Revisiting Process Virtualization: A Systematic Review of How Collaboration Tools Support Social Presence and Situation Awareness

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***Abstract*—Process Virtualization Theory (PVT) provides a framework for understanding the virtualization of work processes. Recent research underscores the importance of social presence and situation awareness — two critical IT characteristics that support remote interaction. Through a systematic literature review of 32 research articles, this paper examines how collaboration tools enhance virtual teamwork by fostering these IT characteristics, highlighting their role in trust, coordination, and interpersonal connection. Findings suggest that a strategic mix of synchronous and asynchronous communication strengthens both relational bonds and collective awareness. Thus, this paper extends PVT by showing how collaboration tools cultivate social presence and situation awareness, filling an important gap in digital transformation research.**

Keywords—digital transformation; virtual collaboration; process virtualization theory; collaboration tools.

I. INTRODUCTION

Virtual collaboration has become an integral part of organizational operations, driven by advancements in digital communication technologies and further accelerated by the COVID-19 pandemic. Virtual teams have evolved from a niche practice to a widespread organizational norm [1]. The transition from traditional office environments to remote and hybrid models has necessitated the virtualization of work processes, as defined by the Process Virtualization Theory (PVT) [2]. PVT assesses how physical processes translate to virtual settings.

The pandemic-induced shift to remote work challenged existing assumptions about the limitations of virtual processes, demonstrating that even knowledge work processes with high relational demands could be effectively virtualized [3]. This evolution from a temporary adjustment to a new post-pandemic digital era has opened opportunities to re-evaluate how digital tools can support not only operational efficiency but also the social and relational aspects of teamwork. Central to this discussion are the IT characteristics of social presence and situation awareness, which contribute to creating a sense of interpersonal connection and maintaining contextual understanding within remote teams.

Through a systematic literature review, this paper shows how digital communication tools enhance social presence and situation awareness in virtual collaboration, thus contributing to digital transformation research with strategies for remote work. By examining how technology facilitates virtual interactions, this research contributes to the broader discourse on optimizing digital collaboration for the evolving needs of virtual teams.

Following this introduction, Section II anchors the study in PVT and synthesizes prior work on social presence and situation awareness that motivates the review. Section III specifies the systematic review protocol — databases queried, selection criteria, and qualitative analysis — ensuring methodological rigor. Section IV reports the findings in three parts: how collaboration tools foster social presence, how they enhance situation awareness, and finally, how trust links these two mechanisms. Additionally, limitations are addressed. Section V concludes with theoretical and managerial implications and directions for future research.

II. BACKGROUND

A virtual team is defined as a group of individuals who collaborate toward a shared goal while being geographically dispersed, relying primarily on digital technologies to coordinate their work and overcome spatial, temporal, and organizational boundaries [4]. Over the past few decades, growing numbers of employees have worked fully or partially remotely, indicating a steady rise in virtual collaboration [1]. The COVID-19 pandemic, coupled with mandatory remote work policies, accelerated the shift toward both remote and hybrid team structures [5]. As a result, most organizations today exhibit some degree of virtuality, making it increasingly difficult to draw clear distinctions between virtual and non-virtual teams [6].

The virtualization of work processes is a fundamental prerequisite for enabling remote collaboration. PVT provides a theoretical framework for analyzing the digital transformation of business processes by examining the extent to which physical processes can be effectively replicated in virtual environments [2]. At the core of PVT lies the concept of process virtualizability, which determines how well a process can be executed without reliance on physical interactions between individuals or individuals and objects. This concept plays a crucial role in guiding organizations through digital transformation by identifying which processes are most suited for virtualization [7]. Four constructs determine whether a process can be effectively virtualized: sensory, relationship, synchronization, as well as identification and control requirements [2][7]. ‘Sensory requirements’ address the need to replicate physical experiences; ‘relationship requirements’ emphasize personal and social interactions; ‘synchronization requirements’

ensure timely, real-time or sequential execution; and 'identification and control requirements' manage identity verification and oversight mechanisms. These factors negatively affect virtualizability, meaning that as their importance increases, the feasibility of virtualization decreases [2].

PVT's core model highlights three information technology (IT) characteristics that moderate process virtualization. IT characteristics are 'representation', which ensures that virtual processes accurately simulate their physical counterparts; 'reach', which extends accessibility by enabling location-independent participation; and 'monitoring capability', which provides oversight and ensures compliance through remote activity tracking. Building upon these principles, recent research has expanded the application of PVT across various domains. Studies have examined the barriers to process virtualization in remote work environments, revealing that sensory and synchronization requirements often limit the effectiveness of virtualized processes [8]. Further research extends PVT with e-commerce attributes [9] and participant-related factors [10].

