



Challenges and critical success factors of digital communication, collaboration and knowledge sharing in project management virtual teams: a review

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Abstract:

Technological advancements, globalization, and the COVID-19 pandemic have transformed digital communication into a central tenet of many project management virtual teams (VTs). However, successful VTs are dependent on communication, collaboration and knowledge sharing among team members. Through a systematic literature review, this study investigates the challenges and critical success factors of digital communication, collaboration, and knowledge sharing in project management VTs. As a result, eight key common themes were identified - trust, cultural diversity, collaboration tools and technology, communication and knowledge hoarding, leadership, psychological safety, communication guidelines and training, and resource planning. Furthermore, given the geographically dispersed nature of VTs, they face additional challenges than teams that interact face-to-face (in-person). Therefore, mitigating the challenges by focusing on the identified themes could lead to project success.

Keywords:

virtual project teams; digital communication; collaboration; knowledge sharing; systematic review.

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1. Introduction

With the acceleration of virtual project execution and the rapid advancement in information and communication technologies, traditional face-to-face or 'in-person' ways of working have transformed. As a result, many organizations have adopted virtual ways of working, either through fully virtual project teams or a hybrid-based approach [1, 2]. The importance of communication and knowledge sharing in any project-based environment is essential for project success, and this has become more evident with the rise of digital project execution [3]. Additionally, the drive toward project virtual teams (VT) has accelerated with the widespread proliferation of new digital communication technologies and the global COVID-19 pandemic [4-6]. A survey suggested that approximately 66% of multinational corporations utilize VTs, where 80% of the respondents believed this number would continue to increase [5]. This number is expected to be significantly higher in the post-COVID era and will remain prevalent for the foreseeable future. Therefore, VTs must communicate effectively to ensure project success, and digital communication plays a vital role in this endeavor.

Dispersed project VTs typically comprise individuals with various cultural backgrounds, moral reasonings, skills and knowledge, which are brought together to achieve a common goal through different virtual collaboration platforms, including but not limited to, telephone, email, instant messaging, video conferencing and cloud-based information sharing platforms [5, 7].

With project tasks continuously growing in complexity for geographically dispersed and electronically dependent teams, internet-related technologies have become necessary for project execution and stakeholder communication [3]. Significant academic literature has been published on team communication, collaboration, and trust in a project management environment and its effect on project success. For example, a proposed model for project management success indicated that project management success becomes more likely as the degree of collaboration improves, which is influenced by the level of trust between project team members [8]. Moreover, quality communication is required for trust and collaboration in the project to thrive [9]. Thus, digital communication in VTs is critical as it is one of the primary ways knowledge is shared in such a team.

Digital communication refers to the process of sharing information, messages and ideas with others over a particular time and place, with the aid of digital channels and devices [10]. However, digital communications pose several challenges that traditional face-to-face communication typically does not, requiring teams to adapt. One such team adaption is the use of 'swift trust', which refers to situations whereby members of a VT transfer trust from other familiar settings by utilizing stereotypical impressions of each other [11]. The most prevalent challenges digital communication faces are categorized into three main areas. The first relates to information security risks, such as data privacy, confidentiality and security issues. The second challenge relates to the technology that inhibits efficient and effective communication. The last relates to ineffective leadership and inadequate resource planning.

Digital communication in VTs has become essential for many firms to execute projects effectively, ensuring stakeholders are adequately engaged, and it is expected to be used extensively in the foreseeable future. Given the global adoption and continued use of digital communication in VTs, research must focus on identifying the challenges and critical success factors of digital communication, collaboration and knowledge sharing in project management VTs. As of writing, there are no systematic literature reviews that address these aspects holistically. According to Fink, cited in Okoli and Schabram [12], a systematic literature review must be "systematic in following a methodological approach, explicit in explaining the procedures by which it was conducted, comprehensive in its scope of including all relevant material, and hence reproducible by others who would follow the same approach in reviewing the topic" (p. 1). The reasons for conducting a systematic review are to summarize the evidence about technology or treatment, to summarize the evidence of the advantages of a specific method, to identify any research gaps in the existing research, and to provide a deep understanding of new phenomenon [13]. These reasons fit with the aim of our review. Hence, this review fills the gaps by answering the following research question related to digital communication, collaboration and knowledge sharing in project management virtual teams.

Research Question: What are the challenges and critical success factors of digital communication, collaboration and knowledge sharing in project management virtual teams?

The remainder of the paper is structured as follows. The next section presents the research method. The following section discusses the results obtained from the analysis of the shortlisted literature. Finally, a discussion and conclusion are outlined, along with limitations and avenues for further research.

2. Research Method

A systematic literature review was methodologically conducted to locate, appraise and analyze the available evidence to provide an informative and evidence-based response to the research inquiry [14, 15]. The PRISMA model [16] was used to underpin the search parameters, the inclusion and exclusion procedures and the screening. The review was based on four procedural stages outlined in the PRISMA model, including identification, screening, eligibility and inclusion (see figure 1).

