



Virtual teams and software project management success in a developing country: an empirical study

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Received: 28 March 2023 / Revised: 27 January 2024 / Accepted: 28 February 2024 / Published online: 26 March 2024

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Abstract The globalization of software development processes and outsourcing of software development projects worldwide has led to the creation of virtual teams. These teams are fraught with challenges due to the geographical dispersion of members, differences in time zones, and different cultures. Virtual teams have become an essential aspect of software development projects. Even after many advancements in this area and the challenges posed by virtual teams, the current rate of software project success generates the need to study this area. A quantitative approach is used to study the responses provided by team members working as a part of a virtual team and involved in software projects in the Indian IT industry. The responses received were analyzed using regression analysis to propose and evaluate the proposed research model. The finding of the research indicates that virtual team attributes, such as technological augmentation, team dynamics, diversity, and strategic decision-making, have a significant impact on software project outcomes. In a Virtual team setting, the model developed during this research will serve as a valuable resource for the project leaders to comprehend the factors that influence project success and assist in implementing policies towards successful software projects. The research findings substantiate the previous research done for Virtual teams in developed countries, and the dimensions are evaluated in a completely new environment for developing countries like India.

Keywords Virtual teams · Software projects · Project success · Team diversity · Team dynamics · Technology augmentation · Strategic decision making

1 Introduction

Nowadays, Virtual teams are leading to the popularity of software development projects as a result of globalization and advancement in communication technology. The need for organizations to coordinate work across geographical, functional, intra- and inter-organizational as well as temporal due to the rapidly changing business environment, the marketplace is becoming more globalized, inter-organizational alliances are becoming more and more popular, and organizations are designing more adaptable and versatile organizational structures. (Zuofa and Ochieng 2021; Mawamba and Malik 2022; Kirkman and Stoverink 2021; Setyanitami et al. 2023). COVID-19 and the culture of working from home have further added to the importance of virtual teams (Gifford 2022).

Economic, social, and political barriers are eliminated, and the world is getting flatter and providing a common development platform for growth. In the 1970s, organizations started implementing project management methodologies to handle the expanding demand for software across all sectors. Project managers are selected explicitly from team-based projects based on their expertise, experience and ability to contribute to the result and lead groups of individuals. Organizations can create new ways of creating and managing teams due to the advancement in information technology and communication.

Information Technology (IT) companies from developed economies find it costly to keep a large team of developers on site when they outsource software development project

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assignments overseas. Therefore, these organizations created virtual teams with some members geographically local and others connected over secured networks. Such teams have gained acceptance over the years. It is estimated that there may be up to 8.4 million employees in the USA alone who participate in one or more virtual teams or groups. (Abarca et al. 2021; Karl et al. 2022; Caputo et al. 2023).

Virtual software development teams are the focus of this study. Reviewing the different definitions that have been suggested for virtual teams is imperative. Managing a virtual team involves handling all communication strategies, project management techniques, and human and social processes in such a way that benefits the team. Companies use virtual teams for innovation, decision-making, and solving complex problems and tasks that heavily rely on information processing. (Curseu et al. 2008; Rehman et al. 2020; Mwamba & Malik 2022). Virtual teams are complex due to micro-level team dynamics and cross-cultural communication needs (Glikson and Erez 2020). In contrast to virtual groups, virtual teams have more interdependence and interaction between members. These teams are brought together to focus on a specific project with a specified end date, and sometimes they serve as temporary work arrangements. (Muszyńska 2022). These virtual teams are self-managed knowledge work teams from different areas of expertise established to complete a specific organisational task within a specific time frame. Virtual teams can be temporary or permanent and set up for a specific purpose, such as a strategic planning team. Global virtual teams are members with diverse cultural backgrounds spanning different geographical locations or nations (Handke et al. 2020; Ferreira et al. 2021). A crucial component of information processing in teams is the development of complex knowledge structures, which is facilitated by heterogeneity in team composition (Curseu et al. (2008); Kiely and associates 2022). From the definitions above, virtual teams are socio-technical systems comprising two or more individuals who communicate and collaborate to accomplish common goals. In contrast, at least one or more team members work in a different location, company, or time zone; therefore, coordination and communication are mainly based on electronic communication media (Martins et al. 2004; Hertel et al. 2005; Morley et al. 2015).

The Standish Chaos Report (2020, 2021) and the 3Pillar Global Report (2021) stated that professionals are still very concerned about the software failure rate after decades of using project management concepts in software development. The advent of virtual teams adds another level of complexity to the development process. It is imperative for us to identify and understand the traits of virtual teams which contribute to software project success.

