

Remote Agile Tools and Technologies: A Comparative Analysis of Communication Methods

Elvis Chukwuani, Humphrey Borketey, Kiana Kiashemshaki, Emily Massie,
Blessing Nwala, and Mehrdad Yadollahi
*Department of Computer Science
Bowling Green State University, Bowling Green, Ohio

Abstract: Our research is a qualitative study that investigates the impact of various forms of communication on the agile process. In recent years, more companies have changed their communication methods to adapt to remote work. This has raised concerns about the productivity of the remote agile approach. We have used an anonymous survey to investigate six forms of communication used in either in-person or remote agile software development. We have discovered that different agile methods use different forms of communication between clients and co-workers. The most frequently used forms of communication in agile software projects are email, in-person meetings, and teams. Email, in-person meetings, and zoom meet the efficiency, financial, and ease-of-use requirements for agile developers.

Keywords: agile, communication, survey, software development, remote

1. INTRODUCTION

In late 2019, the COVID-19 virus began to spread in China. What was at first a locally isolated contagion began to grow exponentially, causing it to rapidly spread worldwide. The increasing death rate toll led world governments and health organizations to impose strict measures such as lockdowns, travel restrictions, and social distancing. This further led to many companies indefinitely closing their physical spaces of operation, resulting in an economic decline. To curtail the damage, businesses that could adopt a remote work approach did so. This transition was possible due to the widespread availability of high-speed internet and advanced communication collaboration tools.

The remote work model can take the form of 100% remote work from anywhere or a hybrid approach where professionals would work a specified number of days from anywhere and the rest in person. Software development teams transitioned rapidly to the remote model, adjusting existing Agile methodologies to suit their needs [1]. A notable challenge presented by the transition was the reduction in social interactions, although this was augmented by activities such as daily standups and retrospective meetings [1]. Before the pandemic, the Agile methodology was occasionally incorporated into remote software development, but during the pandemic, working remotely was forced onto software developers at a large scale without time to be trained or adapt [3]. Agile methodologies, known for their iterative and collaborative approach, have now become the gold standard in software development.

Understanding how Agile practices adapt to both in-person and remote work settings has become paramount, as this impacts a sizable portion of the workforce [4]. Our research has compared and evaluated different communication methods employed in Agile software development. With the growing prevalence of remote work and the widespread

adoption of Agile methodologies, the choice of communication methods has become a critical determinant of the success of distributed software development projects.

The adoption of advanced conferencing and collaboration tools that mimic the in-person experience has helped in the transition. We have aimed to understand to what extent this has impacted productivity as differences exist between remote and in-person workstyles. To understand how these tools impacted the productivity of software development teams, we have sought to answer these questions:

- RQ1: What communication methods do software developers currently use in Agile projects?
- RQ2: Do software developers select a communication method based on a project's specifications?
- RQ3: How long have agile software developers implemented these communication methods?
- RQ4: Do the current communication tools/methods meet the requirements of software developers?

The rest of this paper has been structured as follows: Section II (Related works) entails similar papers in this field, their work, and the gap our paper fills. Section III (Problem and Approach) discusses the current problem and proposes our solution to this problem. Section IV (Experiment) entails how we collected our data and analyzed the results. Section V (Threats to Validity) concerns the threats and validity of this research. Section IX (Conclusion) section summarizes other sections and ends the paper.

2. RELATED WORK

Toward the end of the pandemic, Ralph et al. [5] conducted research in which questionnaires were sent to multiple remote software developers all over different continents in different sectors, and 2225 valid responses were obtained. His research focused on trying to understand the relationship between the productivity of remote software developers and their well-

being, and environment. Results showed a useful correlation, but his research did not focus on specific factors affecting this productivity. Their research just focused on well-being, but they did not delve into which communication methods were being used which would have led to the decline in productivity.

In 2021 Mill et al. [6] looked at agile remote software developers by conducting thorough research to gain useful insights into this new stimulus. He conducted a qualitative survey amongst the developers and got 2265 responses and a qualitative survey with 608 responses. The research was aimed at finding the remote developer's abilities, to meet set milestones, organizational culture, interaction and cooperation, and communication with stakeholders and other important entities. The results of the study provided evidence that social connection and communication stand out as two of the most noteworthy and prevalent challenges individuals are facing [6]. Their research did not go deep to find out what is causing such problems, it could be resulting from the choice of communication methods used by the organization.