2.1 Search strategy and keywords

A theory-driven, progressive sampling approach was used to collate the literature related to digital communication in project management, i.e., sequential selection of literature based on content/theory rather than statistical considerations, to develop an overarching understanding of literature. Furthermore, a repetition strategy was used to select various academic literature, where similar articles are selected (published by different authors, academic institutions and countries) to ensure diverse perspectives and approaches are encapsulated. This academic literature included peer-reviewed journal articles, conference papers and book chapters. Thought leadership articles, blogs, reviews, editorials, and letters were excluded as sources of information, given their lack of academic credibility. Only literature published in English was included. Literature published before the year 2000 was excluded, given the progressive evolution of communication, collaboration and knowledge sharing over the past two decades.

An initial set of keywords and phrases were used as part of the search strategy to ensure all overarching themes were covered while narrowing the initial search to only the most relevant articles. The following keywords were used: virtual team, global virtual team, virtual project execution, digital communication/collaboration, agile project execution and project management critical success factors. An additional search strategy was implemented using the initially identified articles' reference list to source additional relevant literature.

2.2 Screening and selection

Four trusted academic research databases (Web of Science, Scopus, Science Direct and Elsevier) were used to source relevant literature. These research databases were selected based on their credibility amongst researchers, literature coverage, discipline focus area, accessibility and general popularity. Figure 1 illustrates the PRISMA process used to select relevant academic literature whereby an initial set of 447 articles was refined and shortlisted based on the exclusion of duplicates, year published, article title, abstract and methodological quality to reach a final article count of 31 relevant literature sources.

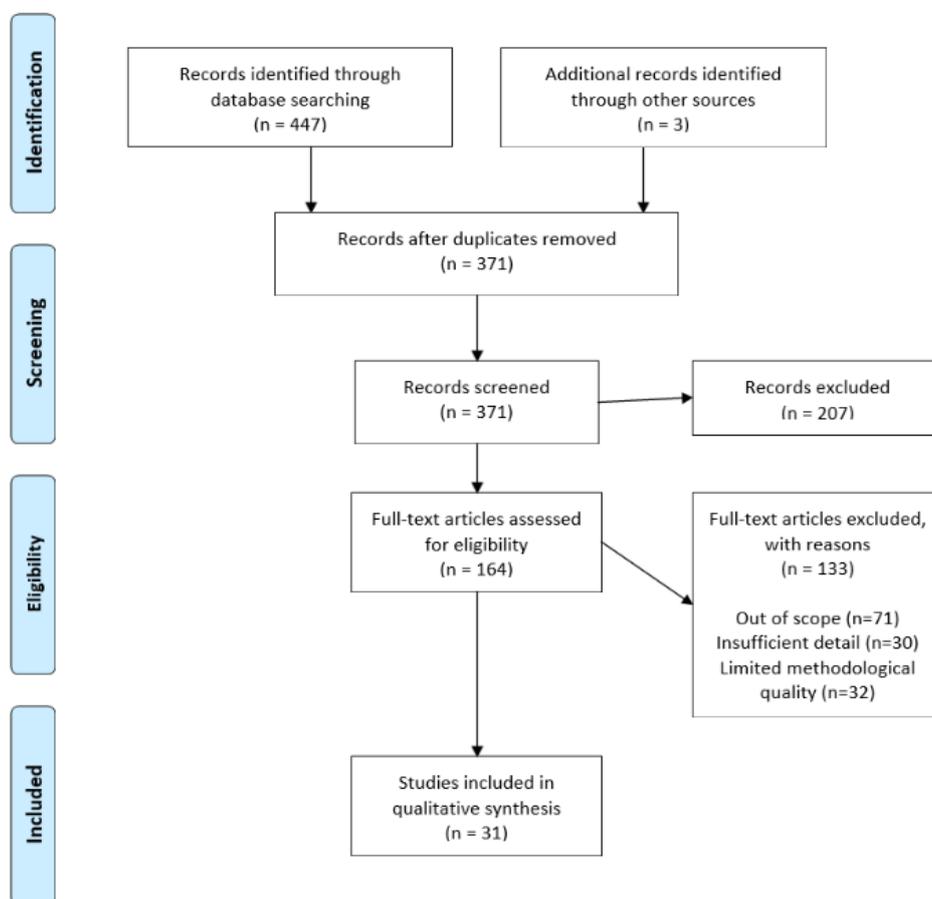


Fig. 1. PRISMA literature selection and reduction process

2.3 Data extraction and quality assessment

According to the Cochrane handbook for systematic reviews, the data extraction process should collect sufficient and unambiguous data that accurately represents the source in a structured and organized manner [17]. Hence, a data extraction framework in the form of an Authors Matrix [17, 18] was developed in Microsoft Excel (see exemplifying sample in Appendix A). It was used to track all shortlisted articles' key information, including but not limited to the article title, author(s), year of publication, primary industry, core concepts discussed and main findings.