This research studies virtual teams in software project management in the Indian Software Industry. The

Information Technology (IT) sector has drastically changed in the last few decades in India, a country moving towards demonetization and becoming part of three trillion economies (Business Today Report 2023). According to The National Association of Software and Service Companies (NASSCOM), India is a major worldwide destination for software development projects. According to the NASSCOM Tech Start-Up Report, 2022, the Indian technology industry growth was 15.5% in 2022 with \$227Bn revenue. If we try to understand this in the Indian context, India's total IT services exports have reached USD 177 Billion in 2021, projected to reach \$245 Billion in 2023. These confirm that India's information technology (IT) and information technology-enabled services (ITeS) sectors contribute significantly to the nation's Gross Domestic Product (GDP) and employment generation (NASSCOM 2022). Software development outsourcing is a major portion of this sector. Development work is outsourced from developed countries such as the United States, the United Kingdom, and the rest of Europe to India. However, a review of research literature on the subject suggests that limited empirical research has tried to examine and understand how virtual teams work in the Indian context and how it impacts software project success (Lu 2015; Fossum et al. 2020; Presbitero 2021; Setyanitami et al. 2023).

This study highlights the low rate of software project success and studies the important factors in the virtual team scenario. Most software development projects are deploying global virtual teams, so the study is important. The challenges faced in managing teams must be focused on understanding the ingredients of successful software projects in Indian software firms. This will add to the basic parameters of the project's success, i.e. time, budget and scope, thus adding to the existing body of knowledge.

The study identifies four virtual team dimensions and examines their impact on software project management success. These dimensions are Team Diversity, Team Dynamics, Technology Augmentation, and Strategic Decision Making. Working in a global virtual environment can create communication gaps, which groups address using information and communication technologies. Our study will help us understand the factors contributing to virtual teams' success in working on software projects. This understanding will help academics and corporate managers reduce the failure rate of software development projects.

2 Literature review

Project management principles and frameworks provide a systematic and scientific way of managing projects, which also applies to software development work. The literature review highlights the previous work done in software project

management and the deployment of virtual teams in these projects.

2.1 Software development initiatives

Software project management has been a guiding framework for planning, controlling, and analyzing software projects since the 1960s. Despite the establishment of software project management principles, concerns persist over project failures, particularly in terms of budget and time overruns, as highlighted in the Standish Group Reports of 2020 and 2021. Project success in the realm of software development is commonly defined as the timely completion within the allocated budget and adherence to pre-determined functional specifications (Nokes 2007; Moran 2009; Tam et al. 2020). Given the persistent challenges and concerns surrounding software project success, it is imperative to delve into various factors influencing project outcomes (Nasir and Shabuddin 2011; Ibraigheeth and Fadzli 2019; Pereira et al. 2022; Zhang 2022).

The intricacies of software development lie in its dual nature, combining elements of both science and art. Unlike other engineering projects, software development is characterized by its inherent complexity and ad-hoc nature, where the final product is intangible. In response to these challenges, organizations have increasingly turned to agile software development frameworks, such as Scrum. Within the Scrum methodology, a product owner establishes a product backlog, and the entire project unfolds iteratively through sprints. Regardless of the chosen framework, the success of software projects often rests on the shoulders of teams, which may operate in a virtual capacity in many instances, adding an additional layer of complexity to project dynamics. Understanding these nuances is crucial for comprehending the unique challenges and opportunities that influence the success of software development projects (Avikal et al. 2022; Arora et al. 2023).

2.2 Virtual teams

Virtual teams represent sophisticated socio-technical systems, uniting two or more individuals who collaboratively work towards common objectives. It should be noted that these teams are characterized by the presence of a minimum of one member who is located in a different location, organization, or different time, which makes electronic forms of communication and coordination necessary. (Martins et al. 2004; Hertel et al. 2005; Setyanitami et al. 2023; Caputo et al. 2023). This paper has provided a comprehensive overview of various definitions of virtual teams in the introduction, establishing the groundwork for an in-depth exploration. The utilization of virtual teams has been a longstanding practice, accumulating substantial knowledge

about effective management strategies, particularly in the realm of virtual meetings. Recent years have witnessed a heightened focus on enhancing collaborative work practices, often driving investments in new technologies. Concurrently, the distinctive nature and features of virtual teams present a host of challenges that significantly impact project success. This underscores the importance of comprehending the success factors inherent in global software projects that involve virtual teams (Iyamu and Adelakun 2021; Abdulmuhsin and Tarhini 2021).

2.3 The gap analysis and hypothesis formulation

The importance of digitization in various spheres of life has led to the expansion of the world's information technology (IT) industry. IT and ITeS (IT enabled Services) sector has also evolved profoundly over the last three decades in India. According to the NASSCOM report, this sector generated significant revenues locally within India and in exports (NASSCOM 2022). The IT industry is also one of the largest employers in the country. Given the sector's size, the study of virtual teams in software development projects is very important. Software development companies introduced project management techniques during the 1970s to manage the expanding software requirements across all sectors. Project managers lead teams of individuals who are specifically selected for a project based on their expertise, experience, and ability to contribute to the outcome. Global software projects are conducted in the current global environment, affecting business and the economy as a whole. (Korrapati and Rapaka 2009; Tsoy and Staples 2021).

