Effectiveness of the forced usage of alternative digital platforms during the COVID-19 pandemic in project communication management

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A R T I C L E   I N F O

A B S T R A C T

The COVID-19 pandemic social distancing forced a shift from Face-to-Face (F2F) to virtual work sessions, applying innovative digital tools. These tools have previously been neglected, mainly due to a conservative approach or prioritization. Consequently, their effectiveness was never tested in depth. While applying these innovative digital tools during the COVID-19 pandemic was clearly preferable to shutting down organizational activity, managers and workers recognized the advantages of these alternatives and tended to apply them in the post-COVID-19 period. However, in this post-pandemic period, which is free from social distancing limitations, a relatively full space of choices was introduced again, which raised the question whether these alternatives should be kept. Therefore, this study examines whether digital communication tools can adequately substitute F2F sessions in project management. We conducted an experiment with participants $(n = 269)$, asking them to perform project-oriented tasks on four platforms: as individuals, in an F2F group meeting, on Zoom, or using WhatsApp. The results indicate that while an F2F meeting is more effective than individual work, Zoom and WhatsApp are not. These findings appear surprising and may contradict the concept of group empowerment. The use of digital sharing platforms did not affect the tasks' performances nor create synergy. This raises the issue of whether these digital means are here to stay, should be discarded, or must be upgraded.

1. Introduction

We are currently living in the information age that began in the mid-20th century [1]. One of the major, if not the most central component of this era, is digital (or data) communications, which enable the transfer of information via computerized, digital means [2]. Digital communication in the context of this research, is also known as Computer-Mediated Communication (CMC), and refers to email, video conference, chat, instant messaging, etc. [3]. This technology is considered revolutionary because of the extent to which it is used [4]. The adoption of digital means is referred to as "digital transformation" [5] Research conducted by the International Data Corporation (IDC) predicts that by 2022, 65 % of the global GDP will be digitized; by 2023, 75 % of organizations will have a comprehensive digital transformation; by 2025, 75 % of business leaders will leverage digital platforms; and that in 2025, 50 % of enterprises will have an organizational culture oriented towards a digital transformation [6]. Digital communication has virtualized actions and objects [7], e.g., the replacement of a tangible paper letter by an email message. Studies of the impact of digital

communication on society have argued, for example, that phone calls and texting have a positive effect on wellbeing, while on-line social networks may have a negative effect [8]. Schneider & Sting [9] examined employees' perception regarding digitalization that is triggered by Industry 4.0 and discussed how to promote digitalization initiatives as part of the employees' environment. According to a PMI (Project Management Institute) survey from 2018, 80 % of organizations considered innovators proficient at recruiting and employing project leaders who possess the skill sets required to propel the organization forward in a digital environment [10].

While digital communication technology has been available for many years, its acceptance and adoption were moderate [11]. However, an unexpected factor impacted this continuous process. The onset of the COVID-19 pandemic, when the first known case was identified in December 2019 in a market in Wuhan, China, spread quickly [12], and became a worldwide pandemic [13]. The proximity between people increases the infection rate [14], and therefore, the effort to control the spread of the virus included lockdowns and other measures to reduce physical proximity between people. However, these actions had a negative impact on the economy [15]. Gibson [16] showed that in order to overcome the difficulties associated with social distancing during the COVID-19 pandemic, many organizations implemented practices that demonstrate inclusion and vitality in communication while working on-line. As a result, the adoption of digital communications accelerated by a quantum leap during the pandemic, and an enormous amount of digital solutions aimed to compensate for the social distancing limitations emerged [17]. According to the McKinsey Institute, "The COVID-19 crisis is causing a need for acceleration beyond what we had seen before, going from three tiers of speed down to two" [18]. The question is, will digital communications continue to replace Face to Face (F2F) communications that require physical proximity?

The COVID-19 pandemic forced many organizations to change their communication behavior and move from F2F communication to remote communication by using platforms such as Zoom or WhatsApp [19]. These web-based, collaborative tools provide audio and video streams for both online and offline sessions, and organizations can use them for working on projects [20]. Remote communication technologies, such as videoconferencing, are not novel. However, adopting these means was accelerated and indeed forced by the COVID-19 pandemic in many fields, e.g., learning in a virtual classroom [21].

Collaboration is a pervasive need that is made possible by sharing information, resources, and responsibilities [22,23]. Collaboration in a working group might encourage the emergence of synergism in the organization, based on pooling the knowledge, information, ideas, skills, and insights of individual employees working in teams or professional working groups. As a result, the end product of teamwork is greater than what could have been achieved if the individuals had worked independently [24]. Means of communication are necessary in order for information to be shared. According to Zhong et al. [25], internet-based technologies offer a variety of web applications for remote communication and knowledge sharing that enable remote interaction with peers and with knowledge repositories. They defined "Collaborative Intelligence" as "a measure of an agent's capability to perceive and comprehend new information, share required resources, information, and responsibilities with other peers to resolve new local and global problems in a dynamic environment" [25, p. 70].

Many organizations use a project-based approach to accomplish business tasks. Managing any aspect of a project involves communication within the project team and with external stakeholders [26]. In a project, communication may be defined as, "sharing of ideas and opinions between professionals who are working on similar or related tasks" [27], and, more specifically, "a collection of [project] processes that help make sure the right messages are sent, received, and understood by the right people" [28]. Many see the Project Management Body of Knowledge (PMBOK) book as a core text of project management terminology [29]. The PMBOK lists ten knowledge areas related to the project management domain. One of them is project communications management, i.e., the processes required to archive a number of essential goals such as efficiency, control, and conveying project information. Zulch [30, p. 1000] showed that communication should be regarded as a cornerstone of project management and is "the function that integrates cost, scope, and time to achieve a quality product". In order to build high-performance teams for either traditional or virtual projects, it is necessary to use effective communication techniques and appropriate leadership styles. Effective project communications are a key element of team effectiveness; it requires preparation and persistence, especially in intercultural project teams that involve people from different races, languages, religions, beliefs, and habits [31–33]. However, communication within a project is challenging, and even using English as a common language, for example, does not guarantee effective communication [34].

The present research investigates the effectiveness of remote communication tools such as Zoom or WhatsApp as an alternative to F2F sessions in project communication management. WhatsApp and Zoom are two popular convenient and flexible digital platforms that enable users to communicate and collaborate remotely at any time from any place, offering features such as group messaging, video conferencing, and file sharing [35,36]. WhatsApp, by its nature, is a messaging platform that allows users to send text, voice, and video messages, as well as conducting voice and video calls. Zoom, on the other hand, is a video conferencing platform that allows users to host and join virtual meetings, webinars, and conferences. We chose these platforms because their similarities make them representative of other digital platforms. The literature often mentions using digital platforms like WhatsApp and Zoom for various purposes, like business communication. It discusses their impact on learning and education and their general potential for cooperation and collaboration. For example, Barnes [37] discusses the use of collaborative tools such as Microsoft Teams and Zoom to adapt working practices during COVID-19; Kodama [38] examines the effect of collaborative systems, such as video conferencing, on organizational knowledge creation, sharing, and innovation; Lal, Dwivedu, & Haag [39] explore social interactions using different technology platforms and the implications of flexible working hours and working from home; Hidayat et al. [40], explore the effectiveness of online Zoom learning in elementary schools.