A quality assessment was also conducted on the extracted data. A series of quality assessment questions, based on the Methodological Quality Questionnaire [6], were answered to determine the extracted data's overall quality. The quality assessment questionnaire (see Appendix B) focused on assessing the source and author credibility, selection bias, methodological rigor, and usefulness in addressing the research question. Answers were graded as either "Yes", "No", "Can't Tell" or "Not Applicable", where factors to consider were listed under each criterion.

2.4 Synthesis and analysis

Once the data was extracted and the quality thereof assessed, a concept matrix was used to analyze the connections between the shortlisted literature [18,19]. Apart from identifying common themes, the matrix highlighted gaps in the

research, where additional supportive articles and content were required. The concept matrix was used to identify commonalities amongst the various academic literature, highlighting the bigger picture of critical topics of the systematic review through overlapping claims in individual sources. The completed concept matrix (see exemplifying sample in Appendix C) was also used to calculate the frequencies per theme.

Consequently, eight common themes were identified in the review, as shown in Figure 2, highlighting the reviewed literature's frequency per theme. These themes were mapped per article to easily track and refer to specific articles during the literature review process.



Fig. 2. Concept matrix theme analysis count

Collaboration tools and technology was the most discussed topic, with 24 of the 31 reviewed articles discussing the importance of technology, and 12 of the 24 elaborating explicitly on the importance of such technology, totaling 36. Trust was the second most discussed theme, followed by communication guidelines and training and psychological safety. The following section discusses the results obtained from the systematic review of the literature.

3. Results

The onset of VTs has had a substantial impact on how teams communicate and can assist firms in mitigating risk, minimizing operation costs, and eliminating redundancy of tasks [20]. A significant portion of the academic literature focuses on how digital platforms influence team interaction and the key success factors that allow VT to collaborate effectively [7, 21, 22]. Moreover, Evans [23] states that “collaboration and knowledge sharing are fundamental aspects of problem-solving, decision making and innovation, and are therefore vital for success” (p. 175).

Chen et al. [24] focused on the development of a trust evaluation method between team members in VTs to ensure co-workers effectively share information and collaborate, and found that effective management, resource planning and trust facilitate maximum collaboration. Similarly, Verburg et al. [7] identified critical success factors for project management with similar recommendations that included clear rules for communication, management competency, and team trust. A common theme highlighted in various academic papers was how multicultural teams alter team dynamics and trust and that team members lack the skills to work with people of diverse cultures [25-27].

Based on the systematic literature review, eight key common themes were identified. A conceptual model (see Figure 3) was developed to visually illustrate how the eight themes related to the overarching question of digital communication, collaboration and knowledge sharing in virtual teams. First, collaboration tools and technology form the core foundation for VTs to operate, as, without such technology, the concept of VTs ceases to exist. Second, in most instances, cultural diversity (indicated by the second dotted line) will be present in VTs, specifically in dispersed settings. Cultural diversity has both a direct and indirect impact on how VTs collaborate. Third, four pillars form the basis of effective communication, collaboration and knowledge sharing, namely effective resource planning (where the correct individuals are selected based on the task at hand), trust between team members, effective leadership and well-defined communication guidelines and training. These four pillars result (arrowhead pointing down) in psychological safety that further enhances communication and reduces knowledge hoarding within a VT context.