Schmidtner et al. [7] conducted a research study in Germany, the study aimed to gauge the transition to remote software development in software organizations. The research was conducted on supervisors and project management specialists in agile development rather than software developers. The results pointed out that despite this unfavorable change in the agile approach setting, the shift to remote work proceeded without an issue. Practitioners are now using online resources they were hesitant to use before the pandemic, and they are experiencing greater flexibility at the expense of a negligible productivity loss [7]. Their research did not explicitly point out which online tools their organization integrated into and what exactly these practitioners did to ensure their smooth transition to benefit other practitioners in our field.

Ralph et al. and Mell et al. [5, 6], attempted to find a correlation between the productivity of remote software developers and their attributes. The first paper investigated developer's mental well-being and their ability to perform well. The second paper looked at the interaction between developers as a factor affecting their productivity. Neither of these papers tried to find out what exactly their full development environment is like and not just the human attributes. These papers did not delve deeper to figure out what remote technologies these developers used to achieve their daily tasks. These papers paved the way for further research because they indeed found out there has been a decline in productivity since the remote transition, but they never researched how to improve their existing remote environment.

The value of our research lies in its potential to inform decision-making and drive continuous improvement in remote software development. The study's findings will empower software development teams and organizations, offering insights into how the choice of communication

method helps agile software developers mitigate remote work and in-person challenges, enhancing productivity, communication, and project outcomes. This research not only addresses the current demand for remote work solutions but also provides a pathway for the software development industry to evolve and optimize its practices, delivering better outcomes in the dynamic world of remote software development.

3. EXPERIMENT DESIGN

There has been a notable gap in understanding which communication methods best suit development tasks, leading to a lack of synchronization among team members, increased communication gaps, and inefficiencies in workflow management. The primary aim of this research is to collect and analyze data related to communication methods to inform software developers on how communication methods compare in an agile workspace. We have achieved this aim through an anonymous survey that we have used to collect and analyze answers to recent communication methods based on our research questions.

In this survey, we have found what communication methods are currently being used in agile processes by comparing in-person communication with five common forms of remote communication: email, zoom, teams, discord/slack, and phone calls. Additionally, we have created an option that the responder can self-define to account for other forms of communication not listed. We have collected data on project specifics by identifying the agile method used and the frequency and ease of use for each mode of communication relevant to the responder. Additionally, we have designed the survey to differentiate between the frequency and ease of use for co-worker and client communication to understand how these communication methods are being used in agile processes.

To answer how long forms of communication have been implemented, we have inquired about the frequency of use for each communication form and the length of time working in both remote and in-person settings. To determine if current communication tools meet the requirements of software developers, our survey has been developed with Likert and grouping questions to measure the efficiency of each form of communication.

We have collected data through an anonymous survey built using Qualtrics. This survey has a total of twenty-one questions built of a mix of matrix questions, Likert scale, and multiple and single choice questions. The survey consists of three sections: demographics, environment, and communication.

- **Demographics:** we have collected demographic data including gender, age, and years of working in software development. This is to help understand if the length of experience and respondents' age or gender

directly correlate to their choice of communication methods. This section has three single-choice questions.

- **Environment:** to understand how remote tools affect productivity, we have considered the work environments of the respondents. We have developed questions related to their industry, and their work style - whether remote, in- person, or hybrid. We have also posed questions about the duration for which they have worked in the said work style or if they transitioned from one or the other. This section has seven multiple and single-choice questions.
- **Communication:** in this part of our survey, we have seemed to understand what communication methods are used by our respondents. To measure the effectiveness of these tools, we have questions about what specific tool or combination of tools are in use, whether these tools are paid or free, the length of training, if any, before using these tools, and how these tools have affected their work overall. The communication forms that we have focused on throughout the survey are e-mail, phone, zoom, teams, discord/slack, and in-person meetings. In addition, our survey has allowed respondents to add another communication option in the form of a short response. This section contained eleven matrices, ranking, and grouping questions.