Although the use of digital platforms such as Zoom has become increasingly popular in project communication management, these platforms also arouse questions. They might involve challenges such as the extent to which the communication among project team members is effective.

The research question of this study is: Are F2F sessions more effective in project management than remote digital communications? Project management communication aims to create interactive working environments and collaborative group work to enhance the performances compared to those of individual workers. To answer the research question, we chose individual work as the baseline. We assigned several similar basic tasks to four working environments: Individual, WhatsApp, Zoom, and F2F session. We measured and analyzed the gaps between task performance in the different environments to evaluate the efficiency of each digital communication means. Note that the present study does not engage with the direct effect of the COVID-19 – if any – on project management communication. The proximity restrictions of the COVID-19 pandemic forced the use of neglected available digital means and raised awareness about the need for digitalization as a long-term result of the pandemic [41]. To further focus the research question, the study investigates the effectiveness of the various communication platforms in a non-forced environment, i.e., when organizations have a full space of choice. The COVID-19 scenario only triggered the potential application of digital platforms as an alternative to F2F sessions and changed the attitude of organizations towards the adoption of these means, even when they do not have to do so. This process is the main motive behind this study. As F2F communication was thought to outperform other means, it was not tested against state-of-the-art tools in their current evolution state. Theoretically, it would suffice to measure productivity before, during, and perhaps after the COVID-19 lockdown period to answer this question. However, during the COVID-19 period, many factors unrelated to project management communication, e.g., disruption of the supply chain [42] affected productivity. Since isolating these factors is impossible, this approach could not address the research question.

The remainder of the paper's structuring proceeds as follows: First, the literature review focuses on communications in project management. Then, the research methodology is described, followed by a description of the design and conduct of the empirical study. Next, the results and their analysis are presented. Finally, we discuss the results, their implications, and the limitations of the study, and make recommendations for future research.

2. Literature review

The Project Management Institute (PMI), the largest professional organization for project managers, defines project management as the use of specific knowledge, skills, tools and techniques to deliver something of value to people [43]. Similarly, The Association for Project Management (APM) defines project management as the use of procedures, techniques, abilities, knowledge, and experience to accomplish particular project goals in accordance with predetermined guidelines [44]. Project management has grown in importance across a variety of industries, such as manufacturing, construction, information services, healthcare and professional services sectors [29]. The PMI defines project-intensive industries as those in which occupational employment has a high level of project-oriented work. Since final deliverables in projects are subjected to a limited amount of time and resources, and since the main goal of every organization in these industries is to maximize value for its stockholders, effective project management is crucial [45].

Communication, both formal and informal, which is the specific interest of this research, and its types are the factors of this research, is one of the foundations of collaboration among humans, and it has become significantly more important in the 21st-century environment. Specifically, communication among team members working on a project might help them meet the challenges involved [46]. Project Communications Management, which is the general subject of this research, is among the processes that are required to ensure timely and appropriate planning, collection, creation, distribution, storage, retrieval, management, control, monitoring, and the ultimate disposition of project information [47,48]. Project managers spend most of their time communicating with team members and other project stakeholders, whether internal (at all levels) or external to the organization. Effective communication creates a bridge between diverse stakeholders who may have varied cultural and organizational backgrounds, different levels of expertise, and diverse perspectives and interests, which influence the execution or outcome of the project [43]. Organizations recognize the importance of employees who work effectively with others and the significance of teamwork. The effective functioning of a team creates a collaborative environment, establishes goals and meets the organization's objectives [49–51]. Communication is a key factor for the success of a project, beyond leadership and management skills, which are critical competencies in the project lifecycle [26,52, 53].

Davidz [54] described collaborative systems thinking as an emergent behavior of teams, resulting from the interactions of team members and utilizing a variety of thinking styles, tools and communication media. It was found that teams have three consistent categories of team membership: (a) strong systems leadership, (b) developing systems professionals (such as the ability to ask questions beyond their professional background), and (c) functional specialists who have concurrent membership in several teams. The communication activities in project management potentially have several dimensions that need to be considered, for example, internal (within the project) and external (customers, vendors, other projects etc.) factors; formal (reports, minutes, briefings) and informal (emails, memos, ad hoc discussions) content; vertical (up and down the organization) and horizontal (with peers) direction of communications; official (newsletters, annual report) and unofficial (off the record) communications; written and oral content; and verbal (voice inflections) and nonverbal (body language) data [43].

Project team members must collaborate and manage complex problems together [55,56]. In order to unleash the knowledge that resides within the project team members, there needs to be an open environment in which the team members feel free to contribute to discussions and raise issues [57,58]. In multidimensional projects, each project team member contributes a different type of expertise. Thus, in order to accomplish the project's goals successfully, the project team members need to communicate and collaborate closely [59]. The communication platform may affect these traits; therefore, its selection is significant.

As the landscape of projects becomes more complex and multidimensional, teamwork in a project must engage with emergent topics [60–62]. The number and complexity of relationships in modern projects forces project teams to deal with issues well beyond their discipline. Marzagão and Carvalho [63] found that a large number of procedures and routines are needed in order to deal with

higher degrees of complexity in projects. On the other hand, Daniel and Daniel [64] claimed that complex projects require less standards and procedures and more flexibility and freedom.

The COVID-19 crisis propelled (it even might be said "forced") businesses to adopt a new generation of communications technologies, which enable project managers and workers worldwide to work in virtual teams and improve the global workplace. To date, most of the literature on the COVID-19-forced shift from F2F sessions to digital sessions (especially using Zoom) concerns education. This undercurrent actually began before the COVID-19 pandemic [65–67], but naturally became more prominent with the pandemic outbreak [68,69]. People tend to decide to adopt new technologies based on a few factors, but the impact of the decision emerges only when the technology is widely diffused [70]. Young workers, for example, seem to be the first to adopt new technologies, particularly in the computerized services domain, probably due to their greater experience in this field [71]. Digital communication technology has been available for a long time. An early version of Zoom (not a Beta) was launched in the beginning of 2013 [72], six years before the first COVID-19 outbreak. However, it was not extensively adopted before the COVID-19 pandemic, at which time it offered an alternative to F2F sessions that were restricted due to social distancing policy [73,74]. In addition to the necessary availability, technology adoption and diffusion are affected by a hierarchy of innovation-related needs [75]. This phenomenon is not specific to the COVID-19 period. A constant gap exists between the available and applied technology [76]. Therefore, the COVID-19 pandemic actually brought to the fore the question of the effectiveness of digital communication in project management.

Haas and Mortensen [77] described the differences between team projects today and in the past. According to their research, the geographical, digital and individual diversity within a project team creates the need to build a strong team structure and provide support for each member of the team project. Duarte-Vidal et al. [78] presented the integration and interoperability of digital tools for monitoring and control projects. They claimed that it is a challenge to promote a culture of implementation and adaptation of these innovative methods, and that it is necessary to evaluate the benefits and limitations of such tools. McGloin et al. [79], examined the impact of COVID-19 and Work-From-Home (WFH) on using Computer-Mediated Communication (CMC). Their findings indicated the importance of personal communication channels and suggested mitigating the effect of CMC-only interactions on supervisory relationships. To optimize CMC channels in the workplace environment, they recommend emphasizing a personal connection and honesty in online channels and utilizing the most appropriate channel for building employees' rapport [80]. Brown et al. [81] tested the effect of conference calls, an old digital platform that could theoretically substitute F2F, on the level of information asymmetry in organizations.

