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Mapping The Evolution Of Virtual Collaboration through Systematic Literature Review

Anchal Kukreti
Doctoral Scholar, School of Business UPES, Dehradun, India Email: anchal.107519@stu.upes.ac.in

Raj K. Kovid
Professor, School of Business, UPES, Dehradun, India E-mail: kovidrk@gmail.com ORCID ID: https://orcid.org/0000-0001-5224-0725

Abstract:
Virtual team collaboration allows businesses to work with skilled people from anywhere, saving time and costs. It also increases flexibility and boosts productivity, but the Virtual collaboration between team members has not been thoroughly examined. The PRISMA method was used to identify 75 empirical publications from the Scopus database that are included in this systematic review. After identifying the most well-known nations, journals, authors, and keywords through bibliometric analysis, we employed the TCCM framework to obtain a more thorough understanding. The synthesis encompasses different ideas, traits, settings, and approaches. Managers, strategists, and leaders will gain a thorough understanding of the work done on virtual collaboration from this study. Organisations can advance toward the attainment of virtual team collaboration by following the theoretical, contextual, empirical, and methodological directions provided under the future research agenda.

Keywords: Virtual Collaboration, Systematic Literature Review, TCCM, Remote Work, Bibliometric

1. Introduction

Businesses are increasingly using virtual teams (VTs) because of technological advancements and globalisation (Kimura, 2024). The COVID-19 pandemic's raised demand for remote collaboration in addition to VTs' increasing popularity (Chamakiotis, Panteli and Davison,2021;Whillans, Perlow & Turek, 2021).Geographical dispersion and a reliance on digital communication have caused a number of cooperation issues in VTs, including a decline in team cohesion(Chaudhary, Chopra & Kaur, 2022). In many firms, a team is the fundamental unit of work (Devine, Clayton, Philips, Dunford, &Melner, 1999; Rousseau, Aubé, & Savoie, 2006). One essential component of task management in a company is team member collaboration (Boughzala et al., 2012). Collaboration is essential to organisational effectiveness (Phillips, Lawrence, & Hardy, 2000; To & Ko, 2016) and is defined as "a process where two or more parties work closely with each other to achieve mutually beneficial outcomes" (Letaifa&Goglio-Primard, 2016).

According to Hill and Bartol (2016) andZhang, Li, Yu and Tang (2022), virtual collaboration is more specifically defined as the efficient communication among team members in a geographically dispersed team setting. To fully communicate and collaborate in member of a virtual team need to overcome the limitations imposed by geographical settings. This means that for virtual teams to function successfully, team members will need to engage in a higher level of virtually collaborative behaviour than those in non-virtual teams (Bell and Kozlowski, 2002).

Collaboration in VTs is becoming more difficult as VTs and VT research are used more frequently. Geographical dispersion and reliance on digital communication have caused a number of cooperation issues in VTs, such as a decline in team cohesion (Chaudhary et al., 2022), a halt in knowledge exchange (Swart, Bond-Barnard & Chugh, 2022; Ali & Lai, 2021) and an increase in conflicts (Caputo, Kargina& Pellegrini, 2023). In light of these problems, earlier research has looked at effective leadership in VTs (Han & Hazard, 2022) as well as elements that support knowledge sharing, trust-building, and effective communication (Swart etal., 2022; Breuer, Hüffmeier, Hibben & Hertel, 2020; Kimura, 2024).

These days, a lot of team members are physically dispersed and work together mostly electronically, including members from global virtual project teams (Massey, Montoya-Weiss and Hung, 2003; Plotnick,Hiltz and Privman, 2016; Hassell and Cotton, 2017; Andres and Shipps, 2019). Examples of virtual collaboration include using Google Drive (Van Ostrand et al. 2016) or cooperating in virtual computer-generated environments (Franceschi et al. 2009; Kohler et al. 2011). Successful virtual collaboration is influenced by factors such as social presence (Franceschi, Lee, Zanakis and Hinds, 2009) and social identity (Lin, 2015; Vahtera, Buckley and Aliyev, 2017). Identifying with co-workers as a social group at work greatly enhances each worker's performance on an individual basis and promotes more effective achievement of a general objective (Lin 2015; Porck, Matta and Hollenbeck, 2019). Within the context of a virtual collaboration, one can partially represent their own identity by using an avatar that represents gender, age, and socioeconomic class (Schultze 2010). According to Guegan, Segonds and Barre (2017), team members' social identities can also be carried over into virtual collaboration. Social identity is the process of maintaining one's own identity and identifying with other (virtual) team members by contrasting one's own self-concept with the perceived values, standards, and traits of others (Brown 2000).

These gaps, which will likely expand further in the future, reflect the need for a more thorough analysis and a greater knowledge of this topic. Therefore, a comprehensive review of empirical research on the topic will emphasise the status, key theoretical underpinnings, and contextual and methodological features of the existing literature while also laying the groundwork for future research.Moreover, the application of the TCCM framework in reviewing the literature on virtual collaboration has not attracted much attention from researchers at large So, this paper aims to map the current state of research on virtual collaboration and hence offer a conceptual framework regardingthe future research agenda. The following research questions are intended to be addressed in this paper:

- Which article, writer, nation, organisation, and publication bear the greatest responsibility for the field's growth?
- Which are the main areas of study in the field of online collaboration?
- What are the commonly used theories, contexts, characteristics, and methodologies in the literature?

2. Methodology

The purpose of the study is to assess the status of virtual collaborative research. This study uses topic and gap analysis to examine the depth of current literary works by focusing on the literature on virtual cooperation. Additionally, this study adhered to the TCCM framework provided by Paul et. al (2021). This study used the TCCM framework for the review, a content analysis, and a bibliometric analysis. Using the TCCM framework, which may assist in revealing the theories, contexts, characteristics, and techniques of the current virtual

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collaboration research that has been followed, the goal of the study is to ascertain the current state of research on virtual collaboration.

A process is crucial for systematic literature reviews because it ensures careful planning, reliable execution, transparency, and accuracy; it also helps in identifying potential issues, lowering risk, encouraging accountability, and maintaining the work's quality.