The COVID-19 pandemic has provided a unique context for re-evaluating PVT through a crisis-driven perspective [3]. The global health crisis necessitated the rapid virtualization of knowledge work processes, many of which had previously been resistant to digital transformation. As a result of this accelerated transformation, virtualizability evolved from a dependent variable to a determining factor in the fulfillment of process requirements. Organizations increasingly relied on IT characteristics to address these virtualization challenges, leveraging digital tools to simulate sensory elements, facilitate relationship-building, support synchronous interactions, and enhance monitoring capabilities. In this revised understanding of PVT, two additional IT characteristics — social presence and situation awareness — were identified, which further contribute to the effective virtualization of knowledge work processes. Social presence refers to the ability of IT to create a sense of interpersonal connection in virtual settings. The Social Presence Theory states that the degree of perceived psychological and emotional connection between individuals in a mediated communication environment influences the effectiveness and quality of interactions [11][12]. It emphasizes how communication technologies vary in their ability to convey social cues in virtual settings.

Situation awareness — essentially "knowing what is going on" [13] — centers on perceiving relevant context information, interpreting its meaning, and anticipating its future development. When shared among team members, this becomes team situational awareness [3], a collective view of conditions, implications, and likely trajectories that is vital for the relational demands of remote work.

The pandemic has challenged the notion that processes can only be virtualized to a limited extent, as the empirical reality of widespread remote work has shown that IT can indeed support the social aspects of collaboration in virtual teams. While some critiques have underscored that many recommendations overlooked the involuntary nature of pandemic-related remote work [14], now, in the post-pandemic digital era, the urgency to virtualize has receded. This transition creates an opportunity to reflect on progress made in remote collaboration and to reevaluate the potential of collaboration tools through the lens of social presence and situation awareness. Both of these IT characteristics present innovative pathways for understanding how virtual environments can foster not only operational efficiency but also the interpersonal and contextual dimensions of teamwork.

III. METHOD

To gain insights and a wider understanding of the contribution of collaboration tools to social aspects of virtual collaboration, this paper draws on existing literature. This systematic review analyses how digital communication tools shape social presence and situation awareness in virtual teams, addressing the following research questions:

RQ1: In what ways do digital collaboration tools foster social presence in remote settings?

RQ2: In what ways do digital collaboration tools enhance situation awareness in remote teams?

A. Search Strategy

The review applied the structured approach of [15] to address the research questions. The review scope was defined as a summary of previous research activities and their underlying theories on remote work, collaboration tools, and virtual team collaboration [16]. The research covered several relevant databases (ACM, EBSCO, Emerald, IEEE, Science Direct, Springer). The systematic search combined the keywords "collaboration tool," "new work," "remote work," "hybrid work," "team cohesion," "social bonding," "group cohesion," "sense of community," and "virtual team dynamics" with Boolean AND/OR operators to ensure comprehensive, relevant results. Figure 1 summarizes the four-iteration review process and the resulting study counts as proposed by [17].

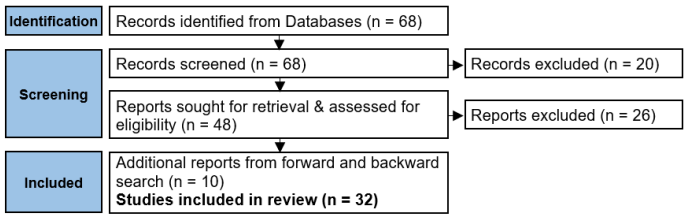

Figure 1: Review Process.

A database search using the predefined terms was followed by abstract screening based on the criteria in Table I, full-text review using the same exclusions, and forward and backward citation tracking, adding ten articles and yielding 32 eligible studies.

TABLE I: EXCLUSION CRITERIA

Exclusion Criteria	• Published before 2010. • No use of collaboration tools. • Focus on teams without a degree of virtuality. • Articles in any other language as German and English.

B. Data Analysis

The collected data was analyzed using qualitative content analysis [18]. Recurring themes and patterns were identified that shed light on key factors in the use and effectiveness of collaboration tools for supporting social presence and situation awareness.

