Journal of Project Management Practice
Faculty of Built Environment, Universiti Malaya.
E-ISSN: 2805-4768
https://ejournal.um.edu.my/index.php/JPMP/

Comparative Analysis of Communication, Team Cohesion, Flexibility, and Productivity in Virtual and In-person Project Management: Evidence from Germany

Reuben Amewuda[1*] & Theophilus Fiifi Ocansey[2]

[1] Department of Agricultural Economics, Agribusiness and Extension, Kwame Nkrumah University of Science and Technology, Private Mail Bag, University Post Office, Kumasi, Ghana.
[2] Department of Business Management, University Canada West-Vancouver House Campus, 1461 Granville Street, BC, V6Z 0E5, Canada.

*Corresponding author: amewudareuben7@gmail.com

Submission date:
7th November 2024
Acceptance date:
30th December 2024

How to cite this paper:
Amewuda, R. & Ocansey, T. F. (2024). Comparative Analysis of Communication, Team Cohesion, Flexibility, and Productivity in Virtual and In-person Project Management: Evidence from Germany. Journal of Project Management Practice, 4(2), 77-96.

ABSTRACT

The study compares virtual and in-person project management based on major dimensions such as communication, team cohesiveness, flexibility, work-life balance, and efficiency. With the shift to remote work, understanding the dynamics of communication, team cohesion, flexibility, and productivity in these environments has become crucial for organisations. The study employed a cross-sectional comparative research design to administer a questionnaire to 420 participants in Germany. The study used Mann-Whitney U Tests to test the two environments. The Mann-Whitney U Test found a statistically significant difference between the in-person and virtual groups ($U=329$, $p = 0.002$), showing that in-person teams communicate more often than virtual groups with a large effect size ($r=-0.536$). The analysis of team-building activities found that virtual teams engage more frequently than in-person teams, with a much larger effect size ($p=0.024$, $r=-0.830$). Moreover, the results regarding privacy show a statistically significant difference between the virtual and in-person project management environments ($p = 0.002$, $r=0.534$), implying that in-person project management environments provide a higher level of privacy than virtual environments. The study concludes that structured communication and team-building activities in a virtual environment enhance trust and collaboration among team members. Organisations are recommended to promote greater communication in virtual teams, address methods for forming virtual teams, address privacy issues in virtual workplaces, encourage work flexibility to reduce working pressure and work on schedules and collaboration of traditional in-person teams.

Keywords: comparative study, virtual and in-person, communication efficiency, team cohesiveness, work flexibility, productivity.

1.0 INTRODUCTION

The COVID-19 pandemic has increased virtual meetings and remote work, changing project management. According to Browne et al. (2022), the pandemic pushed people to quickly adapt to virtual environments, making the virtual element a norm for project management during and after the pandemic. Lisbôa et al. (2021), for instance, found that remote working offers flexibility but also heavily strained team cohesion and interpersonal relationships. According to Ashcroft et al. (2021), virtual care enabled access to more services and improved teamwork among healthcare providers during the pandemic. Stefanik-Guizlo (2024) argued that many virtual participants had trouble building relationships and wanted a hybrid solution that included virtual and physical contact during COVID-19. In addition, Jones et al. (2022), who studied remote work in public involvement activities, found that lack of in-person interaction reduced participation, engagement, and communication.

Before COVID-19, digital technologies significantly changed project management for the better, and this has contributed to the emergence of the growing separation between in-person and virtual project management. The "Project Management Institute (PMI)" identifies project management as the process of using knowledge, skills, tools, and techniques in project activities to meet the requirements of the project (Ferrazzi, 2012). It is well explained in a process in various domains, including scope, time cost, quality, and risk management (Al-Maghraby, 2010).

In-person project management has remained the main form of project management and has the advantages of real-time feedback, possibilities for an impromptu meeting, and improved personal relationships (Ferrazzi, 2012; Dumitraşcu, 2016). However, it is limited by geographical accessibility, high operational costs, and increased work schedules while being less flexible in the "business environment" (Berry, 2011; Rehman et al., 2021). Moreover, strict setups, including in-person disparities between work and personal life, affect work-life balance (Ferrazzi, 2012; Dumitraşcu, 2016). In contrast, virtual project management uses communication technology to contact teams regardless of location. They benefit productivity through circular work without interruptions (Wu, 2021). Nonetheless, it has revealed issues such as digital fatigue, communication barriers, and the ability to maintain team spirit (Bailenson, 2021; Duran & Popescu, 2014). Again, virtual teams may find it challenging to work cohesively and effectively because they cannot physically interact and may have less morale (Ferrazzi, 2012; Beheshti, 2020).

Many studies have been conducted on project management environments. For instance, Beheshti (2020) found that remote work participation depends on communication and leadership. Wu (2021) indicates that digitalisation has changed project management since the virtual environment uses technology to improve project implementation and cooperation. Rehman et al. (2021) found that time zone management, trust management, and coordination management are the greatest obstacles to virtual project management, while clear objectives and communication management are success factors. Kukytė and Jasinskas (2021) found that virtual teamwork improves project outcomes with correct tools and procedures. Mwamba and Ahmad Malik (2022) reveal that virtual works offer flexibility and lower prices but lack motivation and coordination. These studies contributed invaluable literature to the project management environment, frameworks, and theories.

Despite the invaluable contribution of the previous studies, most focus on one aspect of project management and do not compare the two environments. For example, Beheshti (2020) emphasises remote work and employee engagement, and Wu (2021) emphasises digitalisation. Alnsour (2014), Webster and Wong (2008), and Glikson and Erez (2019) studied virtual team trust and conflict. Rehman et al. (2021) and Mwamba and Malik (2022) discuss virtual software project management challenges and success factors. In USA, Bailenson (2021) studied "Zoom Fatigue". Communication is the focus of Duran and Popescu (2014), Seliverstova (2022), and Beheshti (2020). Berry (2011) emphasises virtual team leadership. Dumitraşcu (2016) studied culture and motivation in international virtual project teams in Romania. Goyal et al. (2022) examined virtual collaboration tools and techniques, while Al-Maghraby (2010) analysed Egyptian project frameworks. Shwartz-Asher and Ahituv (2019) emphasise virtual project management security concerns, while Krawczyk-Bryłka (2017) compares traditional and virtual teams with a particular focus on efficiency in Poland.

Despite the growing body of literature on project management, there is insufficient empirical evidence comparing exactly the communication efficiency, team cohesiveness, work flexibility, and productivity of in-person and virtual project management in the German context. Again, no study seems to compare communication,

team cohesion, flexibility, and productivity with in-person and virtual project management in Germany specifically. Little is known about how these approaches compare to each other. This knowledge gap is a significant problem for organisations seeking to improve the management of projects to foster better performance and implement strategic objectives. Since some environments are complex, organisations must determine and adopt the most appropriate strategy.

The study is thus motivated by the need to deal with the increasing sophistication of project management across virtual and in-person contexts, as has become the norm under technological progress and globalisation. With growing investments in virtual teams, the comparative effectiveness of communication, team cohesion, flexibility, and productivity in virtual versus in-person settings is necessary. Hence, this study compares virtual and in-person project management to fill this research gap. The study's specific objectives are: (1) to evaluate the effectiveness of communication and collaboration tools; (2) to assess team building activities and trust; (3) to analyse flexibility and work-life balance; (4) to compare productivity, performance and satisfaction outcomes in virtual and in-person project management environments. These insights are valuable to improve the execution of a project, satisfy the demands of project stakeholders, and support an organisation's key objectives as the world becomes more technologically advanced and globalisation progresses. The study hopes to help program managers, project coordinators, and project team members form hybrid teams with good knowledge of virtual and in-person environments. It is necessary to know the drawbacks of each environment and find a solution to them accordingly in forming hybrid teams.

2.0 LITERATURE REVIEW

2.1 Forms and Modes of Working Environments

The main working environments are traditional office settings, remote locations, and hybrid work environments. These ecosystems exhibit different traits, difficulties, and opportunities worthy of serious analysis. Traditional in-person office setups have dominated professional workplaces. Being together in a physical environment allows employees to work together in person for instant exchanges and rapid feedback. Strong collaborative teams in hospital settings benefit health results, possibly leading to improved cooperation and communication in the workplace (Donnelly et al., 2021). Teams participating in person have a healthier work culture, increase morale and create higher productivity (Ashcroft et al., 2021). However, stress and poor work-life balance can be caused by fixed office hours and commuting (Lisbôa et al., 2021). During the COVID-19 pandemic, these environments were shown to be lacking, and companies were challenged to maintain operations and meet employee safety requirements.

