucial for enhancing AC in virtual teams. Similarly, Cabrera et al. (2002) examined how absorptive capabilities impact performance in virtual teams, concluding that combining individual and team absorptive capacities is a significant predictor of performance.

Snyder (2019) emphasizes the importance of all systematic literature reviews (SLRs) presenting relevant research agendas or propositions that advance the field of

study, as well as providing opportunities to build a theoretical foundation for future research (Alves-Mazzotti, 2002). The analysis synthesized research proposals from the selected papers, based on criteria such as a clear understanding of the research question or objective, methodology, and the authors' suggestions for future studies, all within the context of virtual teams and social interaction.

Table 4 – Research proposals and future studies of the twelve most cited papers

(Continued)

Paper title	Authors and year of publication
Factors for effective BIM governance	Alreshidi et al. (2017)
How typical is your project? The need for a no-model approach for information management in AEC	El-Diraby (2023)
Working smarter and greener: Collaborative knowledge sharing in virtual global project teams	(Olaisen & Revang (2017)
Competition matters! Self-efficacy, effort, and performance in crowdsourcing teams	Dissanayake et al. (2019)
Mobile social media in inter-organizational projects: Aligning tool, task and team for virtual collaboration effectiveness	Zhang et al. (2018)
Understanding Interactions between Design Team Members of Construction Projects Using Social Network Analysis	Herrera et al. (2020)
Elevating the human experience (HX) through service research collaborations: introducing ServCollab	Fisk et al. (2020)
A continuous improvement approach to social and emotional competency measurement	Davidson et al. (2018)
Information Support of Scientific Researches of Virtual Communities on the Platform of Cloud Services	Artem et al. (2019)
A social network perspective of building information modelling in Greek construction projects	Badi & Diamantidou (2017)
A sustainable sociocultural combination of building information modeling with integrated project delivery in a social network perspective	Maskil-Leitan & Reychav (2018)
CultureLabs: Cultural heritage and digital technology at the service of social innovation.	Kaldeli et al. (2019)

Table 4 – Research proposals and future studies of the twelve most cited papers

(Continued)

Citations[a]	Purpose or Research Question	Methodology and approaches
127	Investigates the development of a BIM governance framework (G-BIM) with support of Cloud technologies	Survey
98	Discuss the merit of using a no-model approach (no common product models or ontologies, etc.) for managing information in the AEC	Theoretical paper
82	Explore how to facilitate the sharing of high-quality knowledge in a virtualglobal project team context.	Case Study (Multiple)
50	The question is whether competition is a key crowdsourcing characteristic that influences how teams allocate their effort.	Survey
49	Posits that how well team-tool, task-tool and team-task relationships are handled shape virtual collaboration effectiveness.	Survey
39	Understand the interactions in the design teams of construction projects using Social network analysis metrics.	Theoretical paper
36	Elevating the human experience through research collaborations is the purpose of this article.	Theoretical paper
30	Develop a self-reportmeasure of student social and emotional competency to identify at-risk students.	Survey
30	Creating a system of informational scientific research conducted by virtual research teams.	Theoretical paper
28	A comparative study of two construction projects in Greece: one that utilized BIM, and one that did not.	Case Study (Multiple)
27	Highlight the importance of implementing BIM as a social system.	Case Study (Unique)
27	CultureLabs aims to develop digital tools that can facilitate the organisation projects around cultural heritage.	Survey

Table 4 – Research proposals and future studies of the twelve most cited papers

(Conclusion)

