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RESEARCH ARTICLE

An Empirical Study to Investigate the Impact of Factors Influencing Knowledge Sharing in Virtual Teams

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ABSTRACT This study examines the relationship between virtual team performance and its critical explaining factors, i.e., individual, team, organizational, and technological factors, by exploring the mediating effect of knowledge sharing. For this purpose, a conceptual framework is proposed based on an in-depth Systematic Literature Review (SLR) analysis. Next, data is collected through a survey from 252 IT practitioners working in Pakistan's small and medium-sized enterprises (SMEs). Statistical tests on collected data are applied in statistical package for social sciences (SPSS) and smart partial least squares (SmartPLS) to evaluate the proposed conceptual framework empirically. Finally, 19 industrial and 5 academic experts verified the framework. There is a consensus among researchers and practitioners regarding the factors that contribute to the explanation of knowledge sharing and virtual team performance. Thus, the current study's outcome may facilitate the management of software organizations to improvise their knowledge sharing infrastructure, make the development process more efficient, avoid project failure and increase the productivity of virtual teams.

INDEX TERMS Empirical study, geographically dispersed teams, knowledge sharing, systematic literature review, virtual teams, virtual team performance.

I. INTRODUCTION

A group of geographically separated individuals who use information and communication technology (ICT) to coordinate and discuss their work and do not require a shared physical workplace are considered virtual team members [1]. Based on the most recent study, including a sample size of 1,372 participants hailing from 80 different countries, it was found that a significant majority of 85 percent of the respondents were engaged in professional collaborations inside virtual team settings. Virtual teams have been found to promote organizational productivity by facilitating more efficient work processes, environmental impact, cost saving, resilience and business continuity, fostering value creation, diversity and inclusion, and bolstering an organization's overall capacities and flexibility. This is mainly because management can select the most suitable candidates from a wider talent pool, regardless of geographical location. Virtual teams encounter several difficulties, including but not limited to cultural differences, schedule conflicts, response delays, lack of communication, and most importantly lack of knowledge sharing due to their various cultural backgrounds, dispersed physical locations, and interconnected digital networks [2].

Knowledge sharing is the willingness of a person, team or organization to share their expertise with others. It is a big challenge for virtual teams and can affect their productivity [3], [4] because it is essential for quicker project development, successful teamwork, and business innovation [5], [6], [7]. Sharing knowledge can be advantageous for individuals, groups, and organizations. It helps improve learning, decision-making, productivity, innovation, customer service, problem-solving, and employee engagement

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and satisfaction. Therefore, organizations must ensure effective knowledge sharing among teams [8], [9], [10], which can be facilitated by using online platforms [3].

In today's competitive world, software development organizations are interested in utilizing the benefits of virtual teams. Simultaneously, these organizations strive to increase project success rates and foster organizational growth through effective knowledge sharing. Therefore, many researchers have conducted studies and revealed that knowledge sharing may increase virtual team performance. Interestingly, from the literature analysis, it has been found that many researchers believed critical factors of knowledge sharing may also be the critical factors of virtual team performance. Therefore, virtual team performance and its critical explaining factors, i.e., individual, team, organizational and technological factors, may be mediated by knowledge sharing. However, none of the studies identified all these common factors and their relationship. In addition, the studies need to explore the mediated role of knowledge sharing.

The current study aims to fill the existing gap by investigating the impact of factors influencing knowledge sharing in virtual teams. For this purpose, we have performed the following activities, which still need to be done in past studies:

- An SLR is conducted to identify knowledge sharing and virtual team performance explaining factors. A total of 9 factors were identified from the 31 primary studies.
- A conceptual framework is proposed after classifying the 9 factors into four classes.
- A survey was conducted to evaluate the conceptual framework empirically. In a survey, 252 IT professionals from Pakistani small and medium enterprises (SMEs) participated.
- Finally, 19 industrial and 5 academic experts verified the framework.

The remaining section of this study is presented as follows: The related work of this study is presented in section II. It provides a recent literature review on knowledge sharing in virtual teams. At the same time, section III discusses the research methodology of the current study. Section IV discusses the results from SLR, empirical evaluation, triangulation between SLR and empirical analysis, and expert validation. A detailed discussion of this study is provided in section V. In the last section conclusion, future work, and limitations of the current study are presented.

II. RELATED WORK

This section presents related work on knowledge sharing in virtual teams cited in recent studies. The increasing number of opportunities, competition, and globalization due to ICT also increases remote work, and computer-mediated groups fostered the deployment and rapid growth of virtual teams during the last few years [1]. In the study [2], a research model is proposed, as presented in Figure 1, to evaluate the effect of factors influencing knowledge sharing in the context of virtual teams. The authors investigate the impact

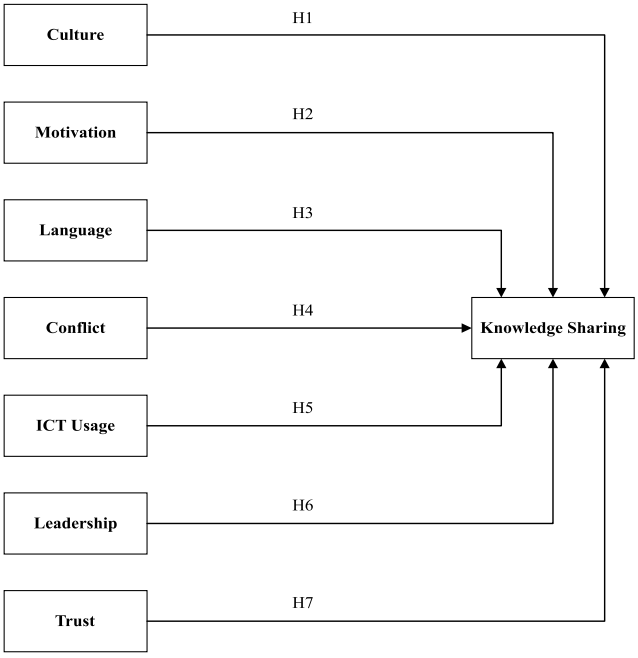

FIGURE 1. Existing framework [2].

of motivation, leadership, ICT, conflict, trust, culture, and language on knowledge sharing. However, this study did not consider other factors influencing knowledge sharing, such as rewards and social interaction. Moreover, the mediating role of knowledge sharing on virtual team performance is suggested but needs to be evaluated.

In another study [3], the authors proposed a four-dimensional framework of factors influencing knowledge sharing. The framework comprises four categories: personal, social, organizational, and technology, with their respective factors. However, the impact of identified factors should have been evaluated empirically by the industry. In the study [4], the authors proposed a conceptual framework to investigate the effect of environmental and individual variables on knowledge transfer behavior in distributed software development. This study used social cognitive theory to scrutinize knowledge transfer behavior in global software development. However, technology, organizational support, and other factors should have been addressed.

Another research [5] investigates how team environment and motivation variables affect knowledge sharing within geographically dispersed teams. The findings reveal that positive knowledge sharing attitudes are significantly related to trust, reciprocal benefits, and enjoyment. The affiliation factor does not find a positive effect on knowledge sharing attitudes. The study's limitation is that the survey was collected using a student sample. Moreover, subjective norms that play a crucial role in cultural diversity were not considered. In a study [6], the authors present a conceptual framework to evaluate the effect of factors influencing knowledge sharing among virtual team members. This study analyses the significance of trust, rewards, online interaction, regular

communication, and technology infrastructure on knowledge sharing. However, the authors did not consider other factors influencing knowledge sharing, such as affiliation and ICT usage. Moreover, a limited sample size, i.e., (160 respondents) was considered to evaluate the proposed framework.

In another research study [7], the authors evaluate the impact of internal barriers, interpersonal conflicts, the composition of teams, time cost trade-offs, and skills required for team members on knowledge sharing in virtual team projects. However, researchers must pay more attention to other important factors, such as motivation, social interaction, and ICT usage. Authors in [8], proposed a framework to evaluate the impact of team cognition and social capital on knowledge transfer in open-source mobile application (OSMA) projects. The findings illustrate that team cognition and social capital significantly influence knowledge sharing in OSMA. However, the sample size was too small, i.e., (152 respondents).

In [9], the authors proposed a conceptual framework to analyze the combined and distinct effects of personal, organizational, and team variables on knowledge sharing. The partial least square (PLS) method evaluates a conceptual model. The findings reveal that enjoyment, affiliation, and attitude have a positive impact. Whereas trust, top management support, and reciprocal benefits have a negative impact on knowledge sharing. In the study [10], a conceptual framework is proposed to examine the association between social capital and the risk of opportunistic behavior in knowledge sharing. The result of the study demonstrates that structural and cognitive social capital significantly affects knowledge sharing. However, the risk of opportunistic behavior has a non-significant impact on knowledge exchange. The authors in [11], proposed an input-mediator-outcome-input (IMOI) model to strengthen the organization's knowledge sharing activities. The model is classified into organizational, team, and individual factors. However, the proposed model needed to be empirically evaluated to investigate the impact of identified factors.

Furthermore, the authors in [12] highlighted the knowledge sharing challenges and facilitators in the context of public sector information and communications technology projects. The authors used the interview method to explore the phenomena of knowledge sharing. However, the results of this study illustrate that organizational barriers are more significant than individual and technology-level barriers. The results are biased because most survey participants belong to public sector organizations. The study [13] proposes a conceptual framework to evaluate the effect of organizational and personal variables influencing knowledge sharing. The study's results reveal trust, motivation, and leadership significantly impact knowledge sharing. However, other important factors, such as affiliation, rewards, and ICT usage, should have been considered.

Moreover, in 2019 the authors in [14] proposed a framework to evaluate the impact of communication on knowledge sharing with mediating role of trust. Furthermore, from the existing literature, we extracted some other factors of knowledge sharing, i.e., individual trust [4], team trust [5], [9], ICT usage [2], motivation [2], social interaction [4], [15], perceived ease of use [3], affiliation [5], [9], rewards [3] and top management support [9], [16]. Although these factors were highlighted in the previous literature, however; none of the studies evaluated the impact of these factors on virtual teams by considering knowledge sharing as a mediating variable. Therefore, the current study aims to contribute theoretically by enhancing the existing conceptual framework with all factors influencing knowledge sharing and virtual team performance. Moreover, the proposed framework is evaluated empirically from Pakistan's SMEs.

III. RESEARCH METHODOLOGY

The research methodology followed throughout this study is illustrated in Figure 2 and presented in this section. Initially, an SLR was conducted to extract factors influencing knowledge sharing in virtual teams. Based on SLR findings, a framework was proposed for analyzing the impact of extracted factors. Furthermore, partial least square structural equation modeling (PLS-SEM) was applied to evaluate the proposed framework empirically.

