Effective Communication in Globally Distributed Scrum: A Model and Practical Guidance

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Abstract

A trend in information systems development is for globally distributed teams to use agile methods and frameworks such as Scrum. In globally distributed (GD) software development, a known challenge is effective team communication. Researchers, however, cannot evaluate effective communication in GD teams using Scrum unless they know what effective communication means in that context. This qualitative study contributes a theoretical model of effective communication in GD Scrum teams and practical guidance for practitioners. Ten industry professionals working in GD Scrum teams were interviewed to capture their understanding of effective communication. Qualitative content analysis was used to analyse the interviews and form a basis for the model and the practical guidance. This novel model consists of communication transparency, communication quality, and communication discipline, which together lead to the alignment of team understanding (i.e., a team-level shared mental model). This theoretical model lays the ground for future research into the effect of Scrum practices on communication in GD contexts, and the effect of communication on team and project success. For practitioners, this study contributes 11 practical actions that professionals recommend for improving and sustaining effective communication.

Keywords: agile software development, communication transparency, communication quality, communication discipline, global software development, shared mental model, team mental model.

1   Introduction

Information systems development often involves globally distributed (GD) software development (Drechsler & Breth, 2019; Herbsleb & Mockus, 2003) together with the use of agile methodologies (also called methods) and frameworks (Baham & Hirschheim, 2022; Maruping & Matook, 2020). Scrum is the most commonly adopted agile framework (digital.ai, 2022; Stavru, 2014) and using Scrum in GD software development is increasingly reported (Hidayati et al., 2020; Marinho et al., 2021).

Effective communication is one of the foundations of success in systems and software development (Defranco & Laplante, 2017). Agile frameworks such as Scrum require intensive communication (Alzoubi et al., 2016; Hummel et al., 2013). Traditionally, Scrum uses face-to-face interactions in small co-located teams with direct face-to-face communication among team members and customers to facilitate successful development work (Strode et al., 2022). In GD agile teams, many of them using Scrum or its variants, face-to-face communication is limited and is known to be problematic (Alzoubi et al., 2016; Bundhun & Sungkur, 2021). Systematic literature reviews (SLR) of agile research identify a lack of research on the social and behavioural aspects of agile development, particularly communication (Diegmann et al., 2018;

Hoda et al., 2017). An SLR by Alzoubi et al. (2016) of geographically distributed agile development, identified many communication challenges and mitigation practices but report a significant lack of knowledge about how efficient and effective communication is achieved in practice in agile contexts. They also highlighted the lack of theory development to explain communication in geographically distributed agile development.

To understand how Scrum improves communication in GD teams, researchers must first understand what 'effective communication' means in this context. Improving the understanding of effective communication in GD Scrum teams by developing theoretical models of this phenomenon should help researchers better understand effective communication in GD Scrum and help identify its antecedents and consequences. That is, they can use this knowledge to identify Scrum practices, combinations of practices, tools that support effective communication, and the precise effect of communication on outcomes such as team and project success.

Effective communication is well understood in small teams and virtual teams (Marlow et al., 2018). Communication practices in agile contexts have been explored (Hummel et al., 2013) and communication in co-located Scrum is understood to be a significant factor in supporting effective teamwork (Strode et al., 2022). Studies of communication in GD Scrum, however, are rare and seldom define 'effective' communication, rather they identify the communication challenges, communicative agile practices, factors, and tools that contribute to communication (Alzoubi et al., 2016; Amar et al., 2019; Hummel et al., 2013). We located one case study of GD Scrum that mentions that Scrum improved communication in a large-scale distributed environment (Paasivaara et al., 2008). Therefore, to better understand effective communication in GD Scrum teams and provide a basis for future research evaluating Scrum's effect on communication in GD contexts, we posed this research question:

What is effective communication in globally distributed Scrum teams?

We answered this question using interviews and qualitative content analysis to explore the experiences of practitioners involved in GD Scrum teams regarding their communication. From this analysis two contributions emerged. The theoretical contribution is an empirically based model of GD Scrum team communication effectiveness comprising communication transparency, communication quality, communication discipline, and alignment. The practical contribution is 11 pieces of advice raised in the interviews that GD Scrum practitioners can adopt to improve and sustain effective communication. This article extends a related conference paper by Kostin and Strode (2022).

The article is organised as follows. In section 2, we define communication and give a brief overview of communication in general. This is followed by subsections on communication in software development, in GD teams and in GD Scrum teams. In section 3, we explain the method including, sampling, data collection, analysis method, and validity measures, and provide participant profiles. Section 4 presents a model of effective communication in GD Scrum teams, and section 5 presents practical guidance on how practitioners sustain and improve effective communication. Section 6 answers the research question and explains how the model contributes to existing knowledge on effective communication in GD Scrum teams and to industry practice. Limitations are addressed followed by considerations of future work. Section 7 concludes.

2   Literature Review: Communication

The discipline of communication emerged in the 1950s and is studied in disciplines such as sociology, psychology, geography, and technology among others (Pooley, 2016). Communication is studied at different levels, modes, and channels. Communication can be interpersonal (Berger, 2005), group and team (Marlow et al., 2018), and organisational level (Cooren et al., 2011). Modes can be synchronous and asynchronous, and channels include face-to-face, electronic messaging, and by documents (Ahmad et al., 2018). In addition, the purpose of communication can be to convey information or to converge on shared meanings, as Dennis et al. (2008) explain in media synchronicity theory. In organisations, communication genres occur. Yates and Orlikowski (2002) theorised six dimensions of communicative interaction that contribute to a genre: purpose, content, participants, form, time, and place. Genres occur when people assemble these communicative interactions into sequences that become embedded over time as organisational norms.

Due to this broad spread of communication studies and theories, we restrict this review to group and team communication. Even with this narrower focus, there are still many team and group communication theories and models (Defranco & Laplante, 2017; Harris & Sherblom, 2018; Marlow et al., 2018; Poole, 1999).

A meta-analysis on the effect of team communication on team performance by Marlow et al. (2018, p.146) defines communication as *"an exchange of information, occurring through both verbal and nonverbal (e.g., email) channels, between two or more team members"*. They note that team communication is typically measured by the degree to which team members receive clear information from team members, how frequently team members interact, and the extent of knowledge sharing among team members. They found a positive and significant relationship between team communication and team performance when they tested the relationship by analysing results from communication studies in business and psychology (150 studies published between 1966 and 2016). They conceptualised team communication as having two factors, communication quality and communication frequency. Communication quality is *"the extent to which communication, both of a verbal and nonverbal nature, adequately distributes pertinent information among team members as needed"* (Marlow et al., 2018, p.148), and communication frequency as the volume of communication between team members. Their results showed that 1) communication quality has a significantly stronger relationship with performance than communication frequency, 2) as familiarity (i.e., the level of knowledge teams have of one another) increases, team communication becomes more strongly related to team performance, and 3) face-to-face teams show a stronger relationship between communication and performance than virtual teams. Another result was that information elaboration and knowledge sharing had a stronger relationship with performance than the other communication measures in the study (e.g., content or openness). The results are based on studies of various team types (e.g., surgical, search-and-rescue, and management), so the extent to which these results apply to software teams is not clear. Software development teams, their tasks, and the products they create may have unique characteristics leading to different results. In addition, since 2016, when the most recent study was published, the variety and quality of tools for collaborating and communicating in virtual software development environments have advanced considerably (Jackson et al., 2022), which could also lead to different results regarding communication.

2.1 Communication in Software Development

Team communication is crucial in successful software development because software development groups and teams must communicate effectively to integrate complex technical and knowledge work. Communication is necessary, not just within software teams, but also between teams, and between teams and other parts of the organisation. For successful software development, communication is also needed to interact efficiently and effectively with stakeholders, because they are key informants in the software development process (Defranco & Laplante, 2017). Communication in software development is identified as a specific research gap by DeFranco and Laplante (2018) in a mapping study of software engineering teamwork research. Their study of 103 papers published from 1999 to 2016 identified two main gaps in knowledge: communication in agile contexts and tools to support communication in GD software engineering.

Communication studies in software development take various perspectives. Communication gaps were studied by Bjarnason et al. (2016). They analysed five cases (5 companies and 15 interviews). The cases varied, some were using agile methods, and some had distributed work arrangements. The analysis showed that communication is more effective and efficient when distances are decreased. The distances they evaluated were geographical, organisational, psychological, cognitive, adherence, semantic, navigational, and temporal.

Communication genres were used by McChesney and Gallagher (2004) to explore communication and coordination practices in two geographically distributed projects in the UK. They found that maintaining team awareness of each other's roles and work activities, and a shared understanding of the project environment contributed to coordination and communication. They also identified various practices that enhanced communication such as establishing a network of knowledgeable staff, query-handling procedures using email, and the use of SCM (software configuration management) tools.

Knowledge about agile practices in Scrum and XP (Extreme Programming) that have a communicative function in collocated settings is well established (Ahmad et al., 2018; Mishra et al., 2012; Pikkarainen et al., 2008). Pikkarainen et al. (2008) analysed two cases (one organisation with two collocated projects) and identified the practices as open office space, daily meetings, task boards on the wall, sprint planning, reflective workshops, pair programming, and continuous integration. They found agile practices enhanced formal and informal communication in teams but could hinder communication in a larger project with multiple external stakeholders. The agile practice of setting up an appropriate open office layout was the focus of Mishra et al. (2012) who identified various physical office layouts that were more or less effective in supporting communication. A more recent systematic mapping study was undertaken by Ahmad et al. (2018). Including 25 primary studies, the focus was on communication channels and agile practices that support effective communication. This mapping study had some weaknesses; theoretical papers were specifically excluded, and most papers published in information systems were excluded because the source databases searched were software engineering oriented. As most research on agile software development appears in either software engineering or information systems publications, omitting one domain considerably reduces the mapping study coverage. The included papers also had to report communication processes, communication channels, and best practices, which may have further reduced the included papers. The results showed that people-oriented processes are more effective, and that communication channels are synchronous (e.g., face-to-

face, video conference) and asynchronous (e.g., email, documents). The practices they identified for communication match those of Pikkarainen et al. (2008) (listed above in this section) except for test-driven development and refactoring.

These studies on communication in software development focus on gaps, genres, and practices. They imply that the outcome of reducing gaps and identifying genres and practices is more effective communication. Although these studies show evidence that certain agile practices, genres of communication, and communication tools improve communication, no explicit definitions, or models of effective communication have emerged.