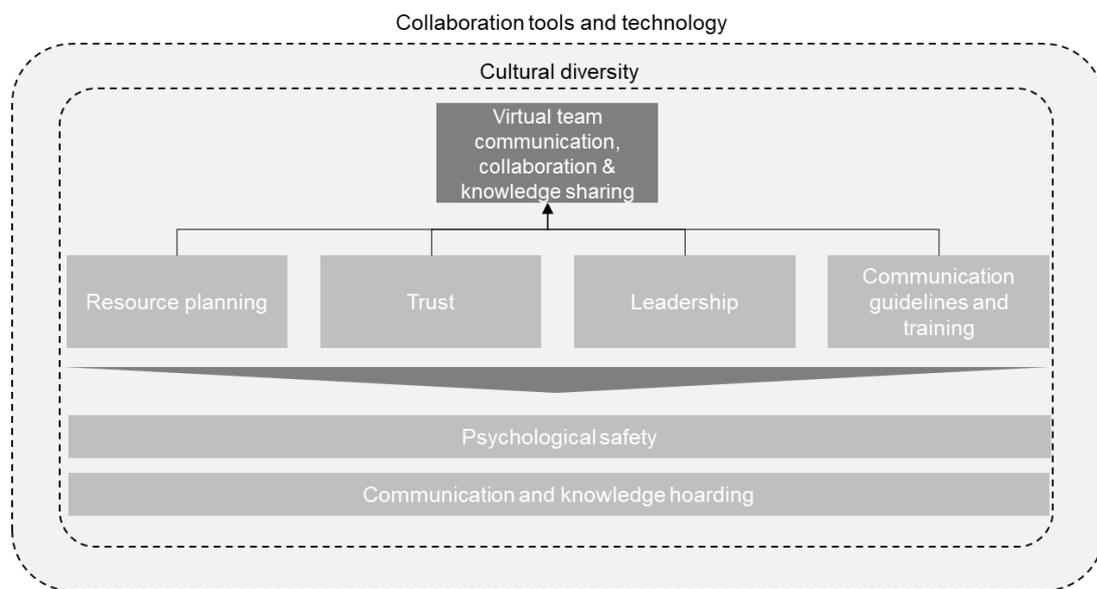


Fig. 3. Conceptual model

The eight key themes are mutually exclusive yet interrelated, with one theme often impacting another. Given the complexity of team interaction and social behaviors, a systematic analysis of each key theme's theoretical underpinnings is discussed below.

3.1 Theme 1: Trust

Trust is defined as “one’s psychological state reflecting a strong expectation that the other will not seek self-interest at the expense of their welfare, thus increasing the willingness to accept vulnerability” [28]. Trustworthiness is an evaluation of the characteristics of a trusted objective. What is significant for virtual interactions is that trust is not solely the trustworthiness of individuals, but also the trustworthiness of the systems teams use for organizing interactions.

Trust is an essential part of building relationships in most human-based interactions, how individuals interact impacts how trust is formed. Trust has been analyzed and examined at the interpersonal, individual, organizational, inter-organizational, calculus-based and cognitive-based levels [20]. Trust can enhance VT effectiveness, support positive behavior and improve conflict [24]. However, numerous factors impact interpersonal trust, including cultural diversity,

interaction experiences, perception of trustworthiness and risk versus reward [1]. Noteworthy, individual levels of trust for multicultural teams decreased during the VT lifecycle, while it increased for unicultural teams, primarily attributed to discrepancies in language, habitual behavior and values [25].

One of the main challenges individuals face in VTs is the development of trust, given the reduction in formal and informal interaction time between individuals [29]. Trust is seen as a critical success factor for VTs, as most tasks are conducted independently, i.e., performed by each team member without supervision. This requires significant confidence in one's ability to trust individuals to execute tasks, with team members often relying on the functional expertise of colleagues to complete tasks [1]. Developing trust in VTs is particularly challenging due to unshared and conflicting goals; however, knowledge sharing is enhanced through coordination and cooperation [28]. Therefore, project execution through virtual platforms brings a certain level of risk, as individuals depend upon one another to complete project tasks virtually.

Conflict and trust are central issues of knowledge sharing and virtual alliances in organizational teams. Strong levels of mutual trust amongst individuals can improve knowledge/resource sharing and joint risk-taking [1]. One of the primary challenges VTs face is encouraging the formation of trust and maintaining and growing trust through various phases of the team life cycle. Greenberg et al. [30] identified five stages in a typical VT lifecycle: team establishment, inception, organization, transition and task accomplishment. The foundation of trust between team members is typically established during the inception and organization phase, and it is, therefore, essential that appropriate communication and collaboration channels are used to enhance trust [30].

Furthermore, VTs interact primarily through digital channels such as telephone or computer-based collaboration platforms, which, compared to face-to-face interaction, reduces social context cues, often resulting in lower levels of social control and behaviors associated with lower levels of trust [7, 28, 31]. To mitigate this risk, the most appropriate collaboration technology should be used, where team members are confident in its ability to share information effectively [32]. Literature also suggests that team members meet face-to-face/in-person for project kick-off to ensure mutual trust is established and where virtual interaction is the only possible means of establishing trust, individual connection sessions are recommended [7, 25, 33]. This allows individuals to connect personally, forming close personal connections that drive trust through virtual engagement. Researchers also recommend a hybrid-based model where both digital and face-to-face communication mediums are used to interact [25]. Likewise, the addition of video to audio-based communication has been shown to improve the quality of strategic decision-making in VTs [21].

It was noted that most of the reviewed literature explicitly highlighted the importance of trust in VTs and was the second-most discussed of all themes. However, the appropriate actions to instill trust were limited, with only high-level success factors highlighted.

3.2 Theme 2: Cultural diversity

Cultural diversity is defined as the diversity of individuals' cultural values that distinguishes one's background and national culture from another [27]. Virtual teams are characterized as being culturally diverse, with researchers having mixed opinions on their effect on VT dynamics and collaboration [32]. Cultural differences were noted between Western and Eastern team members with numerous cultural discrepancies such as language, socially unacceptable working hours, falsehood, lack of respect and confrontational attitude [34]. These cultural discrepancies resulted in team members hoarding knowledge and a lack of knowledge sharing [35]. Specifically, it was noted that Eastern team members worked harder and during more socially unacceptable hours, particularly in VT settings, where well-defined working hours are lacking and that the Western colleagues are more individualist and self-focused than those from the East [34]. Similarly, VT members from countries such as Japan and Brazil tended to follow their leaders without question [32].