The low level of adoption of digital platforms in project management prior to the COVID-19 period introduced a knowledge gap regarding the effectiveness of F2F sessions compared to the effectiveness of sessions via innovative digital platforms (that were initially not used extensively in project management like Zoom), and also compared to widely used older digital platforms. The current research, therefore, aimed to bridge this gap and expand the existing knowledge about the effectiveness of new innovative digital platforms compared to that of F2F, while focusing on project management communication. As already mentioned, even with the extensive adoption of digital platforms during the COVID-19 pandemic, the research question can't be evaluated based on performances from that time. This inability is primarily due to significant external factors, especially the impact on the global economy and the decline in worldwide GDP growth [82,83]. Consequently, the methodology we selected for the current research (described below) was designed to be conducted in a more controlled environment unaffected by these external factors.

While interest in using digital tools for virtual team communication is growing, research on the effectiveness of these tools in project communication management is scant. Further research is required to investigate the relationship between the impact of virtual team structures on team collaboration and knowledge sharing [84].

3. Methodology

The goal of this research is to measure the efficiency of novel communication platforms in the project management arena, particularly those adopted unexpectedly, and quite suddenly, due to the social distancing regulation imposed during the COVID-19 pandemic. To achieve this goal, we simulated the performance of three realistic project tasks that require some creativity and brain-storming, meaning that team-work could potentially contribute to the level of performance. In the selection and design of these tasks, we chose ones motived by contributing to society, e.g., designing a device to prevent a baby or young child from accidently being left in a locked car, known as the "forgotten baby syndrome" which has exacted a price in human life [85]. When workers in the industry face problems to be solved, they are offered incentives such as financial rewards for success and/or promotion. The social task creates empathy, and therefore partially mimics the tangible incentive. Participants were asked to complete the task in three different environments.

a. As Individuals: Each participant in this environment was asked to perform one of the tasks on their own. This is the control group of the experiment, and established the baseline performance level for each task when no team-work option is available.
b. Using Zoom: Groups of 3–7 participants were asked to perform one of the tasks in a Zoom session, i.e., they could communicate with each other using video, audio, and chat.
c. Using a WhatsApp Simulator: Groups of 3–7 participants were asked to perform one of the tasks using a WhatsApp simulator (which was developed for this study), meaning that they could communicate via instant messaging (video calls were not available).
d. In a F2F session (the control group of the experiment): Groups of 3–7 participants were asked to perform one of the tasks while sitting around a table, i.e., in the traditional way.

Participants in the WhatsApp and Zoom environments were asked about their scheduling preferences and were scheduled using a

shared Google Sheet; participants in the F2F environment were scheduled for a preset session (since they all had to participate simultaneously, coordination was carried out by the researchers), while participants in the Individual environment did the tasks on their own schedule. All participants on all platforms faced the same time limit. Beyond scheduling, researchers were also present during multi-participants sessions but were careful not to interfere. Consent, demographic data, and final answers were collected by using Google Forms. The Zoom session used real Zoom software, and participants could choose to maintain their anonymity. The WhatsApp session was based on a specially-developed simulator because there is no way to remain anonymous on WhatsApp. The WhatsApp simulator was programmed in Python, with the server side using the Django web framework; the database, SQLlite; the HTTP server, Nginx; and the user interface, Bootstrap plus CSS and JS. Google Cloud was used to host the virtual machine, which was implemented on the server side. Fig. 1 is a sample screenshot of the WhatsApp simulator. Naturally, the F2F sessions were not anonymous; however, the answers were anonymized, and any link between identity and results was omitted.

The structure of the three tasks and the three performing environments create a layout of a 3×3 elements matrix. To avoid a learning effect that could bias the result, each participant was allowed to participate in only one session, with no overlapping.

3.1. Project tasks

As noted, we designed three tasks with social value so that empathy would serve as an incentive. Each task was planned to take approximately an hour, and at the end of the group sessions, one representative was asked to upload the results. We chose three different tasks, rather than providing the same task to all, to avoid possible bias if a specific task interacted uniquely with the research questions. The three tasks are.

3.1.1. Task A: design a versatile wheelchair for people with disabilities

3.1.1.1. Task description. People with disabilities that impair their lower limbs (paraplegia) may depend on a wheelchair, but not all facilities and sites are accessible to wheelchair users. A wheelchair combines two major subsystems, one for sitting and the other for propulsion. Your task is to design a wheelchair for a relatively young and active person that will increase accessibility to enable the user to carry out tasks independently.

3.1.1.2. Questions to be answered. A.1. What are the five most important requirements of such a device?
   A.2. List five obstacles a standard wheelchair cannot handle (for example, stairs).
   A.3. Choose two obstacles from the above list (A.2) and offer an engineering solution for this problem.
   A.4. Evaluate the cost/benefit for each solution proposed in A.3.

3.1.2. Task B: design a solution to prevent accidently forgetting a child in a vehicle

3.1.2.1. Task description. Unfortunately, forgetting a child in a vehicle is not an uncommon event. As the weather gets hotter, this is a real danger to the child's life, often leading to a tragic death. Your task is to develop guidelines for an engineering solution to this problem.

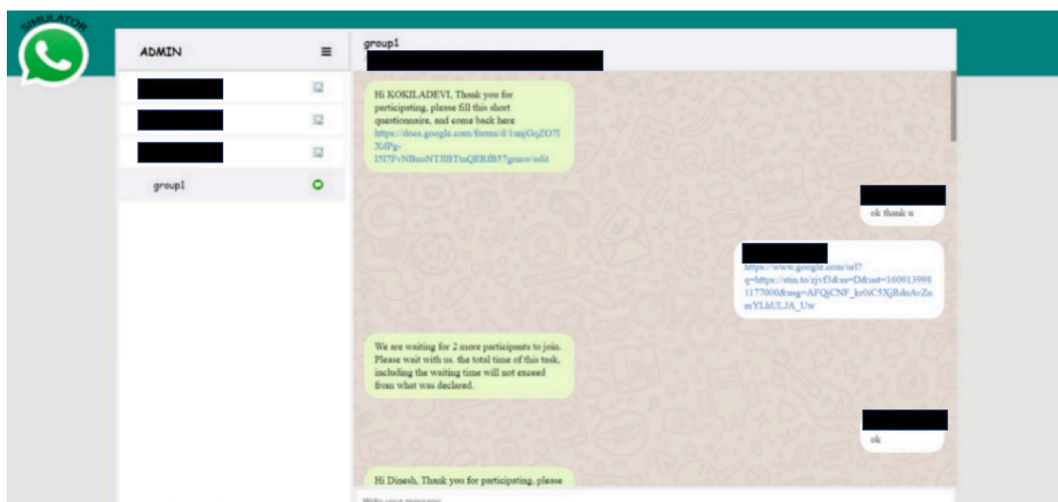*3.1.2.2. Questions to be answered.* B.1. List four reasons why people forget children in a vehicle.

Fig. 1. Screenshot from the WhatsApp simulator. Participants' identifiers were masked to keep their anonymity.

B.2. List four components that should be included in a system to prevent children from being forgotten in a vehicle.