Software development projects are people-focused, technologically advanced, and skill-driven in nature. Organizations can now create new ways to manage teamwork with the developments in communication and information technology. Nowadays, the modern software development process is not complete without virtual teams. Teams of workers with specialized knowledge who work remotely and need to coordinate via technology in order to complete critical organizational tasks are known as virtual teams. (Lipnack and Stamps 2000; Morrison-Smith and Ruiz 2020).

A number of studies have identified factors that influence enhanced performance of virtual teams. Most of the work done in this area has been tested for virtual teams working in the academic setup compared to those deployed for software projects. Table 1 identifies research from the literature that is relevant to this study. It is clear that most research has been done in developing countries, and very few studies examine virtual teams in the context of developing nations such as India. Most of the previous work is exploratory and qualitative, whereas the current study is causal and quantitative in nature (Abarca et al. 2021;

Table 1 Summarization of literature review

No	Research focus	Authors	Results
1	Impact of Demographic Diversity in Software Project Success Deployed in Software Projects	Xue et al. (2005); Dewar (2006); Horwitz et al. (2006); Lu (2015); Rehman et al. (2020)	Data was tested for the academic team and not for the software project team, though the study was for Software Project Management Seven factors considered in the study did not cover all aspects of Software project success Inter-team and intra-team conflict need to be studied further and give practitioners a view which needs to be validated through research
2	Impact of teamwork and team dynamics (including communication and collaboration on the Software project success deployed in software projects	Sze-Sze and Burton (2000), O'Keefe and Chen (2011), Jong et al. (2008), Gilson et al. (2014), Morley et al. (2015) and Bhat et al. (2017), Lu (2015) and Abarca et al. (2021), Vaideyanathan et al. (2010), Horwitz et al. (2006), Germain and McGuire (2014), Cagiltay et al. (2015), Wu(2022) and Setyanitami et al. (2023)	Discusses the role of communication social media platforms on team coordination but does not relate it to software project success Highlighted the challenges outsourced software projects face in terms of communication and coordination, but few studied the Indian context, although India deals in a larger chunk of outsourced projects
3	Impact of technology augmentation on the Software project success deployed in software projects	O'Keefe (2011), Martínez-Moreno et al. (2012), Germain & McGuire (2014, Morley et al. (2015), Glikson and Erez (2020), Kane and Narvel (2021)	Discussed the difference in working between traditional and virtual teams but did not highlight how to manage the difference Highlighted that technology helps manage virtual teams but did not mention web 2.0 in general or social media in specific
4	Impact of strategic decision-making on the virtual teams' performance deployed in software projects	Matos and Lourenco (2013), Prasad and Akhilesh (2002), Morley et al. (2015), Iyamu and Adalakun (2021)	The paper discussed using social software, namely blogs and wikis, in corporate environments but lacked empirical evidence Provide framework for further research, does not talk about team factors, only strategic objectives and work characteristics

Wu 2022). Our study on virtual teams in software project management addresses this gap in the research.

From Table 1, it can be inferred that the less rate of software project success can be overcome by addressing the challenges posed by the virtual teams. Studies cover some aspects mentioned above, and very few comprehensive works have been done earlier. There are a few studies trying to portray an understanding of the combined factors; however, they are qualitative and literature review-based. Hence, this study fills the gap by combining the aspects mentioned above and testing it empirically.

Our literature review shows limited research on virtual teams in developing countries, specifically in the Indian context. We identified four dimensions of virtual teams that impact software project success.

A. Team Diversity: Demographic diversity is associated with the virtual team's formulation. On the one hand, virtual teams provide a way to bring together a pool of talent from across the world and on the other hand, project managers face challenges in handling the team working in different time zones and with different cultural backgrounds (Xue et al. 2005; Dewar 2006; Jimenez et al. 2017; Kozlowski et al. 2021). Diversity refers to the demographic diversity associated with the virtual team's formulation. Virtual teams provide a way to bring together a pool of talent from across the world, and on the other hand, project managers face challenges in handling the team working in different time zones and with different cultural backgrounds (Xue et al. 2005; Dewar 2006; Kozlowski et al. 2021). This diversity of talent and cultural backgrounds significantly affects software project success. Therefore, we define our diversity hypotheses as follows.

H1 There is a significant positive relationship between virtual team diversity and software project success.