Unfortunately, cultural diversity is a source of misunderstanding and conflict [36]. However, contrary to this challenge, literature encourages cultural diversity, emphasizing the enhancement of innovation, creativity, ideas, and different

perspectives that culturally diverse members bring to VTs [35, 37]. Therefore, diversity can be regarded as an important condition for the success of VTs if managed correctly [27].

Managing cultural differences is essential to ensure knowledge is freely shared across multicultural team members and leverages the rich diversity of perspectives, skills and knowledge. Leaders can improve trust and performance through a thorough understanding of cultural differences and their impact on virtual groups [38]. Training should be provided to assist team members in adapting to diverse work styles and cultures and working in harmony [26]. Klitmøller and Lauring [31] suggested that language commonality be implemented in VTs, in terms of verbal and written communication, which refers to using one primary language for communication, typically English. Furthermore, cultural intelligence should be developed to positively contribute to social integration in VTs as it allows team members to understand culturally diverse people through sound reasoning and appropriate behavior [27].

3.3 Theme 3: Collaboration tools and technology

The role of information and communication technology as an enabler is essential for communication and building relationships in VTs [7]. Furthermore, technology is essential for VTs to carry out basic team functions such as collaborating, managing knowledge, communication and decision-making [26].

Lee-Kelley and Sankey [34] have segmented collaboration technology into three incremental generations, depending on the level of interaction and effectiveness. First-generation collaboration technology includes platforms such as emails and conference calls, where human-based emotions are limited, and the primary means of communication are vocal or written. Visual illustrations of information through PowerPoint presentations, videos and online meeting tools are classified as second-generation collaboration tools and are proven to improve human engagement. Third-generation collaboration technology is web-enabled shared workspaces via the internet and cloud-based platforms [34]. This includes new online communication technologies such as online file-sharing systems, global systems for mobile communications, electronic data interchange, web 2.0 applications and cloud computing services [20]. Researchers have recommended the extensive use of second and third-generation technologies for global VT collaboration, with first-generation used primarily for brief information-sharing interactions [35, 39]. Furthermore, rich media (e.g. video conferences) are preferred for knowledge sharing over lean media (e.g. emails) as it allows one to address misinterpretations more easily [31]. A collaborative technological environment in geographically distributed teams provides avenues for interactivity, knowledge sharing and coordination [40].

A study that analyzed the key drivers for project success and value creation noted that an over-reliance on technological infrastructure could hamper the growth of multinational companies when expanding into regions where the necessary technology does not exist [34]. In addition, a lower level of collaboration has been attributed to interactions on digital collaboration platforms, with both system performance and system design as critical elements [28]. Nevertheless, providing strong technical support for VT settings assisted in achieving faster project conduct and control [7].

It must be noted that despite the benefits of rich media, it can add to the challenge of culturally distinct communication behavior discussed in the previous theme. Communication guidelines should therefore be established to ensure diversity exclusion does not occur.

3.4 Theme 4: Communication and knowledge hoarding

Virtual teams are vulnerable to communication breakdowns, mistrust, conflicts and power struggles and must develop mechanisms for sharing knowledge, experiences, and insight critical for accomplishing their mission [35]. The fundamental elements in effectively communicating and sharing knowledge are not solely reliant on the technologies that VTs use but also on the ability and willingness of team members to be actively involved in knowledge sharing [35]. This involves team members actively responding to queries, participating in brainstorming sessions and decision-making, and disseminating ideas among team members [35].

While globally dispersed teams often offer members the opportunity of increased flexibility, research suggests that it is more challenging to manage the communication processes in these VTs [31]. Communication using such digital

channels typically results in misinterpretation of messaging due to the ambiguity of tone and absence of body language cues [41]. To overcome this challenge, VTs require media-rich communication channels when the knowledge to be shared is of a complex and equivocal nature. Media-rich platforms enhance verbal and non-verbal signs as well as enhance cues individuals use for social categorization, i.e. cultural exclusion, which is known to have negative effects on team communication [31]. On the other hand, videoconferencing resources have led to significant improvements in the quality of team decision-making [7]. Therefore, collaborative structures of decision-making are recommended in VTs.

From a knowledge-sharing perspective, VTs are more hesitant to share tacit knowledge than traditional face-to-face teams, given team members' lack of social and informal trust [29, 37]. This is referred to as knowledge hoarding, where team members purposefully withhold certain information due to feelings of mistrust and lack of reciprocity. To mitigate this challenge, Rosen et al. [35] suggest the development of a team Transactive Memory System (TMS) that represents 'the collective team knowledge that individual team members have developed or acquired, encoded, stored and can retrieve'. By developing a TMS, team members can quickly locate valuable knowledge within the collective data bank over time. One of the primary principles that VTs require is knowing "who knows what" and "who can I go to for information," allowing members to access individual knowledge repositories. Hence, VT leaders should also ensure that team members have quick and easy access to relevant information and existing knowledge, to maximize team outputs and enrich members with as much information as required. Additionally, knowledge sharing is positively related to trust, which encourages team members to share openly [42].