The pandemic has accelerated one of the largest transformations in the remote workplace. Digital communication technologies allow employees to work remotely, commonly at home, and interact. This work arrangement has scheduling flexibility, reduced travel time and higher productivity (Mwamba & Malik, 2022). These scholars posit that it reduces stress and anxiety since remote workers can customise their work settings. Obstacles in remote work especially revolve around communication and teamwork. Team members may misunderstand digital communication and feel disconnected (Berry, 2011). Trust and rapport can be difficult without physical presence (Shwartz Asher & Ahituv, 2019).

Hybrid working arrangements are growing as companies attempt to balance mutual support and physical cooperation with flexibility. This hybrid model allows workers to work in the office or at home when they prefer, making it more of a choice (Wu, 2021). On the challenging side, in hybrid contexts, remote workers may lose out on office gossip and become more isolated (Glikson & Erez, 2020). Hence, hybrid team management requires a deep awareness of communication dynamics and a dedication to creating an inclusive culture reflecting all parties' contributions (Duran & Popescu, 2014).

2.2 In-person and Virtual Teams

In in-person project management, effective communication and cooperation are the most important advantages among participants. Ferrazzi (2012) reports that relationship breakdown among project team members is faster solved when people are physically present. Dumitraşcu (2016) agrees with this by noting that in-person

interactions strengthen the team members' collaboration and commitment since physical communication fosters fellowship. Another important aspect Al-Maghraby (2010) raises is a real-time conversation without technology in dealing with particular issues, resulting in better problem-solving and decisions. The genuine separation of work from the physical aspect of interacting with people face to face positively enhances the abilities of team members to manage work-life balance (Ferrazzi, 2012). Shwartz-Asher and Ahituv (2019) used an experimental study with 150 participants to test compliance with directions in virtual and in-person teams using ANOVA. The data collected indicated that virtual teams complied significantly with the directives set by the managers ($p < 0.01$) as opposed to the in-person teams that were informal in their approach. The authors proved that in-person teams enjoyed better social cohesion.

According to Berry (2011), the physical proximity of team members and managers provides a platform for monitoring and correcting behaviours, improving adherence to project timelines and quality standards. This agrees with Rehman et al. (2021), who established that engagement activities are much more effective in the face-to-face environment when considering trust and expectation management. Also, in-person project management enables the appropriate use of traditional approaches and techniques. The effectiveness of the environment was assessed based on the time and speed of meetings held in the project environment (Rehman et al., 2021). Webster and Wong (2008) note that systematic quality management is easier to conceptualise and implement in person since physical inspections and assessments can be made on the spot. Gross et al. (2022) conducted a quasi-experimental study to establish the knowledge gained between virtual and in-person community-based training participants. The study found differences between in-person and virtual participants, where the in-person indicated increased percentage-point knowledge increases than the virtual environment (means [95%CI] = 14.8 [12.3–17.4] versus 11.8 [9.3–14.3], $p < 0.05$). These results add to understanding the importance of in-person training, especially regarding how much knowledge is retained compared with virtual approaches (Gross et al., 2022).

However, despite its strengths, in-person project management involves various challenges. One major disadvantage stem from limited flexibility in comparison to virtual reality environments. This requirement for physical attendance can restrict potential access to talents across geographical space, thereby increasing commuting expenses and office space costs (Dumitraşcu, 2016). Also, it is challenging with in-person project management to stick to a timetable, which may not be flexible enough to cope with working personalities or the difference in time zones.

Virtual teams, on the other hand, obtain numerous benefits from computer-assisted applications such as virtual meetings, communication, chat, and group work applications that facilitate real-time information updates and synchronisation (Wu, 2021; Beheshti, 2020). These tools are of the utmost importance in providing proper communication and cooperation when employees are in different parts of the world (Beheshti, 2020). Being flexible is one of the advantages of having a virtual project since it is not confined to a particular place. One piece of empirical evidence from Mwamba and Malik (2022) was the sequential mixed-methods study where participants completed questionnaires and provided interviews with 80 participants in Zambia and found that virtual teams had higher flexibility and cost-effectiveness ($p<0.01$). Furthermore, Scott-Young (2013) revealed that virtual teams were faster and less costly than in-person teams, with no difference in client satisfaction and outcomes of projects. Also, virtual teams showcased increased team potency, indicating group self-efficacy, more effectively confirming the hypothesis that, when constructed and managed well, virtual teams are as efficient as in-person teams under some circumstances (Scott-Young, 2013). Virtual teams can work from different places, meaning organisations can source talent globally (Goyal et al., 2022). This flexibility results in employees enjoying their jobs and thus delivering optimal performance since they are in the right environment (Glikson & Erez, 2019). Zak et al. (2021) revealed that virtual presentations provided significantly higher results in creativity ($p < 0.001$) than in-person presentations that increased social responsibility ($p < 0.05$). Such findings specify that virtual techniques have advantages and can affect learning processes in various ways.

In addition, there is a potentially large difficulty in a group – people's communication and organisation. Krawczyk-Bryłka (2017) compared traditional and virtual teams based on survey data supported by semi-structured interviews and found that virtual teams faced more communication problems than in-person teams ($p < 0.05$). The lack of nonverbal communication and the presence of signs contribute to the emergence of misunderstandings (Duran & Popescu, 2014). The lack of physical contact reduces interaction and, thus, faces

social isolation most of the time (Beheshti, 2020). Today's employees are more self-driven and must be engaged and encouraged frequently; however, carrying out team-building activities, test checks, and virtual check-ins can be challenging and require extra effort and unique ideas (Krawczyk-Bryłka, 2017). Further, dealing with cultural and language differences also poses challenges in a virtual environment that may require extra caution and flexibility from the project manager (Rehman et al., 2021). Thus, it is argued that the success of virtual project management depends on the proper use of technology and the control of geographically dispersed teams. Goyal et al. (2022) highlight the need for strong project management tools to support tracking, document sharing, and real-time working. Moreover, the problems of digital tiredness and social exclusion remain critical for project managers, establishing a team's culture, and engaging the workforce in meaningful communication (Bailenson, 2021).

2.3 Theoretical Backgrounds and Hypotheses

2.3.1 Media Richness Theory: Theory Underpinning Communication and Collaboration

Media Richness Theory (MRT) was developed by Daft and Lengel in 1986 to determine the effectiveness of the identified communication media in relaying information (Daft & Lengel, 1984). According to this theory, a medium's involvement depends on the medium's ability to transfer information richness (Beheshti, 2020). The theory explains that in-person communication could be more effective for closer feedback and deeper understanding than virtual communication despite its flexibility and lack of media richness. The variable "communication" was adopted from Mwamba and Malik (2022), and the "collaboration" variable was taken from Donnelly et al. (2021) and Ashcroft et al. (2021).

Information Richness	Medium	Feedback	Channel	Source	Language
High	Face-to-Face	Immediate	Visual, Audio	Personal	Body, Natural
↑	Telephone	Fast	Audio	Personal	Natural
	Written, Personal	Slow	Limited Visual	Personal	Natural
	Written, Formal	Very Slow	Limited Visual	Impersonal	Natural
Low	Numeric, Formal	Very Slow	Limited Visual	Impersonal	Numeric

Figure 1. Key Components of Media Richness Theory. Source: (Daft & Lengel, 1984)

Figure 1 shows that richer media offers immediate feedback, which includes clarification and dialogue. In-person communication enables question-and-answer sessions with gestures and body postures. Signals and channels of rich media can disseminate more than one cue at a time, for instance, gestures, voice intonation, and facial expressions. Concerning language variation, structured natural language in rich media is more descriptive and elaborate, improving how to pass messages, concepts, and feelings about products and services. In terms of personalisation, rich media allow the communicators to customise messages according to the individual needs and circumstances of the receiver. The present study builds on Ferrazzi (2012) and Dumitraşcu and Dumitraşcu (2016) to underscore the value of in-person communication in promoting team cohesiveness and interest. Daft and Lengel (1984) posit that instant messaging and email as the source of rich media is lower than in-person, teleconference, and video conferencing. They lack body language and feedback, which delays interaction and communication

(Beheshti, 2020; Wu, 2021). The study adopted the media richness theory to understand the effects that various media have on teamwork in both virtual and in-person environments based on media richness and social presence theories as stated below:

Hypothesis 1: Communication and collaboration tools are more frequent and effective in in-person project management environments than virtual ones.

2.3.2 Tuckman's Stages of Group Development: Theory Underpinning Team Cohesion, Engagement and Trust

This model was originally proposed by Bruce Tuckman in 1965, and it has five stages: formalisation, conflict, formation, implementation, and termination (Tuckman, 1965; Duran & Popescu, 2014).