To achieve accessibility, we have minimized the use of short and long answer responses and kept the format of the questions and answers as clear, organized, and understandable as possible. Additionally, we have used display logic in our survey to help narrow down relevant options for respondents as they progressed through the survey.

To ensure a standardized survey, we have used The Expert-Review score system built-in to Qualtrics. A digital review system that verified the methodology and quality of questions was objective. This score system has rated surveys as poor, fair, and good. Our finalized survey has been rated as fair with the only severe issues being the inaccessibility of mobile devices and use of matrix questions. Additionally, we have created a trap question to identify valid responses.

We have ensured consent from every respondent through a simple verification question at the beginning of our survey that verified that each respondent:

- Was 18+ years of age?
- Acknowledge the collection and use of their response.
- Knew their responses were anonymous.
- Understood the purpose of our research.

Additionally, each respondent could only take the survey once.

Below is a table of all survey questions except demographic questions that have been used in our survey:

TABLE I. SURVEY QUESTIONS

Question Number	Survey Question	Response Options
3	How long have you been working in Software Development?	<ul style="list-style-type: none"> ▪ Less than a Year ▪ 1 - 2 Years ▪ 2 - 3 Years ▪ 3 - 5 Years ▪ 5 + Years
4	What type of software applications does your organization primarily develop?	<ul style="list-style-type: none"> ▪ Medical ▪ Social Media ▪ Security ▪ Finance ▪ Communication ▪ Transportation ▪ Other
5	How long have you work remote?	<ul style="list-style-type: none"> ▪ Never ▪ 6 months or less ▪ Over 6 months up to 1 year ▪ Over 1 year up to 3 years ▪ Over 3 years up to 5 years ▪ Over 5 years
6	How long have you worked in-person?	<ul style="list-style-type: none"> ▪ Never ▪ 6 months or less ▪ Over 6 months, up to 1 year ▪ Over 1 year, up to 3 years ▪ Over 3 years, up to 5 years ▪ Over 5 years
7	Does your organization implement any type of Agile methodologies listed below?	<ul style="list-style-type: none"> ▪ Scrum ▪ Kanban ▪ Lean ▪ XP ▪ Other ▪ N/A

8	Did your company transition from in-person to remote work?	<ul style="list-style-type: none"> ▪ No ▪ Yes 			<ul style="list-style-type: none"> ▪ Email ▪ Phone Call ▪ Zoom ▪ Teams ▪ Discord/Slack ▪ In-Person Meetings ▪ Other
9	Did your company transition from remote work to in-person?	<ul style="list-style-type: none"> ▪ No ▪ Yes 	14	Do you feel that the training you received was helpful to your understanding of the usage of the communication tool?	COLUMN S <ul style="list-style-type: none"> ▪ No ▪ Ye s ROWS <ul style="list-style-type: none"> ▪ Email ▪ Phone Call ▪ Zoom ▪ Teams ▪ Discord/Slack ▪ In-Person Meetings ▪ Other
10	Have you observed an increase or decrease in communication since this transition?	<ul style="list-style-type: none"> ▪ Increase ▪ Neither ▪ Decrease 			COLUMN S <ul style="list-style-type: none"> ▪ Free ▪ Under 10\$ ▪ \$11-50 ▪ \$51-100 ▪ \$100+ ROWS <ul style="list-style-type: none"> ▪ Email ▪ Phone Call ▪ Zoom ▪ Teams
11	What modes of communication do you use when discussing project details with co-workers, and clients?	COLUMN S <ul style="list-style-type: none"> ▪ Co-Workers ▪ Clients ROWS <ul style="list-style-type: none"> ▪ Email ▪ Phone Call ▪ Zoom ▪ Teams 	15	How much does it cost annually to use these communication tool?	COLUMN S <ul style="list-style-type: none"> ▪ Free ▪ Under 10\$ ▪ \$11-50 ▪ \$51-100 ▪ \$100+ ROWS <ul style="list-style-type: none"> ▪ Email ▪ Phone Call ▪ Zoom ▪ Teams
		<ul style="list-style-type: none"> ▪ Discord/Slack ▪ In-Person Meetings ▪ Other 			<ul style="list-style-type: none"> ▪ Discord/Slack ▪ In-Person Meetings ▪ Other
12	Does your company pay extra for special Benefits or Features for any of the following communication tools? (Do Not Select Pigeon Mail)	<ul style="list-style-type: none"> ▪ Email ▪ Phone Call ▪ Zoom ▪ Teams ▪ Discord/Slack (5) ▪ Pidgeon Mail (6) ▪ In-Person Meetings (7) ▪ Other (8) ▪ N/A 	16	How often do you use these modes of communication to discuss project details with co-workers?	COLUMN S <ul style="list-style-type: none"> ▪ Never ▪ Rarely ▪ Sometimes ▪ Frequently ROWS <ul style="list-style-type: none"> ▪ Email ▪ Phone Call ▪ Zoom ▪ Teams ▪ Discord/Slack ▪ In-Person Meetings ▪ Other
13	How much training did you receive on how to use these tools?	COLUMN S <ul style="list-style-type: none"> ▪ None ▪ 1-3 Days ▪ 1-2 Weeks ▪ 2-3 Weeks ▪ 1-2 Months ▪ 3+ Months ROWS			