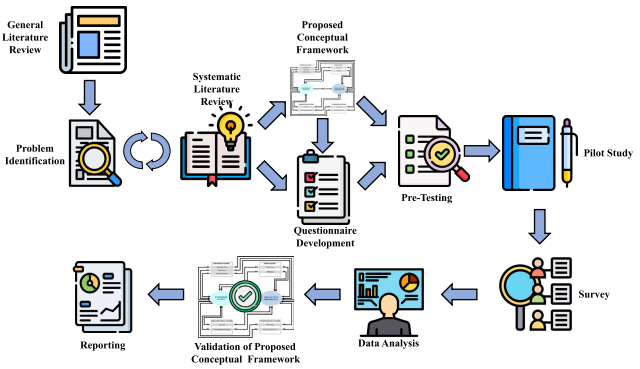

FIGURE 2. Research methodology.

A. SYSTEMATIC LITERATURE REVIEW

SLR is a method for systematically presenting the findings of previous research that are relevant to the research questions objectively and iteratively [17]. The SLR method was followed to identify the factors related to knowledge sharing and the virtual team's performance. In this study, the guidelines of Kitchenham [18] were used to conduct the SLR. Figure 3 depicts the phases and sub-phases of SLR.

1) PLANNING THE REVIEW

The SLR questions, data repositories, search string, inclusion, exclusion and quality assessment criteria were planned in this phase. Detail of each activity is given in subsections.

a: RESEARCH QUESTION

This study focused on identifying critical success factors influencing knowledge sharing and virtual team performance.

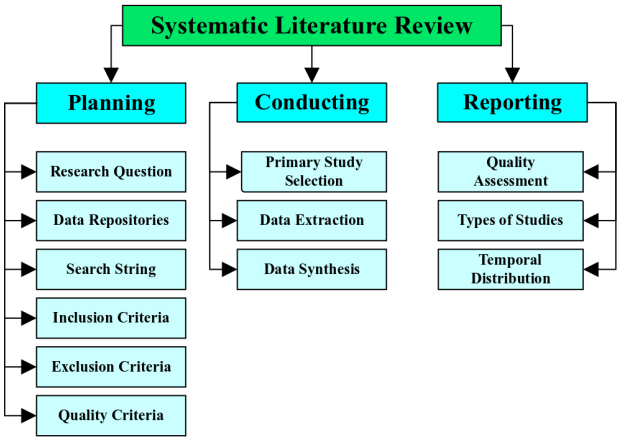

FIGURE 3. Phases of SLR.

In this study, two research questions were formulated, as presented below.

- RQ1: What factors in the literature influence knowledge sharing and virtual teams' performance?
- RQ2: What are the main categories of identified factors influencing knowledge sharing and virtual teams' performance?

b: DATA REPOSITORIES

The primary studies were selected from the following five online data repositories.

- Google Scholar
- IEEE Xplore
- Science Direct
- Wiley Online Library
- Emerald

c: SEARCH STRING

The two search strings given in Table 1 were used to find relevant studies.

TABLE 1. Search string.

Online Databases	Search String Used
Google Scholar and Science Direct	("knowledge sharing" OR "knowledge sharing behavior" OR "knowledge transfer" OR "factor affecting knowledge sharing" OR "knowledge sharing barriers") AND ("virtual team" OR "virtual organization" OR "geographically dispersed team")
IEEE Xplore, Wiley Online Library, and Emerald	("knowledge sharing" OR "knowledge sharing behavior" OR "knowledge transfer" OR "factor affecting knowledge sharing" OR "knowledge sharing challenges" OR "knowledge sharing barriers") AND ("virtual team" OR "virtual organization" OR "teleworking" OR "geographically dispersed team" OR "distributed team" OR "global virtual team" OR "global software development")

d: INCLUSION CRITERIA

In this research, the primary studies were included, which were:

- Published in English.
- Published in conferences or journals.
- Relevant to knowledge sharing in a global virtual team.
- Published during the year 2017 to 2021.
- Focusing mainly on challenges, barriers, issues, and factors influencing knowledge sharing in a virtual team.

e: EXCLUSION CRITERIA

The following criteria were used to exclude studies:

- Duplicate studies.
- Studies with no full text.
- "Blogs," "Posters," "Tutorials," "Slides," and "Editorials".

f: QUALITY CRITERIA FOR STUDY SELECTION

The quality criteria were defined to assess the quality of the selected articles. The articles that fulfilled the quality criteria were given a 1 score. Furthermore, articles that partially fulfilled the quality criteria were given a 0.5 score. The studies that did not fulfil the quality assessment criteria received a 0 score. Table 2 shows the quality assessment questions.

TABLE 2. Quality criteria question.

S. No.	Quality Criteria Question
QA1	Does the research discuss knowledge sharing in virtual teams?
QA2	Does the study evaluate and propose any knowledge sharing framework in a virtual team?
QA3	Are the stated research questions answered?
QA4	Is the limitation of the study taken into consideration?
QA5	Does the study provide future work?

2) CONDUCTING THE REVIEW

Conducting the review has three sub-phases, as discussed below.

a: PRIMARY STUDY SELECTION

A tollgate approach was applied for the in-depth refinement of relevant studies through primary study selection. The tollgate approach consists of five levels, as illustrated in Table 3. By following the tollgate approach, a total of 31 primary studies were selected.

- Level 1: The relevant studies were selected based on inclusion criteria and the search string.
- Level 2: After reading the title, keywords, and abstract, studies were selected or rejected.
- Level 3: After reading the introduction and conclusion, studies were included or excluded.
- Level 4: Studies were selected or rejected after reading the full text.
- Level 5: The primary studies were selected and included in the SLR by applying the quality assessment criteria.

TABLE 3. Tollgate approach levels.

Databases	Level 1	Level 2	Level 3	Level 4	Level 5
Google Scholar	2260	122	75	17	17
Science Direct	259	41	26	6	6
Emerald	242	24	18	5	5
Wiley Online Library	118	6	2	1	1
IEEE Xplore	86	3	3	2	2
Total Papers	2965	196	124	31	31

b: DATA EXTRACTION

To address the initial study inquiries, the primary studies were examined to identify the factors that impact knowledge sharing and virtual team performance. Table 5 presents the factors, their corresponding frequencies, and the article citation from where the factor was selected.

c: DATA SYNTHESIS

In the process of doing a systematic review, the step known as ''synthesis'' is where the data that have been extracted (the findings of separate research) are merged and analysed. This study used this step to categorise the factors into their relevant categories and propose a conceptual framework.

3) REPORTING THE REVIEW

Reporting the review wais the last phase of SLR. It consists of three sub-phases, (i) quality assessment, (ii) type of studies, and (iii) temporal distribution of studies. These steps are briefly described below.

a: QUALITY ASSESSMENT

The quality of the selected primary studies was evaluated by applying quality assessment criteria. The studies with a score of >50% (2.5 for the current study) were considered for further analysis, as suggested in [17]. The quality assessment score is presented in Table 4.

TABLE 4. Quality assessment score.

Ref#	QA1	QA2	QA3	QA4	QA5	Total Score
[1]	1	0	1	1	1	4
[2]	1	1	1	1	1	5
[3]	1	1	0	1	1	4
[4]	1	1	0	1	1	4
[5]	1	0.5	0	1	1	3.5
[6]	0.5	1	1	1	1	4.5
[7]	1	0.5	0	1	1	3.5
[8]	0.5	1	0	1	1	3.5
[9]	1	1	0	1	1	4
[10]	1	1	0	1	1	4
[11]	1	1	0	1	1	4
[12]	0.5	1	1	1	1	4.5
[13]	0.5	1	1	1	1	4.5
[14]	0.5	1	1	1	1	4.5
[15]	1	0.5	0	1	1	3.5
[16]	0.5	1	0	1	1	3.5
[19]	1	1	0	1	1	4
[20]	0.5	1	1	1	1	4.5
[21]	1	1	0	1	1	4
[22]	0.5	1	0	1	0	2.5
[23]	1	0.5	1	1	1	4.5
[24]	0.5	1	1	1	1	4.5
[25]	1	0.5	1	1	1	4.5
[26]	0.5	1	0	1	1	3.5
[27]	1	1	0	1	0	3
[28]	0.5	0.5	1	1	1	4
[29]	0.5	1	1	1	1	4.5
[30]	0.5	1	0	1	0.5	3
[31]	0.5	1	0	0.5	1	3
[32]	0.5	1	0	0.5	1	3
[33]	0.5	0	1	1	1	3.5

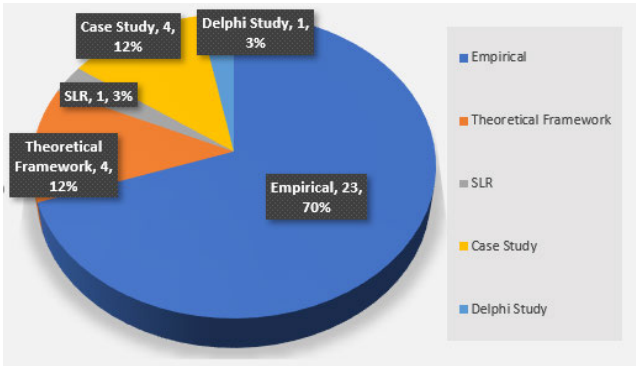

FIGURE 4. Type of studies.

b: TYPE OF STUDIES

In this phase, the primary studies were classified into five types based on the study's data collection method. Of the total 31 primary studies, 70% did empirical analysis, 12% just proposed theoretical frameworks, 3% conducted SLR, 12% applied case studies, and 3% used Delphi data collection methods. This phase helped the researchers to define the data collection method for their studies. Figure 4 illustrates the type and percentage distribution of selected primary studies.

c: TEMPORAL DISTRIBUTION OF FINAL PRIMARY STUDIES

All the primary studies selected were published from 2017 to 2021, as the purpose of SLR was to identify and investigate the latest trends in global virtual teams. Out of thirty-one primary studies, seven were published in 2017, two were published in 2018, eleven were published in 2019, six were published in 2020, and five were published in 2021. Figure 5 depicts the temporal distribution of the selected primary studies.