2.2 Communication in Globally Distributed Software Development

In globally distributed projects and teams, communication is critical and is a recognised challenge because physical, in-person, face-to-face interaction is rarely possible (Carmel & Agarwal, 2001; Giuffrida & Dittrich, 2015). Gibson & Gibbs (2006) argue that communication challenges among virtual teams are caused by different native languages, different national and organisational cultures, time differences (i.e., different time zones and different work schedules at different sites), and geographical distance. For example, team members may lack adequate English-speaking skills (English is the language used in software development worldwide), cultural differences can embarrass and cause misunderstandings between people, and the difference in time zones can make it challenging to participate effectively in meetings due to biological sleep needs.

There is evidence that software development teams working in the same office are more efficient than distributed teams as Espinosa and Carmel (2003) showed when studying coordination costs with mathematical modelling. This reduced efficiency may be because online interaction is often replaced with face-to-face interaction when teams are collocated. Technologies such as online video conferencing are popular and convenient to enable virtual face-to-face interaction and meetings, but this technology may impede the spontaneity and richness of the physical face-to-face interaction needed for novel and complex tasks such as software development (Dennis et al., 2008). The problem with this claim about face-to-face communication is that technology for communication has advanced since these studies were published and the barrier of distance may now be somewhat reduced (Jackson et al., 2022), although the barriers of time zone, culture, and language differences remain.

A lack of face-to-face communication can impact knowledge sharing in global software development. Anwar et al. (2019) reported five categories of knowledge-sharing factors (barriers and facilitators) affecting global software development: individual, technological, organisational, cultural, and geographical. Their SLR of 42 knowledge-sharing studies from 2010 to 2017, identified 22 barriers, those mentioned with the highest frequency were poor organisational culture, language differences, differences in cultural norms, and technological knowledge gaps. They also reported 20 knowledge-sharing facilitators, those with the highest frequency were organisational support, technological support, team communication, and centralised software libraries. Although Anwar et al. (2019) assembled the knowledge-sharing factors that influence communication, they did not define effective communication in the GD software development context.

Factors that lead to effective communication in GD software development were presented in a model developed by Bhatti and Ahsan (2017). Based on the perceptions of 193 respondents from 35 GD software development organisations, the factors included stakeholders'

involvement (where stakeholders are external parties providing requirements), acculturation, usage of appropriate tools and technology, and information availability. Rather than defining the components of effective communication, their model focuses on practices that enhance communication. In addition, the applicability of the model to GD Scrum teams is not clear because the extent to which the respondents were following Scrum or other agile methods was not reported.

2.3 Communication in Globally Distributed Scrum Teams

Research on communication in globally distributed Scrum teams follows a similar pattern to that of distributed software development in general. Communication studies of Scrum projects and teams focus on communication challenges, practices for achieving communication, and a limited number of studies attempt theory development.

The published history of the agile framework Scrum starts in 1995 (Schwaber, 1997) and Scrum is currently the most popular agile framework for software development worldwide (digital.ai, 2022). Originally referred to as an agile method (or methodology), Scrum is usually referred to as a framework. The Scrum framework is described fully in the founder's book (Schwaber & Beedle, 2002) and more recently in the Scrum Guide (Schwaber & Sutherland, 2020). These guides describe Scrum for small co-located projects and teams. For large-scale software development, variants of Scrum are available such as SAFe (Scaled Agile Framework), LeSS (Large-Scale Scrum), and SoS (Scrum of Scrums) (Ebert & Paasivaara, 2017). No Scrum-based framework is specifically designed for distributed or globally distributed development although Scrum is now adopted in that environment (Vallon et al., 2018).

The agile manifesto states the values and principles of agile methods, and is concerned with conveying information, stating, *"The most efficient and effective method of conveying information to and within a development team is face-to-face conversation"* (Beck et al., 2001b). In addition, many Scrum practices are designed to facilitate effective team communication. Colocation is recommended to support unscheduled group and one-to-one communication, and frequent regular meetings such as sprint planning, sprint reviews, retrospectives, and daily stand-up meetings ensure that the whole team is aware of the project and product status (Schwaber & Beedle, 2002). In GD Scrum these practices are also followed but with electronic media facilitating the communication across distances (Yagüe et al., 2016).

Scrum in globally distributed teams and projects may improve communication but the evidence is equivocal. A single case study by Paasivaara et al. (2008) focusing on how a company applied Scrum practices in their large-scale distributed software product development program between Norway and Malaysia, reports that Scrum improved communication. The study concluded that *"an agile method, like Scrum, suits well to distributed settings and actually helps in solving the biggest problem of GSD projects, namely communication, by almost forcing distributed team members to communicate frequently and really learn to communicate"* (Paasivaara et al., 2008, p.93). Others, such as Alzoubi et al. (2016), are less sure, saying, after an extensive systematic literature review, *"it is still arguable whether agile practices can be effectively scaled up and used in GDAD environments due to communication challenges."*[1]

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[1] GDAD stands for globally distributed agile development.

Communication challenges in GD software development teams were identified by Dorairaj et al. (2011) based on the experiences of 18 practitioners working on 14 projects using Scrum (often with XP). They found the lack of effective communication was a key challenge caused by a lack of tools, time zone differences, language barriers, and a lack of teamwork. To increase effective communication, they found that each of these issues needs to be addressed along with increasing formal and informal communication, and building trust between the distributed parts of the team. As noted above, some of these challenges may now be less problematic as tools for communication across distances have increased in number and improved in quality since 2011 (Jackson et al., 2022; Stray & Moe, 2020). More recently, Alzoubi et al. (2016) carried out an SLR of communication challenges that included distributed and globally distributed agile software development. That study captured knowledge in both software engineering and information systems. Of 21 papers analysed, 33% reported on Scrum and 53% reported on Scrum and XP. The rigour of papers in the final 21 was evaluated. The study identified 17 factors that limit communication, thus confirming and extending the findings of Dorairaj et al. (2011). This more recent list included time zone and geographic differences, team number and size characteristics, organisational, project, and customer characteristics, communication tools, culture and language issues, and trust. The study identified techniques (practices) used to overcome each of the limitations (e.g., sprint synchronisation, product demonstrations, appropriate tools for communication, and visiting remote sites). Alzoubi et al. (2016) concluded that more empirical studies were needed to find what enables efficient and effective communication and that communication should be investigated from the perspective of theories such as activity theory and coordination theory. This was because the theoretical maturity of this topic is limited. The topic relies on exploratory studies that are considered less mature than theory-building or testing studies (Edmondson & McManus, 2007).

Along with the practices identified in the SLR of Alzoubi et al. (2016), studies reporting the utility of specific Scrum practices identify daily Scrum meetings and Slack™ (a messaging application) as important for supporting communication in agile global software development. Stray et al. (2013), in a case study of multiple teams, found that daily Scrum meetings are critical to ensure a project is completed because they allow the team to stay in touch, assist each other, conduct their tasks, and discuss problems. A single-case study of agile global software development by Stray and Moe (2020) reported that scheduled Scrum meetings and Scrum-of-Scrum meetings, unscheduled meetings, and using the communication tool Slack ™ facilitated communication.

These few studies of GD Scrum focus on communication challenges, practices, and tools, rather than defining or providing an understanding of what 'effective' communication means in GD Scrum contexts. Theory concerning communication in GD Scrum is limited as noted by Alzoubi et al. (2016) but some theories have emerged. Amar et al. (2019) developed the 5C model, a theory of communication for Scrum-based distributed projects consisting of components that influence communication: competency, correlations, contentment, comprehension, and commitment. The model was developed from 25 interviews conducted in various geographical regions. The 5C model consists of 15 actions, practices, and factors that contribute to communication such as knowledge sharing, planning, scheduling, motivation, social interaction and trust, and creativity, skills, and abilities. The 5C model is concerned with the antecedents to effective communication and does not explicitly define 'effective communication'. Similarly, a conceptual framework developed by Giuffrida and Dittrich

(2015) found that communicative and coordinative practices are mediated by social software in GD teams. The basis of the framework was evidence from two software development cases (one industry case using iterative development, and one of student teams, with only one team using Scrum). They identified communication and coordination factors such as team building, situated articulation, meta-work, and knowledge sharing, but communication effectiveness was not a factor in this model.

Communication effectiveness is recognised by Alzoubi and Gill (2020). They tested the relationship between agile enterprise architecture and performance in geographically distributed agile software development. The mediating variable was 'active communication', which was composed of communication effectiveness and communication efficiency. The questionnaire data was collected in 2015 from 160 respondents worldwide who were involved in agile enterprise architecture and distributed agile development teams. In this study, communication effectiveness was defined as *"Delivering a message as it was intended with minimal disruption and misunderstanding, even if it takes a long time"* (Alzoubi & Gill, 2020, p. 80284) and communication efficiency as *"sharing information and knowledge in a timely manner between distributed teams or distributed team members"* (Alzoubi & Gill, 2020, p. 80971). The overall result was that agile enterprise architecture, communication efficiency, and communication effectiveness have a significant positive effect on the overall development performance. In addition, communication efficiency had a significant positive effect on communication effectiveness although the authors acknowledge that the reason for this relationship is not yet clear and needs further investigation. In their study, 'communication effectiveness' was modelled as a reflective construct with 4 items about task clarity, information sufficiency, detail, and accuracy. 27.5% of the respondents were team leaders/Scrum masters but the extent of Scrum usage among the respondents is not clear. We assume that the majority of respondents were using some form of Scrum, given the worldwide level of Scrum adoption is estimated at 87% (digital.ai, 2022). In addition, that study did not report the extent of global distribution as opposed to within-country distribution of the respondents' teams.

In summary, we found most studies of communication in globally distributed Scrum teams focus on communication challenges and practices to improve communication, that is the antecedents of effectiveness. One study has established a definition and quantitative measurement items for communication effectiveness in globally distributed agile software development but the data collection and analysis for that study were carried out in 2015. Therefore, further exploration of communication effectiveness with a more precise focus on empirical evidence from globally distributed Scrum teams in the current technological environment is warranted. This study therefore aims to develop our understanding of communication effectiveness more fully as a basis for further theory building and testing and to provide specific advice for practitioners.

3   Method

This study aimed to understand effective communication in GD Scrum teams. We chose in-depth interviews to provide the data to answer the research question for two reasons. Firstly, because of the limited theory or theoretical models on this specific sub-topic in communication (Alzoubi et al., 2016), in-depth interviews could provide the detail and insights needed for theory-building about this complex topic (Eisenhardt & Graebner, 2007). Secondly, in-depth interviews are also suitable for exploratory studies (Edmondson & McManus, 2007). This

study was exploratory because the research question was thought to best be answered by talking to people about their recent subjective experiences and perspectives on communication in globally distributed Scrum teams (Bickman & Rog, 2009) rather than by focusing on confirming existing constructs or extending models in the literature.