Proposal for future studies	Theme[b]
Further socio-technical validation are to be done under real construction projects.	Social system (BIM)
Supporting innovating and virtualizing possibilities in the digital world before implementing them in the real world.	Knowledge sharing
Research, development, and innovation grow online. Social relationships also develop online.	Knowledge sharing
Study others crowdsourcing platforms, to examine how the self-efficacy-effort-performance relationship is enacted.	Knowledge sharing
Future studies can take such macro- and micro-level factors into account for a better understanding of the phenomenon.	Virtual collaboration
New types of interaction and new metrics can be added to analyze and understand the interactions of design teams.	Social network
Help us serve humanity through service research collaborations that reduce human suffering and improve human well-being	Virtual assistants
Future projects may examine the extent to which the current measure captures growth in SECs after interventions	Social competence
Establishing effective communication in conducting research on information provision of the virtual team.	Knowledge sharing
"Further work also needs to be done to establish whether BIM is influenced by the procurement route adopted."	Social system (BIM)
Adapting this BIM application model to a social network perspective may help improve the integration between them.	Social system (BIM)
Develop Social innovation via cultural heritage creates a whole new set of questions for humanities and technology.	Social innovation

Notes: a) The number of citations was extracted from the WoS and Scopus databases (2023.12.06)
b) The criteria for choosing the topics is its alignment with the objects of this research, it does not mean that they are the central themes of the paper
Source: the authors

Table 4 summarizes the research proposals and future studies from the twelve most cited papers. In addition to the primary themes of this research, we also examine the incidence of topics related to social systems (BIM) and knowledge sharing. Survey-based and theoretical paper approaches are the most common.

Table 5 summarizes the five literature reviews found in the sample, all recent research carried out in the last five years. We highlight the recurrence of themes: knowledge sharing, and social relationships (Social integration and social identity).

Table 5 – Research agendas proposed in five literature reviews found in this SLR

(Continued)

Paper title	Authors and year of publication	Purpose or Research Question
Trends in Social Network Research in Construction Teams: A Literature Review	Kereri & Harper, (2018)	Investigate trends in the use of social network analysis in construction management research.
What Do We Know About Hackathon Outcomes and How to Support Them? – A Systematic Literature Review	Medina Angarita & Nolte, (2020)	Systematic overview of the current state of the art about hackathon outcomes.
"Social Network Analysis in Software Development Projects: A Systematic Literature Review"	Schreiber & Zylka (2020)	Examines the importance of the application of social network analysis (SNA) in software development projects.
Toward an integrated theory of computer-mediated social interaction	Santucci (2021)	Describe an integration of the media naturalness theory, the continuum model of impression formation and the social identity model of deindividuation effects.
"From the periphery to the centre: a bibliometric review of global virtual teams as a new ordinary workplace"	Tavoletti & Taras, (2023)	Bibliometric analysis of the already substantial and growing literature on global virtual teams (GVTs).