3.5 Theme 5: Leadership

Leadership in a virtual context is typically referred to as 'e-leadership' or 'virtual leadership', and is defined as 'a social influence process mediated by advanced information technologies to produce a change in attitudes, feelings, thinking, behavior, and/or performance with individuals, groups, and/or organizations' [43]. The widespread implementation of VTs has created a new context for leadership and teamwork and is considered a critical success factor for VT performance, with participants emphasizing similar sentiments [44].

VT leadership also monitors team performance and facilitates team development [45]. One of the critical success factors VTs require is the ability for teams to remain resilient, which is defined as the capacity to bounce back from a setback. These setbacks typically occur when essential VT processes start to break down. A bounce-back happens when VTs work closely together to return to a level that produces value-added outcomes through collaboration. A study investigating what makes resilient VTs, concluded that effective leadership is the primary influencing factor that allows teams to bounce back from setbacks, whereas resilience emerges from collaboration and interaction between team members and leaders [32]. Therefore, VT leaders must facilitate and motivate team member interactions, strategically designed to build resilience. This is significantly more important in VT teams than in face-to-face teams, where team member interaction occurs naturally. Leaders who can help develop VT resilience, focus on empowering and transformational leadership, enhancing team design, improving transactive memory, and increasing creativity [32].

Leaders with high levels of motivational, cultural intelligence will positively impact social integration and performance [27]. In addition, the skills of a traditional face-to-face project manager are required over and above the additional specialized skills required in a virtual context, including but not limited to the articulation of goals, assignment of responsibilities and providing continuous feedback [7]. Throughout the collaboration process, leaders should monitor employees struggling or falling behind and encourage them to feel comfortable enough to reach out for help. Recurring personal connection sessions between individual team members and the project leader are recommended to informally catch up and allow leaders to assess team members' sentiments and take appropriate actions [22].

3.6 Theme 6: Psychological safety

Psychological safety was identified as the most important determinant in successfully sharing knowledge in a virtual environment, and it is considered to be the shared belief that a team feels emotionally safe and comfortable for members to take interpersonal risks that challenge the status quo in an open and trusting environment [32]. These researchers also

contend that if VT members do not feel safe in taking risks for fear of embarrassment or interpersonal punishment, the team is at risk of missing out on information critical to overcoming adversity. Psychological safety also encourages team members to be open and candid enough to try new things, think outside the box, and discuss novel ideas [32].

Psychological safety is more relevant in VTs than in traditional face-to-face teams, given the limited social, informal interactions and visual cues, where typically, one person can speak at any given point in time, resulting in more introverted individuals feeling excluded from the team [34, 35]. In addition, for teams to successfully develop psychological safety across the entire team, members require mutual trust and mutual respect, which can be challenging when they do not share the same physical space [46]. Psychological safety also helps cultural teams have more effective processes, and it is especially relevant for working in adverse conditions [32].

A significant correlation between psychological safety and effective virtual leadership was identified by Rosen et al. [35], stating that virtual leaders should create conditions where VT members can see the overall positive value of knowledge sharing. For example, leaders can encourage psychological safety by promoting regular informal/social interactions, promoting a trial-and-error culture, sharing personal information and allowing team members to share first [46].

3.7 Theme 7: Communication guidelines and training

Clear communication rules and trust are required to accomplish work. Project managers perceive these two conditions as vital for improved project control, project conduct, and goal accomplishment [7]. In addition, when team adversity occurs, a well-defined framework of procedures and norms should already be in place that drives VTs to work collaboratively [32].

In order to support VT's progress, management and support guidelines should be used, including seamless project management, process control and how the product and process-related information is shared [1]. In addition, as VTs have membership diversity, team members should be provided with training and support to facilitate communication through both technical and non-technical modes [47]. Consistency in communication in a virtual setting is paramount, particularly when using the same collaboration tool across the team [34].

The agile approach is a common communication framework many organizations use to execute projects, particularly in the software engineering industry. Agile project execution focuses on rapid iterative development, and project requirements and solutions evolve through collaboration between teams. A study investigating the techniques, strategies, and challenges of distributed agile projects found that different techniques are used for local and global knowledge sharing [48]. The study identified some communication guidelines and practices implemented for knowledge sharing: team pairing, customer collaboration, Scrum/Kanban boards, virtual innovation boards, and workshops/seminars. Additionally, daily scrum meetings were frequently used to assign work and plan tasks for the rest of the day.

Team training was also highlighted as a significant success factor in VTs, particularly regarding effectively using the selected collaboration technology [31, 39]. However, little detail was provided regarding what type of training is specifically required, stating that the training is project and team specific. Hence, virtual leaders need to be cognizant that particular specialized training may be required, such as about technology platforms, virtual collaboration, and agile methods.