B. Team dynamics—Limited face-to-face interaction among virtual team members may lead to a lack of trust and low interpersonal compatibility (Vaidyanathan et al. 2010; Gibbs et al. 2017; Schaubroeck and Yu 2017). According to Vaidyanathan et al. (2010) managing team dynamics is an important aspect of virtual teams. Since there is less face-to-face interaction, the project manager has a greater responsibility for understanding team dynamics and redirecting and resolving any conflict (Vaidyanathan et al. 2010; Gibbs et al. 2017; Schaubroeck and Yu 2017). Thus, if the managers manage the team dynamic well, it leads to a better success rate of the software project.

H2 There is a significant positive relationship between virtual team dynamics and software project success.

C. Technology Augmentation—The distributed team members work in a heterogeneous platform; thus, managing the change in technology along with ensuring sufficient security is crucial for the project's success (Vaidyanathan et al. 2010; Bradley et al. 2013; Abarca et al. 2021). The effort is required to scale technology and augment technology as needed since most of the work is done online in virtual teams (Vaidyanathan et al. 2010; Abarca et al. 2021). The project is a success when all tasks are successfully completed. Distribution of task, visibility and tracking of interdependent tasks, and restructuring of tasks if required is important in virtual teams. Therefore, we state our technology augmentation hypotheses as follows.

H3 There is a significant positive relationship between technology augmentation in virtual teams and software project success.

D. Strategic decision-making—There are multiple software project stakeholders and feedback from all of them must be considered when making any strategic decision. This becomes challenging with the widely distributed team (Prasad and Akhilesh 2002; Tannenbaum and Schmidt 2016; Chawla et al. 2018). A strategic decision is an important factor in the success of software projects. This includes a focus on aligning project objectives with the organization's larger mission. Risk analysis should also be taken into account while planning. With the widely distributed virtual team, this becomes challenging. Thus, better planning and communicating the larger vision to all team members results in a successful project (Prasad and Akhilesh 2002; Tannenbaum and Schmidt 2016; Chawla et al. 2018).

H4 There is a significant positive relationship between strategic decision-making in a virtual team and software project success.

Here, we have presented our research hypotheses, whereas, in the next section, we will elaborate on the research methodology used during our study.

It is evident that different variables and dimensions have been studied by previous research, and no study has considered the cumulative effect of virtual teams' dimensions on software project development. The challenges faced by the virtual teams deployed in the software project can be categorized into the four broad categories stated above. The previous literature highlights the software project success factors (Fig. 1).

3 Research methodology

The current study is empirical in nature and proposes to test the impact of the four independent variables Team Diversity,

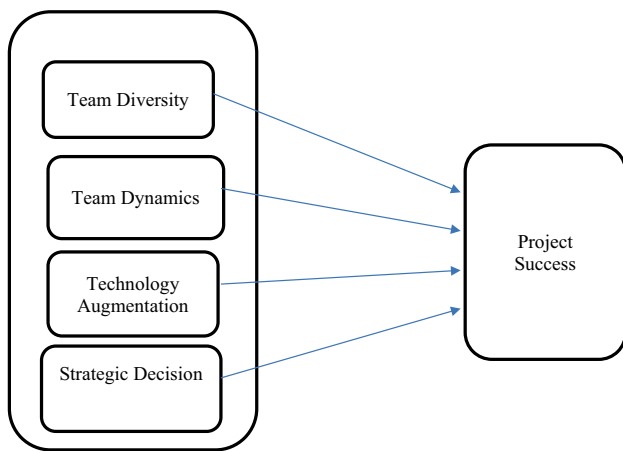


Fig. 1 Proposed research model Source: Author Creation

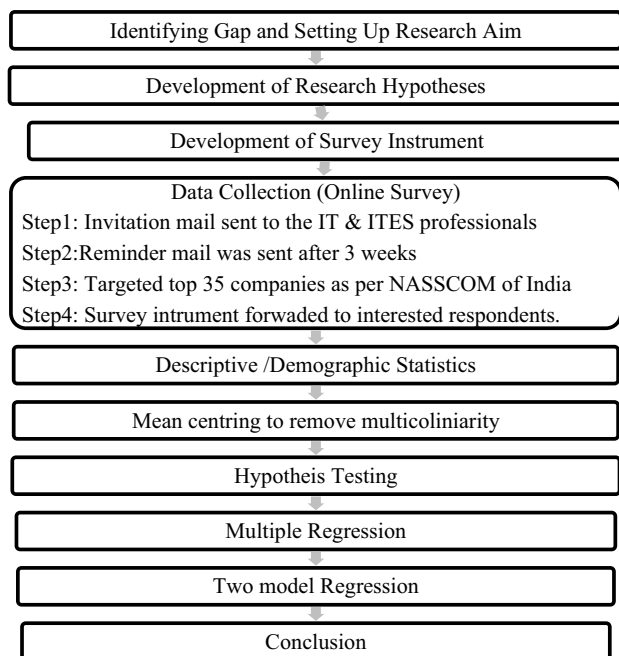


Fig. 2 Block diagram for survey Source: Author Creation

Team Dynamics, Technology Augmentation and Strategic decision making on the software project success utilizing virtual teams.