Table 5 – Research agendas proposed in five literature reviews found in this SLR

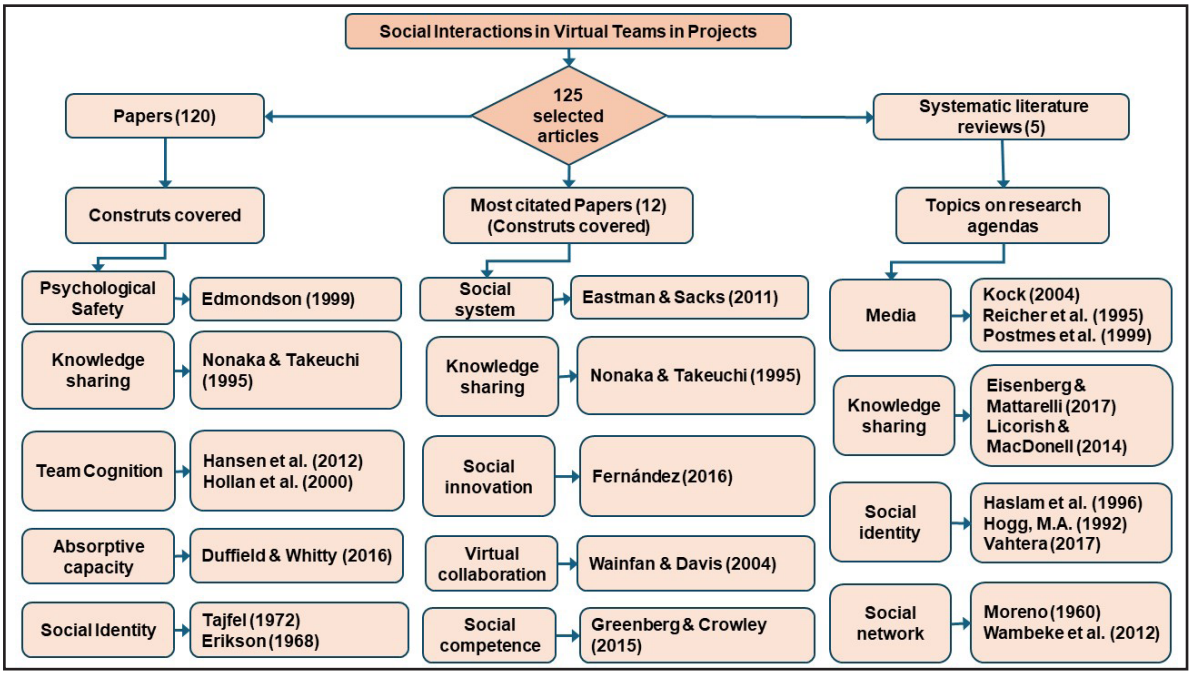
(Conclusion)

Methodology and approaches	Proposal for future studies	Theme[a]
Literature review, qualitative, descriptive	Further inquiries on the social behaviors that can influence interactions and interpersonal relationships between construction team parties	Social Integration in projects teams.
Literature review, qualitative, descriptive	An interview study with hackathon organizers, mentors, and participants to identify potential outcomes and design aspects that have not been addressed in previous research.	Knowledge sharing
Literature review, qualitative, descriptive	Additional research is needed regarding the identification of knowledge brokers and their importance in software projects.	Knowledge sharing
Literature review, qualitative, descriptive	The social identity model of deindividuation effects has yet to be tested with the specific intention of discovering how media characteristics affect selfconcept.	Social identity and media
Literature review, qualitative, descriptive	Provide frameworks and hints to form and manage GVTs that can combine both process advantage and the level of creativity needed in a global economy.	Social interactions

Note: a. The criteria for choosing the topic is its alignment with the subjects of this research, it can does not mean the central theme of the article.
Source: The authors (2024)

Figure 3 schematically summarizes the answer to the research question proposed in this study: What is the state of the art of social interactions in virtual project teams? It presents five recurring constructs identified across the 120 selected papers, the twelve most cited papers, and research proposals in five literature reviews, highlighting the recurring themes of social identity and knowledge sharing. Additionally, we emphasize that constructs originally developed for face-to-face teams have been adapted for use in virtual project teams.

Figure 3 – Summary of findings, answering the research question



Source: the authors (2024)

5 DISCUSSION

5.1 Full analysis

This research indicates that social interactions in virtual project teams positively impact project performance. Effective social practices in the virtual environment, characterized by interactivity and presence, create a positive cycle that enhances the likelihood of project success (Opdenakker & Cuypers, 2019). Although the number of publications on these themes is decreasing, they are distributed across several relevant journals (H index > 33) in business, management, accounting, and computer science. Conferences and symposiums account for 36.8% of the sample, suggesting significant relevance to the study of these topics.

The fact that 55% of the methodologies used are questionnaires and experiments, along with 43% qualitative approaches and 85% deductive studies, highlights the search for factors and characteristics related to the theme of this study (Table 2). In

the sample of 120 papers, five main constructs are concentrated: knowledge sharing, social identity, team cognition, psychological safety, and absorptive capacity (Table 3). The seminal authors cited in these papers originally developed their studies focusing on face-to-face teams, and these constructs are now applied to virtual teams (Table 4). However, when analyzing the five systematic reviews in the sample, we find that, although there is some alignment with the most discussed constructs, these reviews now cite authors who focus specifically on virtual teams.