A comprehensive review of systematic review publications on virtual collaboration is included in this work. The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines are specifically adhered to in this review.PRISMA offers a common, peer-reviewed approach that employs a checklist of guidelines, which were rigorously adhered to in this study to help assure the replicability and quality assurance of the revision process. The search strategy, article selection criteria, quality evaluation, data extraction, and data analysis processes were all detailed in the review protocol that was created.

Paul's interrogative and the TCCM framework are used in the study to analyse knowledge on virtual collaboration (Paul, Parthasarathy and Gupta, 2017). This method provides a comprehensive understanding of knowledge gaps and includes a large number of studies from various data sources. It tries to address all relevant questions from broader contexts, ensuring an extensive and in-depth review of the literature.

The difficulties of thorough data cleaning and consistent metadata across all sources—both necessary for a blended database—are not sufficiently represented by Web of Science and Scopus. By focusing on published material, which ensures a minimum level of agreed-upon scientific quality through editing or peer review, an inherent "quality check" is imposed on the resulting corpus of literature. The primary advantages of bibliometric analysis have previously

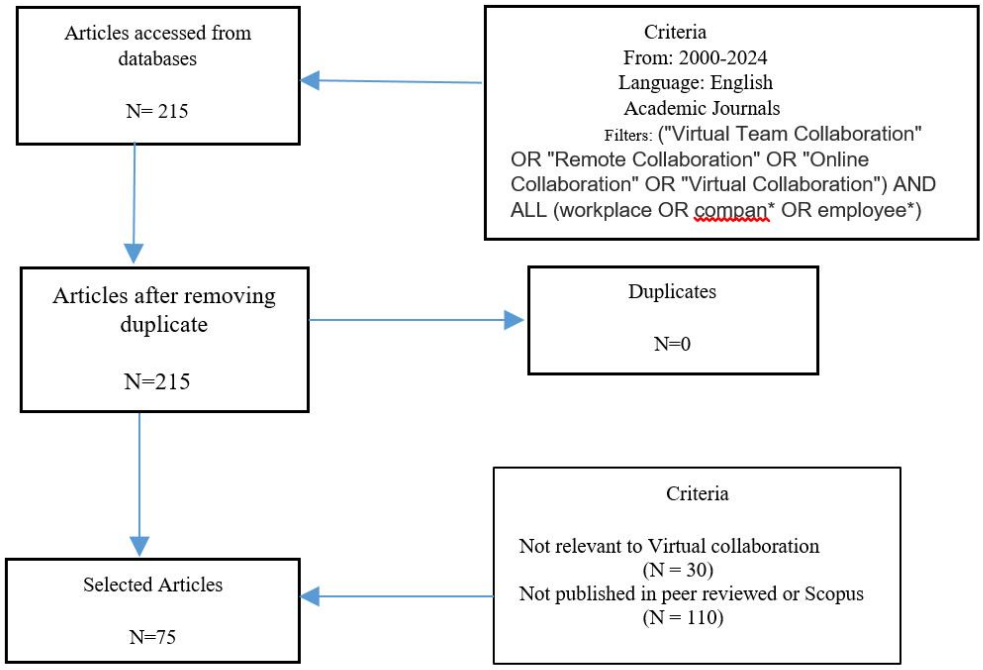

Fig. 1. Inclusion and exclusion criteria.

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http://eelet.org.uk

Source: Authors

been acknowledged (Levine-Clark & Gil, 2009; Vieira & Gomes, 2009; Franceschet, 2010; Singh, Singh, Karmakar, Leta and Mayr, 2021;Muchiri, Erdei-Gally, Fekete-Farkas and Lakner, 2022).

We chose Scopus database and set up filters based on the file type, search term/words, and search time. The first papers were published in academic journals (not including books and chapters) between 2000 and 2024, which corresponds to the 21st century. These papers had the term "Virtual Collaboration" in all fields OR "Collaboration" in the title, abstract, or keyword plus (+) "Remote Work" in all fields. Moreover, non-English-language items were not included.

After identifying 215 studies, the third step involved establishing the remaining inclusion and exclusion criteria (refer to Fig. 1). The authors first studied the abstracts of these papers in order to weed out those that didn't address the context of virtual collaboration. At this point, thirty articles (30) were eliminated.

The final exclusion criterion was determined from the remaining 185 articles. To maintain the quality of the review, we followed Paul and Criado (2020) and excluded articles that were not published in peer-reviewed journals (as required by peer review policy) or that were not indexed in the Journal Citation Report (JCR), Scopus, or the Web of Science (WOS)/Social Science Citation Index (SSCI). Articles published in publications that either ceased to exist or changed their names were also ignored. Accordingly, another 110 articles were excluded, leaving 75 articles to be reviewed and analysed.

3. Results

3.1 Performance Analysis

Fig. 2 illustrates number of articles published on virtual collaboration. There were not many studies conducted during the first six years. The number of articles increased significantly in 2008, 2013, 2017, 2021, and 2023, indicating a sustained interest in the subject. In contrast, scholarly output on virtual collaboration significantly declined in 2015. Specifically, 2023 shows promise in terms of research advancements (28 papers) and in 2024, there were 24 papers, confirming virtual collaboration as an emerging field.

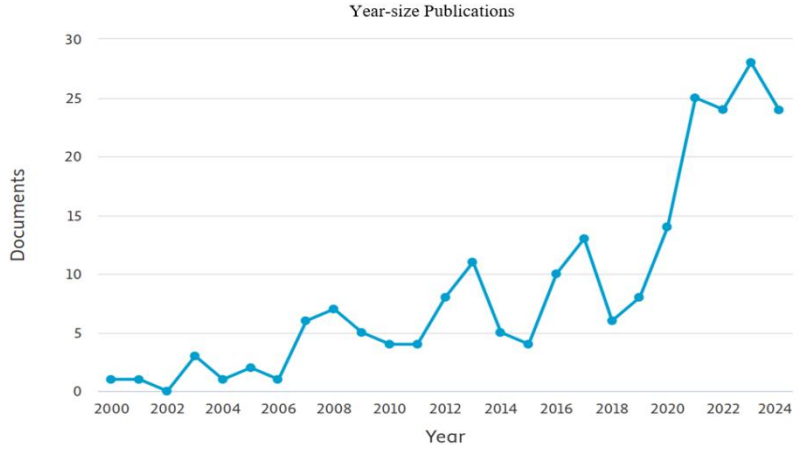

Fig. 2. Year-wise publications.