The Fig. 2 describes in detail the process of data collection and analysis through the survey.

3.1 Sample

The research aims to study the performance of virtual teams working on software projects for Indian IT companies, and hence, the entire country was the sample space considered for the study. India’s NASSCOM report was used to identify cities within the country that were designated as IT hubs. A total of 35 companies were identified in the sample. The purposive Sampling method was used to select IT and ITES organizations in those hubs (Campbell et al. 2020). The use of NASSCOM’s report and the identification of IT hubs ensure a diverse representation of regions, accounting for potential regional variations in team dynamics and project success factors.

3.2 Survey design and data collection

A questionnaire was designed based on the research model, which included twenty items that measured the independent and dependent variables in the study. The variables were measured using a Likert scale (Sullivan and Artino 2013). Demographic data was also captured in the questionnaire.

The survey instrument was distributed to 520 individuals identified within companies in India’s IT hub cities. A total of 400 responses were returned, out of which 394 were usable. The Designation (or titles) of participants included Account Manager (AccM), Project Manager (PrM), Business Analyst (BA), Test Manager (TM), Team Lead (TL), Scientist, Senior Software Engineer (SSE) and Software Engineer (SE). Table 2 summarizes the percentage of respondents by Designation and shows that our respondents included individuals with different roles in virtual software development teams. The survey targeted 520 individuals within IT-hub cities, yielding a substantial response rate of 76.92%. The collection of 400 usable responses ensures statistical robustness and reliability in the analysis. The inclusion of participants with diverse roles, as indicated by Table 2, enriches the dataset, allowing for a multifaceted exploration of the virtual software development team landscape. The questionnaire captures demographic data, providing additional layers of context for the analysis. This information allows for the exploration of potential variations in responses based on participant roles, fostering a deeper understanding of how different roles within virtual teams may perceive and contribute to project success.

Demographic Data analysis: Below Tables 2, 3 and Table 4 presents the demographic distribution.

Table 2 Designation details of respondents

Designation	TL	PM	SSE	SE	PrM	Scientist	TM	AccM	BA
Percentage of respondents	35	20	15	10	5	2	3	7	3

Sample Size = 394

Table 3 Duration of projects

Project duration (in months)	Less than 20	21 to 40	41 To 60	61 to 80	Greater than 80
Percentage of projects	28	22	16	16	18

Sample size (N) = 394

Table 4 Types of projects

Type of project	Type of project (in %)
R&D	30
Maintenance	40
Customization	25
Others	5

Sample size (N) = 394

The tables above provide additional information about the sample, including the Designation of the respondents, project Durations considered (Table 3) and types of projects (Table 4). The diversity in terms of demographics ensures the randomness of collected responses. In summary, the demographic results show that the data were collected from various respondents, covering different projects with different project sizes and from different hierarchical levels of the software project team. The result also highlights that the maximum number of projects considered in the study are in the maintenance phase and of duration three months to ninety-six months.

3.3 Data analysis

The four independent variables are measured on a seven-point Likert scale ranging from strongly disagree to strongly agree to understand their impact on the project success.

4 Results

We used a multi-step process for data analysis. We first reviewed the means, standard deviations and reliability of the variables in the study. The values are provided in the table below. The Cronbach alpha values are all greater than 0.7, confirming the variable measures' reliability.

Table 5 indicates through standard deviation that the mean and variability of the data are good indicators of measurement. We then checked for multicollinearity.

Table 5 Descriptive statistics

		Mean	Standard deviation	Reliability
IV1	Team diversity	4.44	1.366	0.73
IV2	Team dynamics	4.56	1.48	0.76
IV3	Technology augmentation	5.22	1.408	0.70
IV4	Strategic decision making	5.16	1.462	0.83
DV	Software project success	5.16	1.32	0.76

Table 6 Correlation matrix

		IV1	IV2	IV3	IV4
IV1	Team diversity	1			
IV2	Team dynamics	0.688	1		
IV3	Technology augmentation	0.737	0.775	1	
IV4	Strategic decision making	0.659	0.599	0.845	1

Table 7 Correlation after mean centring

		IV1	IV2	IV3	IV4
IV1	Team diversity	1			
IV2	Team dynamics	0.088	1		
IV3	Technology augmentation	0.074	0.005	1	
IV4	Strategic decision making	0.059	0.006	0.008	1

Table 6 shows the correlation matrix, which includes correlations between the variables in this study.