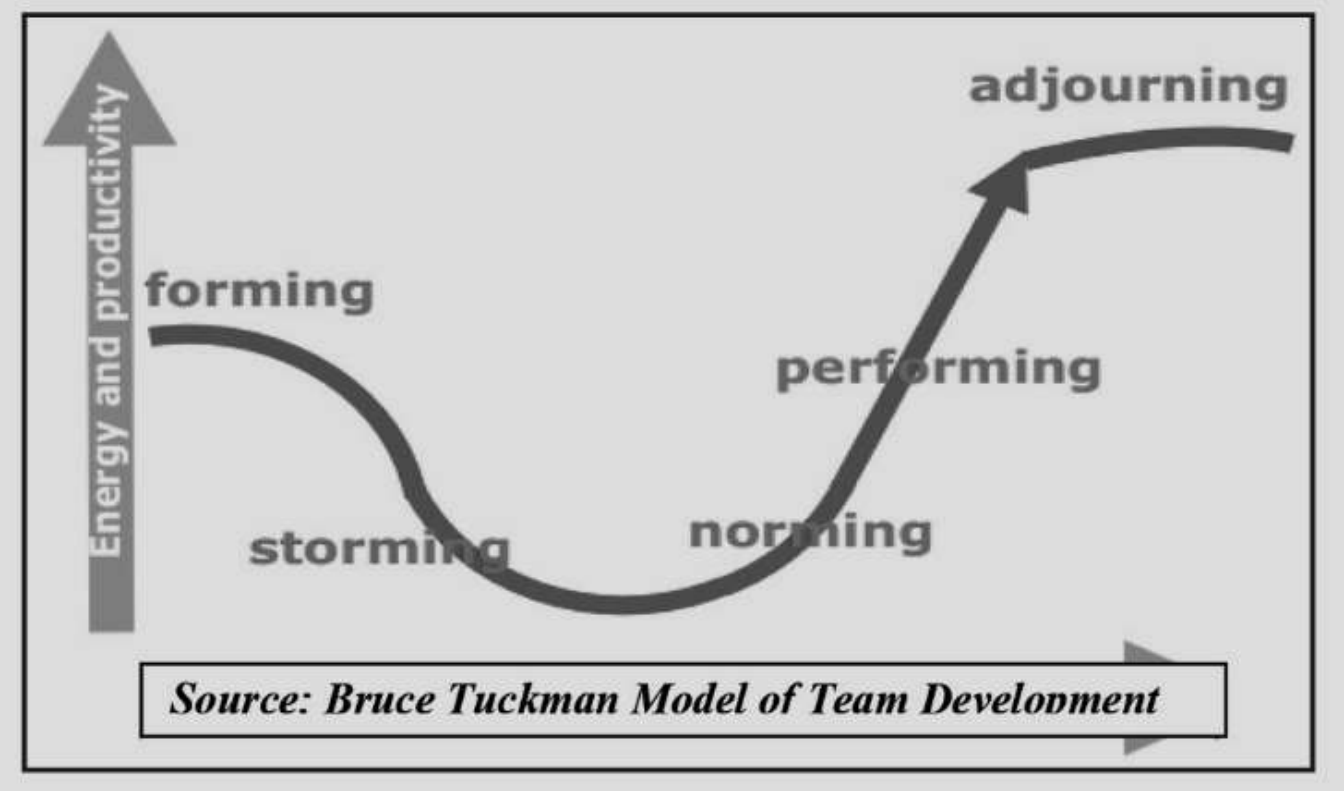

Figure 2. Tuckman's Stages of Group Development. Source: (Kumar et al., 2014)

Kumar et al. (2014) found that group members learn about each other during formation. This stage establishes the foundation for teamwork, motivation, and trust. At the storming stage, teams compete to express their opinions; hence, conflict resolution solutions are needed to control this phase (Figure 2). This stage involves understanding cross-cultural and interpersonal differences and communication to build trust and relationships (Kumar et al., 2014). In in-person settings, team cohesion, participation, and confidence improve in this stage (Dumitraşcu, 2016; Krawczyk-Bryłka, 2017). In the performing stage, the team is more functional and productive towards project goals. According to Huang et al. (2023), high cohesiveness, involvement, and trust improve project outcomes, and satisfaction characterise the performing stage. The final step is adjourning, where the team dissolves after meeting goals characterised by team relationships. Tuckman's model helps define team cohesion, engagement, and trust. Team disagreements can be resolved when appropriately managed throughout its lifecycle, and strong working relationships and performance can be achieved to achieve project success. The study suggests the following hypothesis based on this theory and its applications:

Hypothesis 2: Team-building activities are more effective and frequent in in-person project management environments than virtual ones.

The variables "Team Cohesion" (Donnelly et al., 2021; Ashcroft et al., 2021, 2021; Kukytė & Jasinskas, 2021), "Engagement" (Mwamba & Malik, 2022, 2021; Glikson & Erez, 2020) and "Trust" (Dumitraşcu & Dumitraşcu, 2016; Wu, 2021; Berry, 2011) are derived and analysed from the literature of teamwork.

2.3.3 Job Demands-Resources (JD-R) Model: Theory Underpinning Flexibility and Work-Life Balance

The Job Demands-Resources (JD-R) model investigates the interrelation of job demands and resources and impacts on employees' health and performance (Demerouti et al., 2001; Bakker & Demerouti, 2017; Kukytė & Jasinskas, 2021). Job demands refer to the persistent work requirements of a job that result in effective costs for the employee (Bakker & Demerouti, 2017). Employment resources support achieving work goals, relieving the workload, and supporting positive personal change and growth, such as self-directedness, support, and feedback.

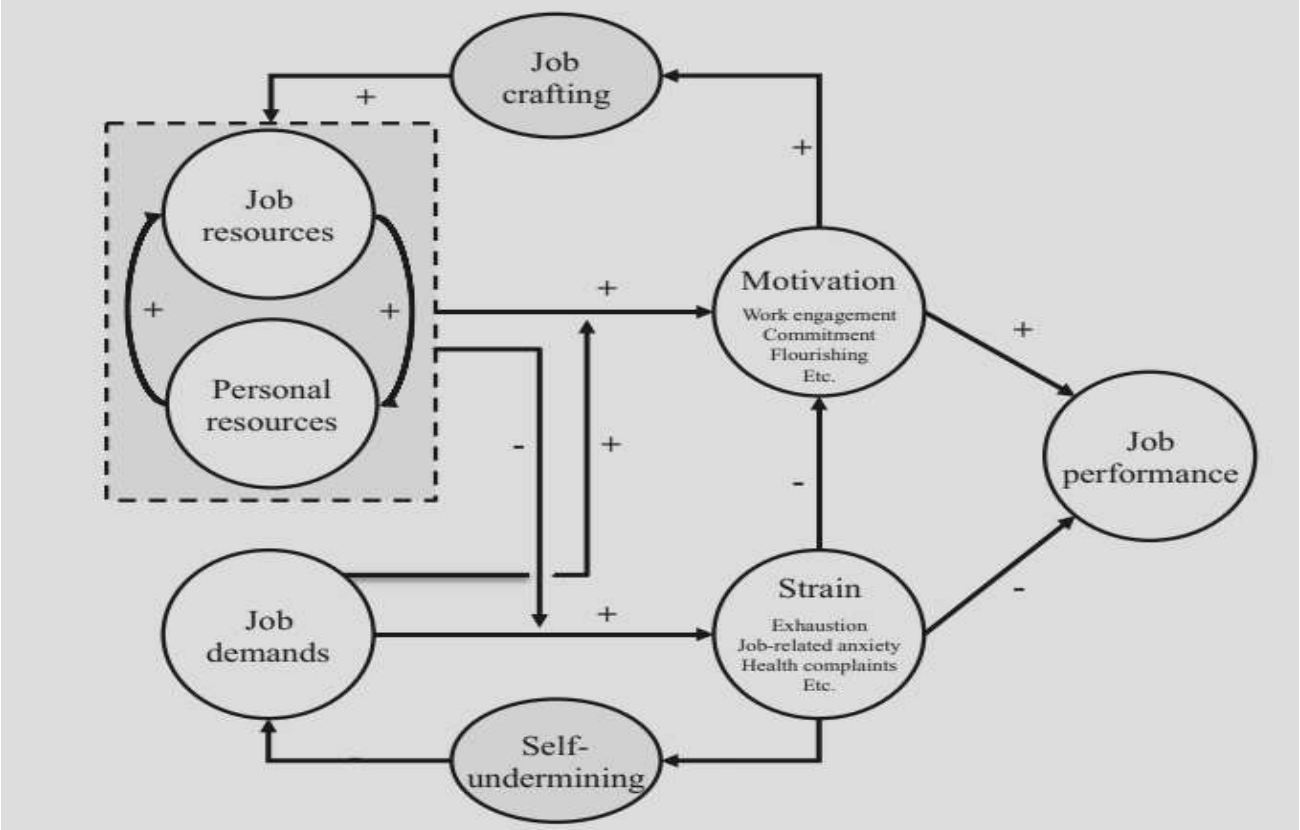

Figure 2. Job Demands-Resources (JD-R) Model. Source: (Bakker and Demerouti, 2017)

Job resources include all parts of a job that can help achieve goals, alleviate job pressures, and permit personal development. According to Figure 3, high job demands, and inadequate resources cause stress and pressure, affecting employees' health. Employee productivity and health improve due to this beneficial association. The flexibility of virtual project management environments is an asset in employment. Virtual workers can operate from numerous locations, adapt their working time to fit work and other activities, and avoid the physical and psychological strain of travelling. According to Bakker and Demerouti (2017), flexibility is a critical resource that can boost job satisfaction and performance. Wu (2021) added to this discussion and noted that virtual project management systems enable continuous work cycles and project productivity while increasing staff workloads. Hence, this study uses the JD-R model to examine how flexibility and work-life balance affect virtual and in-person project management. Based on the above assumptions, the study presents the following hypothesis:

***Hypothesis 3*:** Virtual project management environments provide greater flexibility and work-life balance but offer less privacy than in-person environments.