3.1 Interview design

A semi-structured interview schedule was designed to collect in-depth data. Each interview question had a purpose that was related to the research question. Appendix B lists each interview question and its purpose. The schedule was designed with open-ended questions to provide the participants with the chance to reflect on the topic and share their thoughts, beliefs, and experiences in an informal discussion format. The interview questions focused on how the participant defined effective communication and their experience of communication in GD Scrum teams. The questions were also informed by the personal and professional experience of the researchers, along with, relevant academic and professional/practitioner (grey) literature including the following.

- World of Agile blog (https://worldofagile.com/blog/distributed-scrum-teams/)

- Atlassian knowledge base (https://www.atlassian.com/agile/scrum/distributed-scrum)

3.2 Sample selection and recruitment

Ethics approval was granted by Whitireia Polytechnic before participant selection began. The sampling was purposive, that is each participant was selected according to specific criteria (Miles & Huberman, 1994). All participants had to have experience (at least 1 year) in coordinating communication in GD Scrum teams. We found potential participants by identifying IT professionals with suitable professional experience as displayed in their profile information on LinkedIn™. LinkedIn™ is a networking and career development website used by professionals. Initially, four participants were selected using LinkedIn™ searches and were contacted by direct message. A further five participants were found by sharing a LinkedIn™ post across one researcher's LinkedIn™ network. The post briefly described the research and asked the network to help find suitable participants. One person was an indirect work contact of one researcher. No participants were known to the researchers before the study began. All participants were sent an invitation email or chat message with a link to a consent form to be signed and an information sheet describing the study.

To confirm the participants' experience was appropriate for the study and before proceeding to the interview, each participant completed a participant selection questionnaire (see Appendix A). This short online questionnaire was developed using Google Forms. The questionnaire responses were used to confirm that participants had experience in organising or managing communication in GD Scrum teams, they worked in or with a globally distributed Scrum team, and currently or recently held roles with the responsibilities of Scrum Master, Product Owner, or Agile Coach or similar roles common in Scrum (Schwaber & Sutherland, 2020). People with these roles were selected because they were more likely to have experience in organising communication in GD Scrum teams (Kristensen & Paasivaara, 2021; Srivastava & Jain, 2017). The locations, positions, industries, and years of experience of the participants are shown in Table 1.

Note that, for this study, a team was considered a Scrum team if at least one Scrum practice was used, and the team was considered a globally distributed Scrum team if at least one team member was located overseas. These details were confirmed with the participant selection

questionnaire. In this article, we refer to a Scrum team as one team working on one product. A team can have sub-teams that are 'pieces' of a team that are in different locations.

3.3 Data collection

The interview questions were sent to the participants shortly before the interview. The first author organised and carried out all the interviews. Each interview followed the interview schedule but allowed for variation in responses. The 10 participants were interviewed over five weeks during April and May 2021 with interviews taking up to one hour. Online interviews were used because close physical contact was discouraged due to the COVID-19 pandemic at that time. This also meant interviewees could be in any location in the world and the interview conditions were similar for all participants. The Zoom™ online interview sessions were recorded with the permission of the participants.

3.4 Data analysis

The interview data was transcribed from the recorded interviews using Otter™ software (otter.ai). We used qualitative content analysis to analyse the transcripts (Schreier, 2014) and Microsoft Word tables to organise the analysis. Schreier (2014) explains that the content analysis method involves the systematic description of data through the development and application of a coding framework. The coding framework was first developed by checking every single part of the material that was relevant to the research question. Based on guidelines by Schreier (2014), the procedure we used consisted of the following steps. These steps were carried out by one researcher and the final framework was reviewed by another researcher. Adjustments were discussed and agreed upon jointly. For available source data see Kostin (2021).

1. Collect material. This step included selecting participants, interviewing, transcribing, checking, and cleansing the transcripts of transcription errors.

2. Build an initial coding framework. This framework was based on a first pass of reading carefully through the transcripts. Based on one main category (i.e., communication), analytic codes were developed for each idea about communication found in the transcript. This step is illustrated in Figure 1.

3. Evaluate and modify the framework as the analysis progresses. This involved grouping the codes into categories of communication that were based on common themes identified by the researcher. Each category was defined, and the transcripts reviewed for indicators (i.e., example quotes), and a check was made to ensure the categories were mutually exclusive. This step is illustrated in Figure 1 and Table 2.

4. Perform the full analysis using the developed framework. This involved reviewing all of the transcripts against the categories in the framework, refining the framework if necessary, identifying and defining any new codes or categories, and collapsing categories if they were not substantial or mutually exclusive.

5. Present and interpret the findings.

3.5 Validity considerations

Validity in the qualitative data and findings was achieved by following the guidelines of Creswell and Poth (2016) and Miles and Huberman (1994) on triangulation, transparency, and rich data collection. Triangulation validates that the data and findings are free of bias (i.e.,

come from multiple sources) and include a variety of perspectives. Triangulation was achieved by collecting data from 10 experienced professionals from nine companies in four countries in six relevant positions.
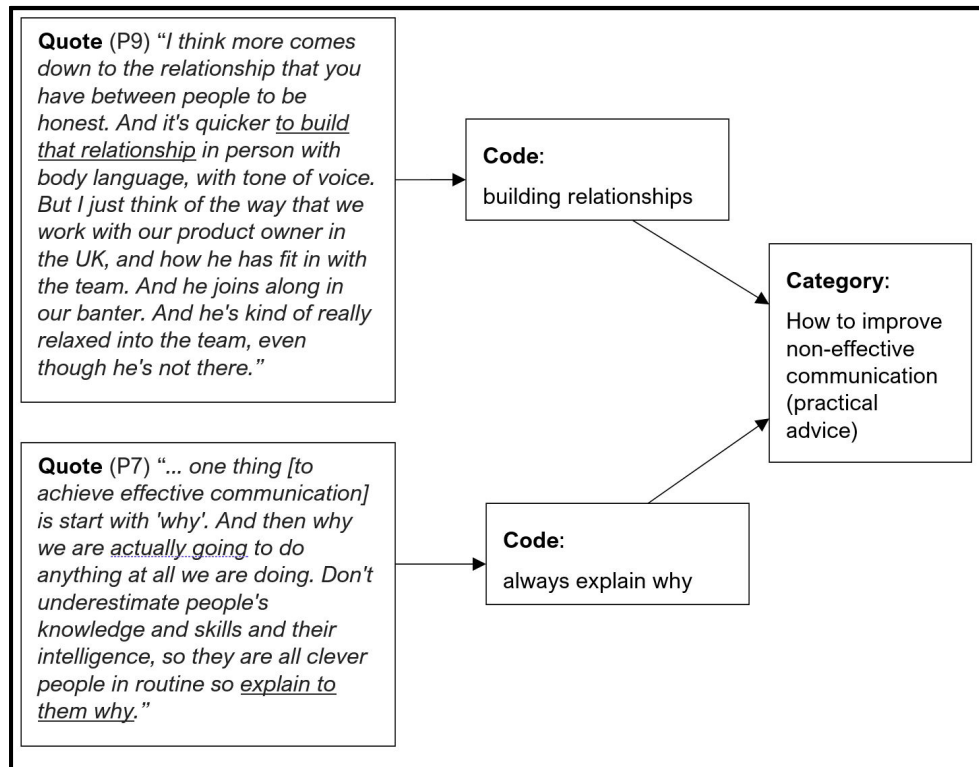

Figure 1. An illustration of the relationship between quotes, codes, and category

Transparency validates the study's conclusions. We aimed for transparency by explaining exactly how the research was organised and actioned in this method section, and how we transformed the raw data in the interview transcripts into the conclusions in the finding's sections, sections 5 and 6. We have included extensive quotes from the transcripts to support transparency in developing the theoretical model and again in the practical guidance section.

Rich data collection validates that the data collected in the interviews were detailed enough to capture people's experiences and ideas. We aimed for rich data by using open-ended questions in the interviews and detailed coding of anything related to the research question.

Creswell and Poth (2016) and Miles and Huberman (1994) also recommend member checks to validate that data is collected without bias. This involves sharing the transcribed text of an interview with the interviewee so they can check and confirm that the data accurately reflects what they said. We were not able to do this because of the high workload of participants who preferred not to carry out member checking, which they communicated to us during the planning of the interviews.

We took several actions to reduce participant and researcher bias. To reduce bias in participant selection we used purposive participant selection with a pre-designed set of inclusion criteria for searching within the LinkedIn™ social media platform (see section 3.2). This was reinforced with a selection questionnaire to ensure the participants had appropriate recent knowledge and experience before they were interviewed (see Appendix A). To reduce bias in data collection we followed a pre-designed semi-structured interview schedule (see Appendix

B), so each participant was questioned on the same topics, and we allowed the time and flexibility for participants to fully describe their knowledge, experiences, and perceptions.

To reduce researcher bias we took these actions. In the analysis phase we relied on automated transcription to fully transcribe all responses, but we also manually checked that the transcript accurately reflected the participant's words. We followed the published procedure for qualitative content analysis (Schreier, 2014), and analysed each transcript in the same way following that procedure. During the analytical coding step, the researcher sought to be open to all possible initial codes related to communication. Although we took these steps to reduce researcher bias, qualitative research is inherently subjective and may be prone to bias (Sarker et al., 2013) because participants may omit, over-emphasise, or downplay events or experiences. Reassuring participants of confidentiality was one action taken to mitigate this problem, along with triangulation of sources. The problem that can occur when the researchers inadvertently influence the participant's responses (i.e., reactivity bias (Gorard, 2013)) was also controlled somewhat by following an interview schedule.

3.6 Participant profiles

The participant profiles are displayed in Table 1. The participants had a range of senior roles in agile projects and their experience ranged from 1 to 5 years. They were engaged in projects concerned with IT, financial services (fintech), and healthcare. The residency, team location, and headquarters indicate the global distribution of the participants and their Scrum teams.

	Residency	Head-quarters	Team location	Position	Field	Experience
P1	USA	UK	China, Taiwan, UK, USA	Product Manager	Fintech*	5+
P2	Philippines	Ireland	Australia, Philippines, USA	Senior Project Manager	IT	1+
P3	Denmark	Denmark	Denmark, France, India, Spain	Scrum Master	Health	5+
P4	NZ	NZ	NZ, Vietnam	Agile Coach	Fintech*	3+
P5	NZ	NZ	Australia, China, India, NZ, Singapore	Senior Project Manager	IT	3+
P6	NZ	Argentina	Argentina, NZ	Founder	IT	3+
P7	NZ	NZ	Australia, NZ	Senior Manager	Fintech*	5+
P8	NZ	NZ	Brazil, NZ	Product Manager	IT	3+
P9	NZ	NZ	NZ, UK	Scrum Master	IT	3+
P10	NZ	NZ	Australia, NZ, UK	Scrum Master	IT	3+
Key	- P (e.g., P1) refers to the participant number and is used in the quotes in this article. - Residency refers to the primary country of residence of the participant. - NZ refers to New Zealand; the UK refers to the United Kingdom. - Exp. refers to the experience level of the participant in years. - P9 and P10 were from the same company; other participants were from different companies. * Fintech is a portmanteau of "financial technology". The term refers to the utilisation of emerging technological innovations by companies to competitively provide financial services that may challenge conventional approaches. - IT is information technology						

Table 1. Participant profiles

The participant interviews resulted in 131 pages of transcript and the analysis created 130 codes. Each code was supported with one or more quotes from the interviews. The codes formed three groups. 12 codes were associated with the understanding of effective communication in GD Scrum teams and contributed to the model development (in section 4). 11 codes were related to how to improve non-effective communication (i.e., practical advice in section 5). The remainder of the codes do not contribute to this article. They were related to communication challenges and communication tools.