The Table 6 indicates the high correlation, which may lead to a multicollinearity problem; hence, the data was centered to remove this problem Iacobucci et al. (2016).

Table 7 indicates low correlation among the four independent variables after centring mean have very low correlation coefficients.

4.1 Multiple regression for independent variables

In order to test the proposed research model, regression analysis was applied to the four independent variables and one dependent variable.

The study focuses on the four important aspects in managing virtual teams deployed in software projects. The results of the regression analysis are provided in Table 8.

The initial result shows that the four independent variables do have an impact on the project's success. The model is significant at a *p* value of 0.05 and shows that the adjusted R square is 0.728. The above table significance with *p* value = 0.000 (< 0.05) with F = 161.018.

Table 8 Results of regression model without moderating effects

Model	R	R square	Adjusted R square	Std. error of the estimate
1	0.813 ^a	0.733	0.728	0.439

Table 9 and Fig. 3 indicates that all the coefficients are significant with p value < 0.05 , with Team diversity having the highest impact with standard beta coefficient = 0.230.

The project’s duration adds to the challenges discussed above by Shenoy and Jha (2018). Thus, this parameter was also included in the regression analysis. For this, the categorical data duration was converted to a dummy variable by coding the duration less than 60 months as zero and more than that as one. (Grotenhuis and Thijs 2015). A two-stage regression model was run to include this, and the results are shown in Table 8.

Table 10 indicates that there is an improvement in the adjusted square value in the second stage model from 0.728 to 0.855; thus, the inclusion of duration as a dummy variable in regression analysis is justified.

Table 11 indicates that the proposed model is significant with p value < 0.05 .

The result of the ANOVA table confirms the significance of the regression model, but it is also important to establish the significance of all the variables considered in the study. From Tables 10, 11, 12, it is evident that all four independent uses of social media with $p < 0.05$ are significant to understand the performance and success of the virtual teams deployed in the software projects.

The results of our analysis show that the four dimensions of virtual teams significantly impact the project’s success and the moderating role of social networking. A significant positive relationship exists among the four virtual team dimensions, Team Diversity, Team Dynamics, Technology Augmentation and Strategic Decision Making, on the software project success. The duration of the project also has a significant effect on the success of the software project.

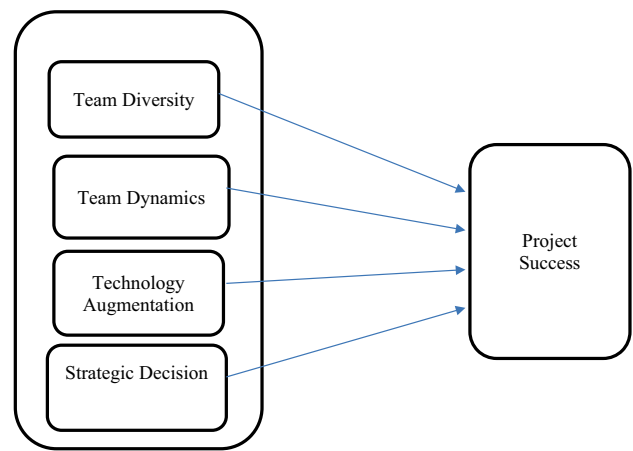


Fig. 3 Empirically tested model Source: Author creation (Empirical result)

Table 10 Results of a two-stage regression model

Model	R	R square	Adjusted R square	Std. error of the estimate
1	0.813	0.733	0.728	0.439
2	0.931	0.867	0.855	0.441

5 Discussion & conclusion

Virtual teams have evolved into a pivotal component of contemporary software development projects, particularly with the prevalent trend of outsourcing. These teams present a unique opportunity to engage a highly skilled workforce dispersed across various geographical locations and time zones. While virtual teams offer notable advantages, they also bring forth challenges that significantly impact software project management. The success rate of software projects is a paramount concern for both academic researchers and industry practitioners alike. The outcomes of this study hold considerable significance in unravelling the intricacies of software project management, specifically in the context of deploying virtual teams.

Table 9 Coefficient table

Model		Unstandardized coefficients		Standardized coefficients	t	Sig. (p value)
		B	Std. error			
1	(Constant)	0.547	0.165		3.323	0.001
	Team diversity	0.226	0.050	0.230	4.556	0.000
	Team dynamics	0.146	0.053	0.151	2.737	0.007
	Technology augmentation	0.035	0.045	0.035	0.795	0.028
	Strategic decision making	0.170	0.045	0.176	3.818	0.000

Table 11 ANOVA-two-stage regression model

Model		Sum of squares	df	Mean square	F	Sig
1	Regression	302.003	7	43.143	208.894	0.000 ^a
	Residual	49.981	242	0.207		
	Total	351.984	249			
2	Regression	305.042	13	23.465	117.968	0.000 ^b
	Residual	46.942	236	0.199		
	Total	351.984	249			