B. PROPOSED CONCEPTUAL FRAMEWORK AND HYPOTHESIS DEVELOPMENT

The framework was proposed after the in-depth analysis of existing studies on knowledge sharing and virtual team performance. The proposed conceptual framework and its relevant hypotheses are given in this section. The proposed conceptual framework consists of nine independent, reflective

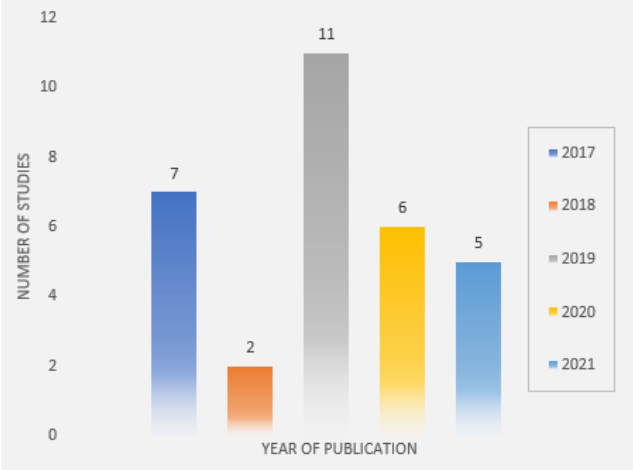

FIGURE 5. Temporal distribution of final primary studies.

constructs, i.e., individual trust, motivation, social interaction, team trust, affiliation, reward, top management support, ICT usage, and perceived ease of use, and dependent variable, i.e., virtual team performance. Considering the prior research work in this field, knowledge sharing is considered the mediating variable. Figure 6 illustrates the proposed conceptual framework.

1) INDIVIDUAL FACTORS

Individual factors are personal characteristics that significantly influence human behavior. People have unique characteristics, preferences, and experiences that influence their perceptions, attitudes, and behavior. Individual factors can help to describe why people act differently in certain situations [3].

a: INDIVIDUAL TRUST

Trust is the *"initial mechanism to support bilateral cooperation between the sender and the receiver that helps to overcome the ideas of the risk and possible vulnerabilities of individuals"* [9]. Trust is essential in facilitating knowledge transfer among geographically dispersed individuals. Promoting visits between globally distributed teams, which can eventually build up individual trust, can help improve trust across remote sites. More trustworthy individuals share their knowledge with their trusted peers [4]. The amount of trust among organizational employees determines their willingness to share knowledge with co-workers as reliable senders and receivers. Individual trust among team members influences employee participation in knowledge sharing in an organization [27]. Individual trust plays an vital role in virtual team performance when team members are geographically dispersed and communicate through ICT tools [34]. Individual trust helps to create successful virtual teams, resolves management conflict, and improves decision quality. According to [35], [36], and [37], individual trust significantly influences virtual team performance. Based on the above discussion following hypotheses are developed.

H1a: *Individual trust significantly influences knowledge sharing.*

H1b: *Individual trust significantly influences virtual teams' performance.*

H1c: *Knowledge sharing mediate the relationship between individual trust and virtual team performance.*

b: MOTIVATION

Motivation is a complex concept because motivational factors vary from person to person. An individual with no desire to perform a particular action is known as demotivated, whereas an individual willing to perform the particular action is known as motivated. There are two types of motivation, intrinsic and extrinsic. Extrinsic motivation is attaining the desired outcome, such as economic, reciprocal, or social benefits, while intrinsic motivation is obtaining pleasure and satisfaction from the activity. The social exchange and social cognitive theory have been used in existing studies to clarify why people hesitate to share knowledge [2] and [4]. The authors in [2] and [5] discussed that individual motivation is a critical aspect that significantly impacts knowledge sharing. However, in the study [9], motivation has a non-significant impact on knowledge sharing. The authors in [2], highlight that motivation significantly impacts virtual team performance. Therefore, it's crucial to consider and evaluate the impact of motivation. Based on the above discussion following hypotheses are developed.

H2a: *Motivation significantly influences knowledge sharing.*

H2b: *Motivation significantly influences virtual teams' performance.*

H2c: *Knowledge sharing mediate the relationship between motivation and virtual team performance.*

c: SOCIAL INTERACTION

Social interaction is defined as the connection between two or more persons. The strong social interaction between individuals makes communication more effective and plays a significant role in knowledge sharing [4]. The authors in [4] and [8] presented that social interaction significantly impacts knowledge sharing in virtual teams. However, in [15], the non-significant impact of social interaction on knowledge sharing is observed. Social interaction is one of the significant challenges affecting virtual teams' performance According to several studies [34], [38], [39], social interaction has a significant impact on virtual team performance. Therefore, social interaction is considered an individual factor in the proposed conceptual framework. Based on the above discussion following hypotheses are developed.

H3a: *Social interaction significantly influences knowledge sharing.*

H3b: *Social interaction significantly influences virtual teams' performance.*

H3c: *Knowledge sharing mediate the relationship between social interaction and virtual team performance.*

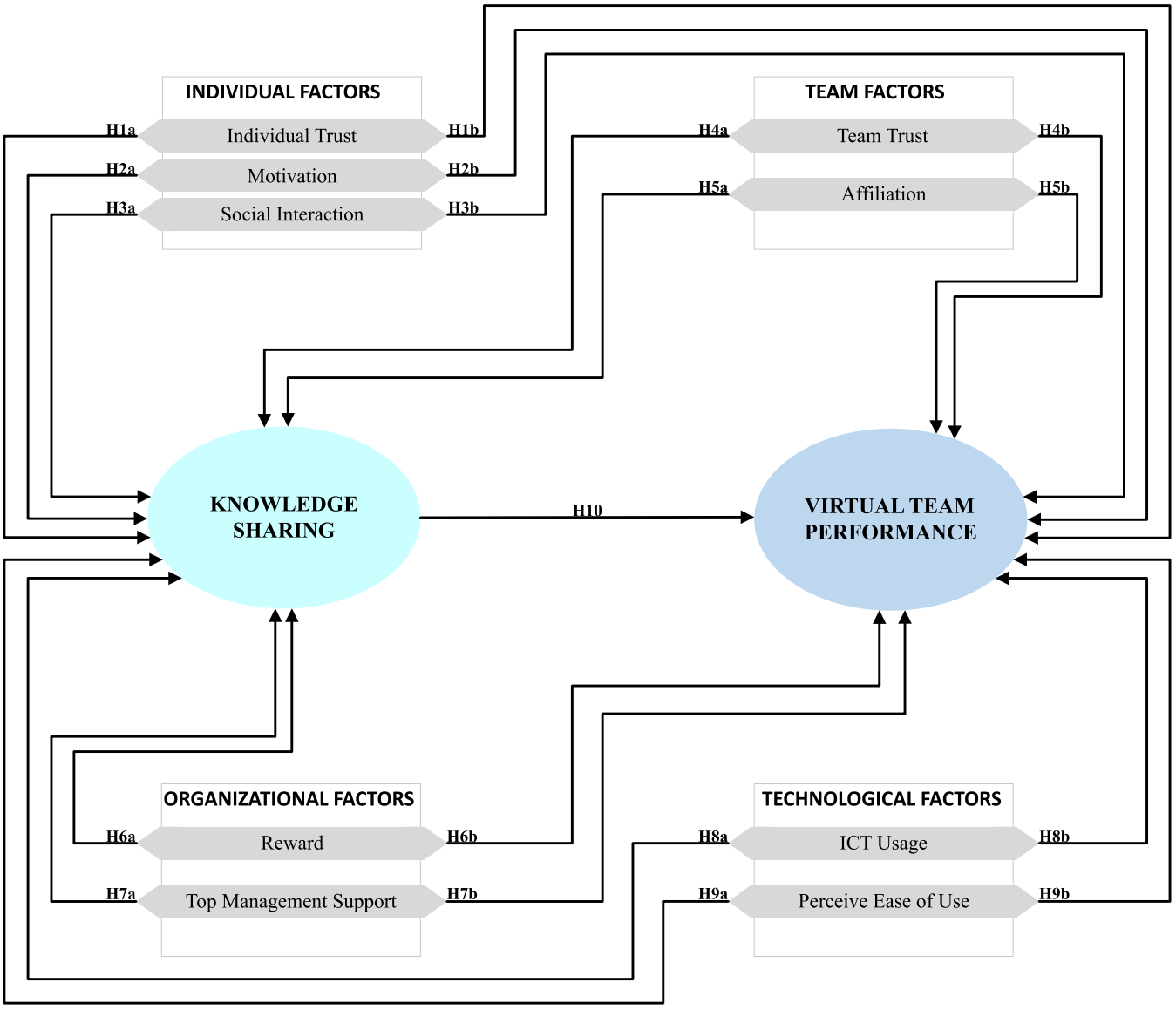

FIGURE 6. Proposed conceptual framework.

2) TEAM FACTORS

The team factors positively influence individuals' opinions and beliefs. The team factors are considered an essential source of social encouragement that can shape member behavior and attitudes within the team. The team environment consists of two components: team trust and affiliation. Existing cultural studies demonstrate that culture can affect the development of team trust and affiliation [5].

a: TEAM TRUST

According to [9], team trust is *"the willingness of someone to be vulnerable to the actions of another entity, based on the expectation that the other entity will perform a particularly important action for the trusting individual"*. The authors in [5], demonstrate that team trust significantly impacts knowledge sharing and virtual team performance. Virtual team members face difficulties building trust through traditional methods such as social norms and social interaction [9]. Moreover, the authors illustrate that team members share more knowledge if they trust each other, especially when there is low task dependency [5]. Also, trust is one of the most critical factors in a virtual environment [5]. However, in a study [9], trust has a non-significant impact on knowledge sharing in geographically dispersed teams. Trust plays a vital role in virtual team performance when team members are geographically dispersed and communicate through ICT tools. In the study [34], team trusts significantly impacts virtual team performance. Based on the above discussion following hypotheses are developed.

H4a: *Team trusts significantly influences knowledge sharing.*

H4b: *Team trusts significantly influences virtual teams' performance.*

H4c: *Knowledge sharing mediate the relationship between team trust and virtual team performance.*

b: AFFILIATION

Affiliation is defined as the unity among group members in a team [40]. Researchers have discovered that members with a high sense of affiliation will create a strong bond with other members, which motivates them to communicate and share more knowledge within the organization [9] and [41]. According to [5] and [9] affiliation significantly impacts knowledge sharing within virtual teams. However, few studies have explored this concept in virtual teams [5], [9], [42]. Additionally, in the study [5], affiliation has a non-significant impact on knowledge sharing. Whereas [9] has a significant impact on knowledge sharing. Therefore, the research needs further clarification to better understand the significance of affiliation in knowledge sharing in virtual teams. The authors in [2] highlight that affiliation has a significant impact on virtual team performance. Based on the above discussion following hypotheses are developed.