4   A Model of Effective Communication in GD Scrum Teams

The analysis showed that communication effectiveness is not a single idea with a single definition but is made up of related concepts. Identifying and defining concepts and explaining their relationships is the process of developing a theoretical model (Dubin, 1978). A theoretical model should have well-defined concepts and a boundary that defines where the model is applicable (Weber, 2012). The boundary for our model is the GD Scrum team.

This section presents a theoretical model of communication effectiveness in GD Scrum teams that comprises four communication concepts, their definitions, and the relationship between the concepts. This is a theory of explanation according to the theory classification framework of Gregor (2006) because the model explains concepts within a specific bounded context but does not aim to predict with any precision and has no testable propositions.

The analysis led to 12 codes that formed four distinct categories of effective communication. We call these categories 'concepts' in the remainder of this article because this is the terminology used when discussing theoretical models. The concept names, concept definitions, and codes that contribute to the concepts are presented in Table 2. These concepts form the model of effective communication in GD Scrum teams and include alignment, communication transparency, communication quality, and communication discipline.

Each concept was defined based on the ideas conveyed in the interviews, but we also referred to standard dictionary definitions. We did this to ensure that the codes related to a concept, the concept name and the concept definition all referred to the same idea that was assigned a recognisable name as defined in a dictionary. This was done to reduce semantic drift between the concept name that emerged from the quotes and codes, and the usual definition of the concept.

The following sections describe the concepts commencing with the outcome concept, alignment. Each concept description includes a discussion and supporting evidence. The evidence comprises direct quotes from the interviews combined with findings from relevant literature if it was available. The arguments for the relationships between the concepts are presented in section 4.5.

The following sections include exemplar quotes to support the arguments for our findings. These quotes are edited lightly as follows. Ellipses (…) indicate elided text that is not relevant (e.g., 'so', 'you know', 'like'). Underlined words or phrases highlight the words relevant to the assigned code. Words in square brackets [] are inserted to clarify a phrase (e.g., to clarify what 'it' refers to in the transcript text).

Communication category/concept, [frequency], and definition	Code
Alignment [4] is a state of agreement between distributed team members about all aspects of the work (i.e., product, priorities, process, and work progress).	• Be on the same page (i.e., have a shared understanding) • Aligning priorities
Communication transparency [6] is clear communication that is open, honest, and readily understood. This includes the conveyance of clear expectations in the team.	• Be open and honest • Convey clear expectations
Communication quality [11] is the conciseness, speed, equality, and responsiveness of communication in the team.	• Interact face-to-face • Give/get quick replies • Have listening and speaking equality • Give/get feedback • Have one-to-one direct communication
Communication discipline [2] is when people communicate in a controlled way by following agreed norms about who to communicate with, what to communicate (e.g., task completion), and use appropriate communication tools.	• Use an appropriate communication tool • Follow through on instructions • Keep stakeholders informed

Table 2. Effective communication in GDST: Communication concept and related codes
Note. "frequency" refers to how many participants mentioned (an) idea(s) leading to the same code.

4.1 Alignment

Alignment in GD Scrum concerns the development and maintenance of a shared understanding among all those involved with the team's work. Alignment codes conveyed the opinion that communication is effective when the priorities of the team, its sub-teams, and any other stakeholders are understood and everyone in the team is said to be 'on the same page' with agreement on priorities. Being on the same page is an idiom meaning "*Of two or more people, thinking in the same manner; having the same general outlook or position*" (Free Dictionary https://idioms.thefreedictionary.com/on+the+same+page).

For example, P3 stated, "*... effective communication is of course, … getting everybody on the same page ... and understanding the vision and priorities and so on, is something I think about when I communicate or try to communicate effectively*".

Alignment is a well-established concept in psychology where alignment in communication is when a shared mental model develops about a situation within a dyad or group (Wachsmuth et al., 2013). A team mental model, which is a team-wide shared mental model, is considered critical to effective teamwork (Salas et al., 2005), is a factor in the success of globally distributed virtual teams (Florea & Stoica, 2019) and globally distributed large-scale software development when coordinating work efforts (Espinosa et al., 2001). Shared, or team, mental models research in agile and Scrum teams is nascent. We found a single study, by Edmondson and Chiu (2020), of collocated Scrum teams showing that a shared-mental model between the Product Owner and the development team affects client and team satisfaction.

4.2 Communication transparency

Transparency in GD Scrum concerns open and honest communication in the team and conveying clear expectations. Transparency was the most frequently mentioned indicator of communication effectiveness. For P10, effective communication was being transparent, open and honest, "*It is about being open again, …, being transparent about your current situation …*". P9, confirmed this, saying, "*Open and honest communication would be successful communication for me.*" P1 viewed being open to questions as a communication advantage for his team and said

"… in my teams, we're very <u>open to any questions anytime</u>. So, the team member can come to me and say … 'we got those questions' or 'we got some delays can we talk about that?' and we are talking about that. This improves communication a lot."

Transparency includes conveying clear expectations. The expectations we found were about tasks, about customer expectations about the product, about capturing acceptance criteria, and conveying expectations about how best to communicate. P5 thought it was about the task, *"To ensure that we have one message, … and <u>set clear expectations and actions for the task</u> so during the Stand Up we go through, we say what are we doing, what have we achieved and what is … planned.".* P8 thought it was about task order and clarity between the team and product owner who were distributed between NZ and Brazil, *"when you're working with a team, it needs to <u>be really clear what they're doing next</u>, and that sort of thinking from product owner to team kind of communication."* P9 explained that she made her expectations clear about how to communicate effectively in an example, *"making sure that the people that I have the most influence over start to communicate effectively, and <u>I'm talking about what that communication, effective communication, looks like</u>, and start, making sure that we are <u>calling out poor communication</u>, but not … in a … 'you did a bad job' kind of way, just gently, or 'Hey, that email that you sent probably could have been more concise, or that email that you sent, you actually didn't give them a deadline as to when they needed to get that information back to you'."*

The ideas about transparency, honesty and openness all occur in the Scrum guide, which explicitly states that a Scrum team should be transparent about problems and progress, and open about challenges (Schwaber & Sutherland, 2020).

Transparency has been linked with trust. For example, Yue et al. (2019) found that transparent communication is associated with trust between team members in a study of organisational change. In agile environments, the industry commentator Eckstein (2013) stated that trust can only be established by transparency. Hennel and Rosenkranz (2021) treat 'transparency', and 'open and honest communication' as distinct but related concepts that influence the resilience of agile teams in a study of psychological safety in three case studies in Germany. They considered that transparency facilitates trust, communication, and knowledge sharing.

While seldom mentioned in agile software development literature, the concept of communication transparency occurs frequently in the organisational literature, but the focus is on clarity in communication at the organisation level rather than the team level. In this literature, common sense definitions are normally used to define transparency as 'openness', 'insight', and 'clarity' (Christensen & Cheney, 2015). Communication transparency also occurs in the context of enterprise social media where it is called communication visibility (Leonardi, 2014), but the concept is narrowly defined as seeing the content of other's social media messages.

Our definition of communication transparency includes conveying clear expectations. There is a lack of research on this aspect of system development, although not meeting customer expectations is reported as an important communication gap in large-scale software development (Bjarnason et al., 2011). Understanding and managing customer expectations is considered a traditional IT project management function (Petter & Randolph, 2009), and one reason why the product owner role emerged in agile software development was to ensure that customer expectations are understood and met (Kadenic et al., 2023; Kelly, 2019). We found no direct support for the importance of conveying clear expectations as a dimension of communication transparency in the IT-related literature.

In summary, our definition of communication transparency is supported by similar definitions in organisation literature (Christensen & Cheney, 2015) and Scrum literature (Schwaber & Sutherland, 2020) except for conveying clear expectations, which does not occur in these sources. This could be because of the need for greater clarity about expectations when teams are distributed and cannot identify expectations just by being close together physically, which can enable informal chat about expectations. Alternatively, this could be because different national cultures have different workplace or task expectations that need to be made explicit (Bastiaansen & Wilderom, 2021; Šmite et al., 2021).

4.3 Communication quality

Communication quality concerns the conciseness, speed, equality, and responsiveness of communication. P9 thought effective communication had to be concise and speedy: *"Effective communication for me, and my team would look like information being shared or requested is as <u>concise as possible</u>. And responses coming in <u>as quick as possible</u>."*

Equality is important for effective communication and involves listening and speaking equally among all team members. P4 said, *"So for me, … effective communication is where <u>equal parts of listening and speaking</u> take place. So, it's a true conversation of both parties... And if I give you an example of how we'd set up the current cross-shore team, with the different time zones, it was very important for us to communicate at the end of the day with each other. So, we are all on the same page of how things are progressing towards our goal, our sprint goal. And that was communicating from both ends. So, it was not just expecting that the across-shore distributed team, which is sitting in Vietnam, is the only one who's responsible for communicating to us, it's <u>both parties communicating equally</u>. And that involves listening as well as speaking."*

Responsiveness was mentioned in different ways. P10 mentions responsiveness as acknowledging that a message has been received and responding in a timely way. *"For me, effective communication … it's about responding. … effectively. … It's important that you are giving the other person, who is expecting an answer from you, … to acknowledge saying that, … 'I have read your message, this is what you want, it's going to take me some time to get you the answer.' But then, 'yes, I'm here to do that for you. Just give me some time'. … saying that, …, 'currently, I'm working on this, but I will get back to you, by the end of the day, or whichever time you need in order to get that question answered'"*. P10 continued, *"Because I've seen in my previous experience, people, if they're not able to do something, they just wouldn't respond to that message or email for a long time, they would say, … I'll get to it, when I have time, …, the right thing to do is acknowledge it, and answer it whenever you can. So that's one <u>very crucial thing, especially for global level communication</u>."*