B.3. Choose two components from the above list (B.2) and define the means required to implement them.

B.4. Introduce two means to assure the reliability of the system, and address both types of errors: a) misidentification of a child left in a vehicle and b) a false alarm when a child was not left in the vehicle.

3.1.3. Task C: design a modification to Zoom that will make it easier for senior citizens to use

3.1.3.1. Task description. During the COVID-19 pandemic, social distancing meant that gatherings were forbidden. This limitation is highly relevant to older people, who are a high-risk group. Nevertheless, technology can change reality, and gatherings can be conducted safely using software like Zoom. However, senior citizens often have lower technological literacy and find it challenging to use these platforms. Your task is to develop guidelines for an engineering solution to this problem.

3.1.3.2. Questions to be answered. C.1. List four advantages of Zoom software.

C.2. List four difficulties that can challenge older people when using Zoom.

C.3. Offer three modifications to Zoom software that might make it easier for senior citizens to use it.

C.4. Choose two modifications from the above list (C.3) and describe how they can be implemented.

All three tasks mentioned (Task A, B, and C above) fall under the concept of project management because they involve planning, organizing, and controlling resources to achieve specific goals within a defined timeframe and budget [29]. Whether it is designing a wheelchair, a child safety solution, or a modification to a software platform, project management principles and practices are essential for successful completion. For example, "Task A: Design a versatile wheelchair for people with disabilities," is related to project management by reflecting aspects such as (1) Scope Definition: The project manager will work with stakeholders to clearly define the scope of the wheelchair design, identifying the specific features and functionalities it should have to meet the needs of people with disabilities; (2) Resource Allocation: Project management involves allocating the necessary resources, such as designers, engineers, materials, and manufacturing facilities, to develop the wheelchair; (3) Timeline and Budget Management: A project manager will set realistic timelines and budget constraints to ensure the project remains on track and within the allocated resources; (4) Risk Management: Identifying potential risks and challenges in the wheelchair's design and development process is crucial for project managers. They will plan for contingencies and implement strategies to mitigate these risks.

3.2. Evaluation indexes

To evaluate the level of performance of each task, we defined four evaluation indexes, each was rated on a discrete scale of 1 (lowest level) to 5 (highest level).
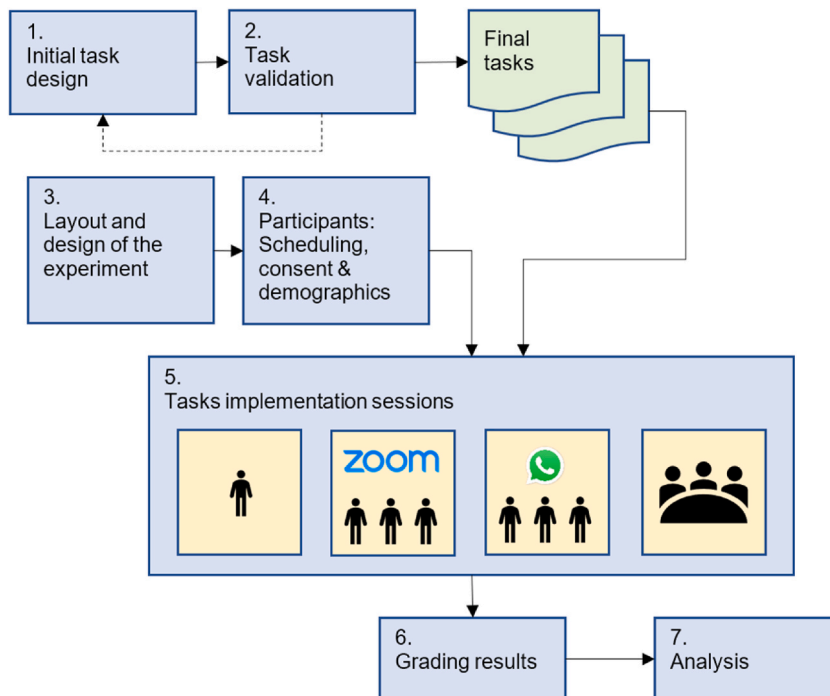

Fig. 2. The experimental phases.

a. Fitness of the answers to the questions: An estimation of how well the answers given by the participants address the questions asked in each task.
b. Applicability of the solution: An estimation of how realistic the solution is; in other words, to what extent might it be applied practically?
c. The level of diversity: How diverse and rich the answers are.
d. Creativity and originality: How creative and original the answers are.

Three specialists in project management undertook the evaluation process. Each of these experts has a deep-rooted history in project management. Among them, two are scholars focused on project management research, while the third is an industry veteran who teaches the subject in academia (when he was in the industry, in addition to his managerial role).

The experts conducted a comprehensive evaluation process of the presented tasks, utilizing four evaluation indexes as described above. Each expert independently reviewed the participants' responses and assigned discrete ratings on a scale of 1–5 for each index. Upon completion, they convened to discuss their findings and compare their evaluations. While each task was carried out differently (according to the platform), the results were presented in a homogeneous template, and the evaluators were blind to the platform of each answer. Thus, it can be assumed that any biases were distributed equally among different elements of the experiment. Since the research question concerns the differences between the various platforms rather than absolute values, the review process should not affect the reliability of the evaluation.

3.3. Experimental stages

The experiment included seven stages as depicted in Fig. 2. Phase #1 was the initial design of the three tasks. These tasks were then validated by a small group of colleagues in phase #2 and refined on the basis of their feedback. The validation phase placed emphasis on the clarity of the tasks. In phases #3 and #4, the participants were recruited, and those who were selected for the non-individual tasks were scheduled according to their preferences. Phase # 5 is the main phase of the experiment, where the participants were introduced to the task, gave their consent to participate, and asked to discuss the task that was allocated to them and to report their answers. Each group nominated a representative who was in charge of reporting the responses on behalf of the whole group (but not necessarily to lead the group). After all answers were collected, they were graded according to the evaluation indexes, and the results were analyzed. The research was approved by the Ariel University ethics committee for non-clinical research in humans (research title: "Estimating of the Contribution of Instant Messaging Communications Means To Carry Out Task in a Project", certification number: AU-ENG-RH-20201031 from OCT. 2020).

In order to establish the internal validity of the experiment, we examined the cause-and-effect relationship between the independent variable, i.e., the communication platform (Individual/Zoom/WhatsApp/F2F) and the dependent variable, i.e., the task's score, and we applied the following steps: a) Three elements were treated randomly: a1) the recruitment of the participants; a2) assigning participants to one of the four platforms (Individual/Zoom/WhatsApp/F2F); and a3) the allocation of the tasks (versatile wheelchair/Prevent children from being forgotten in a vehicle/Modify Zoom for senior citizens). Therefore, each participant had a known and equal probability (compared to the other participants) of being assigned to the various elements, resulting in a close to equal distribution of the confounding variables (e.g., age, gender, and previous experience) within the groups; b) The control group (the F2F platform) was performed in isolation, thus, enabled the examination of the performances of the participants that were not exposed to the manipulation of the different communication platforms. In other words, this approach addressed the question: whether the manipulation itself is responsible for the participants' performance of the tasks?