5.2 Constructs covered

By researching social interactions and virtual project teams, we can build paths to develop mediated communication and create social bonds, leading to better performance and satisfaction (Ala-Kortesmaa & Muñoz, 2023). One way is to identify the factors that influence psychological safety (Edmondson, 1999) and project professionals' well-being in this context (Dzandu et al., 2023). Lechner and Mortlock (2022) warn us about the proactive effort required to cultivate such factors. It is also essential to understand the individualities of project workers and the peculiarities of the work, as both impact psychological safety in virtual teams (Lim, 2022). Specifically, in agile teams, recall Castro et al. (2022), psychological safety is built through openness to dialogue, absence of blame, collective decision-making, and leadership with ownership.

When members perceive a certain degree of psychological safety, they will likely be more open to speaking up, taking risks, and exchanging information (Hao et al., 2022). Knowledge sharing (Nonaka & Takeuchi, 1995) in virtual teams is developed based on trusting relationships (Chen et al., 2021) and collaborative interactions between members based on technical and social factors (Davidavičienė et al., 2020). Successful sharing will focus on trust, cultural diversity, technological tools for collaboration, communication, and leadership (Swart et al., 2022), job stability, organizational norms, integrity, and commitment (Chumg et al., 2022). Online media platforms facilitate this

relationship (Alsharo et al., 2017), involving effective routines for creating, transferring, retrieving, and applying knowledge (Olaisen & Revang, 2017).

Team cognition influences project management (Fiore et al., 2023), underlies team behaviors and attitudes, and improves team performance (Byrne & Eddy, 2023). Dispersed members and different time zones are challenges faced by virtual teams; however, as highlighted by Fachrunnisa et al. (2018), we must understand the relevance of team cognition and seek solutions to overcome them. Global teams benefit greatly from factors that promote team cognition, such as team diversity, knowledge heterogeneity, and collective learning potential (Florea & Stoica, 2019), thus developing absorptive capabilities (Duffield & Whitty, 2016). The organization and the team improve their abilities to acquire and assimilate new knowledge, increasing the teams' effectiveness (Bachmann et al., 2015).

Individual differences, cognition, and learning orientation positively influence the ability to acquire and retain knowledge in virtual project teams (Batarseh et al., 2018). Specifically, Lumseyfai (2020) teaches us that internal team diversity, both at a deep and functional level, positively impacts absorptive capabilities. Batarseh et al. (2018) reinforce that the specific characteristics of projects, such as scope, team perceptions, and time are antecedent conditions for an efficient absorption capacity.

5.3 Topics on research agendas

Media affect creative performance (Gibbs et al., 2021; Postmes et al., 2005) and collaboration effectiveness (Grözinger et al., 2020), contributing to the success of project management and the appreciation of virtual teams (Kaur et al., 2016; Zhang et al., 2018). Media are also associated with the construction of group identity (Haslam et al., 1996; Hogg, M.A., 1992; Vahtera, 2017), which is crucial in offline environments and improves both individual and collective results (Wilson et al., 2015). One way to build group identity in virtual teams is by developing a shared culture and identity that transcends physical and virtual boundaries (Von Thülen & Hartl, 2021), along with

effective leadership that manages this identity to prevent divisions (Lin et al., 2023). Another approach involves integrating cognitive concepts (Hansen et al., 2012; Hollan et al., 2000) to enhance the perception of team identity (Mayfield & Valenti, 2022).

Synthesizing the trends and research proposals from the sample of 120 papers (excluding the five literature reviews), we observed a recurring need for in-depth investigations into the impact of online communications on project tasks and socialization in project performance (Seetharaman et al., 2019). This includes a deeper exploration of conflict categorization (procedural, relational, and task) (Flus et al., 2023) and a clearer definition of how virtual teams establish effective routines for learning (Duffield & Whitty, 2016) and knowledge sharing (Eisenberg & Mattarelli, 2017; Licorish & MacDonell, 2014). From another perspective, Eslahchi (2022) highlights the unique opportunity to understand social interactions in virtual project teams and addresses the challenge of efficiently managing them.