The variables "Flexibility" and "Work-Life Balance" are derived from the work of Kukytė and Jasinskas (2021) and Lisbôa et al. (2021), while Work-Life Balance was derived from Donnelly et al. (2021) and Ashcroft et al. (2021).

Hypothesis 4: No significant differences exist in productivity, performance, and satisfaction outcomes between virtual and in-person project management environments when appropriate tools and strategies are employed. The variables "Productivity" and "Performance" are derived from various studies examining team dynamics' effectiveness, particularly in virtual and in-person project management during the COVID-19 pandemic. For example, productivity was derived from the study of Lisbôa et al. (2021) and Mwamba & Malik (2022). Performance was derived from Donnelly et al. (2021) and Ashcroft et al. (2021).

3.0 METHODOLOGY

3.1 Research Design

The study adopts a quantitative approach and comparative cross-sectional study design that allows the collection and analysis of numerical data comparing two or more variables (e.g., communication, team cohesiveness, and productivity) in virtual and in-person project management environments. The cross-sectional design is suitable because it involves the study of project management characteristics and results in both virtual and in-person at one particular period (Leedy & Ormrod, 2019). It is also convenient for comparing variables in the virtual and in-person project management contexts and for assessing the pilot hypotheses.

3.2 Population and Sampling

The target population for this study are project managers, team members, and stakeholders drawn from projects in different industries, including information technology, construction, healthcare, finance, and marketing industries in Germany. The study targets a German population of 83.8 million (Eurostat, 2024). The study focuses on participants with experience ranging from less than one year to more than ten years. According to the studies conducted by Beheshti (2020) and Alnsour (2014), it is clear that a diversified sample across the industry and different experience levels gives a better picture of how project management takes place in different contexts.

The study used a two-stage sampling strategy to include participants with experience in in-person and virtual project management environments through random and snowball sampling. Simple random sampling was used first to represent industries and roles and capture diverse participants. Second, snowball sampling was conducted to approach individuals with relevant expertise in addressing the research questions. Third, this strategy balanced methodological rigour with practical constraints, enabling the recruitment of a robust sample despite challenges in accessing specific populations. Finally, this sampling technique was introduced to ensure that the presented insights were meaningful and appropriate to the study that compared in-person and virtual project management environments. Incorporating these methods into the study led to a targeted and reliable sample, yielding results supporting the study's validity while overcoming practical limitations.

Since Germany's population was about 83.8 million (Eurostat, 2024), and the population is very large, sample size determination by Cochran's formula was used to get higher accuracy and confidence with the results. Cochran's formula is applied when the populations are large to obtain a large sample size for the required level of accuracy (Creswell & Creswell, 2022). The Cochran's formula is specified below:

$$n_0 = \frac{Z^2.p.(1-p)}{e^2} \quad (1)$$

Where:
Z=1.96 (for a 95% confidence level)
p = 0.5 (maximum variability)
e = 0.05 (margin of error)

$$n_0 = \frac{(1.96)^2 * 0.5 * (1-0.5)}{(0.05)^2} \quad (2)$$

n_0 = 384.16

The sample size was calculated to be 384, but 420 respondents were received from IT, construction, healthcare, finance, and marketing departments. These additional responses were added to increase the data's representation of the large population. Hence, the study used a 420-sample size.

3.3 Data Collection

The survey questionnaires were used as the research instrument for data collection in this study. The questionnaire consists of five sections. The survey was conducted through an online survey platform to obtain a vast and geographically dispersed sample population in Germany and the surrounding area. The survey link and the company's social media pages were emailed to participants. All participants were informed of the anonymity of their responses and were guaranteed their responses. Rehman et al. (2021) and Kukytė and Jasinskas (2021) confirmed that it is possible to collect data through an online survey from a large and geographically diverse population, which gives an extensive understanding of the discussed subject.

The questionnaire was described as follows. The *Demographic Information* is provided in Section 1 of the questionnaire. It contains the respondents' roles, regions, years of experience, gender, and primary project management environment. The second section is *Communication and Collaboration* and comprises tools used for communication, frequency of this communication, and ease of working together. *Team Cohesion and Trust* comprises section 3, which focuses on the extent of team engagement, how often teams engage in team-building activities, knowledge of each other, team members' strengths and weaknesses, professionalism, and trust. Section 5 was *Work-Flexibility and Work-Intrusion*, containing three questions regarding work schedule flexibility and work interference with personal life and workload. In section 6, the following areas are included: *Productivity and Performance*; rating overall productivity, assessing how effective project management tools and processes are, assessing to what extent project management has achieved project management goals; Satisfaction; rating the overall satisfaction with the project management environment; recommendation; assessing one's propensity to recommend the environment.

3.4 Analytical Methods

The hypothesis testing used the Mann-Whitney U Test (Wilcoxon Rank-Sum Test) to test 4 hypotheses. Choosing appropriate statistical tests in research is important, particularly when dealing with data that do not follow parametric tests' assumptions, like the t-test. According to Leon et al. (1998), in the absence of t-test assumptions and with independent observations, the Mann-Whitney test is appropriate for this study in comparing two groups using ordinal data (e.g., 1st, 2nd, 3rd) without equal spaces between units. Since the data was nonnormal, the primary means of hypothesis testing was the Mann-Whitney U test (Leon et al., 1998). The study is robust due to the Mann-Whitney U Test, which can work with ordinal or non-normally distributed data with a large sample size of 420. The Mann-Whitney U Test statistics formula was demonstrated as follows:

$$N = n_1 + n_2 \quad (3)$$

$$Uobs = n_1 . n_2 + \frac{n_1 (n_1 + 1)}{2} + R_1 \quad (4)$$

The rank-biserial correlation (r) formula is:

$$r = 1 - \frac{2U}{n_1 * n_2} \quad (5)$$

Interpretation of the rank-biserial correlation (r) is as follows:
$|r| \geq 0.5$: Large effect.
$0.3 \leq |r| < 0.5$: Medium effect.
$0.1 \leq |r| < 0.3$: Small effect.
where,
N = The total number of subjects
n_1 = Sample size of in-person group
n_2 = Sample size of virtual group
$Uobs$ = The observed U statistic for the virtual group
R_1 = The sum of the ranks for the in-person group
r = The rank-biserial correlation

The choice of this test is justified below. Test hypothesis assumptions, including the t-test, assume normality in data or almost normal data (Orozco-del-Castillo et al., 2013), while the Mann-Whitney U Test uses the ranks of the data instead of the data itself, so it is resistant to normality violations to this study. In addition, Mahdjour (2015) discuss that the Mann-Whitney U Test can uncover differences in central tendencies even when parametric test requirements are inadequate. Thus, the Mann-Whitney U Test in this study is more appropriate and trustworthy than the t-test because of the ordinal scale (Likert scale from 1-5) in which the team cohesion, flexibility, communication, and productivity metrics are measured (Santiago & Kang, 2022). Another important advantage of the Mann-Whitney U Test is that it helped the study to measure effect size for the significant values. Understanding this effect size is critical in determining their practical significance and implications. According to Fay and Proschan (2010), the Mann-Whitney U Test provides an opportunity to calculate effect sizes, measures of the magnitude of differences between groups commonly ignored when conducting t-tests. This part is important in project management studies since knowing the extent of different team dynamic differences helps in managerial decisions and strategies.

Descriptive statistics, such as means, standard deviations, frequencies, and percentages, were used to summarise the sample's demographic characteristics. By taking this step, the study was able to present a fairly concise picture of who the respondents were, from their roles to years of experience to the distribution of gender and project environment (virtual vs. in-person). In addition, a pre-test analysis was conducted before hypothesis testing to confirm that the t-test could be used to compare the virtual and physical project management environments. Appendix 1 shows that most of the variables in the data did not meet the assumptions of parametric tests except a few (Team-building activities, Team members' strengths and weaknesses, privacy), which revealed significant non-normality ($p < 0.05$). Therefore, parametric assumptions for the test of independence t-test were unmet for most variables. Hence, the Mann–Whitney U Test was mainly used in this study to avoid issues from the non-normality of the data and bolster the reliability of the test results. However, the t-test of independence is included in the study in light of the lack of normality applied to all variables and, just in case, provides an avenue to compare the parametric and non-parametric results for robustness and credibility for the variables.