3.4. Experimental study

The study participants were recruited from engineering students and through Amazon Mechanical Turk (MTurk). The engineering students were 4th-year students towards a B.Sc. degree in management and industrial engineering, and they took a project management course that covered fundamental concepts, applied techniques, and tools aimed to teach project managers how to organize, plan, and control projects. Among the learned topics were project environment, stakeholders, organization and plan, cost, resources, scheduling, risk management, knowledge management, quality management, and communication management. Project management principles and methodology put particular emphasis on planning, controlling, and managing projects to achieve successful completion. This course focused on general concepts rather than on specific projects. None of the experimented tasks were part of the course curriculum. MTurk has been validated as a reliable platform for this type of experiment [86]. However, as explained in section 3.5, it was relatively difficult to conduct this type of experiment on this platform; thus, the engineering students' experiment type yielded most of the results. The experiments were not utterly anonymous since the vast majority (about 98 %) of the participants were engineering students (with their identity known), and the involvement of F2F sessions. The group was therefore relatively homogeneous regarding the participants' task-relevant skills. This trait of the empirical study contributes to reducing the unexplained variance and enables a more accurate measurement of the effect of the independent variables (the platform) on the dependent variable (performance on the tasks). To avoid bias, we separated the participants' **identities and the results, thus allowing** them to perform the experiment tasks without being concerned about their academic evaluation. The participants were randomly assigned to the various environments and tasks, so that the effect of relatively minor differences in their skills on the dependent variable was minimized. Demographic data collected aimed to provide a general picture of the empirical study population rather than correlate the performances, specifically the working environment differences, with the demographic data. To prevent a carryover effect, a

"between-subjects" design was used, assigning each participant to one experiment only. The compensation includes a fee of $8.5 on average for carrying out the "HIT" (the MTurk task); no compensation was paid to the engineering students. Participation was as anonymous as possible; as mentioned above, during the Zoom session this was a choice, and links between F2F participants' identities and results were omitted. Participants were required to be at least 18 years old and provide their consent. Some experiments were not fully completed, mainly when conducted with MTurk. While the participants of the incomplete experiments were paid, the results were disqualified. We conducted a total of 83 valid and successful experiments with $n= 269$ participants, among them 30 experiments with individuals (30 participants) and 53 experiments with groups, each included three, five or seven participants (with 239 participants), as depicted in Table 2. Each experiment lasted around 1 h (including the time required to fill in the answers). The demographic data distributions is described in Table 1. Over 98 % of the participants reported that they use WhatsApp with high frequency, and the others at moderate frequency. When asked if WhatsApp can be used as a means of communication to carry out tasks in a teamwork, 41 % answered "very much," 39 % "very," 16 % "medium level," and 4 % "very little" or "don't know." Regarding the safety of using WhatsApp, 10 % think its "extremely safe," 33 % "very safe," 41 % "moderately safe," and 16 % "not safe" or "not safe at all".

3.5. Experimental layout

The recruitment of the group experiment was challenging because of their interactive nature, which is characterized by two factors: a) The requirement for time synchronization. Unlike common experiments that are conducted on crowd-working platforms, where each participant is isolated from the others and can execute their task at their own time, our case required the group to start the task together and interact throughout; b) The drop-off rate was high, which meant that the entire session was wasted. These issues are documented in the literature [87,88]. Early on, almost all of our sessions failed. We then tried a few approaches and consulted anonymously with some participants to understand their side of the issue. This enabled us to overcome these obstacles by making the following changes: a) Unintuitively, we scheduled the task to be executed immediately on the crowd-sourcing platform (MTurk), and in a future preset time with the student participants. It seems that crowd-workers tend to take tasks that are available when they login to the MTurk platform, rather than schedule them into their diary; b) We studied and chose convenient working hours; c) We provided an anonymous support chat or support on the platform itself. Although this required the presence of an admin, we could use the chat to request participants not to drop off (there was no intervention in any of the professional aspects of the tasks); and finally, d) We adjusted the payment per task to provide some incentive. However, just raising the payment was insufficient. We found that the other means besides raising the payment are more significant, and in the end, we could even lower the payment.

The entire experimental layout is depicted in Table 2. The horizontal groups are divided by the three tasks, while the major column groups show the experimental platforms.

4. Results

After completion of all the experiments, the answers were ranked as explained in section 3.2 above. Each one was graded on a scale between 1 (worst) and 5 (best). The overall grades of the Individual, WhatsApp, Zoom, and F2F environments are depicted in Fig. 3. In this box-plot, the middle line inside each box represents the average value, the bottom and the top of each box represent the first and third quartiles respectively, and the whiskers represent maximum and minimum values. This visualization shows that there were no significant differences between the performances of the individual, WhatsApp, and ZOOM environments, but F2F did seem to yield better performance.

The breakdown of the grades (performances) for each evaluation index and each environment are depicted by the "radar chart" in Fig. 4. The concentric lines of the graph depict the grade, where proximity to the center indicates a lower grade. Again, it is evident that
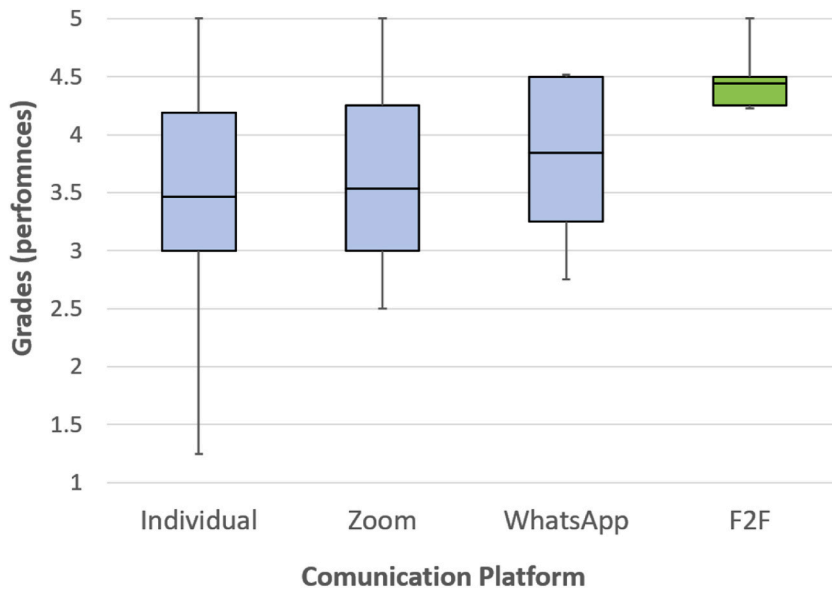
Table 1
The demographic data distributions.

|	Amount	Percentage (%)
Gender		
Female	140	52
Male	129	48
Age		
18-25	135	50
26-30	129	48
31-40	5	2
Education		
High school graduate with diploma	27	10
Associate degree	16	6
Bachelor's degree	183	68
Master's degree	43	16
Employment		
Employee	186	69
Self-employed	3	1
Out of work and looking for work	59	22
Out of work but not currently looking for work	13	5
Scholarship	8	3

Table 2

The experimental layout.