Source: Author's analysis

3.1.1 Most Influential Authors: The top 10 most influential authors have been mentioned in Table 1. The selection criteria for the category are the number of publications and the number of citations. According to the analysis, Majchizak, Ann has published 2 documents and with

897 citations, having the highest number of citations and publications. On the other hand, Dougherty Deborah, J. published 1 document with 880 citations.

Table 1: Most Influential Authors
Source: Author's

3.1.2 Highly Cited Documents: The most cited papers were given in Table 2 along with the authors, the year of publication, and the title of the source. The most often mentioned works

Author with highest citation			**Author with highest citation**		
Author	Document	Citation	Author	Document	Citation
Majchizak, ann	2	897	Majchizak, ann	1	897
Dougherty Deborah	1	880	Ferreira-lopes, luana	2	14
Faraj, samer	1	880	Richey, catherine	2	14
Griffith, terri	1	880	Van rompay-bartels, ingrid	2	14
Zammuto, Raymond	1	880	Bhardwaj, aashish	2	17
Kim, young-gul	1	392	De vreede, gert-jan	2	110
Koh, joon	1	392	Kumar, vikas	1	17
Paroutis, sotirios	1	292	Shrivastava, archna	2	25
Saleh, alya al	1	292	Noonan, jerona	2	6
Alsharo, mohammad	1	215	Alexi, joanna	1	13

are those by Alsharo, Gregg and Ramirez, (2017), Suh and Lee (2017), Strobl, (2014). Alsharo, most-cited work, "Virtual team effectiveness: The role of knowledgesharing and trust"and concluded by pointing out knowledge sharing positively influences trust and collaboration among virtual team members.

Table 2. Articles included in review

No.	Author (year)	Title	Citations	Journal
1	Alsharo, M., Gregg, D., & Ramirez, R. (2017)	Virtual team effectiveness: The role of knowledge sharing and trust	215	Information & Management
2	Suh, A. and Lee, J. (2017)	Understanding teleworkers' techno stress and its influence on job satisfaction	192	Internet research
3	Strobl, C. (2014)	Affordances of web 2.0 technologies for collaborative advanced writing in a foreign language	83	Calico Journal
4	Kahai, S. S., Carroll, E., & Jestice, R. (2007)	Team Collaboration in Virtual Worlds	74	ACM SIGMIS Database: the DATABASE for Advances in Information Systems
5	Gabriel, A., Monticolo, D., Camargo, M., & Bourgault, M. (2016)	Creativity support systems: A systematic mapping study	73	Thinking Skills and Creativity
6	Das, M., Tang, J., Ringland, K. E., & Piper, A. M. (2021)	Towards Accessible Remote Work: Understanding Work-from-Home Practices of Neuro- divergent Professionals	72	Proceedings of the ACM on Human-Computer Interaction
7	Gressgård, L. J. (2011).	Virtual team collaboration and innovation in organizations	72	Team Performance Management: An International Journal
8	Boughzala, I., & De Vreede, G. J. (2015)	Evaluating Team Collaboration Quality: The Development and Field Application of a Collaboration Maturity Model	61	Journal of Management Information Systems
9	Sutanto, J., Tan, C. H., Battistini, B., & Phang, C. W. (2011)	Emergent leadership in virtual collaboration settings: A social network analysis approach	57	Long Range Planning
10	Yan, Z., Guo, X., Lee, M. K., & Vogel, D. R. (2013)	A conceptual model of technology features and techno stress in telemedicine communication	50	Information Technology & People

Source: Author's

3.1.3 Most Relevant Sources: Table 3 lists the most relevant sources according to their number of documents published and the citations they gathered. The 75documents were published among 153 sources, out of which the top 10 are listed in the table. Organisation Science, International Journal of Electronic Commerce and Journal of Knowledge Management are the most cited sources, where Sustainability (Switzerland), Proceedings of the ACM on human -Human-Computer Interaction and Analysis and Metaphysics are the top 3 sources with the highest number of documents published.

Table 3: Most Relevant Sources

Relevant Citation Wise			**Most Relevant Documents Wise**		
Sources Title	Document	Citation	Sources Title	Document	citation
Organization science	1	880	Sustainability (Switzerland)	5	110
International journal of electronic commerce	1	392	Proceedings of the ACM on human-Human-Computer Interaction	5	142
Journal of Knowledge Management	1	292	Analysis and metaphysics	3	0
Information and management	1	230	Higher education, skills and work-based learning	3	66
Internet research	1	192	Team performance management	3	107
Proceedings of the ACM on human -Human-Computer Interaction	5	142	Interactive learning environments	3	25
Journal of Communication	1	124	International journal of web-based communities	3	36
Journal of management information systems	2	110	Journal of Computer Information Systems	3	29
Sustainability (Switzerland)	5	110	Knowledge management and e-learning	3	35
Team performance management	3	107	Tech trends	3	26

Source: Authors

3.1.4 Most Progressive Countries: Table 4 contains the top 10 countries that are among the most progressive in virtual collaboration research. The list highlights countries based on their citations and published documents. According to the list, the United States has the highest

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citation as well as published the major part of the documents on virtual collaboration research. After Canada, the United States. Australia are oneof the major countries with the highest citation. In the case of documents, after the United States, Germany, and the United Kingdom are the major players.