4.0 RESULTS AND DISCUSSIONS

4.1 Demographic Characteristics

Table 1 presents the demographic characteristics of participants for the study. Regarding the roles in the project, the table reveals that 51.90% of the respondents were team members or employees of the organisation, 28.57% identified themselves as project managers or coordinators, and 19.52% were stakeholders. Participants had different years of experience; the majority (29.29%) had working experience of 3-5 years, 23.1% had working experience of 5-10 years, and 12.62% had more than 10 years of experience. This means that most of the respondents were fairly experienced in project management. On the side of the less experienced ones, those with 1-3 years of project management experience were 24.05%, and those with less than one year were 10.95%. Project managers with experience can build confidence among team members, enabling virtual project success (Kukytė & Jasinskas, 2021). The result further shows that 58.81% of the respondents had incorporated in-person project environments, whereas 41.19% incorporated virtual environments. This is the expected result because project management in the ages is mostly in-person, with only a few companies practising virtual systems. Hence, this result indicates that despite the global pandemic that expedited the digitisation of project management and increased the usage of virtual teams, in-person is still dominating the project management field (Mwamba & Malik, 2022; Wu, 2021).

Moreover, there was an almost equal gender distribution among respondents, with slightly more male respondents, 45.52%, while the female respondents constituted 41.65% and only 12.83% selected 'prefer not to say'. Previous studies indicate that women increasingly join the project management profession, especially in virtual environments (Kukytė & Jasinskas, 2021; Wu, 2021). The most common communication tools (Table 1) are email (21.61%), in-person meetings (21.42%), and phone calls or voicemails (19.21%). "Other" communication tools account for 7.01%, video conferencing (15.85%) and instant messaging (14.89%). Email (21.61%) is a primary communication medium in traditional and virtual project management, as shown by its significant utilisation (Wu, 2021). The COVID-19 epidemic has spurred a shift towards more dynamic and

interactive communication, including video conferencing (15.85%) and instant messaging (14.89%) (Mwamba & Malik, 2022). This result aligns with the Media Richness Theory, which states that in-person communication provides enhanced cues and real-time feedback (Daft & Lengel, 1984), which is valuable for in-person teams, according to Dumitraşcu and Dumitraşcu (2016).

Table 1. Demographic Characteristics of Respondents. (Source: Author's Computation, 2024)

Role in the project	Count	Percent
Project Manager/Coordinator	120	28.57
Stakeholder (business analyst, product owner, sponsor, etc.)	82	19.52
Team Member/ Employee	218	51.9
N=	420	100
Years of Experience	Count	Percent
1-3 years	101	24.05
3-5 years	123	29.29
5-10 years	97	23.1
Less than one year	46	10.95
More than ten years	53	12.62
N=	420	100
Project environment	Count	Percent
In-person	247	58.81
Virtual	173	41.19
N=	420	100
Gender	Count	Percent
Female	172	41.65
Male	188	45.52
Prefer not to say	53	12.83
N=	413	100
Communication Tool	Count	Percent
Video conferencing	165	15.85
Phone call or Voice mail	200	19.21
Instant messaging	155	14.89
Email	225	21.61
In-person meetings	223	21.42
Other	73	7.01
N=	420	100

4.2 Communication and Collaboration Tools in Virtual and In-person Project Management

Hypothesis 1:

Table 2 shows the result of a Mann-Whitney U Test on the *communication and Collaboration tools* used in virtual and in-person project environments. The Mann-Whitney U Test revealed a statistically significant difference between the in-person and virtual groups (U=32824, p = 0.0022). This means there is a statistically significant difference in the level of communication between the two environments. Thus, the survey shows in-person teams communicate more often than virtual groups. Based on this test result, we reject the null hypothesis (H_0) and therefore fail to reject the alternative hypothesis (H_1), concluding that there is a significant difference in the frequency of communication and collaboration tool use in the two environments. Communication in in-person environments happens more frequently than in virtual environments, mainly due to the spontaneous and immediate nature of contact that is easier to make in physical environments than formal and often scheduled virtual contacts. The findings suggest that in-person teams communicate more frequently than their virtual counterparts, possibly because of face-to-face contact and the capacity to sort out problems on the spot.

The rank-biserial correlation (r=−0.536) also indicates a largely negative effect, with the in-person group consistently outperforming the virtual group in the analysed metric. This yields a very strong difference between the two groups relative to the ranks of the variable being compared. Since the effect size is negative or below zero, the ranks for the virtual group tend to be lower than the in-person group. Moreover, the large effect size makes this difference statistically significant (z=3.063 p=0.0022) and practically meaningful. The results imply that organisations focusing on communication-heavy projects should use in-person setups to prioritise frequent communication.

Moreover, this finding aligns with previous findings that in-person teams engage in more spontaneous and frequent communication due to physical proximity (Ferrazzi, 2012). Based on the Media Richness Theory by Daft and Lengel (1984), in-person communication is much more dynamic as more interaction is likely in such an environment due to proximity. In more detail, scholars noted that in-person teams benefit from real-time feedback, body language observation, and turn-taking flexibility, which increase team member engagement and understanding (Berry, 2011; Dumitraşcu and Dumitraşcu, 2016; Kukytė and Jasinskas, 2021; Schwartz-Asher and Ahituv, 2019). Virtual teams lack this immediacy and richness of communication due to informal technology tools that may be asynchronous, leading to misinterpretations and reaction delays. Due to this drawback in virtual teams, Kukytė and Jasinskas (2021) recommend that effective communication in virtual teams requires deliberate strategies to prevent misunderstandings and to maintain team awareness.

Concerning the *effectiveness of the communication tools*, the study found no significant difference between in-person and virtual teams (p = 0.3547). This implies that both environments can leverage communication tools regarding the context and the available instruments. *Miscommunication or misunderstanding* also had no significant difference (p = 0.1663) compared to in-person. Finally, based on the Mann-Whitney U Test, the median *ease of collaboration* is not significantly different between in-person and virtual teams (p = 0.774). This indicates that both environments afford similar collaboration, particularly where those tools and strategies aid teams in a project. One might argue that the fact that both environments are almost equal in terms of ease of collaboration might mean that, if equipped with the right tools and handled correctly, project management in both environments can yield similar productivity results regarding team collaboration.

Table 2. Mann-Whitney U Test for Communication and Collaboration Tools

Variable	Obs	Rank Sum	Expected	*z*	Prob > |*z*|
Frequency of communication					
In-person	247	55585.5	51993.5	3.063	0.0022***
Virtual	173	32824.5	36416.5		
Combine	420	88410	88410		
The rank-biserial correlation (r)/Effect Size	-0.53633				
Effectiveness of the communication tools					
In-person	247	53076	51993.5	0.925	0.3547
Virtual	173	35334	36416.5		
Combine	420	88410	88410		
misunderstandings or miscommunications					
In-person	247	53526	51993.5	1.384	0.1663
Virtual	173	34884	36416.5		
Combine	420	88410	88410		
Ease of collaboration					
In-person	247	51656	51993.5	-0.287	0.774
Virtual	173	36754	36416.5		
Combine	420	88410	88410		

*** means significant at 1% (p<0.01) Likert Scale: 1=Lowest, and 5=Highest. Source: (Author's Computation, 2024)

4.3 Level of Team Cohesion and Trust in Virtual Versus In-person Project Management

Hypothesis 2:

The findings in Table 3 compare team cohesion and trust in virtual and in-person project environments. The Mann-Whitney U Test analysis of team building activities found a significant difference between the virtual and in-person project management environments by confirming the Mann-Whitney U Tests at the 5% level with a calculated p-value equal to 0.0237 ($p<0.05$). The result shows that the virtual teams engage in team-building activities more frequently than their counterparts in the in-person teams. Here, we reject the null hypothesis (H_0), support the alternate hypothesis (H_1), and conclude that a significant difference exists in the team-building activities in virtual settings compared to in-person settings.

The rank-biserial correlation ($r=-0.830$) also indicates a negative effect, with the virtual group consistently outperforming the in-person groups. This effect size yields a very strong difference between the two groups relative to the ranks of the variable being compared. Moreover, the large effect size makes this difference statistically significant ($z=-2.262$, $p=0.0237$) with a practical implication. This result implies that organisations operating virtual teams invest in customised team-building strategies and technologies to improve cohesion and trust.