H5a: *Affiliation significantly influences knowledge sharing.*

H5b: *Affiliation significantly influences virtual teams' performance.*

H5c: *Knowledge sharing mediate the relationship between affiliation and virtual team performance.*

3) ORGANIZATIONAL FACTORS

Organizational factors refer to those variables which are related to the organization of the virtual team. It is difficult to say that employees automatically share their knowledge with other employees without getting rewarded and the support of top management. The reward system in the organization, with top management support, motivates employees to share their knowledge to obtain extrinsic benefits.

a: REWARDS

The authors in [43], discussed that rewards are classified into two types intrinsic and extrinsic. Extrinsic rewards contain monetary incentives such as an increase in pay and bonuses. In contrast, intrinsic rewards are based on recognition mechanism such as promotions and job security. Many authors [27], [43] illustrate that rewards significantly impact knowledge sharing. However, some studies [44] and [45] revealed that rewards have a non-significant impact on knowledge sharing. In the study [34], the authors discussed that the performance of virtual teams significantly increases by implementing an effective reward system in the organization. Therefore, it is important to evaluate the impact of rewards on knowledge sharing and virtual teams' performance. Based on the above discussion following hypotheses are developed.

H6a: *Reward significantly influences knowledge sharing.*

H6b: *Reward significantly influences virtual teams' performance.*

H6c: *Knowledge sharing mediate the relationship between rewards and virtual team performance.*

b: TOP MANAGEMENT SUPPORT

Managers can create social networks for organizational employees. It helps to maintain team members' interaction and foster trust relationships, which are critical for knowledge sharing [46], [47]. According to the past few studies [9], [47], [48], [49], top management support increases the willingness of employees to share their knowledge with other employees in virtual teams. However, the authors in [9] and [50] discussed that top management does not impact on knowledge sharing. Top management support manages team conflicts, motivates team members, and builds trust to enhance virtual team performance. According to several authors [36], [37], [51], top management support significantly influences the performance of virtual teams. Therefore, the top management support variable's results are contradictory and need further clarification. Based on the above discussion following hypotheses are developed.

H7a: *Top management support significantly influences knowledge sharing.*

H7b: *Top management support significantly influences virtual teams' performance.*

H7c: *Knowledge sharing mediate the relationship between top management support and virtual team performance.*

4) TECHNOLOGICAL FACTORS

ICT usage and perceived ease of use are the critical technological factors influencing knowledge sharing in virtual teams. In the study [52], the authors discussed that a reliable information technology system enables employees to share more knowledge in their organization.

a: ICT USAGE

ICT facilitates knowledge sharing among team members within the organization. ICT is a technological platform that enables employees to communicate using various technologies such as video conferencing, email, voice mail, wikis, etc. [2], [53]. The selection of communication medium needs to be improved in virtual teams. ICT's efficient and effective use significantly impacts knowledge sharing and virtual team performance [54]. Based on the above discussion following hypotheses are developed.

H8a: *ICT usage significantly influences knowledge sharing.*

H8b: *ICT usage significantly influences virtual teams' performance.*

H8c: *Knowledge sharing mediate the relationship between ICT usage and virtual team performance.*

b: PERCEIVED EASE OF USE

Employees' understanding of using information technology for knowledge sharing is perceived ease of use [55], [56]. Moreover, the authors in [3] and [57], almost 8% of respondents indicated that the challenge of posting online affects knowledge sharing. In the study [58], perceived ease of use significantly impacts knowledge sharing within the virtual team. According to [2] and [59], perceived ease of use significantly impacts virtual team performance. Based on the above discussion following hypotheses are developed.

H9a: *Perceived ease of use significantly influences knowledge sharing.*

H9b: *Perceived ease of use significantly influences virtual teams' performance.*

H9c: *Knowledge sharing mediate the relationship between perceived ease of use and virtual team performance.*

5) KNOWLEDGE SHARING

Knowledge sharing is a communication process between two or more individuals, comprised of acquiring and providing knowledge. Several authors [1], [2], [9] highlighted that an increase in knowledge sharing enhances the performance of virtual teams. However, none of the studies empirically evaluate the impact of knowledge sharing on virtual team performance. This study uses knowledge sharing as a mediating variable that impacts virtual team performance. Based on the above discussion following hypotheses is developed.

H10: *Knowledge sharing significantly influences virtual team performance.*

C. EMPIRICAL ANALYSIS OF PROPOSED FRAMEWORK

The empirical analysis of the proposed conceptual framework is presented in this section. Data collection was performed using the survey method. The respondents included chief executive officers (CEOs), developers, software engineers, and project managers of virtual software development teams in Pakistan's SMEs. The data was collected from the respondents through a close-ended questionnaire. The questionnaire comprises two main sections: the first focuses on demographic information, and the second lists the factors influencing knowledge sharing and virtual team performance. A five-point Likert scale was used; the participants expressed their views on how much they agreed and disagreed with the statement. The five options of the Likert Scale were: "Strongly Agree" = 1, "Agree" = 2, "Neutral" = 3, "Disagree" = 4, and "Strongly Disagree" = 5. Neutral values provide unbiased results.

Pre-testing was performed to reduce the questionnaire's measurement errors and to check the question ordering [17]. In addition, content validity was performed to verify the questionnaire's authenticity. It also includes evaluating the readability of the questionnaire, sentence structure, fonts, and grammatical mistakes. In addition, suggestions from experts were considered, and the changes were applied to the questionnaire. Moreover, before the final online survey, a pilot study was conducted on 30 respondents to evaluate the validity of the questionnaire.

The most frequently used technique, i.e., the random sampling technique, was used to collect data from May 2022 to August 2022. To statistically analyze the collected data, the PLS-SEM method was used. After the respondents' consent, the online survey link was shared with 320 respondents. A total of 288 responses were received. Following the exclusion of either missing or incomplete questionnaires, a total of 252 replies were deemed suitable for subsequent research.

IV. RESULTS AND FINDINGS

This section presents the results of the SLR and describes them in detail. The data extracted through SLR consists of factors influencing knowledge sharing and virtual team performance. Moreover, the empirical evaluation of the proposed conceptual framework has been described. Furthermore, triangulation and validation of the proposed conceptual framework are presented.

A. RESULTS FROM SLR

This section provides a detailed list of factors influencing knowledge sharing in virtual teams extracted through SLR. The 31 primary studies identified 9 critical success factors affecting knowledge sharing and virtual teams' performance. The extracted factors and their frequencies are illustrated in Table 5.

TABLE 5. Results from SLR.

ID	Factor	Frequency	Reference Papers
Individual Factors			
IT	Individual Trust	8 (25.8%)	[4], [7], [8], [11], [12], [13], [14], [33]
MOT	Motivation	9 (29.1%)	[2], [4], [5], [9], [11], [16], [22], 23], [33]
SI	Social Interaction	4(12.9%)	[3], [4], [8], [15]
Team Factors			
TT	Team Trust	7 (22.5%)	[2], [5], [6], [8], [9], [11], [14]
AFF	Affiliation	2 (6.4%)	[5], [9]
Organizational Factors			
REW	Reward	4 (12.9%)	[3], [6], [12], [22]
TMS	Top Management Support	3 (9.6%)	[3], [9], [16]
Technological Factors			
ICT	ICT Usage	4 (12.9%)	[2], [3], [13], [26]
PEOU	Perceived Ease of Use	2 (6.4%)	[3], [28]

B. DEMOGRAPHIC ANALYSIS OF RESPONDENTS

The demographic information of respondents is presented in Table 6. According to the survey results, 35.3% of organizations have 10-50 employees, 16.3% have 51-100 employees, 6.7% have 101-150 employees, 3.6% have 151-200 employees, and 38.1% have 201-250 employees. Furthermore, the

TABLE 6. Demographic analysis of participants.

Demographics	Respondents	Frequency	Percentage
Organization Size	Less than 50	89	35.3%
	51 to 100	41	16.3%
	101 to 150	17	6.7%
	151 to 200	9	3.6%
	Above 200	96	38.1%
Work Experience	Less than 5 years	214	84.9%
	5 to 10 years	31	12.3%
	More than 10 years	7	2.8%

survey results illustrate that 84.9% of respondents have work experience of 1-5 years, 12.3% have work experience of 5-10 years, and 2.8% have work experience of more than 10 years.

C. RELIABILITY ANALYSIS

The reliability analysis of the questionnaire was performed to check the internal consistency of items. The internal consistency analyses the association of items within the construct and their interrelated construct items. In this study, Cronbach's alpha was used to measure the internal consistency of items. According to [60], Cronbach's alpha value greater than 0.60 is acceptable. The internal consistency of each construct was analyzed and illustrated in Table 8. The results depict that the reliability of each construct is satisfied.

D. DESCRIPTIVE ANALYSIS

The descriptive analysis of the data collected through the survey is presented in this section. Each construct item was analyzed by calculating the standard deviation, mean, kurtosis, and skewness. In this study, each construct was measured through two, three, or four items by using a five-point Likert scale. The constructs, motivation (MOT), social interaction (SI), and knowledge sharing (KS), were measured by using four items. In addition, affiliation (AFF), team trust (TT), rewards (REW), top management support (TMS), ICT usage, and virtual team performance (VTP) were measured by using three items. Furthermore, individual trust (IT) and perceived ease of use (PEOU) were measured by using two items. According to [61], the acceptable range of skewness is from -1.96 to $+1.96$. Otherwise, the data is highly skewed, and -3 to $+3$ for kurtosis is acceptable.

E. CORRELATION ANALYSIS

The correlation analysis measured the association between constructs, as presented in Table 9. Pearson's correlation was used to analyze the relationship among the constructs of the proposed conceptual framework. According to [62], the following guidelines were used for interpreting the correlation coefficient.

- The ± 1 value for the correlation coefficient depicts a strong relationship.
- The value from 0 to ± 0.3 for the correlation coefficient depicts a weak relationship.
- The value from ± 0.3 to ± 0.7 for the correlation coefficient depicts a moderate relationship.
- The value from ± 0.7 to ± 1.0 for the correlation coefficient illustrates a strong relationship.

F. RESULTS OF PLS-SEM

The significance of the proposed conceptual framework was analyzed by applying PLS-SEM using SmartPLS 3. The PLS-SEM consists of a structural and measurement model. The structural model depicted the association between the latent variables. In contrast, the measurement model depicted the interconnection between the survey data and latent variables. The PLS-SEM is generally used when the proposed conceptual framework is complex, contains too many latent variables, and requires more accurate results [62].

1) MEASUREMENT MODEL ANALYSIS

The conceptual framework suggested in this study was reflective because all latent variables were affected by indicators. The measurement model analyses and evaluates the cause-effect relationship between indicators of latent variables. The discriminant and convergent validity techniques were used to evaluate the measurement model.

a: CONVERGENT VALIDITY

The correlation among items of latent variables was determined by convergent validity. The standardized outer loadings and average variance extracted (AVE) metrics were crucial to analyze convergent validity. According to [63], the acceptable values of outer loadings are greater than 0.60. Table 7 presents each latent variable's outer loadings and cross-loadings values. The value of composite reliability lies between 0.8 to 0.9. Further, AVE helped to analyze the average variance shared by latent variables. The results of composite reliability and AVE are presented in Table 8.

b: DISCRIMINANT VALIDITY

The discriminant validity of the proposed conceptual framework is presented in this section. According to Fornell & Larcker criterion, the square root of the AVE of each construct must be greater than the correlation of other constructs. Table 9 depicted that the value of AVE on the diagonal was greater than the correlation of other latent variables; therefore Fornell & Larcker criterion was satisfied.