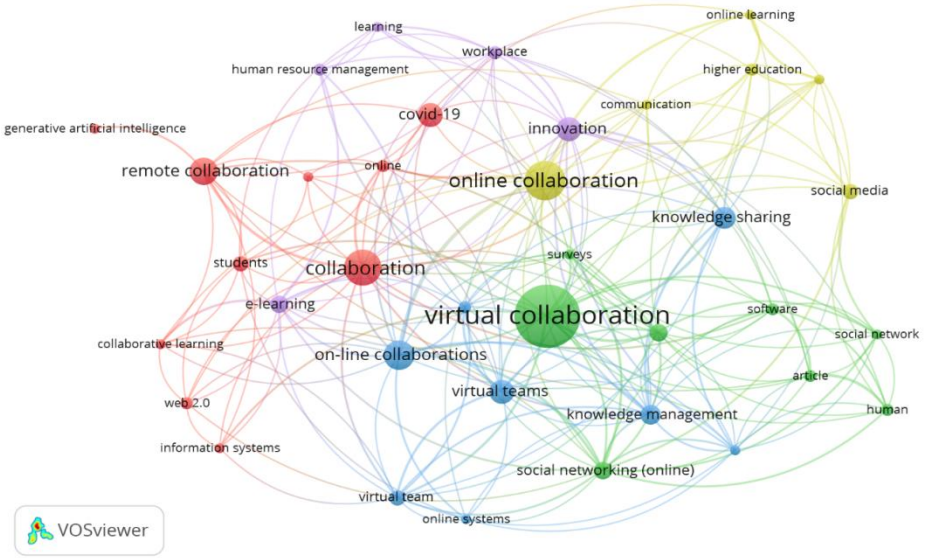
Table 4: Most Progressive Countries

Most Progressive Citation Wise			Most Progressive Documents Wise		
Country	Documents	Citation	Country	Documents	Citation
United states	65	2220	United states	65	2220
Canada	9	1137	Germany	21	304
Australia	12	990	United Kingdom	20	596
United Kingdom	20	596	China	14	264
South Korea	2	584	Australia	12	990
Hong Kong	6	350	Canada	9	1137
Germany	21	304	Italy	9	146
China	14	264	Netherlands	7	93
France	6	258	France	6	258
Jordan	2	219	India	6	84

Source: Author's

3.1.5 Keywords Co-occurrence Network:

In this section the keywords were presented which has been majorly used by the authors. Out of 1213 keywords with five occurrences only 37 keywords were linked with each other. The keywords have 5 clusters. Some of the clusters were intertwined with repeated keywords mentioned in the clusters. Out of 37 keywords the most repeated keywords were: Virtual collaboration, Collaboration, Online collaboration, Knowledge sharing, Remote collaboration, Knowledge management etc.



Source: Author's Analysis

3.1.6 Co-cited Author: Fig 5 showed the authors cited together and the link between the authors.

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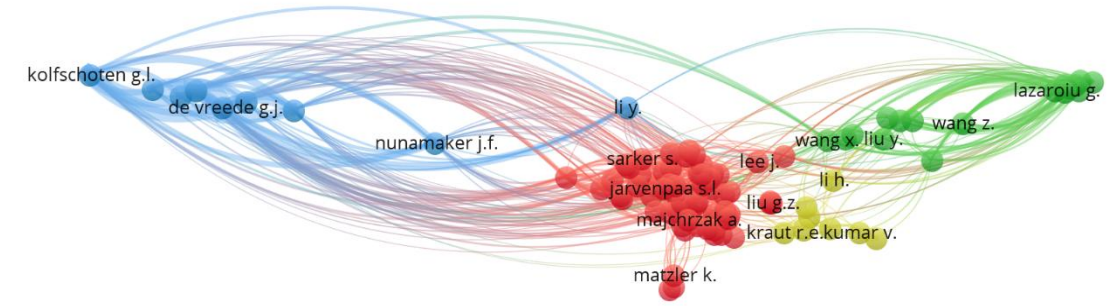
Vol 15, Issue 2s (2025)
http://eelet.org.uk

Fig 5: Co-cited Authors



Source: Author's

3.1.7 Co-cited Countries: Fig 6 expressed the link between the countries and their citations of being together.

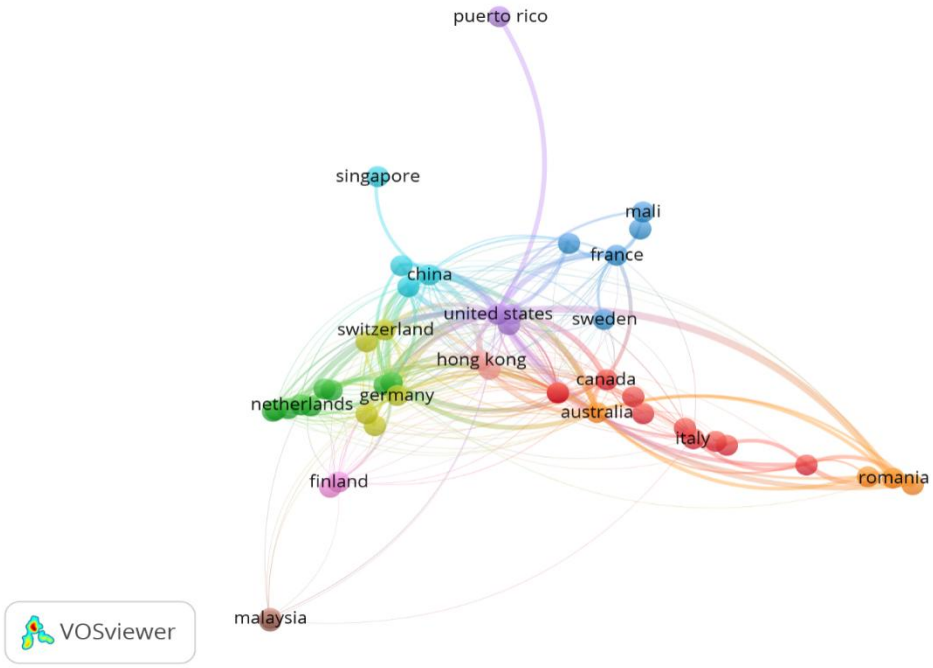


Fig 6: Co-cited Countries
Source: Author's

1.2 Framework Analysis

This study followed the TCCM framework for analysis. In the figure, the framework analysis of Virtual collaboration research has been described.