3.8 Theme 8: Resource planning

Resources can be segmented into three mutually exclusive categories: team resources for team organizing, including required skills and knowledge; product resources for product development and implementation; and external resources for teams. The planning and management of these resources are more challenging for VTs than traditional face-to-face project execution as these resources are typically more geographically dispersed, requiring a higher degree of management and leadership.

Effective VT collaboration relies on efficiently managing distributed resources, safe and timely sharing of resources and strategic human resource management [24]. Researchers who developed a trust evaluation method for VT co-workers found that given the higher degree of uncertainty associated with virtual project execution and the increased need for innovation required a secure, flexible and dynamic resource management and sharing system [34]. Furthermore, the technology resources available at different VT sites could be different [47].

The initial selection of human resources that form part of the core project team is essential for project success, where the correct individuals are selected based not only on their skills, knowledge and competencies but also on their ability to effectively communicate and socialize with others [34]. However, human expertise and vertical integration can be utilized in VTs to make resources readily available [47]. In addition to selecting the right team members, VT leaders also need to manage product resources, most notably the confidentiality of certain information such as intellectual property, patents and licenses.

4. Discussion and conclusion

This study provided an overview of the challenges and critical success factors of digital communication, collaboration and knowledge sharing typically faced in project management virtual teams (VT). Based on a review of VT-related literature, it is evident that additional challenges exist for VTs compared to traditional face-to-face teams, given their often geographically dispersed nature and heavy reliance on digital collaboration technology. However, researchers agree that virtual means of working offer team members more flexibility regarding time and location of work [31, 49]. The findings of the reviewed literature corroborate the generally held view that communication, collaboration and knowledge sharing in VTs is more challenging than in traditional face-to-face teams; hence VTs require additional support.

The eight identified themes are summarized in Table 1. These themes are viewed as the key factors that are significantly different from traditional face-to-face teams, requiring a more meticulous planning approach to enable VTs to execute their defined goals successfully.

One of the principal findings from this review was the significance of trust in virtual settings and that VT members require an additional sense of trust on a personal and process/system level [1, 28, 44]. The literature recommended that all team members meet face-to-face/in person during the inception and organization phases of the project lifecycle in order to establish individual trust during the early phase of project execution, with a hybrid model being the ideal approach to maximize team collaboration and knowledge transfer thereafter [25, 42]. In addition to individual trust, team members need to trust the systems and technology used to communicate and collaborate [28].

Psychological safety should be embedded by allowing team members to be open and candid, think outside the box and discuss novel ideas without fear of retribution [32]. Leaders are seen as the shapers of a psychologically safe team culture in which they enable VT members to feel safe to share ideas, offer constructive criticism and seek help [35].

Technology was a critical foundation for digital communication, with the recommendation of using a combination of first, second and third-generation collaboration technology [34]. Given the media richness of third-generation collaboration technologies, such as video conferencing tools, it is advisable to use them for large and complex information exchanges, particularly those that involve knowledge-sharing activities. Virtual team members should be provided with adequate training and technical support to become competent in using the selected technology [39]. Furthermore, appropriate virtual communication guidelines that outline how team members should interact and share should be developed and followed [48].

Table 1: Themes of communication, collaboration and knowledge sharing in virtual teams

Key themes	Overview and key research points: challenges and critical success factors
1. Trust	<ul style="list-style-type: none"> ▪ Digital communication channels hinder individual trust ▪ VTs require high levels of trust, which is more challenging to develop in virtual settings ▪ Multicultural VTs have lower levels of trust than unicultural teams due to discrepancies in language, habitual behavior and values ▪ Face-to-face interactions are recommended during project kick-off to establish trust among team members
2. Cultural diversity	<ul style="list-style-type: none"> ▪ Cultural diversity breeds cultural discrepancies ▪ Diversity in cultural backgrounds is a source of misunderstanding and conflict ▪ Team members require cultural intelligence
3. Collaboration tools and technology	<ul style="list-style-type: none"> ▪ Technology is essential for VTs to carry out their basic team functions, such as collaborating, communication, decision making and knowledge sharing ▪ VTs use a combination of first, second and third-generation collaboration technology; however third-generation technology is recommended ▪ Rich media communication is preferred over lean media
4. Communication and knowledge hoarding	<ul style="list-style-type: none"> ▪ VTs are prone to communication breakdowns, mistrust, conflicts and power struggles ▪ Standard communication guidelines should be set out and agreed upon by the team ▪ Teams must develop knowledge-sharing mechanisms ▪ Tacit knowledge is more challenging to share than explicit knowledge ▪ Media-rich digital platforms improve the level of communication ▪ Developing a Transactive Memory System is key to effectively sharing information ▪ Quick and easy access to relevant information and existing knowledge is required
5. Leadership	<ul style="list-style-type: none"> ▪ Effective virtual leadership enhance VTs resilience ▪ Virtual leaders should actively promote member interaction and lead conversations ▪ Empowering and transformational leadership traits are required in virtual settings ▪ Virtual leaders should monitor employees who are struggling and encourage them to reach out for help
6. Psychological safety	<ul style="list-style-type: none"> ▪ Team members should feel safe sharing thoughts and ideas openly ▪ Strong correlation between psychological safety and effective virtual leadership ▪ Promote informal/social interactions and a trial-and-error culture
7. Communication guidelines and training	<ul style="list-style-type: none"> ▪ Clear communication rules and trust are required to work collaboratively ▪ An agreed-upon language is recommended, primarily the most common language spoken amongst the team ▪ The agile approach fosters knowledge sharing in distributed teams. ▪ Team member training on how to fully utilize collaboration technology and tools, frameworks and methodologies should be provided
8. Resource planning	<ul style="list-style-type: none"> ▪ Selection of the correct resources – technology and non-technology related ▪ Utilize the right human personnel and vertical integration