Social presence is understood as the degree to which digital communication tools facilitate awareness of the other person and interpersonal relationships during interaction [11]. Accordingly, the category of 'interpersonal relationship/team cohesion' is used. In addition, the review also looks at the concepts of 'collaboration' and 'community/belonging'.

Situation awareness refers to the collective understanding of work dynamics within a team. It is promoted through the provision of information within the team and identified accordingly through the concept of 'knowledge exchange'. In addition, it is primarily shaped by 'informal communication' — accordingly, this forms a further concept.

From the analysis, 'trust' emerged as a relevant concept that is crucial for effective virtual collaboration, so this concept is also taken up in the analysis. The appendix presents the resulting concept matrix, which analyzes the literature and classifies it by research design and type of tool mentioned.

C. Limitations

Although this review followed a structured protocol across multiple databases, the reliance on a single researcher remains a significant limitation. Potential selection bias might have affected the breadth and inclusivity of identified studies, as different reviewers could have interpreted inclusion and exclusion criteria differently or identified additional relevant publications. Moreover, focusing on specific search terms may have overlooked research addressing remote collaboration from adjacent perspectives (e.g., organizational psychology, workplace design). Together, these factors could limit the generalizability of the findings and should be considered when interpreting the results.

IV. FINDINGS

A descriptive summary of the findings regarding social presence, situation awareness, and trust is presented below.

A. Social Presence

Social presence is a critical factor in virtual collaboration. Many studies emphasize that digital platforms can be designed to foster the feeling of togetherness typically experienced in face-to-face settings. Synchronous communication tools, such as video conferencing and instant messaging, have been found to be particularly effective at cultivating social presence by enabling immediate, reciprocal interaction and conveying rich social cues (e.g., facial expressions and gestures), all of which are vital for establishing and maintaining interpersonal bonds [19][20]. Immersive digital environments, such as virtual workspaces and avatars, can further strengthen this sense of connection by simulating physical co-presence, thereby enhancing engagement and team cohesion [21][22]. For instance, the platform Gather lets remote colleagues initiate spontaneous interactions by virtually approaching one another [22]. This ability for rapid, informal encounters can mitigate the isolation that often arises in remote settings [20][23][24].

The Embodied Social Presence Theory (ESPT) suggests that virtual workspaces should replicate key aspects of physical interaction to improve communication, particularly by enabling participants to interpret nonverbal signals even in digital environments [21]. Through the use of synchronous video tools and virtual reality platforms, ESPT's focus on embodied co-presence reduces ambiguity in remote interactions and reinforces interpersonal relationships.

Some authors emphasize that organizational culture and shared values can be reinforced through collaboration tools when they are used for team-building events, recognition programs, and personal updates [25]. Similarly, planned informal interactions can improve social presence by compensating for the lack of casual conversations in the corridor [26]; teams that allocate time for social check-ins tend to feel more aligned and engaged. Studies further highlight the importance of intentional, well-structured digital communication to replicate the camaraderie of co-located offices [27][28]. Frequent touchpoints, such as virtual coffee chats and informal Slack channels, help remote employees preserve a communal sense of identity [23][26]. Meanwhile, personalized introductions — including Asynchronous Semi-Guided Professional Introductions (ASGPIs) — facilitate the exchange of personal and professional information, thereby strengthening interpersonal connections [20].

It is also recognized that even asynchronous tools can support social presence by enabling indirect reciprocity and sustained connections over time, yet their overall impact is constrained by the absence of immediate interaction and emotional engagement [21]. However, studies indicate that an overreliance on asynchronous communication can lead to feelings of social isolation and a reduced sense of belonging, particularly in teams that lack prior face-to-face interactions [25]. The literature stresses that choosing the right mix of synchronous and asynchronous channels is vital for sustaining high-quality interactions [24][29]. Platforms, such as Slack, Teams, Gather, or Zoom, allow for both project-focused conversations and casual "break room" chats [30]. This multimodal approach ensures that teams can adapt their communication methods to both the complexity and urgency of tasks [19]. Well-timed, media-rich interactions, like video-based calls early in a team's lifecycle, foster personal rapport, while text-based channels and shared documents suffice for routine status updates [29][31]. This provides a direct link and a transition to situation awareness.