2) STRUCTURAL MODEL ANALYSIS

In this study, we applied structural modelling analysis to validate the hypothesis of the proposed conceptual framework. Figure 7 depicts a structural model with path coefficients and outer loadings. Gray circles represent independent variables, light blue circle present mediating variable, and dark blue circle depicts dependent variable. Moreover, the R-square indicates how closely each data point fits. The value for

TABLE 7. Outer-loadings and cross-loadings of indicators and constructs.

	IT	MOT	SI	AFF	TT	REW	TMS	ICT	PEOU	KS	VTP
IT1	**0.855**	0.219	0.337	0.355	0.206	0.275	0.221	0.087	0.123	0.338	0.322
IT2	**0.863**	0.193	0.266	0.256	0.237	0.277	0.346	0.144	0.213	0.347	0.28
MOT1	0.168	**0.745**	0.176	0.185	0.125	0.179	0.201	0.123	0.082	0.263	0.166
MOT2	0.174	**0.676**	0.19	0.217	0.153	0.261	0.137	0.063	0.077	0.197	0.122
MOT3	0.242	**0.771**	0.254	0.168	0.176	0.187	0.151	0.147	0.196	0.28	0.298
MOT4	0.127	**0.732**	0.15	0.199	0.206	0.165	0.124	0.162	0.196	0.324	0.274
SI1	0.179	0.127	**0.658**	0.203	0.19	0.188	0.052	0.06	0.183	0.309	0.282
SI2	0.225	0.232	**0.771**	0.19	0.181	0.342	0.11	0.155	0.208	0.43	0.34
SI3	0.29	0.214	**0.773**	0.314	0.139	0.312	0.209	0.08	0.226	0.384	0.303
SI4	0.305	0.152	**0.637**	0.227	0.24	0.192	0.123	0.153	0.255	0.341	0.236
AFF1	0.232	0.128	0.214	**0.737**	0.178	0.27	0.185	0.191	0.228	0.328	0.334
AFF2	0.292	0.231	0.287	**0.768**	0.17	0.176	0.086	0.123	0.197	0.297	0.335
AFF3	0.28	0.228	0.242	**0.756**	0.156	0.288	0.058	0.106	0.244	0.352	0.435
TT1	0.204	0.196	0.143	0.199	**0.848**	0.188	0.14	0.173	0.158	0.31	0.19
TT2	0.245	0.211	0.227	0.205	**0.875**	0.18	0.13	0.165	0.142	0.362	0.22
TT3	0.22	0.19	0.292	0.176	**0.88**	0.091	0.145	0.219	0.166	0.365	0.168
REW1	0.235	0.132	0.267	0.319	0.173	**0.804**	0.155	0.132	0.248	0.364	0.269
REW2	0.257	0.247	0.355	0.277	0.16	**0.85**	0.168	0.13	0.282	0.35	0.224
REW3	0.3	0.264	0.301	0.224	0.101	**0.822**	0.144	0.208	0.238	0.399	0.307
TMS1	0.273	0.183	0.178	0.128	0.137	0.22	**0.867**	0.137	0.14	0.28	0.256
TMS2	0.277	0.192	0.111	0.106	0.166	0.122	**0.896**	0.208	0.113	0.277	0.248
TMS3	0.321	0.171	0.177	0.148	0.117	0.152	**0.874**	0.188	0.18	0.283	0.28
ICT1	0.131	0.176	0.163	0.185	0.251	0.171	0.134	**0.825**	0.215	0.275	0.198
ICT2	0.144	0.168	0.085	0.144	0.133	0.17	0.224	**0.843**	0.186	0.282	0.189
ICT3	0.07	0.108	0.159	0.144	0.165	0.149	0.156	**0.87**	0.308	0.298	0.202
PEOU1	0.152	0.161	0.305	0.245	0.125	0.267	0.105	0.243	**0.895**	0.35	0.299
PEOU2	0.2	0.195	0.244	0.29	0.196	0.288	0.189	0.261	**0.902**	0.361	0.336
KS1	0.259	0.261	0.351	0.225	0.346	0.33	0.19	0.223	0.314	**0.698**	0.339
KS2	0.288	0.237	0.354	0.364	0.322	0.242	0.248	0.31	0.262	**0.748**	0.426
KS3	0.338	0.275	0.411	0.349	0.299	0.348	0.226	0.192	0.25	**0.72**	0.415
KS4	0.31	0.339	0.436	0.357	0.251	0.424	0.285	0.285	0.359	**0.832**	0.52
VTP1	0.295	0.249	0.332	0.377	0.184	0.293	0.261	0.192	0.286	0.544	**0.857**
VTP2	0.292	0.249	0.391	0.415	0.162	0.206	0.274	0.186	0.325	0.454	**0.872**
VTP3	0.292	0.276	0.309	0.455	0.213	0.317	0.207	0.206	0.278	0.422	**0.801**

TABLE 8. Construct reliability and validity.

Variables	Cronbach's Alpha	Composite Reliability	AVE
IT	0.701	0.849	0.738
MOT	0.716	0.822	0.536
SI	0.702	0.804	0.508
AFF	0.705	0.800	0.569
TT	0.837	0.902	0.754
REW	0.766	0.865	0.681
TMS	0.853	0.911	0.773
ICT	0.802	0.883	0.717
PEOU	0.761	0.893	0.807
KS	0.741	0.837	0.564
VTP	0.785	0.874	0.699

R-square lies between 0 to 1 [62]. The R-square for knowledge sharing was 0.516, and virtual team performance was 0.437. The sample mean, standard deviation (SD), P-value, and T-stat were calculated for each proposed hypothesis. The acceptable range of T-stat for two-tail significance is $T > 1.96$ and $P < 0.05$. Table 10 illustrates that the evaluation of the measurement model was statistically significant.

a: HYPOTHESIS EVALUATION

This study proposed ten hypotheses to analyze the impact of factors influencing knowledge sharing and virtual team performance. The PLS-SEM was applied to evaluate the proposed hypotheses using 6000 bootstrapping samples. The impact of independent and mediating variables is illustrated in Tables 12 and 13. The effect of individual trust (IT) on KS was non-significant, with Beta = 0.067, S.D = 0.055, T-stat = 1.206, and $P > 0.05$. Hence, H1a was not supported. The total effect of IT on VTP was non-significant, with Beta = 0.063, S.D = 0.062, T-stat = 1.012, and $P > 0.05$. Hence, H1b was not supported. Lastly, H1c evaluates whether KS mediates the relationship between IT and VTP. With the inclusion of mediating variable, the direct impact of IT on VTP became non-significant with Beta = 0.043, S.D = 0.061, T-stat = 0.696, and $P > 0.05$. The indirect effect of IT on VTP was also non-significant, with Beta = 0.020, S.D = 0.018, T-stat = 1.113, and $P > 0.05$. So, hypothesis H1c was rejected. The mediation effect between IT and VTP is presented in Figure 8(a), and hypothesis evaluation is illustrated in Tables 10 and 11.

Moreover, the effect of MOT on KS was significant with Beta = 0.110, S.D = 0.050, T-stat = 2.179, and $P < 0.05$.

TABLE 9. Correlation analysis and discriminant validity of construct.

	IT	MOT	SI	AFF	TT	REW	TMS	ICT	PEOU	KS	VTP
IT	**0.859**										
MOT	0.242*	**0.732**									
SI	0.350*	0.260*	**0.713**								
AFF	0.358*	0.259*	0.327*	**0.754**							
TT	0.258*	0.229*	0.259*	0.222*	**0.868**						
REW	0.321*	0.261*	0.372*	0.329*	0.174*	**0.825**					
TMS	0.331*	0.207*	0.177*	0.145*	0.159*	0.188*	**0.879**				
ICT	0.135*	0.177*	0.161*	0.185*	0.215*	0.192*	0.202*	**0.847**			
PEOU	0.196*	0.198*	0.305*	0.298*	0.179*	0.309*	0.164*	0.281*	**0.898**		
KS	0.400*	0.373*	0.519*	0.434*	0.400*	0.451*	0.319*	0.337*	0.396*	**0.751**	
VTP	0.350*	0.307*	0.410*	0.492*	0.222*	0.325*	0.297*	0.232*	0.354*	0.571*	**0.836**

*. Correlation is significant at the 0.05 level (2-tailed).

TABLE 10. Structural model evaluation.

Hypothesis	Beta	S. D	T-stat	P-value	Results
H1a: IT → KS	0.067	0.055	1.206	P>0.05	Not Supported
H2a: MOT → KS	0.110	0.050	2.179	P<0.05	Supported
H3a: SI → KS	0.245	0.052	4.710	P<0.05	Supported
H4a: TT → KS	0.172	0.051	3.383	P<0.05	Supported
H5a: AFF → KS	0.141	0.053	2.677	P<0.05	Supported
H6a: REW → KS	0.156	0.059	2.620	P<0.05	Supported
H7a: TMS → KS	0.112	0.048	2.344	P<0.05	Supported
H8a: ICT → KS	0.122	0.050	2.429	P<0.05	Supported
H9a: PEOU → KS	0.113	0.050	2.248	P<0.05	Supported
H10: KS → VTP	0.303	0.073	4.133	P<0.05	Supported

Hence, H2a was supported. The total effect of MOT on VTP was non-significant with Beta = 0.098, S.D = 0.051, T-stat = 1.903, and P > 0.05. Hence, H2b was not supported. Lastly, H2c evaluates whether KS mediates the relationship between MOT and VTP. With the inclusion of mediating variable, the direct impact of MOT on VTP became non-significant with Beta = 0.064, S.D = 0.050, T-stat = 1.288, and P > 0.05. Moreover, the indirect effect of MOT on VTP was also non-significant, with Beta = 0.033, S.D = 0.018, T-stat = 1.882, and P > 0.05. So, hypothesis H2c was rejected. The mediation effect between MOT and VTP is presented in Figure 8(b), and hypothesis evaluation is illustrated in Tables 10 and 11.

The effect of SI on KS was significant with Beta = 0.245, S.D = 0.052, T-stat = 4.710 and P < 0.05. Hence, H3a was supported. The total effect of SI on VTP was significant with Beta = 0.175, S.D = 0.058, T-stat = 3.023 and P < 0.05. Hence, H3b was supported. Lastly, H3c evaluates whether KS mediates the relationship between SI and VTP. With the inclusion of mediating variable, the direct impact of SI on VTP became non-significant with Beta = 0.101, S.D = 0.059, T-stat = 1.718 and P > 0.05. Moreover, the indirect effect of SI on VTP was significant with Beta = 0.074, S.D = 0.023, T-stat = 3.252, and P < 0.05. So, hypothesis H3c was accepted. This shows that the relationship between SI and VTP is fully mediated through KS. The mediation effect between SI and VTP is presented in Figure 8(c), and the hypothesis evaluation is illustrated in Tables 10 and 11.