P6 talked about 'message receiving' in communication and how senders should consider the situation of the receiver and choose when to send and how to send a message. *"…effective communication depends mostly on the recipient of the message. So, if I am at a different time zone, and I just sort of throw something to you, because you need to know, but I'm not accounting into the fact that maybe it's, …, 3 am in the morning for you, and then you're going to wake up, and at the first time in the morning you won't read that, then that's not going to be that effective. So effective communication abilities through the team to me is <u>about accounting for whoever receives the message that is in a proper situation or appropriate environment to receive it</u>."* P6 continued later, saying that for any communication of value *"if it's not received properly, then the communication fails."*

Direct person-to-person communication was viewed as a way to support responsiveness. P4 explains, *"… if you're trying to build a high-performing team, then you need to make sure that <u>each</u>*

individual can communicate with the other and the team … ." P4 continued: *"it's individuals communicating with each other at their level, but being able to listen, being able to communicate back. So, it's both sides, not just listening, but also speaking, and speaking your mind, and being able to effectively say - this is the problem and hey, I need some help, or Hey, I can help you out. So listening, if someone needs help by saying – 'Hey, I'll be able to help with that because I know, I've resolved that problem before'."* P9 mentioned the interactive nature of effective communication, *"An equal kind of back-and-forward or two-way flow of information."*

Communication quality in our model is similar to closed-loop communication, a factor in effective teamwork in all team types. Salas et al. (2005) defined closed-loop communication in a review and model-building article on effective teams as *"the exchange of information between a sender and a receiver irrespective of the medium"* (Salas et al., 2005, p. 561), that involves following up with team members to ensure the message was received, acknowledging that the message was received, and clarifying with the sender of the message that the message received is the same as the intended message. For agile teams, Strode et al. (2022) argue that whole-team closed-loop communication is critical for effective teamwork without specifying if this applies to all teams or only collocated teams. Our findings concur with this idea that giving and acknowledging replies or feedback within the team is a factor in effective communication in GD Scrum teams.

Marlow et al. (2018) defined communication quality as the extent to which communication distributes pertinent information to the team members as needed (see section 2). Our definition, however, is concerned with conciseness, speed, equality, and responsiveness of communication among the team members, rather than just conveying pertinent information.

In organisation studies, there is no consensus on a definition of communication quality. Communication quality is reported in domains such as retailing (Mohr & Sohi, 1995), management (Orpen, 1997), health (Fawole et al., 2013), and virtual teams (Chang et al., 2011) among others, but often with no clear definition. In psychology, González-Romá and Hernández (2014) define it as *"the extent to which communication among team members is clear, effective, complete, fluent and on time"* (p. 7).

In studies of agile and Scrum teams in distributed environments, communication quality is mentioned but we could find no sources that define the concept in an agile context or describe it in any depth (Ågren et al., 2022; Lampropoulos & Siakas, 2018; Lukusa et al., 2021). Therefore, our definition of communication quality appears to be unique. Each dimension of communication quality can affect communication in GD Scrum. If messages are not concise, they can take a long time to convey, and the meaning can become unclear especially if there are language differences. If responses are not speedy, they can cause teams in other time zones to delay their decision or tasks for longer than is optimal. If distributed teams do not equally contribute to discussions, then the silent partners' ideas, decisions, problems, or solutions may never be known leading to less effective communication and teamwork.

4.4 Communication discipline

Disciplined communication means following accepted norms for communication. In our findings, this encompassed who to communicate with (e.g., teammates, stakeholders), what to communicate (i.e., following through on tasks and communicating task status), and using appropriate communication tools. The Scrum framework (Schwaber & Sutherland, 2020) sets out the broad norms for communication in each sprint, for example, in daily stand-ups, sprint

planning and reviews, and retrospective meetings, specifying who should be involved and what activities should take place to share knowledge and decision-making.

Communication discipline includes the code 'Keep stakeholders informed' because regular, frequent, and consistent communication with stakeholders affects teams, projects, workflow, and product quality. Stakeholders are closely involved in Scrum teams because they can provide financial, social, and political support and timely information about requirements. For example, P2 explained that communication with the stakeholder about requirements and acceptance criteria are important to avoid problems: *"… the requirements and basically the acceptance criteria, those requirements are well understood, such that…, during the sprint review or during … when we demo the application, or even during going live …, then it is smooth and it will not face … red flags for the customer or client like, 'wait, that's not up to what we discussed'… ."*

The importance of what to communicate is evidenced in the code 'following through on instructions' to achieve effective communication. P5 explained it this way. *"Yes, it [communication] can be 100% effective, but it's your propensity to pick up an instruction, follow it through, complete it, and then report back as being completed."*

Using an 'appropriate communication tool' for the situation and the subject matter was also important. P6 said, *"So, effective communication abilities through [the] team to me is about accounting for whoever receives the message, that is [they are] in a proper situation or appropriate environment to receive it, sometimes that means that <u>certain conversations have to be a video call, for instance."</u>* P9 said, *"I think they [communication tools] are all efficient in their own way, just <u>depending on what we want to achieve</u>."*

Few theories, frameworks, or models focus on communication discipline. The idea does emerge as a factor in studies of psychological safety in virtual teams. For example, Lechner and Tobias Mortlock (2022) interviewed 16 members of virtual teams (of all types) and recommended 'discussing the rules of the game' in virtual teams to enable psychological safety. They argue that behavioural norms about how the team wants to work together are created by explicitly discussing the rules rather than letting them emerge organically, as they do in collocated teams. These authors consider three actions are needed to negotiate the rules of the game: agree on shared goals and responsibilities, develop a common code of conduct, and align the use of tools with the team's needs. These actions share similarities with our communication discipline, but our concept is more specific because it includes who and what to communicate. However, 'who' and 'what' can be negotiated when agreeing on shared goals and responsibilities and can be written down in a code of conduct. The idea of aligning the use of tools with the team's needs is reflected in our idea of using appropriate communication tools.

Scrum research and the grey literature seldom mention norms, although Scrum activities such as deciding on a 'definition of done' (Kopczyńska et al., 2022) and deciding on action items in retrospectives (Andriyani et al., 2017) could contribute to norm development. Agile team norms emerged in four Scrum teams in a company with teams in Malaysia and Norway in a study by Stray et al. (2016). However, in that study differences in communication norms were attributed to cultural differences and a lack of team maturity, however, these causes were not discussed in detail.

Communication discipline is not a distinct concept in the literature on virtual team types or distributed software development teams. Therefore, our definition of communication

discipline appears to be unique. Communication discipline might be more important for GD Scrum teams than collocated teams because Scrum and software development requires high levels of communication and teamwork, both of which are constrained by the teams' distribution in time and location, and their reliance on electronic media to communicate. For example, explicit team communication norms about who to communicate with and what to communicate become more important if a message is to be read many hours after it is sent, to avoid additional delays in response. Sending one's message to the most appropriate person can be more important if responses must be timely. Using the right media and tool for the type of information one wants to convey also matters, as many studies confirm (Dennis et al., 2008; Jackson et al., 2022).

4.5   Communication model relationships

The relationships between the four concepts related to effective communication in GD Scrum teams, alignment, communication transparency, communication quality, and communication discipline complete the theoretical model. We argue that communication transparency, quality, and discipline lead to alignment, that is, they are precursors of alignment. In other words, alignment, which is a shared understanding in the team (i.e., a team-level shared mental model), is an outcome of transparent, high-quality, and disciplined communication. Furthermore, alignment can be considered equivalent to effective communication in GD Scrum teams. This relationship is illustrated in Figure 2.
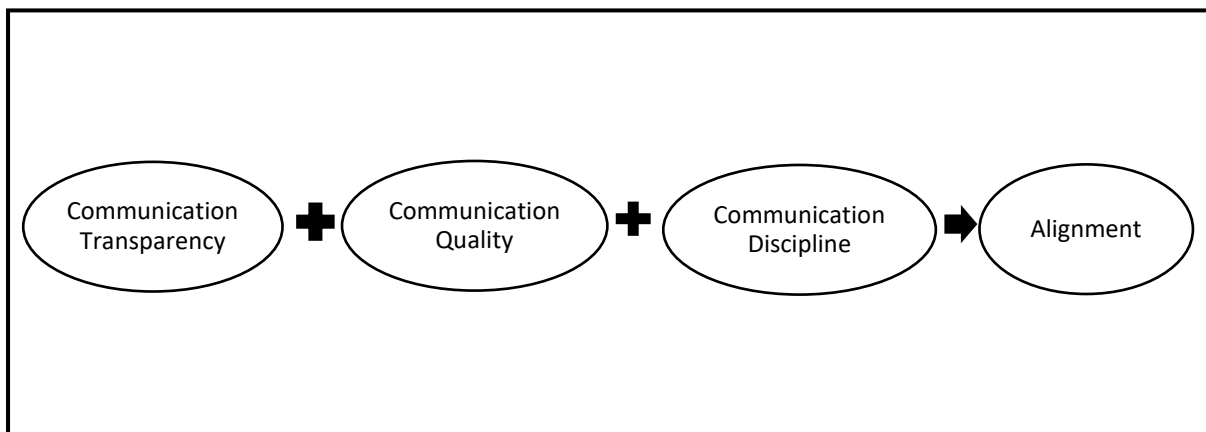

Figure 2. A model of effective communication in globally distributed Scrum teams

The argument that alignment is the outcome in the model is based on ideas in media synchronicity theory (Dennis et al., 2008; Kittelman et al., 2018), which poses that communication has two main processes 1) conveyance of information and 2) convergence of meaning (i.e., developing shared meanings). Kittelman et al. (2018) argue that in general, information must be conveyed before a convergence of meaning occurs. Using this distinction, our model includes conveyance and convergence.

Communication quality, transparency, and discipline are concerned with conveying information. For example, information is conveyed among team members (is sent and received) with high quality (e.g., is concise and responsive), transparently (e.g., is open and honest), and in a disciplined manner (e.g., following communication norms).

Convergence of meaning according to Kittelman et al. (2018) is about developing shared meanings. We have defined alignment as equivalent to shared understanding, so we consider convergence and alignment, to be equivalent.

Based on these ideas, communication quality, transparency, and discipline convey information and lead to alignment (i.e., convergence on a shared mental model). This implies that to achieve high levels of alignment, actions to achieve communication quality, transparency, and discipline should be included in GD Scrum team communication. The illustration in Figure 2 shows a + sign to indicate the relationship. The arrow indicates the idea that these three concepts lead to alignment.

5 Practical Guidance for Improving and Sustaining Communication

The analysis that led to our proposed model of effective communication also revealed concrete practical guidance for improving and sustaining communication in GD Scrum teams. Participants were asked for their insights about how to improve communication, how they kept communication effective, and the challenges they encountered (see Appendix B for the interview schedule). From those questions, 11 codes emerged that were categorised as practical actions the participants took to improve and sustain effective communication. The 11 practical actions are listed below. The list is not ordered. The numbers indicate how many participants referred to this practice.