B. Situation Awareness

While social presence fosters emotional connection, situation awareness centers on the ability to stay informed about colleagues' work progress, needs, and challenges in real time, essential for coordinating team efforts and ensuring alignment. While traditional offices often rely on spontaneous observations and overheard conversations [32],

remote work environments lack these spontaneous exchanges and must adopt purposeful strategies to maintain comparable levels of context [33]. The inability to observe colleagues' work activities or engage in impromptu discussions often leads to knowledge silos and reduced collaboration efficiency [34]. In addition, [35] found that virtual team members often hesitate to seek help because problems are harder to explain and responses are slower. To counteract these effects, many teams have adapted their communication practices by integrating asynchronous chat tools, such as Slack, which facilitate real-time knowledge exchange despite physical separation [26]. Tools, such as email, shared documents, and discussion forums, contribute to collaboration by supporting structured information exchange and enabling parallel collaboration [19][36].

It is underlined that knowledge sharing keeps remote teams aligned and efficient [37]. Similarly, [24] argues that social support, which includes knowledge-sharing practices, strengthens connectivity and reduces workplace stress, fostering a more cohesive understanding of team dynamics. Furthermore, [36] describes that mutual exchange of knowledge builds trust and reinforces collective competence. The authors highlight the significance of informal knowledge exchange in virtual environments, where psychological safety plays a crucial role in facilitating open discussions and information flow. For example, short, informal encounters or informal side chats during official meetings allow members to ask quick questions, seek clarifications, or exchange immediate feedback, much as they might in the physical workspace [26][34]. Additionally, these ongoing knowledge exchanges, whether over group messaging or video calls, counteract the risk of isolation and misalignment [26][31].

According to [29], well-structured check-ins and routine status updates via shared platforms help team members anticipate when others might need assistance. This transparency not only aids productivity but can also reduce stress and foster mutual trust, as teams learn to predict and fill potential gaps [27][29][38]. This more flexible backup behavior can also be enabled by "total information awareness" — circulating relevant communications to all team members, even those not directly involved [39]. Such communication practices are linked to outcomes like improved team performance [36], while consistent rules, norms, and leadership behaviors can further reinforce positive team functioning in virtual contexts [28][40][41]. However, [35] emphasizes that virtual teams must deliberately invest in relationship-building. For example, proactively introducing newcomers through informal sessions can foster familiarity even faster than in co-located teams.

C. Trust

Trust is a fundamental prerequisite for the effectiveness of virtual teams, closely linked to social presence and situation awareness. Occasional face-to-face meetings or richer social engagement can significantly enhance trust. Even a brief in-person kickoff fosters early trust that carries into online collaboration [42]. When in-person interaction is not feasible, virtual teambuilding events, informal chats, or open channels can help create spontaneous bonding moments, reinforcing interpersonal connections [35][43]. Then, technology must support both task-related and relational exchanges to facilitate trust [44]. Trust and team cohesion are highly interdependent: When early trust is established, cohesive collaboration develops more easily, whereas low initial trust complicates maintaining unity across geographic and temporal divides [42]. Similarly, [38] highlights that without deliberate efforts to foster socio-emotional bonds, relationships between subordinates and managers can deteriorate in purely virtual settings, further undermining trust.

In the context of social presence, shared emotional cues, authentic self-disclosure, and informal interactions foster affective trust. High-synchronicity media convey nonverbal cues that help team members assess intentions, while excessive asynchronous text communication can undermine trust due to misinterpretation [19]. A well-balanced media strategy that supports both structured collaboration and spontaneous social contact strengthens trust at the group level [30][36].

From a situation awareness perspective, low trust hampers information flow, as individuals hesitate to disclose difficulties or seek help in perceived hostile environments. Weak trust discourages transparent data sharing due to fears of appearing incompetent or misusing sensitive information [39]. Conversely, high-trust teams proactively coordinate, offer support, and monitor emerging challenges, enhancing performance in remote settings [29][42]. At the leadership level, trust mitigates the "invisibility problem" in remote work, enabling fair treatment, nonintrusive oversight, and accountability without micromanagement [14][38][45].

In sum, while social presence creates the emotional conditions under which trust thrives, situation awareness ensures that group members have enough insight into one another's actions and challenges to uphold a trustworthy, dependable workflow. Tying these two elements together, trust becomes the linchpin that channels technological affordances into truly cohesive remote teamwork

V. Conclusion and Future Work

This research demonstrates that thoughtful applied collaboration tools can replicate many of the relational and informational aspects of co-located work. Key strategies include informal virtual gatherings, immersive technologies, and personalized introductions that foster interpersonal connection [20][21][26]. Transparent communication and leadership support, through regular check-ins and structured feedback, are equally important for cultivating trust and reinforcing a supportive organizational culture [28][46]. Teams benefit from structured yet informal exchanges and real-time collaboration platforms that sustain project visibility and cohesive teamwork [26][34].