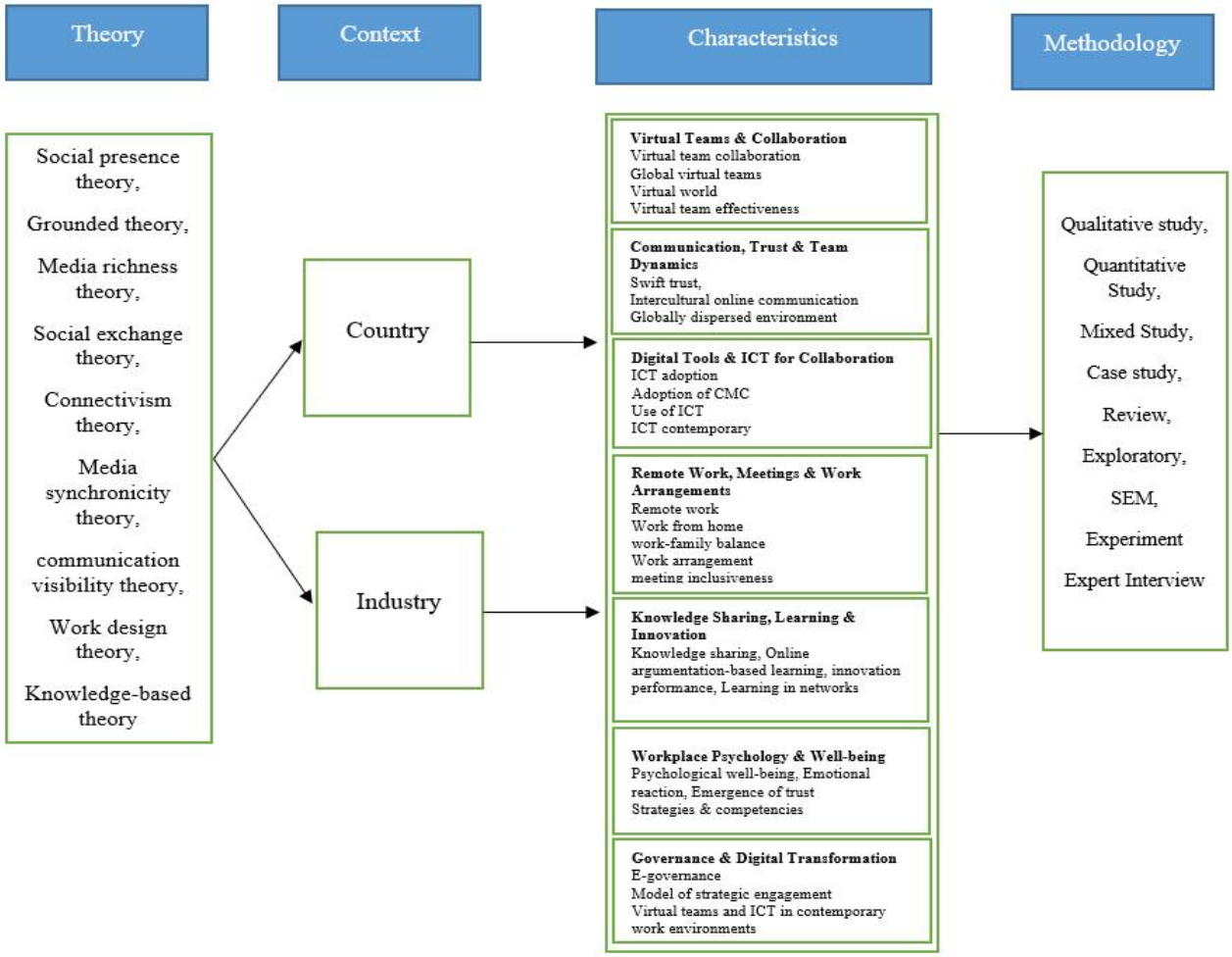


Fig 7: TCCM

Source: Author's

3.2.1 Review of the Theories

In 75 documents, 52 theories have been discussed separately, with some connected to other theories in the virtual collaboration research. The top5 theories are: (i)Social presence theory, (ii) Grounded Theory, (iii) Media Richness theory, (iv) Social exchange theory, and (v) Media Synchronicity theory.

3.2.1.1 Social Presence Theory

According to Cheng (2008), communication is successful when the medium provides the proper social presence needed for the degree of interpersonal participation needed for a task. According to social presence theory, when people communicate remotely, the degree to which technology facilitates authentic, high-quality social interactions determines the social influence of the exchange. Intimacy, immediacy, warmth, and interpersonal connection are all increased by more realistic communications, according to the hypothesis (Short, Williams and Christie, 1976; Boughzala, VreedeandLimayem, 2012; Qiu & Dauth, 2022; Alsharo et al., 2017; Yan, Guo, Lee and Vogel, 2013).

3.2.1.2 Grounded Theory

European Economic Letters
ISSN 2323-5233
Vol 15, Issue 2s (2025)
http://eelet.org.uk

Country Context	Sources	Articles
China	(Shen & Wang, 2024); (Qiu & Dauth, 2022); (Yu, Shen &Khazanchi, 2022); (Zhang, Li, Yu & Tang, 2022); (Song, Razi, & Tarn, 2021) (Zhang, Pan &hua Ouyang, 2020); (Yan, Guo, Lee & Vogel, 2013); (Meng & Wu, 2013).	8
USA	(Swartz & Shrivastava, 2022); (Das, Tang, Ringland & Piper, 2021); (Song, Razi & Tarn, 2021); (Owens & Hite, 2022); (Painter, Posey, Austrom, Tenkasi, Barrett & Merck, 2016); (Levy, Ramim & Hackney, 2013); (Rockinson-Szapkiw, 2012); (Palmer, Dunford, Rura-Polley & Baker, 2001).	8
Germany	(Redlbacher&Hattke, 2024); (Kern, Emmerich &Lübbe, 2023); (Qiu & Dauth, 2022); (Swartz & Shrivastava, 2022); (Kauffeld Tartler, Gräfe, Windmann& Sauer, 2022).	5

Finding theory from facts is the goal of the social science research methodology known as grounded theory (Masili, Binci, Cerruti, Appolloni and Giraldi, 2024; Ungureanu, Cochis, Rodighiero, Bertolotti, Mattarelli, Montanari and Scapolan, 2018; Levy, Ramim & Hackney, 2013).