1. Always explain why [1].
2. Convey and follow through on one message [1].
3. Build relationships [1].
4. Hold a team charter session [4].
5. Create a safe environment for communicating [4].
6. Model good communication behaviour [1].
7. Respect personal boundaries when communicating across time zones [4].
8. Consider personal communication preference mismatches [3].
9. Use agile practices for communication, whether the team is distributed or not [2].
10. Look for the root causes of problematic communication [1].
11. Allow for reduced body language signals in virtual communication [4].

This section provides arguments, evidence, and supporting literature for the 11 practices.

5.1 Always explain why

When communicating, the person requesting others to change should always explain why the change is needed. A participant (P7) who was a coach said that explaining why (i.e., explaining why some change was necessary) helped team members understand the usefulness or benefits of adopting new practices. His example was about introducing a sprint review to get customer feedback on the product. P7 explains, *"The approach that I take, usually in coaching people, even that's the approach I asked the Scrum Masters to do, is you start with 'why'. When you're introducing a practice, you are going to introduce a particular way of working, you start with why. It's Simon Sinek's … golden circle that talks about why before you talk about how and what. … we talk about how important it is for example, for us to actually get feedback from our customers, from our user, from our stakeholders to make sure that we are delivering value to them or delivering capabilities or features that they will be using and appreciating and getting return on investment. And it's the only way we can get, …, the confidence that … we are actually doing the right thing. It's only possible when we get feedback, so therefore, we must get feedback. … Now we're going to actually do it, is yes we're going to have a sprint review, we're going to have it in once in two weeks so once in three weeks for one hour … ."* He explained that this practice helped convince people that the new practice was the right

thing to do, *"and they will say yes to it, … no matter how difficult this is, we <u>have to do it because it's</u> <u>the right thing to do</u>. So, you educate people with the why. I mean all the people are working in our teams are very smart people, very intelligent people, they are developers and testers, they are analysts … these are people who care for the work they do and therefore, if you cannot explain to them why some new practices or new … process is put in place [then] they will find that this is not the right thing for them to do or adopt."*

The idea of 'always explaining why' is explained in a leadership manual by Sinek (2011) who argues that leaders should explain why to followers so the followers know the reason for the work they undertake, how the work fits with organisational goals, or why a change is needed. This idea is related to 'work meaningfulness' in leadership literature (Kipfelsberger et al., 2022). Wolf et al. (2022) reported, based on 12 interviews, that explaining why is important for activity coordination in internal communications in IT-intensive start-up companies. Smart (2018) also recommended Sinek's (2011) advice when implementing agility in DevOps environments. We found no advice on this practice in GD Scrum, GD agile, or virtual team research. This practice could be pertinent in both collocated and distributed environments, but as we explained in section 4.2 'Communication Transparency', when teams are distributed there is a need for explicit communication about the reasons for actions or requests. This is because the team members are not close together physically and cannot observe the situation or take part in informal chat; they cannot identify the reason for a request or a change by implicit communication.

5.2   Convey and follow through on one message

'Convey and follow through on one message' means communicating carefully to the whole team by focusing on conveying one message to all sub-teams who are in different locations. P5 explains how important this is when distributed teams work simultaneously on different software components that must be integrated. He advises conveying and following through on one message, particularly to follow through on video calls or verbal messages with written confirmation: *"We ensure that we have one message and set clear expectations and actions for the task. So, during the stand-up we go through, we say what we are doing, what have we achieved and what's planned. Yeah. But what we've got to say on top of that is where the priorities are and then link those priorities together so if you've got China that's taken on a piece of work. You've got India and then New Zealand, and we're working on segments at some point in time, they all need to integrate. … And so, the coordination is very difficult to put into a JIRA ticket or into a user story, that's project management, and you've got to communicate effectively and that is to bring all three parties together and say at this place at this time. At this junction, we're going to integrate, and we all have to be ready … we all need to meet the mark together at the same time, just be really prepared to integrate and then test the product. … communication was the key, written communication following all video conferencing. If there was no communication or written communication, often particular tasks, or those priority of tasks would not be completed or individuals that you set the task of following through and talking with somebody or following through on an action. Yeah, they don't carry it out. And they don't do what they've been instructed to do."*

As we explain in section 4.3 Communication Quality, teamwork studies confirm that communication involves following up with team members to ensure the message was received, acknowledging that the message was received, and clarifying that the message received matches the intended message (Salas et al., 2005). Furthermore, in an agile teamwork study, Strode et al. (2022, p. 23) argue that "the team follows up on the progress of tasks" is an

indicator of effective communication in agile software development. Although this practical advice is undeniably important for collocated Scrum teams, for GD Scrum teams, developing components in different countries and then integrating them, this advice is likely to be even more critical due to the extra overhead in time and cost if a message is not received correctly.

5.3 Build relationships

When the team is distributed, extra effort and time are needed to build and maintain good relationships between the distributed sub-teams. P4 describes some of the practical efforts made by his team, *"… you have to invest a lot of time in it… I have invested, personally, a lot of time in making sure that I've got the relationship going [with] the other side. We play games; we watch videos together. In retros, we want something inspirational together, we talk about our family lives, we talk about all sorts of <u>things to keep that personal connection going</u>, because otherwise, it gets a bit harder, because we're just there to ship them work and expect them to deliver work. And that's the model that I never wanted to build. So, for me, … I wanted to make sure that I could create a <u>very highly trustworthy team</u> with high performance in-built and self-organizing ... Right, I'm not responsible for them to organize, [that is] their responsibility."*

The purpose of building relationships is to build trust among team members, which is needed to support effective collaboration, communication, and knowledge sharing (Newell et al., 2007). The importance of trust as a foundation for effective teamwork has a long history (Salas et al., 2005), and is recognized as a problem for virtual work teams of all types (Newell et al., 2007) as well as GD software development teams (Casey, 2010). Building relationships and trust is a central idea in the agile manifesto (Beck et al., 2001a) and the Scrum guide (Schwaber & Sutherland, 2020). A study by Tyagi et al. (2022) focuses on building trust in GD Scrum teams and, like our participants, they recommended regular socialization within and between teams to build and improve trusting relationships.

5.4 Hold a team charter session

When an agile team first assembles our participants recommended that they write a team charter. The Agile Practice Guide team charter (Griffiths et al., 2017) includes agreements about team values, working arrangements, ground rules for communicating, and group norms (agreed behaviours). Four participants introduced a team charter session to improve communication or to keep communication effective. Two of them said:

"So part of it was having a team charter when we first came together as a team, just making sure that we had <u>an agreed set of principles</u> that we would work towards, making sure that it was raised. Not, just any working principles … things like meeting etiquette, showing up to meetings on time." (P9) The team charter had several communication-related purposes including providing a forum for discussing preferred team dynamics, individual preferences, and the importance of being open about things that have gone wrong.

"Initially, we had a team charter session, you know, it's about talking about the team dynamics, that relationship we want to have in the team … everybody talks about, 'Oh, this is what I don't like, this is what how I like' ... usually when a new team is formed, we have the team charter session, <u>which kind of makes people understand what each other's preferences</u> are. So, during that time, definitely we talk about, … it's important to be open. And … it's important to admit if something goes wrong." (P10)

Scrum (Schwaber & Beedle, 2002; Schwaber & Sutherland, 2020) does not mention team charters but they are often introduced by agile and Scrum coaches. Team charters are not a new idea (Wilkinson & Moran, 1998) but they are accepted practice in project management

(PMI, 2021) and agile software development (Griffiths et al., 2017) but research on team charters is scant in agile software development or GD Scrum. The quotes above mention that when the charter is being developed by the team, this provides an opportunity to talk about and show openness. Therefore, this practice would have benefits for any type of agile team but would particularly help a GD team to act transparently and discuss how they will achieve communication quality and discipline.

5.5 Create a safe environment for communicating

The environment must be a safe place for team members before authentic communication will occur. Our participants thought that striving for a safe environment, although a challenge, was important for effective communication. P2 said, *"… this is actually quite difficult because you actually don't know how they work with each other. So, I guess, trying to encourage that <u>open communication</u> or <u>over communicating</u> to them. Like, guys, <u>again, we are one team we have one goal here</u> as much as possible. Can we all be open and transparent and have the courage to have the least difficult conversation upfront, when there is something wrong? And then to really share with them that … this is respected and … <u>this is a safe environment to speak up</u> if we have something in mind."*

Hennel and Rosenkranz (2021, p. 11) said about agile teams *that "team members need to feel safe to speak freely"*. This idea of a safe work environment is called psychological safety which is *"a shared belief held by members of a team that the team is safe for interpersonal risk taking"* (Edmondson, 1999, p. 354). In these environments, team members are more likely to seek feedback, ask for help, speak up about concerns or mistakes, and explore innovative ideas (Edmondson, 1999). In GD Scrum, different teams can have different cultural, national, and workplace expectations and norms so being explicit about what a 'safe environment' means is necessary and might not always be easily achieved. Thorgren and Caiman (2019) explored this issue in a single case study of GD Scrum between teams in Europe and South America. They found major differences between the distributed teams in their attitudes toward inclusiveness, perceptions of, and trust in collective responsibility, and openness in communication, and overcoming these differences can take ongoing time and effort.

5.6 Model good communication behaviour

Modelling good communication behaviour was considered important. One participant noted that he tried to model good behaviour by discussing his own mistakes so that other team members would feel it was safe to follow this practice. P10 explained that, *"what I particularly tried to do is … what I said, … there are … many instances where I would just say, <u>'Oh, I actually made a mistake'</u>, it's probably something that the team really doesn't need to know, it could be something that is between just the product owner and me, but <u>I would admit that in front of the team</u> so that they know, … <u>if I can admit them, they can also admit if things go wrong with their work</u>. So, I think that is extremely important to … show them how it feels when you admit your mistakes."*

This advice is related to encouraging a work environment that supports psychological safety. The participant is modelling the behaviour he wants to encourage in the team. This type of role modelling is reported in a case study of collocated Scrum when onboarding newcomers into agile teams (Gregory et al., 2022), but otherwise, there is scant research on this topic in agile literature. The agile coach role does include advice to model agile-related behaviours and this guidance seems appropriate for all forms of Scrum adoption, GD or collocated (Adkins, 2010).