Nevertheless, technology remains only one pillar; clearly defined channel norms, active leadership, and periodic face-to-face encounters are still necessary to deepen trust and creativity, making hybrid collaboration the most resilient operating model [14][27][32][42][47][48].

Practitioners should adopt platforms that combine rich real-time interaction with asynchronous flexibility and embed visibility features — presence indicators, shared task boards, and sentiment dashboards — to increase situation awareness and social presence [27][32][49].

Tool developers should design configurable mixed-synchronicity architectures and trust-enhancing affordances, such as privacy-aware analytics and seamless transitions between immersive and text modes. This will allow teams to adjust interaction richness as projects evolve [48].

Future research opportunities lie in controlled and longitudinal experiments that go beyond description to isolate the causal effects of specific platform features on outcomes such as trust building, knowledge sharing, and team performance [29]. Comparative studies across industries and cultural contexts, supplemented by in-situ and neurophysiological measures, could further reveal boundary conditions of PVT and illuminate how social presence and situation awareness dynamically co-evolve. Advancing these agendas will yield collaboration ecosystems that not only virtualize processes but actively cultivate the human connections on which effective teamwork depends.

REFERENCES

[1] J. M. Barrero, N. Bloom, and S. J. Davis, "The Evolution of Work from Home," *Journal of Economic Perspectives*, vol. 37, no. 4, pp. 23–49, Nov. 2023, doi: 10.1257/jep.37.4.23

[2] E. Overby, "Process Virtualization Theory and the Impact of Information Technology," *Organization Science*, vol. 19, no. 2, pp. 277–291, Mar. 2008, doi: 10.1287/orsc.1070.0316

[3] A. Zeuge *et al.*, "Crisis-driven digital transformation as a trigger for process virtualization: Fulfilling knowledge work process requirements for remote work," *International Journal of Information Management*, vol. 70, 102636, Jun. 2023, doi: 10.1016/j.ijinfomgt.2023.102636

[4] J. Lipnack and J. Stamps, "Virtual teams: The new way to work," *Strategy & Leadership*, vol. 27, no. 1, pp. 14–19, Jan. 1999, doi: 10.1108/eb054625

[5] M. Sako, "From remote work to working from anywhere," *Commun. ACM*, vol. 64, no. 4, pp. 20–22, Apr. 2021, doi: 10.1145/3451223

[6] S. Zheng *et al.*, "Understanding the positive and negative effects of team virtuality: A theoretical review and research agenda," *Human Resource Management Review*, vol. 34, no. 2, 101013, Jun. 2024, doi: 10.1016/j.hrmr.2024.101013

[7] E. Overby, "Migrating Processes from Physical to Virtual Environments: Process Virtualization Theory," in *Information Systems Theory*, Y. K. Dwivedi, M. R. Wade, and S. L. Schneberger, Eds., in Integrated Series in Information Systems, vol. 28. New York, NY: Springer New York, 2012, pp. 107–124. doi: 10.1007/978-1-4419-6108-2_6

[8] Y. Feng, J. Park, and M. Feng, "What is holding back business process virtualization in the post-COVID-19 era? Based on process virtualization theory (PVT)," *Front. Psychol.*, vol. 14, Feb. 2023, doi: 10.3389/fpsyg.2023.1084180

[9] M. Barth and D. Veit, "Which Processes Do Users Not Want Online? Extending Process Virtualization Theory," *ICIS 2011 Proceedings*, Dec. 2011.

[10] B. Balci and C. Rosenkranz, "'Virtual or material, What do You Prefer?' a Study of Process Virtualization Theory," *ECIS 2014 Proceedings*, Jun. 2014.

[11] J. Fulk, J. Schmitz, and C. W. Steinfeld, "A Social Influence Model of Technology Use," in *Organizations and Communication Technology*, Newbury Park, London, New Delhi: Sage Publications, 1990.

[12] J. Short, E. Williams, and B. Christie, "The social psychology of telecommunications." John Wiley, 1976.

[13] M. R. Endsley, "Toward a Theory of Situation Awareness in Dynamic Systems," *Hum Factors*, vol. 37, no. 1, pp. 32–64, Mar. 1995, doi: 10.1518/001872095779049543

[14] S. Torres and M. A. Orhan, "How it started, how it's going: Why past research does not encompass pandemic-induced remote work realities and what leaders can do for more inclusive remote work practices," *Psychology of Leaders and Leadership*, vol. 26, no. 1, pp. 1–21, 2023, doi: 10.1037/mgr0000135

[15] J. vom Brocke *et al.*, "Reconstructing the giant: On the importance of rigour in documenting the literature search process," in *17th European Conference on Information Systems, ECIS 2009*, 2009, pp. 2206–2217.