The effect of TT on KS was significant with Beta = 0.172, S.D = 0.051, T-stat = 3.383 and P < 0.05. Hence, H4a was supported. The total effect of TT on VTP was non-significant with Beta = 0.008, S.D = 0.060, T-stat = 0.141 and P > 0.05. Hence, H4b was not supported. Lastly, H4c evaluates whether KS mediates the relationship between TT and VTP. With the inclusion of mediating variable, the direct impact of TT on VTP became non-significant with Beta = -0.044, S.D = 0.056, T-stat = 0.786 and P > 0.05.

Moreover, the indirect effect of TT on VTP was significant with Beta = 0.052, S.D = 0.019, T-stat = 2.749, and P < 0.05. So, hypothesis H4c was accepted. This shows that the relationship between TT and VTP is fully mediated through KS. The mediation effect between TT and VTP is presented in Figure 8(d), and hypothesis evaluation is illustrated in Tables 10 and 11. The effect of AFF on KS was significant with Beta = 0.141, S.D = 0.053, T-stat = 2.677 and P < 0.05. Hence, H5a was supported. The total effect of AFF on VTP was significant with Beta = 0.313, S.D = 0.065, T-stat = 4.806 and P < 0.05. Hence, H5b was supported. Lastly, H5c evaluates whether KS mediates the relationship between AFF and VTP. With the inclusion of mediating variable, the direct impact of AFF on VTP became significant with Beta = 0.270, S.D = 0.068, T-stat = 4.003 and P < 0.05. Moreover, the indirect effect of AFF on VTP was significant with Beta = 0.043, S.D = 0.019, T-stat = 2.241, and P < 0.05. So, hypothesis H5c was accepted. This shows that

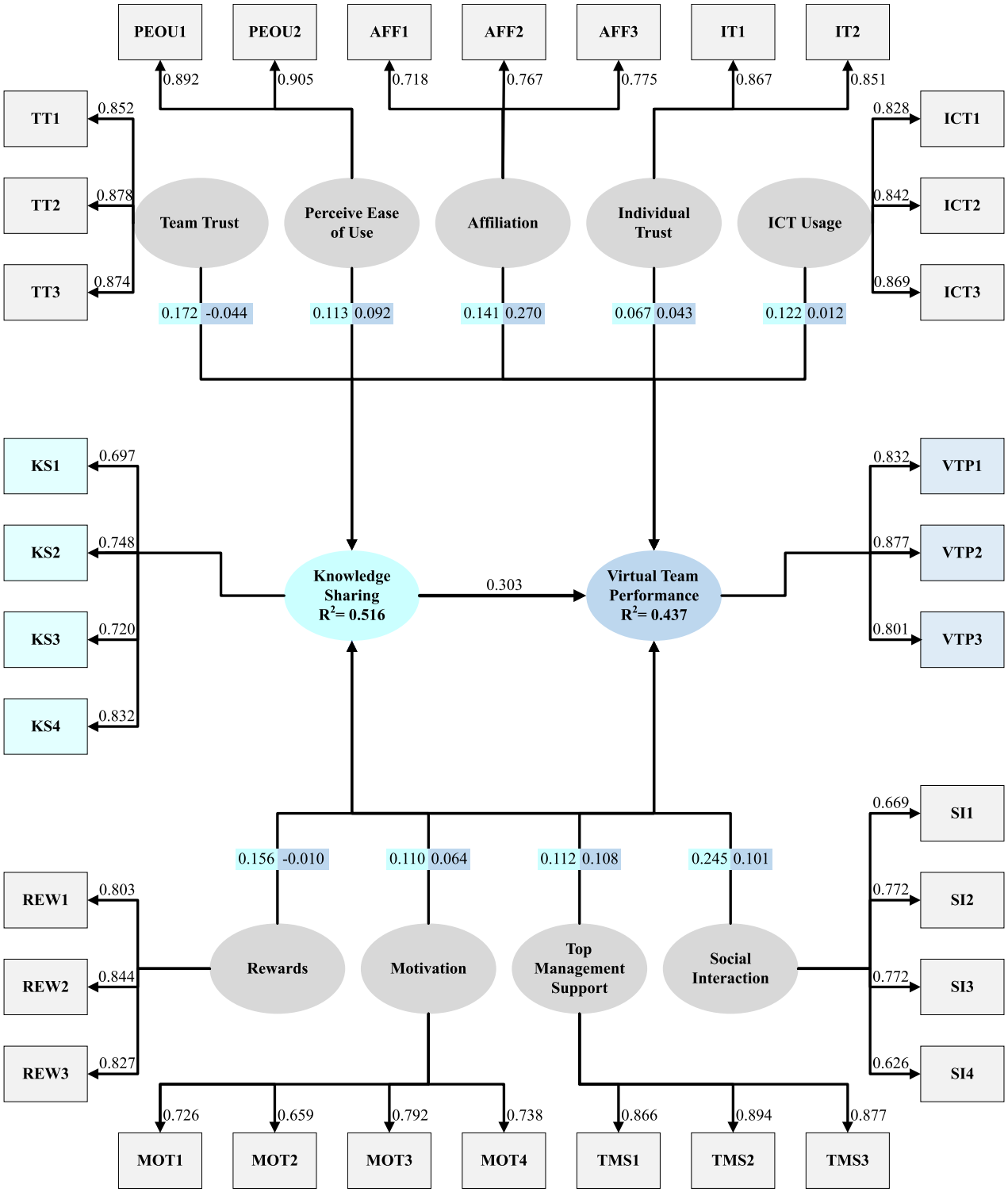

FIGURE 7. Structural model with path coefficients and outer-loadings.

the relationship between AFF and VTP is partially mediated through KS. The mediation effect between AFF and VTP is presented in Figure 8(e), and hypothesis evaluation is illustrated in Tables 10 and 11.

The effect of REW on KS was significant with Beta = 0.156, S.D = 0.059, T-stat = 2.620 and P < 0.05. Hence, H6a was supported. The total effect of REW on VTP was non-significant with Beta = 0.037, S.D = 0.061,

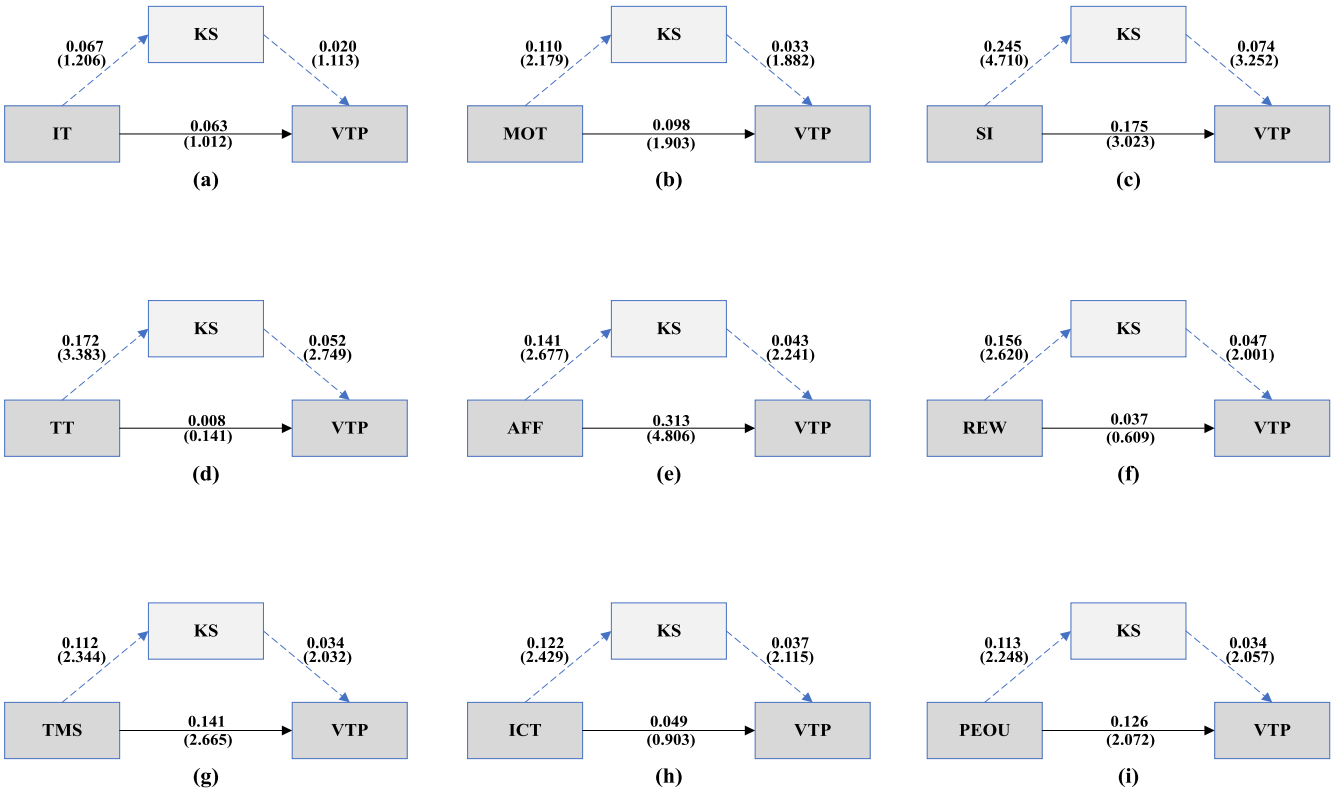

FIGURE 8. Mediation model with beta coefficients and T-stat.

TABLE 11. Mediation analysis.