These results contradict some previous findings. For instance, some scholars have highlighted that virtual teams often struggle with communication barriers and feelings of isolation, which can hinder team cohesion and performance (Mwamba & Malik, 2022). Cultural diversity in virtual teams presents another layer of complexity that can be addressed through targeted team-building activities. Some scholars noted that the global nature of virtual teams can lead to misunderstandings and conflicts arising from cultural differences (Dumitraşcu & Dumitraşcu, 2016). However, this finding highlights the commitment of virtual teams, which, despite the absence of regular in-person communication, plan intricate team-building activities such as status meetings, updates, and social networking (Duran & Popescu, 2014; Krawczyk-Bryłka, 2017). This finding argues that digital tools are very useful in improving virtual team building (Wu, 2021).

In addition, the Mann-Whitney U Test revealed no significant difference ($p = 0.142$) for an engagement. In addition, the study found no difference in the knowledge of the team member's strengths and weaknesses between in-person and virtual teams. This implies that both forms of teams are equally effective in determining the team member's strengths and weaknesses. Moreover, the hypothesis stating that there is a difference in perceived professionalism and dedication between in-person and virtual teams has been rejected. This means there is no significant difference in the level of professionalism and commitment to their projects in both the virtual and in-person teams. The previous finding indicates that the physical workplace environment does not dictate professional conduct but is a work culture that reflects the work ethic of every worker and the team (Beheshti, 2020). Comparing the level of trust with virtual teams with that of in-person teams found an insignificant result with a p-value greater than 5% level ($p = 0.697$).

Table 3. Level of Team Cohesion and Trust in Virtual Versus In-person Project Management

Variable	Obs	Rank Sum	Expected	*z*	Prob > |*z*|
Engagement					
In-person	247	53349	51993.5	1.166	0.2437
Virtual	173	35061	36416.5		
Combine	420	88410	88410		
Team-building activities					
In-person	247	49313.5	51993.5	-2.262	0.0237***
Virtual	173	39096.5	36416.5		
Combine	420	88410	88410		
The rank-biserial correlation (r)/Effect Size	0.82989				
Team member's strengths and weaknesses					

In-person	247	52774	51993.5	0.658	0.5103
Virtual	173	35636	36416.5		
Combine	420	88410	88410		
Professionalism and dedication					
In-person	247	52797	51993.5	0.682	0.4954
Virtual	173	35613	36416.5		
Combine	420	88410	88410		
Trust					
In-person	247	51188.5	51993.5	-0.686	0.493
Virtual	173	37221.5	36416.5		
Combine	420	88410	88410		

** means significant at 5% ($p<0.05$). Likert Scale: 1=Lowest, and 5=Highest. Source: (Author's Computation, 2024).

4.4 Flexibility and Work-Life Balance Offered by Virtual and In-person Project Management

Hypothesis 3:

Table 4 shows the Mann-Whitney U Test result for the flexibility and work-life balance between an in-person project management environment and a virtual one. The results of the Mann-Whitney U Test regarding privacy show a statistically significant difference between the virtual and in-person project management environments at a 1% level ($p < 0.002$). This result shows in-person project management environments provide more privacy than virtual environments. Therefore, we reject the null hypothesis (H_0) and fail to reject the alternative hypothesis (H_1), thus implying a significance in the extent of privacy between virtual and in-person project environments. This is because many workers engage in virtual work in their homes or other public domains, where operations tend to infringe on their privacy. In contrast, in-person interactions commonly involve more structured and defined settings in which it is easier to protect privacy. This finding is consistent with other research about virtual work, highlighting difficulties that most virtual workers encounter in setting clear boundaries between private and working lives and organising their obligations (Wu, 2021).

The large effect size ($r=-0.534$) yields a very strong difference between the two groups relative to the ranks of the variable being compared. Moreover, the large effect size makes this difference statistically significant ($z=-2.262$, $p=0.0237$) with a practical implication that remote work should establish a distinct boundary between professional responsibilities and personal time (Wu, 2021). Members of virtual teams engage in communication via computer-mediated channels and may be situated in diverse geographical locations. This circumstance presents challenges in establishing personal privacy, as it becomes difficult for them to disengage from collaborative efforts. On the other hand, teams that operate in person benefit from the availability of dedicated office spaces, which significantly contribute to maintaining privacy in the workplace, in contrast to online environments. The findings align with Bailenson (2021), who contends that virtual workers encounter a deficiency in privacy, leading to challenges such as digital fatigue and the erosion of boundaries.

In addition, the Mann-Whitney U Test analysis found insignificant differences in satisfaction with work flexibility with in-person and virtual teams ($p=0.846$). This interprets that both environments offer equal satisfaction with work flexibility despite virtual environments being more flexible. The findings regarding workload management also indicate no significant differences between the in-person teams, indicating that in-person and virtual teams encounter a comparable challenge regarding workload management. This finding implies that when both environments are equipped with appropriate tools and managerial strategies, they can enable the organisation's workload to be managed at an equivalent level.

Table 4. Mann-Whitney U Test for Flexibility and Work-Life Balance

Variable	Obs	Rank Sum	Expected	*z*	Prob >|*z*|
Satisfaction with work flexibility					
In-person	247	52129	51993.5	0.119	0.9051
Virtual	173	36281	36416.5		
Combine	420	88410	88410		
Privacy					
In-person	247	55637	51993.5	3.078	0.0021***
Virtual	173	32773	36416.5		
Combine	420	88410	88410		
The rank-biserial correlation (r)/Effect Size	-0.53392				
Managing workloads					
In-person	247	52923	51993.5	0.788	0.4304
Virtual	173	35487	36416.5		
Combine	420	88410	88410		

*** means significant at 1% ($p<0.01$). Likert Scale: 1=Lowest, and 5=Highest
Source: (Author's Computation, 2024).

4.5 Productivity, Performance, And Satisfaction Outcomes Between Virtual and In-person Project Management

Hypothesis 4:

Table 5 compares the productivity, performance, and satisfaction outcomes between virtual and in-person project management environments. The hypothesis testing for the productivity, performance, and satisfaction-dependent variables indicates no significant difference between virtual project management and in-person environments. From the results, the overall productivity of in-person teams is not statistically different from virtual teams. Similarly, the use of project management tools and the effectiveness of the processes are statistically the same, which means that both environments utilise their tools equally effectively. Based on these findings, we fail to reject the null hypothesis (H_0) and conclude that the two environments have no difference in productivity, performance, and satisfaction. This conclusion corroborates the agreement with some literature, suggesting that virtual teams can deliver the same results as in-person teams when the plan has the proper means and methods (Wu, 2021; Ferrazzi, 2012).

Table 5. Mann-Whitney U Test for Productivity, Performance, and Satisfaction Outcomes

Variable	Obs	Rank Sum	Expected	*z*	Prob > |*z*|
Rating overall productivity					
In-person	247	52409	51993.5	0.362	0.7175
Virtual	173	36001	36416.5		
Combine	420	88410	88410		
Project management tools and processes effectiveness					
In-person	247	51041.5	51993.5	-0.83	0.4063
Virtual	173	37368.5	36416.5		
Combine	420	88410	88410		
Achieve project milestones on time.					
In-person	247	52923	51993.5	-0.235	0.8145
Virtual	173	35487	36416.5		
Combine	420	88410	88410		
Overall satisfaction with the project environment					
In-person	247	52901.5	51993.5	0.798	0.4249
Virtual	173	35508.5	36416.5		
Combine	420	88410	88410		

The project environment allows me to perform at my best					
In-person	247	52965	51993.5	0.835	0.4036
Virtual	173	35445	36416.5		
Combine	420	88410	88410		
Recommendations to others					
In-person	247	53009	51993.5	0.872	0.383
Virtual	173	35401	36416.5		
Combine	420	88410	88410		

Source: (Author's Computation, 2024). Likert Scale: 1=Lowest, and 5=Highest

5.0 IMPLICATIONS AND CONCLUSIONS

The findings from Hypothesis 1 indicate that in-person teams are more communicative than virtual teams because of the immediacy and spontaneity associated with in-person interactions. The practical implication is that organisations focusing on communication-heavy projects (creative or crisis management) should stick to in-person setups to prioritise frequent communication. A large effect size for communication frequency ($r=-0.536$) confirms the presence of a strong difference in communication. This finding made a theoretical implication by supporting the Media Richness Theory, which emphasises the benefits of richer communication channels, like in-person interactions, in encouraging frequent, effective communication. The inherent limitation of virtual teams is further reflected in the fact that future research should aim to replicate the immediacy and richness of in-person interaction.

Hypothesis 2 found that team-building activities are far more common and effective in virtual project management environments than in-person teams. The effect size ($r=--0.830$) also indicates a large effect, with the virtual group consistently outperforming the in-person group regarding team-building activities. These results can help organisations operating virtual teams invest in customised team-building strategies and technologies to improve cohesion and trust. The large effect size ($r=--0.830$) observed in team building activities in virtual teams further supports the need to rethink theories such as Media Richness Theory in remote working settings.