17	How often do you use these modes of communication to discuss project details with clients?	COLUMN S <ul style="list-style-type: none"> ▪ Never ▪ Rarely ▪ Sometimes ▪ Frequently ROWS <ul style="list-style-type: none"> ▪ Email ▪ Phone Call ▪ Zoom ▪ Teams ▪ Discord/Slack ▪ In-Person Meetings ▪ Other 	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td data-bbox="852 192 986 412"></td> <td data-bbox="986 192 1249 412"></td> <td data-bbox="1249 192 1551 412"> <ul style="list-style-type: none"> ▪ Discord/Slack ▪ In-Person Meetings ▪ Other </td> </tr> <tr> <td data-bbox="852 412 986 645">21</td> <td data-bbox="986 412 1249 645">Rank the following modes of communication based on the frequency of use in a single year, where 1 is the mode, most often used?</td> <td data-bbox="1249 412 1551 645"> <ul style="list-style-type: none"> [1] Email [2] Phone Call [3] Zoom [4] Teams [5] Discord/Slack [6] In-Person Meetings [7] Other </td> </tr> </table>			<ul style="list-style-type: none"> ▪ Discord/Slack ▪ In-Person Meetings ▪ Other 	21	Rank the following modes of communication based on the frequency of use in a single year, where 1 is the mode, most often used?	<ul style="list-style-type: none"> [1] Email [2] Phone Call [3] Zoom [4] Teams [5] Discord/Slack [6] In-Person Meetings [7] Other
		<ul style="list-style-type: none"> ▪ Discord/Slack ▪ In-Person Meetings ▪ Other 							
21	Rank the following modes of communication based on the frequency of use in a single year, where 1 is the mode, most often used?	<ul style="list-style-type: none"> [1] Email [2] Phone Call [3] Zoom [4] Teams [5] Discord/Slack [6] In-Person Meetings [7] Other 							
18	In your experience, how difficult is it to use these communication methods for discussing project details with co-workers?	COLUMN S <ul style="list-style-type: none"> ▪ Difficult ▪ Neither ▪ Easy ▪ N/A ROWS <ul style="list-style-type: none"> ▪ Email ▪ Phone Call ▪ Zoom ▪ Teams ▪ Discord/Slack ▪ In-Person Meetings ▪ Other 	<p>Because we have aimed to understand how communication methods are used in an agile environment, our target population consists of people working in software development who use an agile approach to build products. Lastly, we have collected and analyzed the results of our survey based on the responses we received.</p> <p>We have performed statistical and qualitative analysis (thematic) based on the responses to the survey and have identified patterns related to the demographics, working environment, and communication methods.</p> <p>4. RESULTS AND DISCUSSION</p> <p>We have distributed the survey through a link via email and canvas to our target population of software developers. In total, we have had 12 valid responses to our survey, where we have identified valid responders as those who did not select pigeon mail as a method of communication in question 12.</p>						
19	In your experience, how difficult is it to use these communication methods for discussing project details with clients?	COLUMN S <ul style="list-style-type: none"> ▪ Difficult ▪ Neither ▪ Easy ▪ N/A ROWS <ul style="list-style-type: none"> ▪ Email 	<p>4.1 Demographic Data Analysis and Results</p> <p>For gender, seven responders identified as female, and the rest identified as male. For age, six of our responders were between the ages of 18 and 24, three were between the ages of 25 and 30, and the last two were over 40 years old. Six of our responders had between 1-2 years of experience in software development, four had less than a year of experience and 1 had between 3 to 5 years of experience.</p>						
		<ul style="list-style-type: none"> ▪ Phone Call ▪ Zoom ▪ Teams ▪ Discord/Slack ▪ In-Person Meetings ▪ Other 	<p>Based on these demographics, we have found that four or more women have used email, phone calls, teams, and in-person meetings to communicate with co-workers, and have used email and zoom with clients. We have found in these communication forms that Zoom and in-person meetings were considered the most effective by women. Three men have used email and in-person meetings for both client and co-worker communication. We have found that in addition to email and in- person meetings, men also considered Zoom to be effective. For responders over the age of 29, we have found they do not use Discord/Slack.</p>						
20	Drag and drop the following modes of communication into the following groups based on the effectiveness to project communication?	GROUPS <ul style="list-style-type: none"> ▪ Not Effective ▪ Slightly Effective ▪ Slightly Effective ▪ Very Effective ▪ N/A OPTIONS <ul style="list-style-type: none"> ▪ Email ▪ Phone Call ▪ Zoom ▪ Teams 	<p>Across all valid responders, we have found that email, phone calls, teams, and in-person meetings were often picked for co-worker communication “Fig. 1”. We have found that email and in-person meetings were often picked for client communication.</p>						