5.7   Respect personal boundaries when communicating across time zones

Respect for personal boundaries when communicating across time zones is a way to maintain effective communication. P1 explained what happened during the COVID-19 pandemic lockdowns, *"There are so many different means of communication right now. I know video, voice, and text, and I saw a lot of software that helps you deal with those things. but I think sometimes the communication, especially nowadays like when the pandemic hit … it became more … personal and touchier … <u>you have to know how to communicate with people</u> so it's like I was constantly learning when the lockdowns started. I know some simple things when you call someone, <u>someone doesn't turn the camera on or someone does</u> … One way you communicate different things is when you speak to people from, different places of the world they're different… especially when it's a global distribution, … there are certain nationality traits or … personality characteristics that you have to consider, and we have to always be mindful about… For example, teams in Asia, most of them, they try to work as hard as they can. They're literally available 24/7. And, … you have to be mindful of people's time, … you cannot … just go and randomly ask the question in the middle of the night and just not even expecting a response but try sending, sharing the communication, even talking to someone, even messaging or emailing someone <u>when it's [not their work] time</u>. It may hurt so much [i.e., damage relationships] … Now, when the pandemic … happened, people just lost track of working time. That's just very bad … I think that by then, …, people should be … more <u>mindful about others' time</u> right now … I think that's the most important thing for communication."*

Communicating when there are time zone differences between agile teams is a central issue in GD agile software development (Alzoubi et al., 2016). Alzoubi et al. (2016), based on an SLR, report that respecting work timetables and religious holidays is related to time zone differences. They recommend making certain meetings mandatory whereas our participants recommend respecting and accommodating a team member's personal time frames. Respecting personal boundaries regarding time and interruptions is seldom mentioned explicitly in GD Scrum sources.

5.8   Consider personal communication preference mismatches

Personal communication preferences need to be considered to support effective communication. This communication is at the individual level and can be as simple as a preference for email or phone for quick communications. Three participants acknowledged the challenge of personal communication preference mismatch. P1 explained it this way, *"Basically, the nature of the distribution is that … at some point, it gets very personal … especially when we talk about communication, one person prefers one way, the other person prefers to [communicate in] another way … as a product manager I spent 90% of my day just talking to people or writing, or … in some way or form communicating to others, and yes it's very personal ... And I think it is the same for everyone. <u>Trying to understand how to properly communicate with your peers</u>, with someone you work with all the time is the most important … thing."*

This practical advice involves identifying communication preferences and adapting to them. This is a specific piece of advice not explicitly addressed in GD agile or Scrum studies. A survey by Hoffmann et al. (2022) (pre-COVID-19 pandemic) of human-related challenges in software engineering teams (192 respondents worldwide; 38% distributed; agile use not reported) identified different communication preferences as an interpersonal challenge reported by respondents in a qualitative section of their survey. This study, however, did not report if the degree of team distribution increases this issue with communication preferences.

5.9 Use agile practices for communication

Scrum practices contribute to effective communication. P5 found that careful and clear communication helped the distributed team to be autonomous because it gave them a clear idea of what was required and helped them understand what should be happening next. This included the verbal and written communication that typically occurs when engaged in Scrum ceremonies such as stand-up meetings and in the use of artefacts such as user stories. P5 explained, *"The key thing is … clarity when you're working with a team, it needs to be really clear what they're doing next, and that sort of thinking from product owner to team … communication. And so <u>leveraging things like user stories</u>, which we still use, is quite useful. Making sure that we are using things like stand ups effectively. … I think this communication helps the team move forward. … it should be … open and more of a dialogue … I mentioned how we use our stand-ups; we don't use them for status updates. We use them to get a picture of our work, and to decide what the next most useful thing we could do as a team is … it's not someone turning up and saying what needs to be done next. …good, <u>effective communication helps the team become more self-organising</u> is probably a good point here as well. And that's a combination of dialogue through video chat, it's a combination of well-written work and well-managed work, to the point where if I don't turn up to a stand-up, work still happens, and it still happens in the way that I've thought it might go anyway."*

One participant explained that even if the team was not distributed across time zones, they would not change their communication patterns but would continue to use their chosen agile practices to maintain effective communication. When the researcher asked, *"In the hypothetical situation where all the common challenges are resolved, can it be said that the communication definitely becomes effective in this case?"* P1 explained, *"Not really, I mean the communication is still going to be the very same. We'll have a bigger overlap in terms of the working hours or will have just one big overlap because the hours are the same, but the communication is still going to be the very same … <u>we won't change any practices</u> and will still do this Scrum [meeting conference] calls, will still do the backlog refinements and everything, we will still maintain our documentation, will still do the retrospectives, we still do the very same … things [agile ceremonies]."*

Agile practices are known to affect communication in collocated projects (Pikkarainen et al., 2008; Sharp & Robinson, 2010). Scrum has multiple regular meetings where communication occurs (e.g., planning meetings, daily meetings, retrospectives, and product demonstrations), and artefacts such as task boards display sprint backlogs to communicate information (Schwaber & Sutherland, 2020), and the agile manifesto recommends colocation to enable communication (Beck et al., 2001a). In distributed situations, meetings and artefacts enable communication, although their effectiveness is likely to be moderated by the availability of good internet connections, virtual task wallboards (Sallin & Kropp, 2022) and other collaboration tools for software engineering (Jackson et al., 2022).

5.10 Look for the root causes of problematic communication

Even if the communication problems caused by time zone differences were removed, communication might still be difficult. P9 explained that time zone differences might be blamed for poor communication when the underlying cause was a performance issue; for example, one person who is tardy in responding to emails can affect non-distributed work but have a more serious effect on the progress of daily work if the long time-lag due to the time zone difference is not considered. P9 explained, *"I think if we could fix all of those [challenges], we'd still find another problem that we thought was related to those things and actually wasn't. So, we probably say, Oh, yeah, 'that's happening, because we've got a distributed team because of time zones'.*

And actually, you could find that <u>it was a performance issue</u> with someone just doesn't respond on time, because … they're not sending the emails on time, or they're not making the emails concise enough … I think that we probably blame these certain problems for why things are happening. And I think if it was all resolved, we'd find another set of problems that were happening for whatever reason. Yeah, that sounds really pessimistic, but I just don't think that <u>if those were solved, it's not the magic pill to improve communication</u>."

Problematic communication might be due to any number of causes and may not be due to the distributed nature of development as shown in the survey by Hoffmann et al. (2022) (see section 5.8) of problems in human aspects of software engineering where many of the same problems were reported in both collocated and distributed environments. This idea of finding root causes is not addressed in GD Scrum or agile literature but appears to be a sensible problem-solving tactic when looking for appropriate solutions to communication issues. The tactic is formalised as root-cause analysis in project management (PMI, 2021).

5.11 Allow for reduced body language signals in virtual communication

Non-effective communication when using virtual communication was attributed to the reduction in natural communication, in particular, the inability to read non-verbal communication signals conveyed by body language. P6 commented on the negative effect on communication when body language is not visible, *"Normal communication changes dramatically. If you study communication at any level, you realize instantly that there are different <u>levels of communication</u>. And that visual audio and text have different levels of how they are, not only communicated but … perceived. And a factor within those is also the physicality of being in the same room as the other person. Because of what body language represents. Body language is not just the face, this is the entire body. And it's the nuance of it as well. So, I may say something, and your toe may move. And I can only pick up that maybe if I'm in the room, and he can be asleep, or sad, or … But when you're doing a video call, a lot of it is lost. And there are difficulties depending on how people are, on how that will result, because some people will be very vocal and they … let you know, but other people are not that vocal, or they're not that direct. So, they will not address an issue unless you do it. So, <u>if you miss that physical trigger, you have no way of … addressing that</u>."*

There is a large body of knowledge on non-verbal communication because it contributes significantly to the messages and meanings perceived in face-to-face communication between humans (Hall et al., 2019). Virtual communication reduces non-verbal clues due to the nature of the communication media available (e.g., phone, teleconferencing, email, video calls, virtual boards, chat) (Jackson et al., 2022). The lack of non-verbal communication in virtual team interactions is generally agreed to be a problem (Morrison-Smith & Ruiz, 2020). In software engineering, research into the effect of a lack of non-verbal communication in GD teams is scant. Ciancarini et al. (2021) found that non-verbal communication helps to establish successful meetings and contributes to positive interactions among individuals in software engineering roles. They concluded that curbing or limiting non-verbal communication may cause work issues and reduce work effectiveness. The study was based on online interviews with 38 IT professionals in Russia with 45% of interviewees using Scrum and 21% using other agile methods, but if the interviewees worked in distributed teams was not reported. These results imply that GD Scrum teams using electronically mediated communication might suffer from less effective communication due to the lack of non-verbal clues in interactions such as meetings. However, specific advice on how to overcome this issue is not available. As we

argue in section 4, employing transparent, quality, and disciplined communication should help.

In summary, in the 11 items or practical advice we found that only two pieces of advice explicitly were related to agile practices, item 4 'hold team charter sessions', and item 9 'use agile practices for communication'. Item 3 'build relationships', and item 5 'create a safe environment' have been explored in GD Scrum studies, but the remainder of the items have not been a specific research focus in GD Scrum or agile studies.

Our list of practical advice is not exhaustive. For example, our participants did not mention problems that occur if teams speak different languages or have different accents. Therefore, our practical advice should be considered alongside other recent studies of GD Scrum or agile in remote contexts, especially if the advice is based on in-depth qualitative empirical data. For example, Šmite et al. (2021) provide specific advice on overcoming cultural barriers in GD Scrum teams, Bablo et al. (2023) provide lessons learned for improving communication when Scrum teams became virtual due to the COVID-19 pandemic as do Reunamäki and Fey (2023), who report solutions to communication issues in remote work in an agile organisation with non-IT agile teams. Espinosa et al. (2015) provide advice for managers on how to improve communication in follow-the-sun virtual teams, although not explicitly for software engineering teams. Even studies of how to configure communication tools in large collocated teams can provide practical ideas that might be appropriate for GD software development environments (Calefato et al., 2020).

6   Discussion

This study has addressed the question of what effective communication is in GD Scrum teams. The findings are based on the understanding and experiences of industry professionals conveyed in interviews. Qualitative content analysis was used to analyse the interview transcripts leading to two contributions, a theoretical model of effective communication in GD Scrum teams, and practical guidelines for improving and sustaining effective communication. Each model concept and each item of practical guidance is supported with relevant literature, wherever possible.

The first contribution of this study is a theoretical model of effective communication in GD Scrum teams. The model has four communication concepts. Three concepts are about conveying information, namely communication transparency, communication quality, and communication discipline, and the fourth concept is alignment (a shared mental model at the team level), which represents the convergence or outcome of these communication efforts. We have argued that communication transparency, quality, and discipline are likely to be necessary to achieve alignment. Alignment contributes to successful agile projects in collocated projects (Schmidt et al., 2014; Yu & Petter, 2014) but it is not clear how such projects develop in distributed software engineering environments (Espinosa et al., 2007; Florea & Stoica, 2019). Our model contributes to clarity by defining and providing empirical evidence for three antecedents to alignment and by arguing that alignment is equivalent to effective communication in GD Scrum teams.