Total Effects			Direct Effects		Indirect Effects				
Hypothesis	**Beta**	**T-stat**	**Beta**	**T-stat**	**Hypothesis**	**Beta**	**T-stat**	**P-value**	**Results**
H1b: IT → VTP	0.063	1.012	0.043	0.696	**H1c: IT → KS → VTP**	0.020	1.113	P>0.05	Not Supported
H2b: MOT → VTP	0.098	1.903	0.064	1.288	**H2c: MOT → KS → VTP**	0.033	1.882	P>0.05	Not Supported
H3b: SI → VTP	0.175	3.023	0.101	1.718	**H3c: SI → KS → VTP**	0.074	3.299	P<0.05	Supported
H4b: TT → VTP	0.008	0.141	-0.044	0.786	**H4c: TT → KS → VTP**	0.052	2.749	P<0.05	Supported
H5b: AFF → VTP	0.313	4.806	0.270	4.003	**H5c: AFF → KS → VTP**	0.043	2.241	P<0.05	Supported
H6b: REW → VTP	0.037	0.609	-0.010	0.170	**H6c: REW → KS → VTP**	0.047	2.001	P<0.05	Supported
H7b: TMS → VTP	0.141	2.665	0.108	2.118	**H7c: TMS → KS → VTP**	0.034	2.032	P<0.05	Supported
H8b: ICT → VTP	0.049	0.903	0.012	0.216	**H8c: ICT → KS → VTP**	0.037	2.115	P<0.05	Supported
H9b: PEOU → VTP	0.126	2.072	0.092	1.574	**H9c: PEOU → KS → VTP**	0.034	2.057	P<0.05	Supported

T-stat = 0.609 and P > 0.05. Hence, H6b was not supported. Lastly, H6c evaluates whether KS mediates the relationship between REW and VTP. With the inclusion of mediating variable, the direct impact of REW on VTP became non-significant with Beta = -0.010, S.D = 0.060, T-stat = 0.170 and P > 0.05. Moreover, the indirect effect of REW on VTP was significant with Beta = 0.047, S.D = 0.024, T-stat = 2.001, and P < 0.05. So, hypothesis H6c was accepted. This shows that the relationship between REW and VTP is fully mediated through KS. The mediation effect between REW and VTP is presented in Figure 8(f), and hypothesis evaluation is illustrated in Tables 10 and 11. Moreover, the effect of TMS on KS was significant with Beta = 0.112, S.D = 0.048, T-stat = 2.344 and P < 0.05. Hence, H7a was supported. The total effect of TMS on VTP was significant with Beta = 0.141, S.D = 0.053, T-stat = 2.665 and P < 0.05. Hence, H7b was supported. Lastly, H7c evaluates whether KS mediates the relationship between TMS and VTP. With the inclusion of mediating variable, the direct impact of TMS on VTP became significant with Beta = 0.108, S.D = 0.051, T-stat = 2.118 and P < 0.05. Moreover, the indirect effect of TMS on VTP was significant with Beta = 0.034, S.D = 0.017, T-stat = 2.032, and P < 0.05. So, hypothesis H7c was accepted. This shows that the relationship between TMS and VTP is partially mediated through KS. The mediation effect between TMS and VTP is presented in Figure 8(g), and hypothesis evaluation is illustrated in Tables 10 and 11.

The effect of ICT on KS was significant with Beta = 0.122, S.D = 0.050, T-stat = 2.429 and P < 0.05.

Hence, H8a was supported. The total effect of ICT on VTP was non-significant, with Beta = 0.049, S.D = 0.054, T-stat = 0.903 and P > 0.05. Hence, H8b was not supported. Lastly, H8c evaluates whether KS mediates the relationship between ICT and VTP. With the inclusion of mediating variable, the direct impact of ICT on VTP became non-significant with Beta = 0.012, S.D = 0.054, T-stat = 0.216 and P > 0.05. Moreover, the indirect effect of ICT on VTP was significant with Beta = 0.037, S.D = 0.018, T-stat = 2.115 and P < 0.05. So, hypothesis H8c was accepted. This shows that the relationship between ICT and VTP is fully mediated through KS. The mediation effect between ICT and VTP is presented in Figure 8(h), and hypothesis evaluation is illustrated in Tables 10 and 11. Furthermore, the effect of PEOU on KS was significant with Beta = 0.113, S.D = 0.050, T-stat = 2.248 and P < 0.05. Hence, H9a was supported. The total effect of PEOU on VTP was significant with Beta = 0.126, S.D = 0.061, T-stat = 2.072 and P < 0.05. Hence, H9b was supported. Lastly, H9c evaluates whether KS mediates the relationship between PEOU and VTP. With the inclusion of mediating variable, the direct impact of PEOU on VTP became non-significant with Beta = 0.092, S.D = 0.058, T-stat = 1.574 and P > 0.05. Moreover, the indirect effect of PEOU on VTP was significant with Beta = 0.034, S.D = 0.017, T-stat = 2.057, and P < 0.05. So, hypothesis H9c was accepted. This shows that the relationship between PEOU and VTP is fully mediated through KS. The mediation effect between PEOU and VTP is presented in Figure 8(i), and the hypothesis evaluation is illustrated in Tables 10 and 11. Finally, the effect of KS on VTP was analyzed using regression analysis. The results of Table 10 indicate the significant impact with Beta = 0.303, S.D = 0.073, T-stat = 4.133 and P < 0.05. Therefore, hypothesis H10 was accepted.

G. TRIANGULATION OF SLR AND EMPIRICAL STUDY

This section describes the comparison of SLR and empirical study. A comparison of the identified factors influencing knowledge sharing and virtual team performance through empirical study and SLR is presented in Figure 9. This comparison evaluated the similarity and diversity between the two data sets. Table 12 illustrates the ranking of identified factors through SLR and empirical study.

The comparative analysis of SLR and empirical findings was done by Spearman's rank order correlation in SPSS. Spearman's correlation coefficient was identified as 0.771, which shows that SLR and empirical ranking were highly correlated. The P-value was obtained at 0.015, indicating that the rank order was statistically significant. Table 13 illustrates Spearman's correlation between the SLR and empirical rank. The comparison of empirical study and SLR may help the top management of software SMEs to consider these factors while performing virtual activities. Additionally, the findings illustrate the extent to which various factors have a significant or non-significant influence on knowledge sharing and virtual team effectiveness.

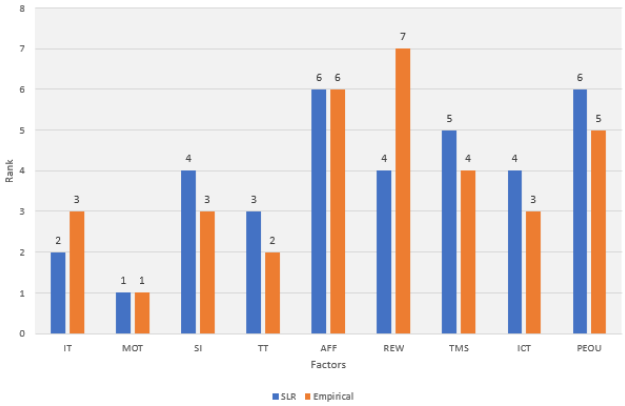

FIGURE 9. Comparison of Empirical study and SLR.

H. VALIDATION OF THE PROPOSED CONCEPTUAL FRAMEWORK

Before performing the actual validation of the proposed conceptual framework from experts, we also performed the initial or pre-validation process in which Dr. Uzair Iqbal Janjua and Dr. Tahir Mustafa Madni validated the first version of the framework. In the pre-validation process following scenarios were covered:

- Readability of the model.
- Logical connectivity of independent, mediating and dependent variables.
- Applicability of the proposed framework to increase knowledge sharing and virtual team performance.

After the pre-validation process, it was observed that the proposed framework presents lots of information in a comprehensive way that is unnecessary. So, it was suggested to present relevant and specific information. All the suggested changes were incorporated into the proposed conceptual framework.

1) EXPERTS VALIDATION

To validate the proposed conceptual framework, we selected the expert judgment review method, as presented in Figure 10, in which different experts from industry or academia were selected and asked to give their reviews, feedback, and comments about the proposed framework.

The validation process is purely based on experts' opinions on either accepting or rejecting the proposed conceptual framework. The data was collected through the survey from 24 experts, of which 19 were from the software industry and 5 from academia.

a: DEMOGRAPHICS ANALYSIS OF EXPERTS

The demographic information of experts is presented in Table 14. According to the results of the validation survey, 8.3% of the experts were project managers, 29.2% were developers, 33.5% were software engineers, 8.3% were team leads, and 20.7% were academicians. Furthermore, the survey results illustrate that 66.7% of experts have work experience of 2-5 years, and 33.3% have experience of 5-10 years.

TABLE 12. Triangulation of identified factors influencing KS and VTP from SLR and Empirical study.

ID	Factors	Occurrence in SLR		Occurrence in Survey		Average Rank
		%	Rank	%	Rank	
IT	Individual Trust	25	2	93	3	2.5
MOT	Motivation	29	1	95	1	1
SI	Social Interaction	12	4	93	3	3.5
TT	Team Trust	22	3	94	2	2.5
AFF	Affiliation	6	6	84	6	6
REW	Rewards	12	4	79	7	5.5
TMS	Top Management Support	9	5	92	4	4.5
ICT	ICT Usage	12	4	93	3	3.5
PEOU	Perceived Ease of Use	6	6	91	5	5.5

TABLE 13. Rank order correlation between SLR and Empirical study.

		SLR Rank	Empirical Rank
Spearman's rho	**SLR Rank**	1.000	0.771*
		-	.015
	Empirical Rank	0.771*	1.000
		0.015	-

*. Correlation is significant at the 0.05 level (2-tailed).

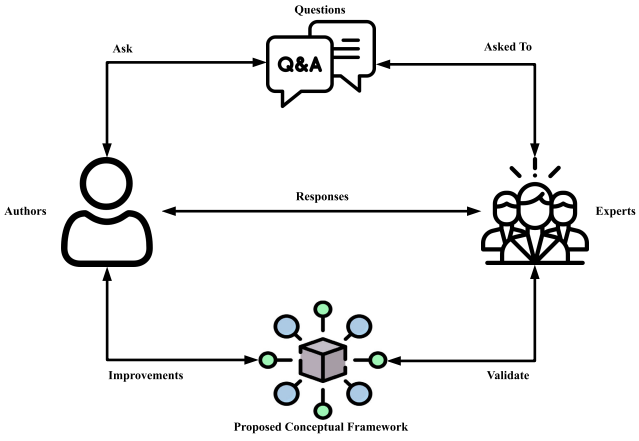

FIGURE 10. Flow of expert opinion.

TABLE 14. Demographic analysis of experts.

Demographics	Experts	Frequency	Percentage
Role	Project Manager	2	8.3%
	Developer	7	29.2%
	Software Engineer	8	33.5%
	Team Lead	2	8.3%
	Lecturer	5	20.7%
Work Experience	2 to 5 Years	16	66.7%
	5 to 10 Years	8	33.3%
Experience of	Industry	12	50%
	Academia	4	16.7%
	Both	8	33.3%

Moreover, 50% of experts are from the software industry, 16.7% are from academia, and 33.3% have industry and academic experience.

b: EXPERTS RESPONSES AGAINST THE QUESTIONS

In the questionnaire following aspects were covered:

- Readability: Is the text readable in the proposed conceptual framework?
- Relevancy of Factors: Are all the factors relevant to knowledge sharing and virtual team performance?
- Understandability: Is the proposed conceptual framework easy to understand?
- Information: Are all the possible factors influencing knowledge sharing and virtual team performance identified in this framework?
- Applicability: Does the proposed framework help the virtual teams increase their performance?
- Feasibility: Does the proposed conceptual framework feasible to be used?