3.2.1.3 Media Richness Theory

A technology's capacity to deliver instant feedback, both verbal and nonverbal, and to modify messages is referred to as media richness (Avolio, Kahai and Dodge, 2001b). It is also the capacity to incorporate all data, give immediate input, and create specific language for every participant(Kanthak and Hertel, 2016; Ben Sedrine, Bouderbala &Nasraoui, 2021; Qiu & Dauth, 2022; Boughzala, et. al., 2012).

3.2.1.4 Social Exchange Theory

Social exchange theory deals with the interpersonal exchange of intangible social costs and benefits (Kelley and Thibaut, 1978; Chen, Wu, Yang & Tsou, 2008). Social exchange “is voluntary actions of individuals that are motivated by the returns they are expected to bring and typically do in fact bring from others” (Yu, Shen andKhazanchi, 2022; Alsharo et al., 2017; Chen et al., 2008).

3.2.1.5 Media Synchronicity Theory

Building on media richness theory, media synchronicity theory posits that efficient collaboration technology must enhance the way individuals collaborate simultaneously with a shared goal. In particular, the notion asserts that when technology's synchronisation capacity aligns with collaborators' needs, collaboration will be improved (Dennis, Fuller, &Valacich, 2008;Yan et. al., 2013; Boughazalaet. al., 2012)

3.2.2 Review of Contexts

Understanding the context of the literature and how it came to be is known as a contextual analysis of the literature. This section is an essential component of the SLR since it outlines the conditions necessary for the creation of literature in this field. Because of this, the elements included in this part enable the development of the existing literature and the confirmation of any future research directions that are mentioned in this study in terms of efficacy.

In the in-depth analysis of the selected articles divided the articles contexts in terms of Countries and industry. Out of the 75 articles, a total of 34 articles have focused on a countries picture towards Virtual collaboration research where on the other hand 37 articles were focused on a firm’s perspective towards Virtual collaboration.

Australia	(Law, Trieu, Madz, Coyle, Glover, Tian, & Wu, 2024); (Crossman & Bordia, 2012); (Palmer, Dunford, Rura-Polley & Baker, 2001).	3
India	(Tripathi & Singh, 2022); (Swartz & Shrivastava, 2022)	2
Taiwan	(Barrett, Liu & Wang, 2022); (Chen, Wu, Yang & Tsou, 2008)	2
UK	(Song, Razi & Tarn, 2021); (Palmer, Dunford, Rura-Polley & Baker, 2001)	2
Industry Context		
Education	(McCool & Mitchell, 2024); (Barrett, Liu & Wang, 2022); (Swartz & Shrivastava, 2022); (Kasim, Darus, Lee, Subramaniam &Januin, 2022); (Ferreira-Lopes, Van Rompay-Bartels, Bezanilla &Elexpuru-Albizuri, 2022); (Alt &Naamati-Schneider, 2022); (Candra, Novaliendry, Jaya, Huda & Nashir, 2022); (Ozturk, Avci & Kaya, 2021); (Sher, Kent & Rafaeli, 2020); (Long & Meglich, 2013); (Levy, Ramim & Hackney, 2013); (Crossman & Bordia, 2012); (Rockinson-Szapkiw, 2012); (Assimakopoulos, Theocharopoulos&Benardis, 2010); (Chen, Wu, Yang & Tsou, 2008); (Diffin, Chirombo, Nangle & De Jong, 2010); (Reisslein, Seeling&Reisslein, 2005).	17
IT	(Masili, Binci, Cerruti, Appolloni& Giraldi, 2024); (Kern, Emmerich &Lübbe, 2023); (Song, Razi & Tarn, 2021); (Zhang, Pan &hua Ouyang, 2020); (Alsharo, Gregg & Ramirez, 2017); (Painter, Posey, Austrom, Tenkasi, Barrett & Merck, 2016); (Ryzhkova, 2015); (Boughzala& De Vreede, 2015); (Gressgård, L. J. (2011).	9
Health care	(Law, Trieu, Madz, Coyle, Glover, Tian & Wu, 2024); (Das, Tang, Ringland & Piper, 2021); (De Vries, Van Bommel & Peters, 2018); (Yan, Guo, Lee & Vogel, 2013).	4
Design	(Ozturk, Avci & Kaya, 2021); (Ungureanu, Cochis, Rodighiero, Bertolotti, Mattarelli, Montanari &Scapolan, 2018).	2
Tourism	(Hernández, Aguilera, Pompa & Gačnik, 2023); (Abou-Shouk, 2018).	2
Construction	(Pejoska-Laajola, Reponen, Virnes& Leinonen, 2017).	1

3.2.3 Review of Characteristics: After analysing the documents, another important aspect has been evaluated. The aspect is the characteristics of the studies done in Virtual collaboration research. The top 5 characteristics of the studies are (i) Virtual teams and collaboration, (ii) Communication, Trust, team dynamics, (iii) digital tools and ICT, (iv) Remote work, (v) Knowledge sharing and learning innovation.
These characteristics cover the major portions of the studies conducted. These topics are from all the stages of virtual collaboration development andcover the country and firm's concerns presented in a framework.

3.2.4 Review of Methodology

As the focus of the study is primarily on empirical analysis, this study describes the main methodologies used for both country and firm level of analysis, presented in Table5.

The topics have multi-dimensional characteristics, where various methodologies were used to explore the characteristics of the studies. As the studies mainly used qualitative studies to fulfil their objectives using surveys, questionnaires, expert interviews, and practical exposures of building models,they are the next most used methodologies for Virtual collaboration research. There are other studies that used reviews, Bibliometric,Delphi-basedinterviews and systematic literature review. The top 10 findings have been described in Table 5 with their sources.