Q11 What modes of Communication do you use when discussing project Details with Co-Worker/Clients?
 10 Responses



Fig. 1. Forms of communication used by respondents.

We have answered our third research question by comparing the forms of communication used by software developers who have had over 1 year of experience “Fig 2” with those with less than a year of experience “Fig 3.”

Q11 What modes of Communication do you use when discussing project Details with Co-Worker/Clients? (Under 1 Year of Experience)
 3 Responses



Fig. 3. Forms of communication used by respondents with under 1 year of software development experience.

We have found that responders with over a year of software development experience use more forms of communication in addition to email, and in-person meetings. Responders who have had over a year of experience also have used and considered teams an efficient form of communication.

4.2 Working Environment

In the working environment section of our survey, we have found that the communication forms differ based on the types of agile methods used with projects. We have found that XP and Scrum were the most popular agile methods chosen. When compared, we have found that XP and Scrum were similar but XP “Fig. 4”, used teams to communicate with co-

workers more than Scrum.
 Q11 What modes of Communication do you use when discussing project Details with Co-Worker/Clients? (XP)
 3 Responses



Fig. 4. Forms of communication used in XP.

We have compared remote, and in-person work environments. We have discovered that for strictly remote work “Fig. 5.” communication with both clients and co-workers has been conducted through teams. While in-person work has used a

larger variety of communication forms “Fig. 6.”

Q11 What modes of Communication do you use when discussing project Details with Co-Worker/Clients? (Remote Only)
 3 Responses



Fig. 5. Forms of communication used in remote work.

Q11 What modes of Communication do you use when discussing project Details with Co-Worker/Clients? (In-person work over 6 months)
 5 Responses



Fig. 6. Forms of communication used in in-person work.

This has answered our second research question of whether communication methods change to suit project specifications. Based on the working environment, we have determined that the types of communications that are used in agile projects are different based on the agile method used or based on remote or in-person environments.

4.3 Communication

We have confirmed that no other forms of communication outside of the six we have listed were considered for agile projects, answering our first research question. The most frequently used communication form for communicating with co-workers has been email, in-person meetings, and teams. The most frequent communication with clients has been via email and zoom.

We have found that email was considered the easiest form of communication to use between both clients and co-workers. Additionally, the most effective forms of communication have been in-person meetings, email, and zoom. Largely, all forms of communication have been cost-effective, costing under ten dollars. This concludes our last research question, where we have found that the forms of communication that best meet the requirements of software developers working with Agile are in-person meetings, teams, zoom, and email for both co-worker and client communication.