The experts were asked nine closed-ended questions. Based on the results presented in Table 15, the expert's feedback was critically analyzed, and the proposed conceptual framework was validated.

V. DISCUSSION

The current study investigates the performance and effectiveness of virtual teams. Most underdeveloped countries are focusing on virtual teams to enhance their productivity with the help of ICT. Pakistan is also experiencing a rise in the proliferation of virtual teams to bolster its economic endeavors. Recent literature shows virtual teams face several challenges, including cultural differences, schedule issues, response delays, lack of communication, and knowledge sharing [2], [9]. Authors in several studies highlighted that knowledge sharing (KS) is the critical challenge affecting the performance of virtual teams [1], [2], [9]. Therefore, it is crucial to identify the factors influencing KS which further influence the virtual team's performance. In recent studies, the authors proposed several models to identify and evaluate the factors impacting virtual teams [3], [5], [9]. Moreover, the researchers theoretically highlighted that increasing KS increases virtual teams' performance (VTP). However, the studies need to empirically evaluate the impact of KS on VTP in Pakistan's SMEs. Therefore, the current study aims to identify and evaluate the factors influencing KS and VTP in Pakistan SMEs to fill the existing gaps.

TABLE 15. Expert responses.

S. No	Questions	Results
Q1	Is the concept of virtual teams understood?	1) Clearly understood (83.3%) 2) Partially understood (16.7%) 3) Not understood (0%)
Q2	Are you working in an organization/ Company etc.? "Or" Do you work individually (Freelancing)?	1) Organization (95.8%) 2) Freelancing (4.2%) 3) Other (0%)
Q3	Evaluation of the design of the proposed conceptual framework.	1) Excellent (37.5%) 2) Good (54.2%) 3) Average (8.3%) 4) Poor (0%) 5) Very Poor (0%)
Q4	Is the text readable in the proposed conceptual framework?	1) Yes (91.7%) 2) Partially (8.3%) 3) No (0%)
Q5	Are all the factors being relevant to knowledge sharing and virtual team performance?	1) Yes (79.2%) 2) Partially (20.8%) 3) No (0%)
Q6	Is the proposed conceptual framework being easy to understand?	1) Easy to understand (75%) 2) Need some explanation (25%) 3) Need detailed explanation (0%)
Q7	Are all the possible factors influencing knowledge sharing and virtual team performance are identified in this framework?	1) All are correct and well defined (75%) 2) Some are correct and well defined (25%) 3) None are correct and well defined (0%)
Q8	Does the proposed framework help the virtual teams to increase their performance?	1) Yes (87.5%) 2) Partially (12.5%) 3) No (0%)
Q9	Does the proposed conceptual framework feasible to be used?	1) Yes (70.8%) 2) Partially (29.2%) 3) No (0%)

In order to answer RQ1, this study conducted an SLR. By conducting SLR, 31 primary studies were selected, and nine critical success factors of KS were extracted and classified into four categories to answer RQ2. The operationalization has been performed to refine the identified factors and their respective categories. Moreover, a conceptual framework is proposed based on the findings of SLR. The quantitative analysis was performed to empirically evaluate the hypothesis of the proposed frameworks. A survey was collected from 252 respondents working in Pakistan's SMEs. The result of PLS-SEM indicates the impact of individual trust (IT) on KS and VTP. The authors in [4] and [13] discussed that IT significantly affects KS. In contrast, the results of the current study depict a non-significant impact on KS (Beta = 0.067, T-stat =1.206, P > 0.05). Moreover, the mediation effect of IT on VTP is also analyzed (Beta = 0.020, T-stat =1.113, P > 0.05). However, the indirect effect of IT on VTP is not supported.

Moreover, the authors in [2] and [4] illustrate that motivation (MOT) significantly influences KS and VTP. However, in [9], MOT has a non-significant impact on KS in virtual teams. Therefore, it's crucial to consider and evaluate the impact of MOT. The results of the empirical analysis of the current study depict that MOT has a significant impact on KS (Beta = 0.110, T-stat = 2.179, P < 0.05). The mediation effect of MOT on VTP is also evaluated (Beta = 0.033, T-stat =1.882, P > 0.05). The results indicate that the indirect effect of MOT on VTP is rejected. According to [4], strong social interaction (SI) between individuals makes communication effective and significantly influences KS [4]. The authors in [2], [4], and [8] demonstrate that SI significantly impacts KS and VTP. The results of empirical analysis present that SI has a significant impact on KS (Beta = 0.245, T-stat = 4.710, P < 0.05). Furthermore, the mediation effect of SI on VTP is also analyzed (Beta = 0.074, T-stat = 3.252, P < 0.05). The results indicate that the indirect effect of SI on VTP is accepted

The authors in [5] illustrate that team members share more knowledge if they trust each other. Also, trust is one of the most critical factors in a virtual environment [5]. The results of PLS-SEM depict that team trust (TT) significantly impacts KS (Beta = 0.172, T-stat = 3.383, P < 0.05). Moreover, the mediation effect of TT on VTP is also analyzed (Beta = 0.052, T-stat = 2.749, P < 0.05). The results indicate that the indirect effect of TT on VTP is accepted. Several studies discussed that members with a high sense of affiliation (AFF) would create a strong bond, which motivates them to communicate and share more knowledge with other employees [9] and [41]. According to authors of [2], [5], and [9], AFF significantly impacts KS and VTP. However, only some studies have explored this concept in virtual teams [5], [9], and [42]. The results of empirical analysis present that AFF has a significant impact on KS (Beta = 0.141, T-stat = 2.677, P < 0.05). Furthermore, the mediation effect of AFF on VTP is also analyzed (Beta = 0.043, T-stat = 2.241, P < 0.05). The results indicate that the indirect effect of AFF on VTP is supported.

Moreover, the authors in [3] and [43] demonstrate that rewards (REW) significantly impact KS and VTP. However, some studies [44], [45] revealed that REW has a non-significant impact on KS. The results of empirical analysis present that REW has a significant impact on KS (Beta = 0.156, T-stat = 2.620, P < 0.05). The mediation effect of

REW on VTP is also evaluated (Beta = 0.047, T-stat = 2.001, P < 0.05). The results indicate that the indirect effect of REW on VTP is accepted. According to several studies [9], [47], [48], [49], top management support (TMS) increases the willingness for KS among employees of virtual teams. However, the authors in [9] and [50] demonstrate that top management has a non-significant impact on KS. The results of empirical analysis present the significant impact of TMS on KS (Beta = 0.112, T-stat = 2.344, P < 0.05). The mediation effect of TMS on VTP is also analyzed (Beta = 0.034, T-stat = 2.032, P < 0.05). The results indicate that the indirect effect of TMS on VTP is accepted. ICT's efficient and effective use significantly impacts KS and VTP [54]. The empirical analysis results show that ICT usage significantly impacts KS (Beta = 0.122, T-stat =2.429, P < 0.05). Furthermore, the mediation effect of ICT usage on VTP is also analyzed (Beta = 0.037, T-stat = 2.115, P < 0.05). The results indicate that the indirect effect of ICT usage on VTP is accepted.

Authors in [3] and [57] illustrate that almost 8% of survey respondents highlighted the online posting challenge. In the study [58], perceived ease of use (PEOU) significantly impacts KS in a virtual team. The results of our study depict that PEOU has a significant impact on KS (Beta = 0.113, T-stat =2.248, P < 0.05). Moreover, the mediation effect of PEOU on VTP is also evaluated (Beta = 0.034, T-stat = 2.057, P < 0.05). The results indicate that the indirect effect of PEOU on VTP is accepted. According to several studies [1], [2], [9], KS not only enhances VTP but also increases the productivity of software organizations. The results of the current study illustrate that KS has a significant impact on VTP (Beta = 0.303, T-stat = 4.133, P < 0.05). So, the proposed hypothesis H10 is supported significantly.

Conclusively, the results of the empirical analysis show that all the factors influencing KS and VTP are significantly supported except individual trust and motivation. The impact of these factors was analyzed in Pakistan's SMEs. The results of this study support the organizations to improve KS to increase the performance of virtual teams. Moreover, the triangulation between SLR and the empirical study was also performed. The results of Spearman's correlation show a strong relationship between SLR and empirical study. Furthermore, the proposed conceptual framework is validated by 24 experts (19 from industry and 5 from academia) to check the readability, understandability, relevancy, feasibility, and effectiveness. The results of expert opinion depict that the proposed conceptual framework is feasible, all the factors are relevant, and help the software SMEs to increase their performance.

Theoretically, this study contributes to the existing literature by identifying and evaluating the influencing factors of KS and VTP. This study's societal and practical implication strengthens KS activities and increases VTP in Pakistan's SMEs. The outcome of the current research facilitates the management of software organizations to improvise their infrastructure of KS in geographically dispersed teams.

VI. CONCLUSION

The utilization of ICT in virtual teams has experienced a notable surge in recent years due to significant technological advancements. Previous studies have indicated that knowledge sharing poses a significant challenge impacting virtual team performance. Due to limited research on knowledge sharing in a virtual team, it is difficult for software organizations to improvise virtual team performance. Therefore, we conducted an SLR to identify critical success factors that affect knowledge sharing in geographically dispersed teams. According to the results of SLR, the nine factors were identified and classified into their respective four categories; individual, team, organizational, and technological. Furthermore, a conceptual framework was proposed to investigate the impact of identified factors and the mediating role of knowledge sharing on virtual team performance. A survey was conducted from the Pakistan SMEs to collect data and empirically evaluate the proposed conceptual framework. The results of the current study illustrate that all factors influencing knowledge sharing significantly impact virtual team performance except individual trust and motivation. Furthermore, the proposed conceptual framework is validated by both industry and academic experts. The aforementioned statements imply that enhancing information sharing within a virtual team positively impacts the team's performance, ultimately contributing to the successful completion of a project.

A. LIMITATIONS AND FUTURE WORK

All research studies have some shortcomings and limitations. So, this study also has some things that could be improved. Firstly, the factors influencing knowledge sharing and virtual team performance were identified from SLR. However, other factors, such as conflict, communication, and language, can be considered in future research, which may significantly impact virtual team performance. Additionally, in the future, the researchers can identify more factors from the software industry by conducting interviews. Secondly, the results of this study cannot be generalized because the survey was conducted in Pakistan's SMEs. Therefore, to overcome this limitation, applying the same study to other countries is suggested. In addition, the researchers may consider large-size software organizations to analyze more significant results.

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