[16] H. M. Cooper, "Organizing knowledge syntheses: A taxonomy of literature reviews," *Knowledge in society*, vol. 1, no. 1, pp. 104–126, Jan. 1988.

[17] M. J. Page *et al.*, "The PRISMA 2020 statement: an updated guideline for reporting systematic reviews," *BMJ*, n71, Mar. 2021, doi: 10.1136/bmj.n71

[18] U. Kuckartz, *Qualitative Inhaltsanalyse. Methoden, Praxis, Computerunterstützung (Qualitative content analysis. Methods, practice, computer support)*, 4., Überarbeitete Aufl. in Grundlagentexte Methoden. Weinheim: Beltz, 2018.

[19] O. Torro, H. Pirkkalainen, and H. Li, "Media synchronicity in organizational social exchange," *ITP*, vol. 35, no. 8, pp. 162–180, Dec. 2022, doi: 10.1108/ITP-06-2020-0384

[20] G. C. Muresan, S. Mititelu, J. Andres, and M. C. Schraefel, "'Should I Introduce myself?': Asynchronous semi-guided professional introductions for enhanced perceived team effectiveness in new virtual dyadic teams," *International Journal of Human-Computer Studies*, vol. 188, 103279, Aug. 2024, doi: 10.1016/j.ijhcs.2024.103279

[21] J. Yang and H. Fang, "Integrating Embodied Social Presence Theory and Process Virtualization Theory to assess business process virtualizability: The mediating role of embodied co-presence," *PLoS ONE*, vol. 19, no. 6, e0305423, Jun. 2024, doi: 10.1371/journal.pone.0305423

[22] L. Okpara, C. Werner, A. Murray, and D. Damian, "The role of informal communication in building shared understanding of non-functional requirements in remote continuous software engineering," *Requirements Eng*, vol. 28, no. 4, pp. 595–617, Dec. 2023, doi: 10.1007/s00766-023-00404-z

[23] S. Bilderback and M. D. Kilpatrick, "Global perspectives on redefining workplace presence: the impact of remote work on organizational culture," *JEET*, vol. 4, no. 1, pp. 62–72, Oct. 2024, doi: 10.1108/JEET-08-2024-0023

[24] K.-L. Tan *et al.*, "Beyond laptops and tables: unveiling Singapore's success in hybrid work through a two-wave gender multigroup analysis of compassionate leadership," *ER*, vol. 47, no. 1, pp. 148–172, Jan. 2025, doi: 10.1108/ER-02-2024-0108

[25] A. Asatiani and L. Norström, "Information systems for sustainable remote workplaces," *The Journal of Strategic Information Systems*, vol. 32, no. 3, 101789, Sep. 2023, doi: 10.1016/j.jsis.2023.101789

[26] A. Whillans, L. Perlow, and A. Turek, "Experimenting during the shift to virtual team work: Learnings from how teams adapted their activities during the COVID-19 pandemic," *Information and Organization*, vol. 31, no. 1, 100343, Mar. 2021, doi: 10.1016/j.infoandorg.2021.100343

[27] E. De Bruyne and D. Gerritse, "Exploring the future workplace: results of the futures forum study," *JCRE*, vol. 20, no. 3, pp. 196–213, Nov. 2018, doi: 10.1108/JCRE-09-2017-0030

[28] C. Mayer, T. Sivatheerthan, S. Mütze-Niewöhner, and V. Nitsch, "Sharing leadership behaviors in virtual teams: effects of shared leadership behaviors on team member satisfaction and productivity," *TPM*, vol. 29, no. 1/2, pp. 90–112, Feb. 2023, doi: 10.1108/TPM-07-2022-0054

[29] L. L. Gilson, P. Costa, T. A. O'Neill, and M. T. Maynard, "Putting the 'TEAM' back into virtual teams," *Organizational Dynamics*, vol. 50, no. 1, 100847, Jan. 2021, doi: 10.1016/j.orgdyn.2021.100847

[30] C. Miller *et al.*, "'How Was Your Weekend?' Software Development Teams Working From Home During COVID-19," in *2021 IEEE/ACM 43rd International Conference on Software Engineering (ICSE)*, May 2021, pp. 624–636. doi: 10.1109/ICSE43902.2021.00064