Table 12 Coefficient table-two-stage regression model

Model		Unstandardized coefficients		Standardized coefficients	t	Sig
		B	Std. error			
1	(Constant)	0.586	0.152		3.858	0.000
	TeamDiversity	0.226	0.049	0.225	4.621	0.000
	TeamDynamics	0.167	0.052	0.173	3.219	0.001
	TecnologyAugmentation	0.024	0.046	0.024	0.537	0.009
	StrategicDecisionMaking	0.163	0.046	0.165	3.553	0.000
2	(Constant)	0.208	0.295		0.367	0.014
	TeamDiversity	0.289	0.107	0.287	2.708	0.007
	TeamDynamics	0.417	0.110	0.430	3.797	0.000
	TecnologyAugmentation	0.007	0.146	0.007	0.047	0.009
	StrategicDecisionMaking	0.120	0.222	0.121	0.538	0.005
	Int_TDiv_DM	0.089	0.120	0.055	0.744	0.028
	Int_TDynamics_DM	0.327	0.124	0.187	2.635	0.009
	Int_TechAugm_DM	0.044	0.154	0.029	0.286	0.045
	Int_StretDecision_SM	0.052	0.227	0.034	0.228	0.028

In analyzing the study’s results, the regression analysis underscores the significance of all four independent variables—Team Diversity, Team Dynamics, Technology Augmentation, and Strategic Decision Making—in ensuring the success of software projects. Notably, Team Diversity emerges as the most influential factor, with a pronounced impact, followed closely by Team Dynamics, where the influence is further shaped by the strategic decision-making process. Surprisingly, Technology Augmentation exhibits the least impact on software project success. This aligns seamlessly with the study’s assertions, as the modest coefficient for technology augmentation suggests that contemporary software development projects proficiently handle the integration and expansion of new technologies, indicating minimal concern in the present digital era.

The study’s findings emphasize the overarching importance of managing team-related considerations and effectively communicating the project vision to every team member. This strategic perspective significantly influences the success of software projects conducted through virtual teams. The lower impact of Technology Augmentation underscores the industry’s adeptness in navigating technological advancements, while concurrently highlighting

the critical role of cohesive team dynamics and strategic decision-making in ensuring project success in the virtual team paradigm within the dynamic landscape of software development.

5.1 Implications for managers

The findings of this study hold substantial implications for the Information Technology (IT) industry in India and other nations relying on virtual teams for software project management. Firstly, the study underscores the critical significance of effective team communication, collaboration, coordination, leadership, and trust in ensuring the success of virtual team management. Acknowledging these factors becomes imperative for organizations seeking optimal outcomes in software project execution. Additionally, the study highlights the pivotal roles of technological augmentation and strategic decision-making in achieving overall software project success.

Secondly, a crucial emphasis is placed on fostering effective team dynamics within virtual teams. Organizations are encouraged to proactively build trust, encourage open communication, and adeptly manage conflicts to cultivate

a conducive team dynamic. Enhancing team dynamics can result in elevated collaboration, improved decision-making processes, and heightened levels of team satisfaction. This underscores the need for organizations to prioritize strategies that strengthen interpersonal relationships within virtual teams.

Furthermore, the study accentuates the importance of investing in new technologies to augment collaboration and coordination within virtual teams. Organizations are urged to explore and adopt innovative virtual work technologies that facilitate real-time communication, seamless document sharing, and efficient project management. Such investments can yield higher levels of team productivity, improved project outcomes, and bolster organizational competitiveness in the ever-evolving IT landscape.

Lastly, strategic decision-making within virtual teams emerges as a critical determinant of project success. Organizations are advised to actively seek opportunities for enhancing collaboration, knowledge sharing, and decision-making processes within their virtual teams. Effective decision-making, coupled with strategic guidance, can foster increased team engagement, heightened motivation and morale, and ultimately lead to superior project outcomes. In summation, this study furnishes valuable insights into the optimal utilization of virtual teams in software project management within the IT industry. Organizations can leverage these insights to refine their virtual team management practices, elevate team performance, and achieve superior project outcomes in a competitive global landscape.

5.2 Limitations

While our research contributes to the existing literature on virtual teams and software development project success, it suffers from a few limitations. First, the complexity of projects was not captured in this study. Secondly, our sample consisted of software development firms in India which received software projects outsourced by companies in developing countries. Our study was restricted to India, which is only one developing country.

5.3 Areas of future research

We now explore a few areas for future research. In our research, we identified dimensions of virtual teams and how they influenced software project success. The model we proposed and empirically tested in the study can be extended to the virtual teams deployed for other sectors like service and fast-moving consumer goods (FMCG). Secondly, our research focused on one developing country, India. The research findings can be further elaborated to study the behaviour in other developing countries to

substantiate the research model. This can help us determine whether our findings are also generalizable to other countries.