Task	Individual	WhatsApp			ZOOM			F2F		
	Participants (also experiments)	Group size	Experiments	Participants	Group size	Experiments	Participants	Group size	Experiments	Participants
A.	10	3	5	15	3	6	18	3	3	9
Versatile wheelchair		5	5	25	5	4	20	7	1	7
B.	10	3	2	6	3	2	6	3	1	3
Prevent children from being forgotten in a vehicle		5	2	10	5	2	10	5	1	5
		7	2	14	7	2	14	7	1	7
C.	10	3	2	6	3	2	6			
Modify Zoom for senior citizens		5	2	10	5	2	10	5	2	10
		7	2	14	7	2	14			
Toal number of experiments	30		22			22			9	

Fig. 3. The grades (which indicate performance) for all the tasks in each environment. The middle bar indicates the average grade; the vertical extensions represent the standard deviation.

F2F (the blue line) yielded higher performances for all indexes except for creativity and originality, for which WhatsApp received the same grade.

   A one-way, between-subjects ANOVA statistical analysis of the results was conducted for all tasks to compare the effect of the environment on the score for the Individual, WhatsApp, Zoom, and F2F tasks (Table 3). The Environment factor was found to have a significant effect on score [$F(3, 78) = 3.691, p = 0.015$]. The ANOVA analysis, as an omnibus test, indicated that the statistical results were generally significant. We applied the Tukey HSD (honestly significant difference) post hoc test to find the specific significantly
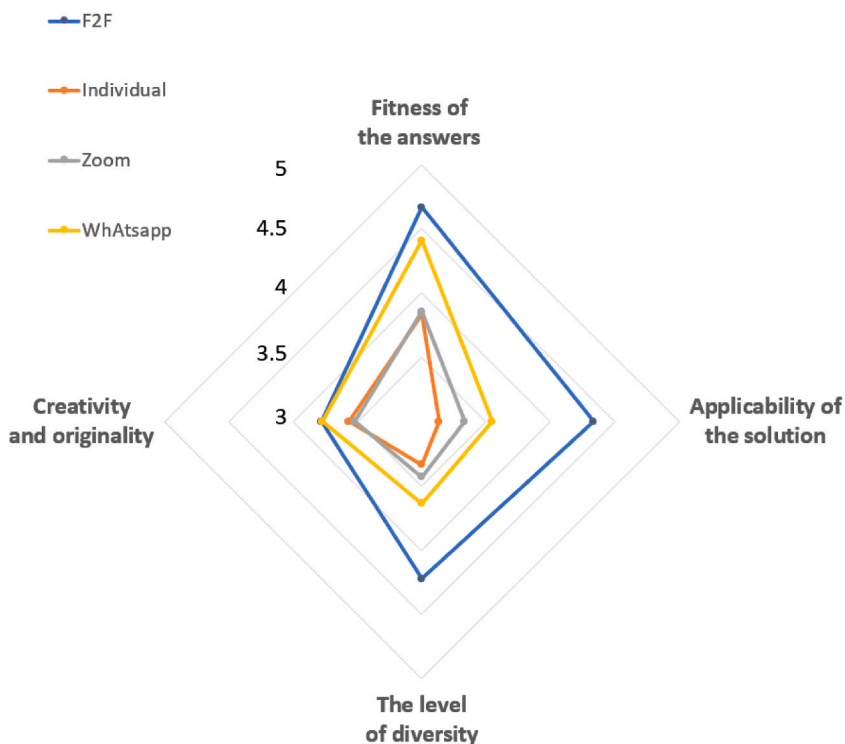
Fig. 4. Grades (performances) of each index for each environment and for all tasks.

Table 3

One-way, between-subjects ANOVA test.

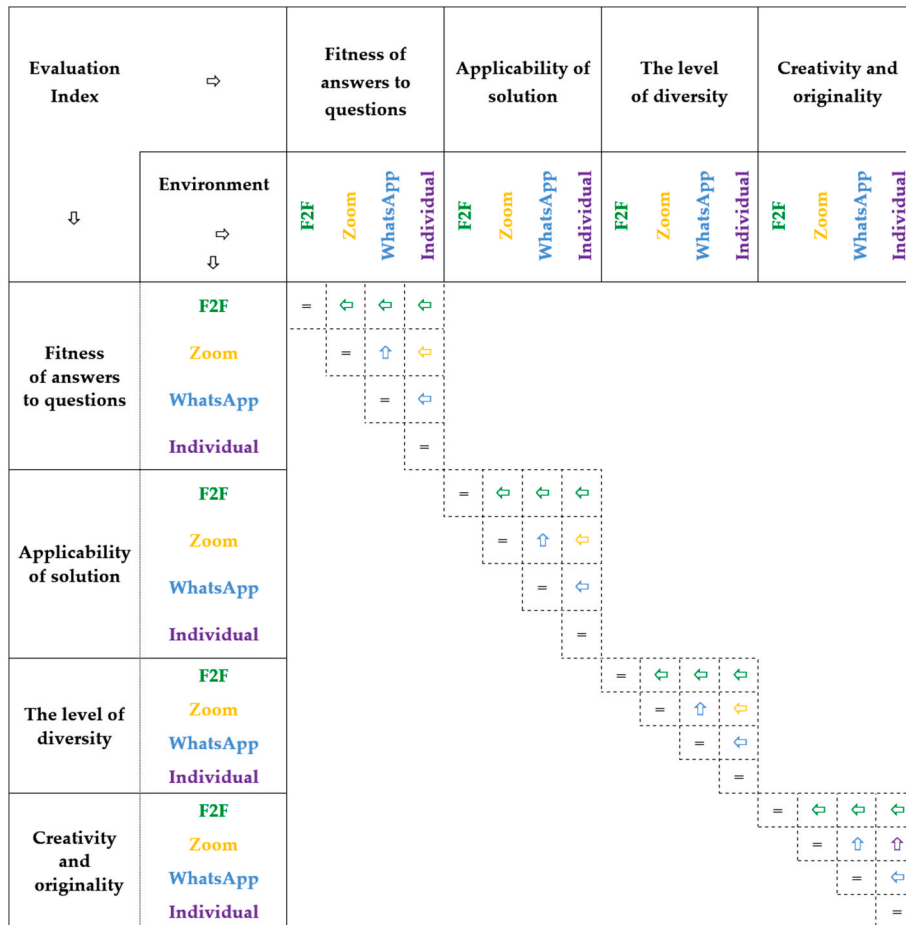| Score	Sum of Squares	d.f.	Mean Square	F	Sig.
Between Groups	**7.620**	**3**	**2.540**	**3.691**	**.015**
Within Groups	**53.668**	**78**	**.688**		
Total	**61.287**	**81**			

Fig. 5. Comparison of the average performance on all tasks in each environment, according to evaluation indices.

different means. By this, we answered the research question of whether digital communication means outperform F2F sessions given their advantage over individual work. The test indicated that the score for F2F ($M = 4.44, SD = 0.32$) was significantly higher than Zoom ($M = 3.54, SD = 0.79$), and also significantly higher than Individual ($M = 3.46, SD = 1.02$).

A comparison of the grades for each environment and index is depicted in Fig. 5. The equal signs on the diagonal mark where each measurement crosses itself (therefore necessarily equal), and the arrows point towards the environment in which higher performance was achieved. For example, when considering the "Applicability of the solution," participants performed better in the WhatsApp environment than in Zoom.