[31] A. Alaiad, Y. Alnsour, and M. Alsharo, "Virtual Teams: Thematic Taxonomy, Constructs Model, and Future Research Directions," *IEEE Transactions on Professional Communication*, vol. 62, no. 3, pp. 211–238, Sep. 2019, doi: 10.1109/TPC.2019.2929370

[32] M. Landowski *et al.*, "Beyond Hallway Chats ? Negotiating Content Awareness in Hybrid Work Practices," in *Proceedings of Mensch und Computer 2024*, Karlsruhe Germany: ACM, Sep. 2024, pp. 508–513. doi: 10.1145/3670653.3677523

[33] T. Losev, S. Storteboom, S. Carpendale, and S. Knudsen, "Distributed Synchronous Visualization Design: Challenges and Strategies," in *2020 IEEE Workshop on Evaluation and Beyond - Methodological Approaches to Visualization (BELIV)*, Salt Lake City, UT, USA: IEEE, Oct. 2020, pp. 1–10. doi: 10.1109/BELIV51497.2020.00008

[34] B. Viererbl, N. Denner, and T. Koch, "'You don't meet anybody when walking from the living room to the kitchen': informal communication during remote work," *JCOM*, vol. 26, no. 3, pp. 331–348, Aug. 2022, doi: 10.1108/JCOM-10-2021-0117

[35] A. Lechner and J. Tobias Mortlock, "How to create psychological safety in virtual teams," *Organizational Dynamics*, vol. 51, no. 2, 100849, Apr. 2022, doi: 10.1016/j.orgdyn.2021.100849

[36] M. Mahtta *et al.*, "A pathway to virtual team performance in the New Normal paradigm," *JOEPP*, vol. 9, no. 4, pp. 549–571, Sep. 2022, doi: 10.1108/JOEPP-11-2020-0218

[37] I. Wahl, D. Wolfgruber, and S. Einwiller, "Mitigating teleworkers' perceived technological complexity and work strains through supportive team communication," *CCIJ*, vol. 29, no. 3, pp. 329–345, Apr. 2024, doi: 10.1108/CCIJ-05-2023-0061

[38] T. D. Golden and A. Fromen, "Does it matter where your manager works? Comparing managerial work mode (traditional, telework, virtual) across subordinate work experiences and outcomes," *Human Relations*, vol. 64, pp. 1451–1475, Nov. 2011, doi: 10.1177/0018726711418387

[39] J. V. Dinh *et al.*, "Developing team trust: Leader insights for virtual settings," *Organizational Dynamics*, vol. 50, no. 1, 2021, doi: 10.1016/j.orgdyn.2021.100846

[40] E. Raguseo, L. Gastaldi, and P. Neirotti, "Smart work: Supporting employees' flexibility through ICT, HR practices and office layout," *EBHRM*, vol. 4, no. 3, pp. 240–256, Dec. 2016, doi: 10.1108/EBHRM-01-2016-0004

[41] S. A. Newman and R. C. Ford, "Five Steps to Leading Your Team in the Virtual COVID-19 Workplace," *Organ Dyn*, vol. 50, no. 1, 100802, 2021, doi: 10.1016/j.orgdyn.2020.100802

[42] R. Paul, J. R. Drake, and H. Liang, "Global Virtual Team Performance: The Effect of Coordination Effectiveness, Trust, and Team Cohesion," *IEEE Transactions on Professional Communication*, vol. 59, no. 3, pp. 186–202, Sep. 2016, doi: 10.1109/TPC.2016.2583319

[43] A. S. L. De Andrade, V. Jackson, R. Prikladnicki, and A. Van Der Hoek, "On meetings involving remote software teams: A systematic literature review," *Information and Software Technology*, vol. 175, 107541, Nov. 2024, doi: 10.1016/j.infsof.2024.107541

[44] L. S. Müller, S. Reiners, J. Becker, and G. Hertel, "Long-term effects of COVID-19 on work routines and organizational culture – A case study within higher education's administration," *Journal of Business Research*, vol. 163, 113927, Aug. 2023, doi: 10.1016/j.jbusres.2023.113927

[45] L. Chernyak-Hai and E. Rabenu, "The New Era Workplace Relationships: Is Social Exchange Theory Still Relevant?," *Ind. Organ. Psychol.*, vol. 11, no. 3, pp. 456–481, Sep. 2018, doi: 10.1017/iop.2018.5