The results of hypothesis 3 indicate that in-person project management spaces provide far better privacy than virtual spaces. This is a practical challenge for remote workers who typically operate in informal settings where work and personal life munge into each other, potentially eroding one's privacy and possibly causing digital fatigue. This finding implies that organisations should develop strategies to overcome these challenges, such as providing privacy-enhancing tools and training for virtual teams. These findings support existing work (Bailenson, 2021) on how the erosion of privacy in the virtual workplace can create an imbalance in work-life balance.

Hypothesis 4 found no significant difference in productivity, performance, and satisfaction outcomes between virtual and in-person project management environments. This shows that virtual teams can reproduce results from in-person teams with appropriate tools and methods. These results are consistent with existing literature (Wu 2021, Ferrazzi 2012) theoretically, as virtual teams can perform the same as in-person teams, depending on the case. The results reaffirm project management theories regarding the universality of tools and techniques to encompass a balance of virtual and in-person dynamics.

The study concludes that an in-person environment makes it easier for teams to communicate more effectively and have natural team cohesiveness. Virtual teams, on the other hand, have shown remarkable adaptability in achieving these objectives by setting a communication structure and addressing team building. Virtual environments benefit from more flexibility that positively impacts work-life balance despite the downsides, including privacy issues and the distinction between work and personal life. Despite the abovementioned differences, this study reveals no significant differences in productivity, performance, or satisfaction between the two environments. The results of this study indicate that virtual teams are not only a feasible approach to in-person project management but also a promising one that can yield similar outcomes if enriched by appropriate tools and conscious efforts.

The study addresses a relevant issue in project management by comparing virtual and in-person environments, especially as remote work is becoming popular during COVID-19. Media Richness Theory, Tuckman's Stages of

Group Development, and the Job Demands-Resources Model provide a strong theoretical foundation. Using a large sample size (420 participants) ensures the validity of the findings. It provides useful information regarding critical aspects: communication, collaboration, team cohesion, trust, flexibility, privacy, and productivity. Therefore, the study employs Mann-Whitney U Tests and performs an item analysis, reducing the possibility of biases in the results and increasing the validity. It can be argued that despite the study's several advantages, it also has limitations. The absence of sector-based analysis means that the results may not cover various sectors, which may require different approaches in project management. Hence, future studies can include sector-based analysis to determine the effectiveness of the project environments across sectors.

6.0 REFERENCES

Al-Maghraby, R. (2010). Project management frameworks: comparative analysis. *Proceedings of the IPMA 2010 World Congress, Istanbul, Turkey*, 1–3.

Alnsour, B. H. (2014). The Use of Virtual Project Teams for Project Management in Jordanian Corporations. *Eurasian Journal of Business and Management*, *2*(2), 50–60. https://doi.org/10.15604/ejbm.2014.02.02.004

Angel, G. (2021). *Traditional vs Virtual Teams: A Qualitative Study of Perceived Success* (pp. 1–65) [MSc Thesis].

Anvekar, R. D. (2023). *Project Management for Virtual Teams: A Comparative Analysis* [MSc Thesis].

Ashcroft, R., Donnelly, C., Gill, S., Dancey, M., Lam, S., Grill, A. K., & Mehta, K. (2021). The Delivery of Patient Care in Ontario's Family Health Teams during the First Wave of the COVID-19 Pandemic. *Healthcare Policy*, *17*(2), 72–89. https://doi.org/10.12927/hcpol.2021.26656

Bailenson, J. N. (2021). Nonverbal Overload: a Theoretical Argument for the Causes of Zoom Fatigue. *Technology, Mind, and Behavior*, *2*(1). https://doi.org/10.1037/tmb0000030

Bakker, A. B., & Demerouti, E. (2017). Job Demands–resources theory: Taking Stock and Looking Forward. *Journal of Occupational Health Psychology*, *22*(3), 273–285.

Beheshti, N. (2020, August 27). *Is Remote Work Good or Bad for Employee Engagement? Your Leadership Holds the Answer*. Forbes. https://www.forbes.com/sites/nazbeheshti/2020/08/27/is-remote-work-good-or-bad-for-employee-engagement-your-leadership-holds-the-answer/?sh=38a043c676f9

Berry, G. R. (2011). Enhancing Effectiveness on Virtual Teams: Understanding Why Traditional Team Skills Are Insufficient. *Journal of Business Communication*, *48*(2), 186–206. https://doi.org/10.1177/0021943610397270

Browne, T., Jones, S., Cabacungan, A. N., Lang-Lindsey, K., Schmidt, L., Jackson, G., Schatell, D., Damron, K. C., Ephraim, P. L., Hill-Briggs, F., Bolden, S., Swoboda, A., Ruff, S., Danielson, P., Littlewood, D., Singer, D., Stewart, S., Vinson, B., Clynes, D., & Green, J. A. (2022). The Impact of COVID-19 on Patient, Family Member, and Stakeholder Research Engagement: Insights from the PREPARE NOW Study. *Journal of General Internal Medicine*, *37*(Suppl 1), 64–72. https://doi.org/10.1007/s11606-021-07077-w

Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and Mixed Methods Approaches* (5th ed., pp. 55–104). SAGE Publications.

Daft, R., & Lengel, R. (1984). Information Richness. A New Approach to Managerial Behavior and Organization Design. *Research in Organisational Behavior*, *6*, 191–233. https://doi.org/10.21236/ada128980

Donnelly, C., Ashcroft, R., Bobbette, N., Mills, C., Mofina, A., Tran, T., Vader, K., Williams, A., Gill, S., & Miller, J. (2021). Interprofessional primary care during COVID-19: a survey of the provider perspective. *BMC Family Practice*, *22*(1). https://doi.org/10.1186/s12875-020-01366-9

Dumitraşcu, I., & Dumitraşcu, D. D. (2016). How Culture and Motivation Interact in an International Virtual Project Team. *International Conference KNOWLEDGE-BASED ORGANIZATION*, *22*(2), 425–431. https://doi.org/10.1515/kbo-2016-0073

Duran, V., & Popescu, A. (2014). The Challenge of Multicultural Communication in Virtual Teams. *2nd World Conference on Business, Economics and Management*, *109*, 365–369. https://doi.org/10.1016/j.sbspro.2013.12.473

Eurostat. (2024). *Database*. Europa.eu. https://ec.europa.eu/eurostat/data/database

Fay, M. P., & Proschan, M. A. (2010). Wilcoxon-Mann-Whitney or t-test? On assumptions for hypothesis tests and multiple interpretations of decision rules. *Statistics Surveys*, *4*(0), 1–39. https://doi.org/10.1214/09-ss051

Ferrazzi, K. (2012, March 20). *Virtual Teams Can Outperform Traditional Teams*. Harvard Business Review. https://hbr.org/2012/03/how-virtual-teams-can-outperfo

Galas, A., Pilat, A., Leonardi, M., & Tobiasz-Adamczyk, B. (2018). Research Project Evaluation—Learnings from the PATHWAYS Project Experience. *International Journal of Environmental Research and Public Health*, *15*(6), 1071. https://doi.org/10.3390/ijerph15061071

Glikson, E., & Erez, M. (2019). The emergence of a communication climate in global virtual teams. *Journal of World Business*, *55*(6), 101001. https://doi.org/10.1016/j.jwb.2019.101001

Goyal, N., Abdulahad, A. I., Privett, J. A., Verma, A., Foroozesh, M., & Coston, T. S. (2022). Student Grade Evaluation, Survey Feedback, and Lessons Learned during the COVID-19 Pandemic: A Comparative Study of Virtual vs. In-person Offering of a Freshman-Level General Chemistry II Course in Summer at Xavier University of Louisiana. *Education Sciences*, *12*(3), 226. https://doi.org/10.3390/educsci12030226

Gross, G., Ling, R., Richardson, B., & Quan, N. (2022). In-person or Virtual Training?: Comparing the Effectiveness of Community-Based Training. *American Journal of Distance Education*, *37*(1), 1–12. https://doi.org/10.1080/08923647.2022.2029090

Huang, Y., Leng, C., & Zhan, L. (2023, January 1). Application of Virtual Reality Technology in Project Management. *Proceedings of the 2nd International Conference on Information, Control and Automation, ICICA 2022*. https://doi.org/10.4108/eai.2-12-2022.2327952

Jones, E., Frith, L., Gabbay, M., Tahir, N., Hossain, M., Goodall, M., Bristow, K., & Hassan, S. (2022). Remote working in public involvement: findings from a mixed methods study. *Research Involvement and Engagement*, *8*(1). https://doi.org/10.1186/s40900-022-00396-0