5. Discussion

This study investigated the effectiveness of using modern communication platforms as a substitute for Face to Face (F2F) project management sessions. The use of these platforms was forced by the COVID-19 pandemic and not adopted willingly in most of the organizations. We conducted 83 valid and successful experiments with ($n = 269$) participants. In each experiment, participants were asked to perform one of three pre-designed tasks, in one of four environments: Individuals, Zoom, WhatsApp, and F2F (in the last three environments, there were three, five or seven participants in each group). The performance quality was measured according to four indexes. The baseline of this research is the performance of Individuals because we expected a teamwork to yield better results. However, teamwork requires communication, and therefore the means of communication were the main factor in this research. The

Table 4

Comparison of F2F communication vs. digital platforms.

Aspect	Face-to-Face Communication		Digital Communication Tools/Platforms	
	Advantages	Disadvantages	Advantages	Disadvantages
Rich Nonverbal Cues	Enhances understanding and empathy by allowing for gestures, body language, facial expressions, and tone of voice.		Video conferencing can capture some nonverbal cues, but nuances might be lost.	Digital means like WhatsApp lacks nonverbal clues, which could cause miscommunication or misinterpretation
Immediate Feedback	Real-time conversational explanation and correction are made easier by instant responses.		Offers real-time feedback, especially video calls.	Delays in feedback with instant messaging could make decision-making and problem-solving more difficult.
Personal Connection	Enhances connections and trust by fostering closeness on a human level.		Maintains connections across distances. Video calls can help retain a semblance of personal connection.	May come out as impersonal, which weakens the feeling of connection.
Reduced Miscommunication	Face-to-face contact reduces the likelihood of misunderstandings and provides immediate clarification.		Conversations, especially written ones, can be archived for review.	There's a risk of misinterpretation without vocal and facial cues.
Effective Group Dynamics	Enables efficient group decision-making, dispute resolution, and brainstorming through unplanned conversations.		Features like screen sharing, collaborative editing, and virtual whiteboards can enhance group dynamics.	The experience might differ from in-person interactions.
Privacy Concerns	More private in general, lowering the possibility of unauthorized access or data breaches.			Requires secure platforms and encryption to ensure privacy. There's a potential risk of security threats, especially if not properly secured.
Time and Location Constraints		Physical presence is necessary, which limits flexibility and raises time and travel costs.	Provides flexibility.	
Distractions and Multitasking	Talks that are more concentrated due to less interruptions in a controlled atmosphere.			Distractions, multitasking, and diminished focus are all possible during virtual encounters.
Technology Dependence	No significant technology dependence.			Requires reliable platforms and stable internet connections. Communication might be hampered by technical problems
Geographic Boundaries		Communication with people in far-off places is difficult due to geographic restrictions.	Eliminates geographical restrictions and enables communication with individuals anywhere.	

results show with statistical significance that only F2F sessions were superior to Individual performances, while Zoom and WhatsApp are not. These results indicate that those platforms are not an adequate substitute for working F2F and suggest that there is no significant evidence for remote communications providing an advantage for working groups compared to traditional F2F sessions.

These findings are somehow unexpected and may contradict the concept of group empowerment. The mechanism of the group enables individuals to share views, ideas and attitudes when focusing on issues together, something that cannot be replicated by a standalone individual. As the researcher observed, using remote communication means did launch an open, collaborative discussion but still did not yield any significant advantage over an individual working alone.

One possible explanation for these unexpected results may be rooted in the communication tools themselves or the way they were adopted. The implementation of information and communications technology (ICT) in the workplace had a significant impact on workers' performance and productivity [89,90]. One example, using ICT enables workers to work at locations other than the workplace. Kirk and Belovics [91] use the term "e-workers" to describe people who work this way. The COVID-19 pandemic forced many organizations to move from working at their usual facilities to having people work from home. In fact, this move happened very quickly, propelling people to become e-workers or remote workers often without much planning or preparation. Various remote communication platforms, whether Zoom and WhatsApp (presented in this paper), or other platforms, including smartphone applications, enabled organizations to maintain business continuity during COVID-19 pandemic [92].

Alongside the benefits of remote communications, they also have disadvantages that must be monitored constantly. These known challenges include, for example, the need to ensure that the transition to a completely remote working environment is smooth [93,94]. Newson et al. [95] found that human social flexibility is insufficient to satisfy all social needs in a virtual setting since F2F communication remains the only form of contact associated with higher levels of wellbeing. The increased use of computer-mediated communication did not impact wellbeing positively and has even emerged as a negative factor among young individuals [93, 95–97]. Insights gained in these previous studies agree with the current research finding that to improve the effectiveness of remote

communication tools in a project environment, they should not be introduced and implemented all at once but gradually.

The implementation of distant communication technologies depends on individual comfort levels, monetary resources, and visionary leadership [96,97]. Therefore, in addition to the importance of ICT tools, we must consider the difficulties of individual communications and knowledge sharing within the project team and what can be accompanied by them. As part of the process, it is important to train members of the project team and familiarize them with ICT tools, including their possible flaws. When adopting and using remote communication tools, it is recommended to develop reciprocity and cooperation within the project team, give members prompt feedback, emphasize time-on-task, and respect the diversity among the project members. The year 2020 was a turning point for creating and identifying innovative collaboration beyond F2F interaction [98]. The current research results support this assumption and emphasize the need to find better remote communication platforms because Zoom and WhatsApp platforms were not shown to offer any significant advantage for working in teams. However, the application of digital communication also embeds remote working, which may be a significant factor. Future research may isolate this factor, e.g., when applying digital communication from the workplace to test this issue.

Both F2F and digital communication have their strengths and weaknesses, and the effectiveness of each method depends on the specific context, goals, and preferences of the individuals involved. Table 4 summarizes the advantages and disadvantages of F2F communication compared to digital (remote) communication tools/platforms [89–98].

Virtual reality (VR) technologies are one possible solution for working on collaborative projects [99]. Immersive or cyberspace VR can help to generate realistic images, videos, and sounds of a real project's objects and tasks, and simulate a person's real physical presence in a virtual remote environment. Immersive collaboration analytics has been applied to examine task efficiency and collaborative behavior in a VR environment by Chen et al. [100]. They found that although users were acting in a virtual world, they were sensitive about their proximity to each other and preferred to be aware of the physical actions of their partners. Thus, the results of this research support the need to examine other remote communication tools, such VR, that may better enable networked human groups to efficiently combine their knowledge, wisdom, insights, and intuitions for project tasks. Another alternative that might be considered is Artificial Swarm Intelligence (ASI). This collaborative technology connects groups of human participants in real-time systems ("hive mind") that deliberate and converges on a common mission [101]. Indeed, at Zoom's 2021 annual conference of its clients (Zoomtopia), the company announced a few innovations, including, for example, a virtual board (Zoom Whiteboard) that is designed to enable collaboration between colleagues and brainstorming when remotely working [102]. They are also developing cooperation with Facebook's virtual reality application (Horizon Workroom) that enables conducting sessions using virtual reality technology.

The basic assumption of this research was that effective project communications are crucial for achieving effective teamwork. The current study examined the use of remote communication platforms for engineering projects and showed that the platform itself does not necessarily improve the performance of the teamwork. Consequently, there are other aspects that should be investigated.