In summary, there are a number of interesting questions that can be answered in future research.

Appendix 1: Data collection questionnaire

Questionnaire

Name of the respondent:
 Name of the organization:
 Designation:
 Contact number:
 Email:
 Name of the project: (A brief description requested)
 Completion status of the project (in %):
 Duration of project (in months):
 Type of project: a) R&D b) Customization
c) Maintenance d) Other

Kindly answer the following questions on a seven-point scale.

Where,
 ‘1’ indicates ‘Strongly Disagree’ ‘2’ indicates ‘Disagree’.
 ‘3’ indicates ‘Disagree Somewhat’ ‘4’ indicates ‘Undecided’.
 ‘5’ indicates ‘Agree Somewhat’ ‘6’ indicates ‘Agree’.
 ‘7’ indicates ‘Strongly Agree’.

Sl.No	Statements	Scale						
		1	2	3	4	5	6	7
1	To what extent would you agree or disagree that the project conformed to the estimated budget of the project?							

Sl.No	Statements	Scale						
		1	2	3	4	5	6	7
2	To what extent would you agree or disagree that the project conformed to the estimated time of the project?							
3	To what extent would you agree or disagree that the project conformed to the functional requirement of the software developed?							
4	To what extent would you agree or disagree that the cultural diversity in the project team was managed (through the collaboration tool in the software project)?							

Note: Collaborative tool- Tools like Jing, Dropbox, Huddle etc. have project management suites and workspaces, group task-managers, and collaborative productivity and conferencing applications

5	To what extent would you agree or disagree that the diversity in time zone in the project team was managed (through the collaboration tool in the software project)?							
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Sl.No	Statements	Scale						
		1	2	3	4	5	6	7
6	To what extent would you agree or disagree that the geographical diversity in the project team was managed (through the collaboration tool in the software project)?							
7	To what extent would you agree or disagree that the trust with in the project team was maintained (through the collaboration tool in the software project)?							
8	To what extent would you agree or disagree that the coordination with in the project team was managed (through the collaboration tool in the software project)?							
9	To what extent would you agree or disagree that the leadership in the project team was executed (through the collaboration tool in the software project)?							

Sl.No	Statements	Scale							Sl.No	Statements	Scale						
		1	2	3	4	5	6	7			1	2	3	4	5	6	7
10	To what extent would you agree or disagree that there was use of Common standards in the project?								16	To what extent would you agree or disagree that there was Clarity of requirements in the project?							
11	To what extent would you agree or disagree that there was Clarity of roles & responsibilities in the project?								17	To what extent would you agree or disagree that there was Customer expectation were realistic in the project?							
12	To what extent would you agree or disagree that there was Adaptability to new platform in the project?								18	To what extent would you agree or disagree that there was Participation of team in decision making in the project?							
13	To what extent would you agree or disagree that there was Conformity to the agreed functionality in the project?								19	To what extent would you agree or disagree that there was Job satisfaction in the project, while working in virtual environment?							
14	To what extent would you agree or disagree that there was Reusability of technical objects in the project?								20	To what extent would you agree or disagree that there was Recognition & motivation in the project, while working in virtual environment?							
15	To what extent would you agree or disagree that there was Clarity of mission in the project																

Note: Virtual Team- A virtual team is formed when at least one of the members of the team works in a different location, time zone or culture

Appendix 2: Construct validity

	Component			
	Team diversity	Team dynamics	Technology augmentation	Strategic decision
Cultural issues	0.573	0.028	0.075	0.091
Time zone difference	0.803	−0.034	−0.173	−0.063
Geographical diversity	0.832	0.09252	0.26454	0.143
Trust	−0.389	0.715	0.098	−0.217
Coordination	0.038	0.926	0.473	−0.362
Leadership Issues	0.186	0.914	0.24	0.055
Knowledge transfer	0.162	0.032	−0.133	0.033
Structure of project task	−0.132	−0.029	0.133	0.067
Clarity about roles & responsibility	0.023	0.076	0.187	0.534
Lack of common standards	0.039	0.046	0.716	0.261
Adaptability to hardware/software	0.102	−0.38	0.873	0.066
Buggy release or missing feature	−0.023	0.013	0.863	−0.028
Reusability of the technical objects and security	0.261	−0.046	0.772	0.162
Clarity of mission	0.023	0.076	0.187	0.534
Clarity of requirement	0.388	0.102	0.065	0.906
Customer expectation	−0.154	−0.0515	0.028	0.941
Participation of members-decision	0.566	0.50228	0.25597	0.813

	Component			
Job satisfaction	−0.554	0.013	0.032	0.185
Recognition & motivation	0.018	0.136	−0.333	0.028

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