Krawczyk-Bryłka, B. (2017). Comparative Study of Traditional and Virtual Teams. *TASK QUARTERLY*, *21*(3), 233–245. https://doi.org/10.17466/tq2017/21.3/o

Kukytė, A., & Jasinskas, E. (2021). The Management of a Virtual Project Team in an International Company: The Perspective of Virtual Project Team Leaders. *Tiltai*, *86*(1), 168–185. Researchgate. https://doi.org/10.15181/tbb.v86i1.2266

Kumar, S., Deshmukh, V., & Adhish, V. S. (2014). Building and Leading Teams. *Indian Journal of Community Medicine*, *39*(4), 208–213. NCBI. https://doi.org/10.4103/0970-0218.143020

Leedy, P. D., & Ormrod, J. E. (2019). *Practical Research: Planning and Design* (12th ed., pp. 154–229). New York Pearson Education, Inc. https://pce-fet.com/common/library/books/51/2590_%5BPaul_D._Leedy,_Jeanne_Ellis_Ormrod%5D_Practical_Res(b-ok.org).pdf

Leon, A. C., Bellack, A. S., & Hersen, M. (1998). Descriptive and Inferential Statistics. In *Comprehensive Clinical Psychology* (pp. 243–285). Pergamon. https://doi.org/10.1016/B00804270(73)002649

Lisbôa, D., Rocha, T. da, Machado, L., Caldeira, C., & De Souza, C. (2021). Working in the COVID-19 pandemic: an observational study. *Journal on Interactive Systems*, *12*(1), 283–293. https://doi.org/10.5753/jis.2021.2178

Mahdjour, S. (2015). Set Up for Growth? — An exploratory analysis of the relationship between growth intention and business models. *International Journal of Innovation Management*, *19*(06), 1540009. https://doi.org/10.1142/s1363919615400095

Mwamba, M., & Ahmad Malik, D. M. (2022). The Role of Digital and Virtual Teams in Project Management: Zambia Centre for Communications. *International Journal of Scientific Research and Management*, *10*(05), 3383–3398. https://doi.org/10.18535/ijsrm/v10i5.em02

Orozco-del-Castillo, M. G., Ortiz-Alemán, C., Urrutia-Fucugauchi, J., Martin, R., Rodriguez-Castellanos, A., & Villaseñor-Rojas, P. E. (2013). A genetic algorithm for filter design to enhance features in seismic images. *Geophysical Prospecting*, *62*(2), 210–222. https://doi.org/10.1111/1365-2478.12026

Rad, R. F., Sadrabad, A. Z., Nouraei, R., Khatony, A., Bashiri, H., Bozorgomid, A., & Rezaeian, S. (2022). Comparative study of virtual and face-to-face training methods on the quality of healthcare services provided by Kermanshah pre-hospital emergency staff (EMS): randomised educational Intervention trial. *BMC Medical Education*, *22*(1). https://doi.org/10.1186/s12909-022-03277-y

Rehman, A. U., Nawaz, A., Ali, M. T., & Abbas, M. (2021). Role of Project Management in Virtual Team's Success. *IKSP Journal of Computer Science and Engineering*, *1*(2), 32–42. https://iksp.org/journals/index.php/ijcse/article/view/83

Santiago, M., & Kang, H. (2022). The Unintended Consequences of VAM: Excluding Latinx Social Studies Topics. *Education and Urban Society*, *55*(8), 001312452211067. https://doi.org/10.1177/00131245221106712

Scott-Young, C. (2013). *A Workplace Comparison of Virtual and Face-to-face Project Teams: Functioning, Practices and Performance* (pp. 1–17). University of South Australia Business School.

Seliverstova, Y. (2022). Differences in Defining the Virtual and Traditional Teams. *Economic and Regional Studies / Studia Ekonomiczne I Regionalne*, *15*(2), 250–265. https://doi.org/10.2478/ers-2022-0017

Shwartz-Asher, D., & Ahituv, N. (2019). Comparison between Face-to-Face Teams and Virtual Teams concerning Compliance with Directives. *Journal of Service Science and Management*, *12*(04), 549–571. https://doi.org/10.4236/jssm.2019.12438

Stefanik-Guizlo, K., Allen, C., Brush, S., Mogk, J., Canada, S., Peck, M., Ramos, K., Volpe, K., & Lozano, P. (2024). Sustaining connections: feasibility and impact of long-term virtual patient engagement. *Research Involvement and Engagement*, *10*(1). https://doi.org/10.1186/s40900-024-00558-2

Tuckman, B. (1965). Developmental sequence in small groups. *Psychological Bulletin*, *63*(6), 384–399. https://doi.org/10.1037/h0022100

Verzuh, E. (2021). *Fast forward to MBA in project management, sixth edition.* (6th ed.). John Wiley & Sons, Inc.

Webster, J., & Wong, W. K. P. (2008). Comparing traditional and virtual group forms: identity, communication and trust in naturally occurring project teams. *The International Journal of Human Resource Management*, *19*(1), 41–62. https://doi.org/10.1080/09585190701763883

Wu, T. (2021). Digital project management: rapid changes define new working environments. *Journal of Business Strategy*, *43*(5). https://doi.org/10.1108/jbs-03-2021-0047

Zak, A. J., Bugada, L. F., Ma, X. Y., & Wen, F. (2021). Virtual versus In-person Presentation as a Project Deliverable Differentially Impacts Student Engaged-Learning Outcomes in a Chemical Engineering Core Course. *Journal of Chemical Education*, *98*(4), 1174–1181. https://doi.org/10.1021/acs.jchemed.0c01033

APPENDICES

Appendix 6: Shapiro-Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
Frequency of communication	420	0.982	5.071	3.872	0.000***
Effectiveness of the communication tools	420	0.972	8.142	5.001	0.000***
misunderstandings or miscommunications	420	0.993	2.022	1.679	0.047**
Ease of collaboration	420	0.982	5.269	3.963	0.000***
Engagement	420	0.973	7.694	4.866	0.000***
Team-building activities	420	0.995	1.44	0.869	0.192
Team member's strengths and weaknesses	420	0.994	1.841	1.455	0.073
Professionalism and dedication	420	0.983	4.99	3.833	0.000***
Trust	420	0.985	4.334	3.497	0.000***
Satisfaction with work flexibility	420	0.959	11.88	5.902	0.000***
Privacy	420	0.996	1.068	0.157	0.437
Managing workloads	420	0.989	3.052	2.661	0.004***
Rating overall productivity	420	0.966	9.668	5.411	0.000***
Project tools and processes' effectiveness	420	0.976	6.846	4.588	0.000***
Achieve project milestones on time	420	0.981	5.415	4.028	0.000***
Overall satisfaction with the project environment	420	0.945	15.714	6.569	0.000***
The environment allows me to perform at my best	420	0.969	8.825	5.193	0.000***
Recommend to others	420	0.967	9.507	5.371	0.000***

*** and ** means significant at 1% ($p<0.01$) and 5% ($p<0.05$), respectively, which is interpreted as not normally distributed, and the insignificant ones are normally distributed. Source: (Author's Computation, 2024)

Appendix 2: Item Analysis for Reliability

Variable	Item and Total Statistics			Cronbach's alpha (α)
Communication and Collaboration	**Count**	**Mean**	**StDev**	
Frequently of communication	420	3.85	1.098	0.7131
Effectiveness of the communication tools	420	3.55	1.187	0.6449
misunderstandings or miscommunications	420	3.093	0.944	0.7656
Ease of collaboration	420	3.483	1.149	0.6255
Total	420	13.976	3.093	**0.7607**
Team Cohesion and Trust				
Engagement	420	3.917	1.029	0.8537
Team-building activities	420	3.507	1.109	0.8051
Team member's strengths and weaknesses	420	3.476	1.161	0.7929
Professionalism and dedication	420	3.621	1.165	0.7935
Trust	420	3.738	1.078	0.8136
Total	420	18.26	4.358	**0.8448**
Flexibility and Work-Life Balance				
Satisfaction with work flexibility	420	4.074	0.899	0.4794
Privacy	420	3.081	1.147	0.7208
Managing workloads	420	3.524	1.121	0.3428
Total	420	10.679	2.282	**0.6259**
Productivity, Performance, and Satisfaction				
Rating overall productivity	420	3.995	0.922	0.8506
project management tools and processes effectiveness	420	3.833	0.948	0.837
Achieve project milestones on time	420	3.252	1.312	0.878
Overall satisfaction with the project environment	420	3.726	1.118	0.817
The project environment allows me to perform at my best	420	3.762	1.088	0.8288
Recommendations to others	420	3.89	1.1	0.8277
Total	420	22.46	5.035	**0.8633**

Source: (Author's Computation, 2024). Likert Scale: 1=Lowest, and 5=Highest