While the COVID-19 pandemic is not yet fully behind us, an accelerated independent shift is noticed to working from home or other types of remote work [103]. Wu [104] claims that Digital Project Management (DPM), combining traditional project management with the full adoption of digital tools and technologies, is fast evolving and likely to keep its hold in the foreseeable future. Wu maintains that "digital" may encompass a wide range of digitalization-related aspects, including a focus on projects with digital deliverables such as websites, mobile apps, content creation, and marketing campaigns. Additionally, it involves managing and performing project-related activities using the internet and web technologies for communication, collaboration, and problem-solving, facilitating virtual or remote work. While initially virtual teams and DPM emerged as distinct concepts, they converged through the use of digital tools that enable teams to manage their work remotely. However, DPM means more than just adopting digital tools and working on digital deliverables. Strategically, it involves incorporating digitalization into organizational strategies and shifting the culture toward the full adoption of digital work practices. At the same time, although digital communication is convenient, F2F has certain advantages over digital platforms: The personal connection established through in-person meetings builds trust and reduces the risk of misinterpretation and misunderstanding. Physical cues, such as facial expressions and gestures, and the ability to immediately clarify or correct misunderstandings diminish the risk of disconnection and miscommunication that may occur when relying on digital communication methods alone [105].

In the current study, age and professional experience factors limited the diversity of the participants. While the resultant homogeneity reduced the background noise and unexplained variance, it also ignored these factors. However, in many projects, the team members are not homogeneous, contributing to their specific fields. Therefore, although several studies concluded that demographic data had no significance in the preferences and performances of students in F2F vs. online learning platforms [106], this question calls for further study. Hence, future research should lean on a wider population from various groups, cultures, and organizations, to measure the effectiveness of remote communication tools within a non-homogeneous group. To this end, the demographic data may be included as a dependent variable within the research model rather than just be informative. This research mode promises to reveal the effect of demographic factors on the studied research question. Such research should consider the challenge of subjectiveness given the lack of complete, or at all anonymity, and the design must include a significantly higher number of experiments to balance the numerous factors and the potential interaction between them.

Implementing a holistic approach that considers various aspects could improve the use of remote communication tools to achieve higher performances in a project teamwork. These aspects might include organizational patterns, financial considerations, human factors, psychological factors, culture, etc. A holistic approach, known as systems thinking, has already been implemented in identifying problems and designing solutions for a wide range of disciplines and organizational issues [107–109]. Driven by the findings of this research, applying a systems thinking approach might help to determine the components and interactions among the relevant traits of information and communications technologies in the workplace and suggest an optimal way for their implementation.

Innovations such as digital communication means may have the potential to enhance project communications management, however, as we have found, further steps are required before we can achieve effectiveness.

The current study has significant implications both in terms of theory and practice, particularly in the context of project management and effective communication. In terms of theory, by emphasizing the importance of a holistic approach to understanding communication effectiveness, the study contributes to theoretical frameworks that consider not only the technology itself but also factors such as human psychology, organizational patterns, and cultural contexts. This systems approach encourages a more comprehensive understanding of how these factors interact to influence communication outcomes. In terms of practice, the research provides practical insights for organizations, especially during emergencies like the COVID-19 pandemic. It helps decision-makers understand that while digital platforms offer convenience, there might be a cost in terms of effectiveness, thus urging them to make optimal decisions and maximize the benefits of digital tools.

6. Conclusions

This study examined the effectiveness of modern communication platforms as substitutes for in-person project management sessions, a process that was triggered and driven by the COVID-19 pandemic. While during the pandemic, face-to-face (F2F) sessions were prohibited, the results indicate that only F2F sessions were superior to individual performances, while platforms like Zoom and WhatsApp did not demonstrate the same level of effectiveness. These findings challenge the common assumption that remote communication platforms can replicate the benefits of in-person interaction. Despite the features of open and collaborative discussions, platforms like Zoom and WhatsApp were not shown to offer significant advantages over individual work. These unexpected results could be attributed to the nature of the communication tools themselves or their rapid and unplanned adoption during the pandemic. The study suggests that gradual implementation and training are essential for maximizing the effectiveness of remote communication tools. The results also suggest exploring alternative tools like Virtual Reality (VR) technologies and Artificial Swarm Intelligence (ASI) for collaborative projects. These innovative approaches might better facilitate teamwork and knowledge sharing. Effective project communication is crucial for teamwork success. The effectiveness of remote communication tools may depend on factors beyond the tools themselves, such as individual comfort levels, resources, visionary leadership, and fostering cooperation within teams. A holistic approach highlights various factors such as organizational patterns, financial considerations, human and psychological aspects, and cultural context. The concept of holistic systems may be considered an approach for enhancing the overall effectiveness of remote communication tools.

Overall, the study concludes that while modern communication platforms have their merits, they may not fully replace the advantages of F2F interaction, especially in the context of effective teamwork and project communication management. The research findings have practical implications for organizations during emergencies like the COVID-19 pandemic and also in uneventful times. Organizations should make informed decisions about communication tools, recognizing that while remote platforms offer convenience, they may not replicate the benefits of in-person interaction. Continuous improvement of digital platforms is crucial for striking a balance between these benefits and costs.

The study results show that replacing F2F sessions with digital sessions comes at a cost. Digital communication has its merits, for example, enhancing the availability of participants required for a specific session. Such merits may reduce costs, and in routine times, the organization may consider a tradeoff between the benefits and costs of using digital platforms and apply the most appropriate tool for the mission at hand. In an emergency that imposes the use of digital platforms, such as the COVID-19 pandemic, organizations' awareness of costs is crucial information for decision-makers. Thus, the present research may potentially support organizations in making optimal decisions about their tool of choice and the circumstances in which to adopt it. This research also has implications for future research and theories (as detailed henceforth), particularly by emphasizing the need to improve and upgrade digital tools to mitigate the aforementioned tradeoff.

6.1. Limitations and further research

Despite its theoretical and practical contribution, the present research has several limitations. Due to its relatively small sample size and specific context, it may not be possible to generalize the research findings to every industry. Also, it did not cover the communication practices of the entire spectrum of project types or teams. The rapid pace of change in project management digital communication may also be a research limitation. The effectiveness of project management digital communication platforms may change due to the rapid pace of introducing new tools, which risks making the study's findings quickly outdated. Future studies might use project management phases such as scheduling, resource allocation, or risk management to explore the impact of new digital platforms on project communication management. It is essential to determine the long-term effect of using digital platforms on project communication management aspects such as project success and stakeholder satisfaction. Future studies should aim to gain insights into how organizations could leverage digital platforms to enhance project communication management and improve project outcomes. They could identify best practices and success factors that may advance the development of policies and guidelines for using digital platforms in project management.

The COVID-19 pandemic has significantly impacted project communication management and highlighted the importance of clear and transparent communication in project management. Future studies could examine the impact and long-term effects on aspects such as the social interaction and mental health of team members and the ways to collaborate effectively and proactively when alternatives to F2F interactions are applied. These impacts may take the form of an inherent tradeoff between the benefits and challenges of various digital communication platforms. Future studies could also explore innovative tools like Virtual Reality and Artificial Swarm

Intelligence, as mentioned above. These studies will guide organizations toward adopting future-oriented communication strategies, which could lead to more effective collaboration.

Ethics Declarations

Data availability statement

The data is sensitive because it may indicate the individual's level of performance. This information may sometimes even affect the odds of finding a job. Therefore, the data is not publicly available to maintain participants' privacy.

CRediT authorship contribution statement

Sigal Kordova: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Ron S. Hirschprung:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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