[46] K. Tworek, "E-leadership shaped by IT adaptability through Employees' Dynamic Capabilities," *Procedia Computer Science*, vol. 225, pp. 357–365, 2023, doi: 10.1016/j.procs.2023.10.020

[47] M. Marinho *et al.*, "Happier and further by going together: The importance of software team behaviour during the COVID-19 pandemic," *Technology in Society*, vol. 67, 101799, Nov. 2021, doi: 10.1016/j.techsoc.2021.101799

[48] R. Gong and M. Hua, "Designing Multimodal User Interfaces for Hybrid Collaboration: A User-Centered Approach," in *HCI International 2023 – Late Breaking Papers*, M. Kurosu, A. Hashizume, A. Marcus, E. Rosenzweig, M. M. Soares, D. Harris, W.-C. Li, D. D. Schmorrow, C. M. Fidopiastis, and P.-L. P. Rau, Eds., in Lecture Notes in Computer Science, vol. 14054. Cham: Springer Nature Switzerland, 2023, pp. 67–82. doi: 10.1007/978-3-031-48038-6_5

[49] L. Liu, H. Van Essen, and B. Eggen, "An exploratory study of how to design interventions to support informal communication in remote work," in *Nordic Human-Computer Interaction Conference*, Aarhus Denmark: ACM, Oct. 2022, pp. 1–10. doi: 10.1145/3546155.3546673

APPENDIX

TABLE A: CONCEPT MATRIX.

	Classification		Concepts					
Article	Research Design	Tool-Types mentioned	Social Presence			Situation awareness		Trust
			Interpersonal Relationship/ Team Cohesion	*Collaboration*	*Community/ belonging*	*Knowledge exchange*	*Informal Communication*	
[14]	REV	Vid, Pl	x		x		x	x
[19]	REV + CON	VR,Vid,Ch	x	x	x			x
[20]	CON	Vid, Pl	x	x	x	x	x	x
[21]	CON	Pl	x		x			
[22]	Q	VR, Vid, Ch, Pl	x	x	x		x	
[23]	CON	Pl	x		x		x	
[24]	QU	Vid, Ch	x		x	x		x
[25]	REV	Pl, Em	x		x	x	x	x
[26]	Q	Vid, Ch, Em	x				x	
[27]	Q	Pl	x	x	x		x	
[28]	QA	ND	x	x	x			x
[29]	REV	Vid, Ch, Pl, Em					x	x
[30]	QM	Ch, NT	x				x	
[31]	REV	VR, Vid, Ch, Pl, Em	x	x		x		x
[32]	Q	VD	x				x	
[33]	Q	Vid, Ch, Pl, Ph	x	x				x
[34]	Q	Vid, Ch, Em, Ph	x		x		x	
[35]	Q	VR, Vid, Ch, Em	x			x	x	x
[36]	Q	Vid, PL	x	x		x		x
[37]	QU	Vid, Ch, Pl, Em, Ph				x		x
[38]	QU	Em, Ph, ND	x				x	x
[39]	REV + Q	Vid, Em	x	x	x		x	x
[40]	QM	ND		x	x			
[41]	CON	Vid, Ch, Pl, Em, Ph	x	x	x		x	x
[42]	REV + QU	Vid, Ch, Pl, Em	x					x
[43]	RE	VR, Vid, Ch, Pl, Em	x	x	x		x	x
[44]	Q	Vid, Ch, Pl, Em, Ph	x	x		x		x
[45]	CON	Pl						x
[46]	QU	Vid, Ch, Pl		x	x	x		
[47]	QU	Vid, Ch, Pl,	x	x			x	
[48]	CON	Vid, Ch, Pl, Em, Ph	x	x				x
[49]	Q + CON	Vid, Ch					x	
Σ *(Research Design/ Tool-Types/ Segments with concept)*	Q = 10 CON = 8 REV = 7 QU = 6 **QM = 2** **EXP = 0**	Vid = 22 Pl = 18 Em = 13 Ch= 15 Ph = 7 **VR = 5** ND = 3	85	28	36	16	106	53

Classification legend:
Research Design: Q = Qualitative, QU = Quantitative, QM = Mixed, EXP = Experiment, REV = Review/Meta-Analysis, CON = Conceptional/Design Science
Tool-Type: VR = Virtual Reality, Vid = Video, Ch = Chat, Pl = Platform-Suite, Em = e-mail, Ph = Phone, ND = not defined