5. THREATS TO VALIDITY

We consider the threats to validity based on two categories: external and internal.

5.1 External Validity

A foreseeable threat to external validity is the background of our respondents. Although we try to determine the different agile methodologies used by our respondents,

we're unable to determine if respondents previously delivered software projects using methodologies other than agile. There is a likelihood that some communication methods that were best suited to a methodology other than agile were continuously used although not designed for communication in an agile setting. This could have affected the interpretation of our results.

Additionally, low responsiveness to our survey is an external threat, as people who did not respond to our survey might have shared relevant information that could alter the results received. We sent our survey to 32 contacts of which only 14 responded, with 2 responses being invalid hence 12 valid responses. This accounts for a response rate of approximately 44%.

5.2 Internal Validity

One major internal validity is that the pre-determined communication methods would not be representative of the communication styles for the population we have been researching. To mitigate this, we have created an option that allowed responders to mention other communication methods.

6. CONCLUSION & FUTURE WORK

To conclude, this study has addressed the question of what communication method is best for Agile software development regardless of the agile methodology used. The communication methods captured within our study included email, phone calls, Zoom, Discord/Slack, Teams, and in-person meetings. Our results show that email, phone calls, and in-person meetings are the preferred communication choices between clients and co-workers when collaborating on agile projects. For agile projects that employ the XP approach, the results show that Teams is frequently used.

Additionally, for projects that are delivered remotely, the communication methods are limited to remote tools hence Teams is preferred. Furthermore, the results reveal developers with over a year of experience are using a combination of communication methods. Respondents over the age of 29 prefer to use methods other than Discord/Slack. This does not imply a correlation between age and the preferred choice of tools as our survey was not designed to study such trends.

The future work aims to expand the study to better understand the effectiveness of communication tools in Agile methods. It includes plans for a larger study with diverse variables like team size, culture and incorporating qualitative data through interviews. Furthermore, we also aim to develop a machine learning models that recommends suitable communication tools for various software development project conditions, specifically enhancing collaboration in Agile teams.

7. REFERENCES

- [1] M. Neumann et al., "What Remains from Covid-19? Agile Software Development in Hybrid Work Organization: A Single Case Study," 2022 10th International Conference in Software Engineering Research and Innovation (CONISOFT), Ciudad Modelo, San Jose Chiapa, Mexico, 2022, pp. 29-38, doi: 10.1109/CONISOFT55708.2022.00015.
- [2] R. Reunamaki and C. F. Fey, "Remote agile: Problems, solutions, and pitfalls to avoid," *Bus Horiz*, vol. 66, no. 4, pp. 505–516, Jul. 2023, doi: 10.1016/J.BUSHOR.2022.10.003.
- [3] M. C. Annosi, N. Foss, and A. Martini, "When Agile Harms Learning and Innovation: (and What Can Be Done About It)," *Calif Manage Rev*, vol. 63, no. 1, pp. 61–80, Nov. 2020, doi: 10.1177/0008125620948265.
- [4] D. K. Rigby, J. Sutherland, and A. Noble, "Agile at Scale How to go from a few teams to hundreds".
- [5] P. Ralph et al., "Pandemic programming: How COVID-19 affects software developers and how their organizations can help," *Empir Softw Eng*, vol. 25, no. 6, pp. 4927–4961, Nov. 2020, doi: 10.1007/S10664020-09875-Y/TABLES/7.
- [6] C. Miller, P. Rodeghero, M. A. Storey, D. Ford, and T. Zimmermann, "'How was your weekend?' Software development teams working from home during COVID-19," *Proceedings - International Conference on Software Engineering*, pp. 624–636, May 2021, doi: 10.1109/ICSE43902.2021.00064.
- [7] M. Schmidtner, C. Doering, and H. Timinger, "Agile Working During COVID-19 Pandemic," *IEEE Engineering Management Review*, vol. 49, no. 2, pp. 18–32, Apr. 2021, doi: 10.1109/EMR.2021.3069940