The benefits of cultural diversity must be leveraged rather than seeing it as a challenge. Cultural diversity provides a rich diversity of perspectives, skills and knowledge that must be adequately utilized. In order to minimize VT conflict and knowledge hoarding, teams need to develop cultural intelligence and access cultural diversity training [26, 27]. Virtual team leaders have an essential role in their teams' implementation, functioning and cohesiveness. They must strategically select digital communication technologies and human resources to suit the virtual working environment. Likewise, virtual leaders need to have skills and traits to enhance VT resilience.

The study showed that the eight identified themes contribute distinctively, but often in overlapping ways, to the challenges and critical success factors of digital communication, collaboration and knowledge sharing in project management VTs. Furthermore, given the recent shift by many firms to work either on a pure virtual or hybrid model, the obligation of VTs to effectively communicate, collaborate and execute project deliverables is noteworthy. Therefore, VTs need to be aware of the peculiarities, challenges and success factors that are integral to executing projects virtually. Additional training may be required for teams to adjust to the new virtual working methods.

As with any study, this study also has its limitations. The limited number of shortlisted articles may have excluded certain perspectives and insights, resulting in a potential gap. The decision to exclude academic literature published prior to 2000 may have also limited the findings. A gap in the literature was observed with respect to investigating VT structures and the resulting impact on team collaboration and knowledge sharing. Future research could include the suitability of various team structures based on team size, industry and type of project. Furthermore, future research could identify best practices on how VTs should be structured to assign roles and responsibilities to ensure knowledge is effectively and accurately shared.

Finally, many industries have adopted virtual teamwork, especially due to the COVID-19 pandemic, and a continued increase in the adoption of VT work in the future can be expected. While VTs add additional complexity to communication and collaboration in the form of distance, time and cultural diversity, further research is required to determine if and to what extent a hybrid approach mitigates these complexities.

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Appendix A. Authors Matrix – exemplifying sample

No.	Author(s)	Article title	Journal title	Publication year	Type of Research	Research Method	Industry	Core Concepts	Core Findings
1	Tarila Zuofa and Edward G. Ochieng	Investigating barriers to project delivery using virtual teams	Procedia Computer Science	2021	Primary research	Semi-structured interviews	Professional services - Nigeria	Barriers included: greater misinterpretations leading to uneven participation, limited performance, greater conflict, and lack of accountability, monitoring, lack of experience and ineffective personnel skills development.	1. Retaining the need for PMs to develop strategies for ensuring trust and constantly clarifying project goals & guidelines in virtual teams. 2. VTs can work better for the delivery of knowledge & service-based projects that involve design, analysis and planning. 3. Firms must have a clear understanding of parameters for projects it considers for implementing virtually 4. VTs offer cost savings & flexibility.

Appendix B. Quality Assessment Questionnaire

No.	Questions	Yes	No	Can't Tell	Not Applicable
1	Was the source of information used in the article credible?				
2	Were the author(s) and institute who published the article creditable?				
3	Was selection bias avoided in the information used to develop the data?				
4	Was the method used to develop the data appropriate?				
5	Was the method used to combine the findings of studies appropriate?				
6	Are the stated conclusions supported by the data presented?				
7	Were the data and overall article reported in a logical and systematic manner?				
8	Does the extracted data provide value in answering the research question(s)?				

Appendix C. Concept Matrix – exemplifying sample

No.	Article title	Concepts							
		Trust	Cultural diversity	Collaboration tools and technology	Communication and knowledge hoarding	Leadership	Psychological safety	Communication guidelines and training	Resource planning
1	Investigating barriers to project delivery using virtual teams	✓		✓		✓			
2	Advanced multi-phase trust evaluation model for collaboration between coworkers in dynamic virtual project teams	✓✓						✓✓	✓

Concept matrix key: ✓ - theme discussed in the article; and ✓✓ - theme discussed explicitly in the article

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