Table 5: Virtual Collaboration Study Methods

Methods	Sources	Articles
Qualitative study,	(Masili, Binci, Cerruti, Appolloni& Giraldi,2024) (Hendriks,Olt, Sturm& Moos,2024) (Watzek, Rehm & Mulder, 2024) (Redlbacher&Hattke, 2024) (Law, Trieu, Madz, Coyle, Glover, Tian & Wu, 2024) (Hernández, Aguilera, Pompa & Gačnik, 2023) (González & Macias-Alonso, 2023) (Kern, Emmerich &Lübbe, 2023) (Hofeditz, Mirbabaie& Ortmann, 2024) (Barrett, Liu & Wang, 2022) (Swartz & Shrivastava, 2022) (Kasim, Darus, Lee, Subramaniam &Januin, 2022) (Ferreira-Lopes, Van Rompay-Bartels, Bezanilla &Elexpuru-Albizuri, 2022) (Alt &Naamati-Schneider, 2022) (Das,Tang, Ringland & Piper, 2021) (Song, Razi & Tarn, 2021) (Cleary, Slattery, Flammia &Minacori, 2019) (De Vries, Van Bommel & Peters, 2018) (Ungureanu, Cochis, Rodighiero, Bertolotti, Mattarelli, Montanari &Scapolan, 2018) (Eisenberg & Krishnan, 2018) (Breunig, 2016) (Painter, Posey, Austrom, Tenkasi, Barrett & Merck, 2016) (Wilmot, Rushton &Zandona Hofmann, 2016) (Boughzala& De Vreede, 2015) (Fang, To, Zhang & Chang, 2014) (Nanda, Lehto &Nof, 2014) (Strobl, 2014) (Yan, Guo, Lee & Vogel, 2013) (Crossman & Bordia, 2012) (Houldsworth & Alexander, 2005) (Vlachopoulou&Manthou, 2003) (Craver & Gold, 2002) (Levy, Ramim & Hackney, 2013).	36
Quantitative Study	(Shen & Wang, 2024) (Hendriks, Olt, Sturm & Moos, 2024) (Watzek, Rehm & Mulder, 2024) (Redlbacher&Hattke, 2024) (Krastev, Koyundzhiyska-Davidkova& Buckley, 2023) (Alkhodary, Jreissat, Saidat, Ali & Hasan, 2023)(Hernández, Aguilera, Pompa & Gačnik, 2023) (Frajt, Michalikova& Balica, 2023) (Twyman, Murić& Zheng, 2023) (Qiu & Dauth, 2022) (Yu, Shen &Khazanchi, 2022) (Barrett, Liu & Wang, 2022) (Swartz, Shrivastava, 2022) (Kasim, Darus, Lee, Subramaniam &Januin, 2022) (Ferreira-Lopes, Van Rompay-Bartels, Bezanilla &Elexpuru-Albizuri, 2022) (Zhang, Li, Yu & Tang, 2022) (Cutler, Hosseinkashi, Pool, Filipi, Aichner, Tu, & Gehrke,2021) (Ozturk, Avci & Kaya, 2021) (Sher, Kent & Rafaeli, 2020) (Owens & Hite, 2022) (Abou-Shouk, 2018)	29

	(Alsharo, Gregg & Ramirez, 2017) (Boughzala& De Vreede, 2015) (Strobl, 2014) (Yan, Guo, Lee & Vogel, 2013) (Levy, Ramim & Hackney, 2013) (Crossman & Bordia, 2012) (Rockinson-Szapkiw, 2012) (Chen, Wu, Yang & Tsou, 2008).	
Case study	(Masili, Binci, Cerruti, Appolloni& Giraldi, 2024) (Alkhodary, Jreissat, Saidat, Ali & Hasan, 2023) (Alt &Naamati-Schneider, 2022) (Song, Razi & Tarn, 2021) (Zhang, Pan &hua Ouyang, 2020) (Ungureanu, Cochis, Rodighiero, Bertolotti, Mattarelli, Montanari &Scapolan, 2018) (Breunig, 2016) (Painter, Posey, Austrom, Tenkasi, Barrett & Merck, 2016) (Meng & Wu, 2013) (Assimakopoulos, Theocharopoulos&Benardis, 2010).	10
Review	(Orel, Demir, Tagliaro& Rus, 2024) (Tripathi & Singh, 2022) Gressgård, 2011)	3
Exploratory	(Zhang, Pan &hua Ouyang, 2020) (Meng & Wu, 2013) (Houldsworth & Alexander, 2005).	3
SEM	(Abou-Shouk, 2018) (Suh & Lee, 2017) (Yan, Guo, Lee & Vogel, 2013)	3

3. Findings and future research Directions

The papers use TCCM analysis of 75 journal articles from the Scopus database to analyse bibliometric data and examine the literature. The bibliometric is used to research developments and trends in the field of virtual collaboration.

Descriptive analysis was used to examine the first research question, which asked which agency is most accountable for the field's progress. According to the descriptive study, China, the United States, Germany, Italy, and Australia are the top five countries in terms of the total number of publications. The most popular journals for publications are Sustainability, Proceedings of the ACM on Human-Computer Interaction, Journal of Computer Information Systems, Team Performance Management, Knowledge Management and e-Learning.

The top five seminal article authors includeStrobl (2014),Gabriel, Monticolo, Camargo and Bourgault(2016),Alsharo(2017),Suh and Lee(2017).The second research question addresses important areas of study. We were able to investigate new areas of study thanks to keyword research, and we were able to cluster areas in the field and find connections between important research areas by using keyword co-occurrence analysis. Research on virtual collaboration is said to be influenced by the terms that have received the most citations in recent years. Virtual collaboration, online collaboration, knowledge sharing, and remote collaboration are the most significant keywords identified.

The third research question focuses on the prevalent theories, contexts, characteristics, and methodologies applied in earlier investigations. Social presence theory, media richness theory, and social exchange theory are the most widely applied theories in the field. The contexts used in the virtual collaboration focus on the education industry aspects of individuals. The characteristics of the extant literature that have been identified are virtual team & collaboration, communication, trust, Team dynamics, Digital tools and ICT for collaboration, Remote work, Meetings and work arrangement, Knowledge sharing, Learning and innovation.

3.1 Future Research Directions

This section elaborates the potential research opportunities in the Virtual Collaborationresearch area to explore different theoretical aspects, contextual aspects and characteristics and methodologies. Concerning the theories of the area, Social presence theory, Grounded theory, and Media Richness theory have been used primarily in the articles.

The theoretical analysis revealed the frequency of theories widely used in Virtual collaboration research.