In our specific analysis of the twelve most cited studies, we noted additional proposals. Alreshidi et al. (2017) stress the urgency of investigating collaboration, governance, and data management practices in greater depth. Artem et al. (2019) emphasize the need for research on non-technological integration factors, such as the coordination of social networks (BIM), including occupational backgrounds and varying interests. Badi and Diamantidou (2017) also highlight the need for systems integration, pointing out a gap in developing stakeholder management and social responsibility criteria. Herrera et al. (2020) demonstrate the lack of effective scientific communication associated with the exchange of scientific data among virtual team participants. Maskil-Leitan and Reychav (2018) call for more studies on stakeholders' heterogeneous and high-level needs, alongside functional requirements for digital platforms.

We observed alignments in the proposals raised in the reviews, such as Santucci (2021) advocating for greater empirical support for the social identity model across different media. This aligns with Seetharaman et al. (2019), who emphasize the need for a better understanding of socialization in virtual project teams. Similarly, the

review by Tavoletti and Taras (2023) proposes further research on computer-mediated collaboration, supporting Alreshidi et al. (2017) by highlighting the importance of studying collaboration practices in teams.

6 FINAL REMARKS

This research indicates that the constructs of knowledge sharing and social identity (associated with social competence) are key indicators of research trends concerning social interactions in virtual project teams. Regarding knowledge sharing, its relationship with psychological safety is evident (Edmondson, 1999). This suggests that future studies should explore this relationship further, as Swart et al. (2022) recommend. They show that incorporating psychological safety facilitates openness and sincerity among virtual team members, creating a positive environment conducive to generating new ideas. When team participants are psychologically empowered, a culture of knowledge sharing develops, which contributes to project success (Khan et al., 2022).

Another avenue for expanding our understanding of social relationships in virtual teams involves examining how the construction of social identity influences this dynamic. Although little is known about how social identity management and leadership contribute to a shared identity in virtual environments (Op 'T Roodt et al., 2021), Haslam et al. (2023) suggest that social identity plays a role in effective leadership development. The selective use of technology can hinder the development of social identity, as certain types of communication technologies (media) may restrict its growth (Stendal & Fuller, 2017), potentially leading to the exclusion of team members from critical communications.

A limitation of this research is that several articles do not propose future studies. Despite the broad search string, some studies may use similar semantic expressions and thus may not have been selected. Although the three authors conducted the sample selection independently, it is possible that some relevant studies were overlooked.

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Authors

1 – Laurival Siqueira Calçada Junior

Institution: Universidade Nove de Julho – SP, Brazil

Master in Project Management

Orcid: https://orcid.org/0000-0001-8545-480X

E-mail: laurivaljunior15@gmail.com

2 – Leonardo Vils

Institution: Universidade Nove de Julho – SP, Brazil

PhD in Business Administration

Orcid: https://orcid.org/0000-0003-3059-1967

E-mail: vilsleo@gmail.com

3 – Marcírio Chaves

Institution: Pontificia Universidade Católica do Rio Grande do Sul – RS, Brazil

PhD in Computer Science

Orcid: https://orcid.org/0000-0002-3554-0328

E-mail: marcirio.chaves@pucrs.br

Contribution of authors

Contribution	[Author 1]	[Author 2]	[Author 3]
1. Definition of research problem	√	√	√
2. Development of hypotheses or research questions (empirical studies)	√	√	√
3. Development of theoretical propositions (theoretical work)	√		
4. Theoretical foundation / Literature review	√	√	
5. Definition of methodological procedures	√		√
6. Data collection	√		
7. Statistical analysis	√	√	√
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9. Critical revision of the manuscript		√	√
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11. Other (please specify)			

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