Some of these theories have the potential to reveal a unique aspect of virtual collaboration research and its practical implications for organisations. For example, Connectivism Theory posits that students learn through interacting with technology and each other (Kasim, Darus, Lee, Subramaniam, and Januin, 2022). In the context of second language (L2) education, social constructivism is an appealing learning theory. The concept of collaboration has received significant attention in numerous studies (Mirzaei & Taheri, 2016; Kasim, Darus et al., 2022). Social information processing theory suggests that a person's thoughts and actions are influenced by their environment, needs, and goals. Environmental cues can provide social information that influences and controls mental states and behaviours (Salancik and Pfeffer, 1978; Zhang et al., 2022).

Other less-explored theories include Social Capital Theory, Knowledge-Based Theory, and Interdependence Theory (Alsharo et al., 2017); Communication Visibility Theory and Regulatory Focus Theory (Shen & Wang, 2024); EASI (Emotion as Social Information Theory) (Watzek, Rehm & Mulder, 2024); Motivation-Hygiene Theory, Item-Response Theory (IRT), Affect Theory (Qiu & Dauth, 2022); Cognitive Appraisal Theory, Leader-Member Exchange (LMX) Theory, and Conservation of Resources Theory (Tripathi & Singh, 2022); Work Design Theory (Kauffeld, Tartler, Gräfe, Windmann& Sauer, 2022); Equity Theory (Zhang et al., 2022); Dynamic Social Impact Theory (Song, Razi & Tarn, 2021); Social Translucence Theory (Zhang, Pan & Ouyang, 2020); Diffusion of Innovation Theory, Theory of Planned Behavior, Technology Acceptance Model, Theory of Reasoned Action, and the Decomposed Theory (Abou-Shouk, 2018); Bridge Theory and Management Theory (Eisenberg & Krishnan, 2018); Job Characteristics Theory (Suh & Lee, 2017); Sociotechnical Systems (Painter, Posey, Austrom, Tenkasi, Barrett & Merck, 2016); Integrated Discipline-Specific Theory (Wilmot, Rushton &Zandona Hofmann, 2016); Person-Environment (PE) Fit Theory (Yan et al., 2013); Behavioral Complexity Theory (Chen et al., 2008); Leader-Member Exchange and Substitute Theories (Kahai, Carroll & Jestice, 2007); Organization Theory and Punctuated Equilibrium Theory (Palmer, Dunford, Rura-Polley & Baker, 2001).

In the context of virtual collaboration, the education sector is the one that has been examined the most. However, there is scarcity of studies in Tourism (Hernández, Aguilera, Pompa & Gačnik, 2023; Abou-Shouk, 201),Design(Ozturk, Avci & Kaya, 2021; Ungureanu, et, al., 2018) and Construction (Pejoska-Laajola, Reponen, Virnes& Leinonen, 2017).Country wise China is the most studied country in the virtual collaboration context and there are several Country who studied virtual collaboration however, there is some other countries who are less explored virtual collaboration like: India; Taiwan, UK, Saudi Arabia, France, Egypt; Malaysia; Netherlands, Sweden. Therefore, more research is required to examine these contexts.

Virtual collaboration is being used in explaining ICT adoption (Rice & Pennington, 2024); Web2.0 technologies (Strobl, 2014); Leadership (Chen, et, al., 2008); Strategies and competencies (Cleary, Slattery, Flammia &Minacori, 2019); Emergence of Trust (De Vries, Van Bommel & Peters, 2018); Adoption of CMC (Yan, et, al., 2013); Covid-19 Pandemic Era (Candra, Novaliendry, Jaya, Huda & Nashir, 2022); work place learning(Breunig, 2016); intercultural online collaboration(Crossman & Bordia, 2012); Agile teams(Masili, Binci, Cerruti, Appolloni& Giraldi, 2024); Online and onsite collaboration practices (Ungureanu, et, al., 2018); Workplace learning(Breunig, 2016);Teleworker job satisfaction(Suh & Lee, 2017); Therefore, more research is required to examine these characteristics.

Therefore, more research is required to examine these methodologies. Future researchers must use bibliometric and Delphi-based studies to investigate virtual collaboration. Future study can also take advantage of other research methods, like surveys, participant observation, experiments, and expert interviews, to obtain new and improved understandings of virtual collaboration.

Practical Implications

From a practical perspective, since virtual collaboration has a significant impact on a number of beneficial workplace outcomes, it is an important employee-related element that needs to be addressed. The study emphasises the significance of communication, trust, and enhancing virtual collaboration between employees, making virtual collaboration a crucial component of successful communication. Therefore, Managers & Leaders must enhance virtual collaboration between team members for greater organisational good. Some important antecedents or objectives of virtual collaboration have been highlighted in this study; team member can shape relevant antecedents in their organisation to enhance.Future research must therefore examine this context. virtual collaboration between the team members. Teams members can use various collaboration tools for improving the level of virtual collaboration between employees, as it goes a long way to boost productivity, creativity, cohesion, satisfaction, trust and reduced turnover. As a result, firms will be more effective overall and more agile in the current dynamic business environment. By highlighting the value of virtual collaboration and the associated organisational outcomes that are essential for overall organisational effectiveness, this study highlights the necessity of suitable instruments for improving employee virtual collaboration. The study also brings the spotlight on the role of communication, trust, and cohesion in improving virtual collaboration between team members, thus making cohesion an important ingredient for virtual collaboration.

Limitations

The review excluded research articles published before 2000 and only examined those published between 2000 and 2024. This study's dependence on the Scopus database for document extraction is one of its main drawbacks. A larger pool for review may have been created if a greater variety of databases had been used, even though this was done to maintain quality. Since this review is a systematic literature analysis, it does not include flexible information such as bibliographic coupling, co-authorship ties, etc. Third, there aren't enough keywords included in the literature search; adding more could make it more comprehensive for further study.

Conclusion

This paper provides a detailed and in-depth analysis of the virtual collaboration research. Best of the researcher’s knowledge, there is no work conducted using the TCCM framework for the review of virtual collaboration, which is the main reason to conduct the review using the framework. Our study gives a brief bibliometric analysis of virtual collaboration research and providesan alternative theoretical approach for future virtual collaboration research, while revealing social presence theory as the major player in theory for virtual collaboration research.

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