Although this model includes concepts that occur in other studies of communication, in our model they are based on empirical evidence and supporting literature, and assembled uniquely, making a novel contribution to understanding effective communication in GD Scrum teams. The claim that alignment is equivalent to effective communication in GD Scrum

teams has not been made previously in the context of software development, as far as we are aware. Knowledge sharing is frequently referred to in virtual software engineering studies (Giuffrida & Dittrich, 2015; Kiely et al., 2022; Šmite et al., 2021) but our model takes this idea further by explaining how to share knowledge effectively and what the outcome of effective sharing is, which is alignment.

In section 4 where we defined and described the model, we already discussed literature related to each concept. We found that the concepts alignment and transparency are not unambiguous and unique because they are defined and discussed in both organisational (Christensen & Cheney, 2015) and Scrum literature (Schwaber & Sutherland, 2020). Communication quality and discipline appear to be unique concepts that do not occur in prior studies of software development communication. Therefore, these concepts may be more important for GD Scrum communication than in other contexts. This could be because communicators need to be more aware of communication issues and more thoughtful in taking actions to improve quality (e.g., with concise messages, speedy responses, and patience to ensure other parties have time to respond), and discipline (e.g., by following norms and using appropriate communication tools for the task).

The literature review did not identify any specific model of communication for collocated agile software development or Scrum with which we could compare our model. However, two GD agile software development studies address communication effectiveness. Alzoubi and Gill (2020) defined communication effectiveness when studying geographically distributed agile development (see section 2 Literature Review). They conceptualised communication effectiveness as a construct with task clarity and information sufficiency, detail, and accuracy as reflective measurement items. Our communication transparency (i.e., clear communication) concept includes the idea of 'task clarity' but otherwise their construct is not directly comparable with our theoretical concepts.

The closest model to our own is proposed by Bhatti and Ahsan (2017) (see section 2 Literature Review). Their focus was effective communication in GD software development and was not restricted to GD Scrum teams. Their model focuses on practices to support effective communication, whereas our model focuses on abstract communication concepts. For example, transparency and quality have no place in their framework, although our discipline concept includes the idea of using appropriate communication tools as does their model. Another difference is that Bhatti and Ahsan (2017) focused on communication with external stakeholders whereas our focus was on the GD Scrum team. This difference might be explained by the nature of Scrum and other agile approaches, where there are no direct managers and the key stakeholder, (i.e., the Product Owner) is considered a team member.

Our model of communication effectiveness in GD Scrum teams has implications for studies of communication, coordination, and collaboration in GD Scrum and agile software development. Communication facilitates coordination and collaboration (Sharp & Robinson, 2010); therefore, our model could contribute to studies of coordination and collaboration in GD Scrum teams by treating alignment as an antecedent to effective coordination and collaboration. Similarly, alignment might also contribute to quantitative studies of agile team success, effectiveness, or performance because effective communication is considered to contribute to these factors (Alzoubi & Gill, 2020).

For practitioners such as Scrum masters, agile project managers, coaches, and other professionals in Scrum teams this model shows that effective communication is achieved by

communicating with transparency, quality, and discipline. Practitioners might use this knowledge to select agile practices, or other practices, that tend to support transparency, quality, and discipline. They might also want to evaluate the quality of the inter and intra-team mental model (alignment) at intervals as this is an indicator of a team's effectiveness (Strode et al., 2022).

The second contribution of our study is practical guidance for people involved in globally distributed Scrum teams. We have identified 11 items that can improve or sustain effective communication in this context. Two items explicitly suggested using agile practices to enhance communication, two items have been explored in other agile studies (build relationships and provide safe environments for communication), and the remainder are not related to published agile practices. These items emerged directly from the advice of the participants and can be adopted directly by practitioners working in this context.

6.1 Limitations

The study has limitations. The model and practical guidance are based on evidence from a small number of English-speaking participants selected from a single source, LinkedIn™. This limitation affects the generalisability (external validity or transferability (Miles & Huberman, 1994)) of the model and the practical advice. This issue was mitigated by the application of specific selection criteria (see Appendix A) when selecting participants. We ensured that all participants were experts on the topic because they were involved closely in GD Scrum teams, were involved in managing communication, and had multiple experiences across several countries. Furthermore, to improve generalisability, we have discussed supporting literature for each concept in the model and their relationships. However, the model would benefit from large-scale field testing to validate its applicability to all GD Scrum teams, either with a survey or multiple case studies. For the practical advice, we have mitigated the lack of generalisability somewhat by indicating research that supports our items and suggested further appropriate sources of guidance.

The study had limitations that affected its internal validity (credibility or authenticity (Miles & Huberman, 1994)). The exclusion of developers from the study has introduced potential bias because developers might have different experiences of communication. We had a specific reason for this omission since our experiences and research indicated that certain team member roles (i.e., Scrum masters, agile coaches) often take responsibility for organising communication between distributed teams (Kristensen & Paasivaara, 2021; Srivastava & Jain, 2017) and so would provide an overview as well as specific examples of communication. This limitation should be addressed in future work to ensure that all roles that occur in development teams (such as programmers, testers, and product owners) are included in studies of GD communication.

The limitation of using online interviews may have reduced the richness of the data, thus reducing credibility. All interviews were remote due to COVID-19 pandemic restrictions and the geographical distribution of participants. Online interviews meant the interviewer may have missed cues that in-person interviews could reveal, although we did ask the participants for examples if their statements were not specific or unclear. Interviews can also suffer from researcher reactivity bias, which occurs when participants are encouraged to offer a particular opinion or are asked leading questions. This issue was mitigated by designing an interview schedule (See Appendix B) that was followed in each interview. The questions were open-ended, but the researcher was prepared to ask further questions, that were not predesigned,

to draw out additional details, explanations, or examples from the interviewee. There is also an issue of 'textbook answers', that is, when studying agile topics, the interviewer has to be aware of responses that are 'from the textbook' or recalled from a participant's recent training and are not the actual experiences of the participant. This issue can only be identified when the researcher is experienced enough to detect this type of response. Our interviewer was a certified and experienced Scrum master and project manager who was able to ask participants for specific examples to address this issue when it arose.

A further limitation was the lack of member checking, which means that the words or intent of the participants could have been misinterpreted. This is a threat to external reliability or confirmability (Miles & Huberman, 1994). Although the transcripts were fully analysed by a single researcher and then checked and discussed by another researcher this did not necessarily remove the risk of misinterpretation.

6.2 Future work

Avenues for future work on communication in GD Scrum could address these issues.

Are the model concepts necessary and sufficient? Large-scale field studies are needed to clarify if all three concepts are strictly necessary or if one has a more significant influence than the others. Further research could investigate if these three concepts are sufficient to achieve high levels of alignment or if there are other concepts involved that we did not find.

Can alignment be decomposed further? Different types of mental models exist, some might be relevant only to software development teams (e.g., the software architecture and team member technical expertise) (Mohammed et al., 2010), it would be beneficial to understand which mental models matter most in GD Scrum. Furthermore, the relationship between intra and inter-team mental models might make a valuable extension to the model.

Does the model account for communication in agile contexts other than GD Scrum teams? For example, in small-scale collocated Scrum, small-scale virtual Scrum (i.e., in work-from-home arrangements), in large-scale multi-team software development (Dingsøyr et al., 2014), or in any contexts where the global characteristics of time zone and language differences are absent.

Exactly what Scrum practices, sets of practices, or non-agile practices best support each communication model concept? A mapping of practices to concepts would better link this model to practice. This would help practitioners to select agile practices that have the most effect on communication.

Finally, our practical guidelines could be extended by assembling the research-based advice and lessons learned on communication in GD Scrum teams into a comprehensive set of guidelines for practitioners.

7 Conclusion

The article makes two contributions to a better understanding of what effective communication means in globally distributed (GD) Scrum teams. The first contribution is a theoretical model of communication effectiveness in GD Scrum teams based on interviews and supporting literature. The model has four elements: communication transparency, communication quality, and communication discipline, which contribute to alignment. The model equates alignment with effective communication, which is a unique aspect of the model. In addition, our findings indicate that communication quality and discipline may be uniquely

important for GD Scrum teams. This model can help researchers evaluate effective communication in GD teams that are using Scrum because the model defines and describes what effective communication means in that context. The second contribution of this study is practical guidance for GD Scrum practitioners on how to improve or sustain effective communication. This list of 11 items is based on interviews supported by existing research. This article also points to potential areas of future work that could enhance the communication model and strengthen the practical guidance.

Communication models and practical guidance for GD Scrum and agile contexts are important for project and team success. This knowledge needs constant refreshing because communication tools improve rapidly and can change the way people communicate, meaning that communication models and advice in one decade may differ in the next decade. However, even if communication tools begin to closely mimic in-person information sharing, the need to understand, respect, and accommodate cultural differences, adapt to communication norms, and accommodate time zone differences is likely to remain.

References

Adkins, L. (2010). Coaching agile teams: A companion for Scrum masters, agile coaches, and project managers in transition. Boston, Ma, USA: Addison-Wesley Professional.

Ågren, P., Knoph, E., & Berntsson Svensson, R. (2022). Agile software development one year into the COVID-19 pandemic. *Empirical Software Engineering*, *27*(6), 121. https://doi.org/10.1007/s10664-022-10176-9

Ahmad, M. O., Lenarduzzi, V., Oivo, M., & Taibi, D. (2018). *Lessons learned on communication channels and practices in agile software development*. Presented at the Federated Conference on Computer Science and Information Systems (FedCSIS), September 9-12, 2018, Poznan, Poland. https://ieeexplore.ieee.org/abstract/document/8511256

Alzoubi, Y. I., & Gill, A. Q. (2020). An empirical investigation of geographically distributed agile development: The agile enterprise architecture is a communication enabler. *IEEE Access*, *8*, 80269-80289. https://doi.org/10.1109/ACCESS.2020.2990389

Alzoubi, Y. I., Gill, A. Q., & Al-Ani, A. (2016). Empirical studies of geographically distributed agile development communication challenges: A systematic review. *Information & Management*, *53*(1), 22-37. https://doi.org/10.1016/j.im.2015.08.003

Amar, H., Rafi-ul-Shan, P. M., & Adegbile, A. (2019). Towards a 5C theory of communication for Scrum-based distributed projects. In *Proceedings of the British Academy of Management Conference, BAM2019*. British Academy of Management . Aston University, Birmingham, September 3-5 2019. https://irep.ntu.ac.uk/id/eprint/38776/

Andriyani, Y., Hoda, R., & Amor, R. (2017). Reflection in agile retrospectives. In H. Baumeister, H. Lichter, & M. Riebisch (Eds.), *Proceedings of the 18th International Conference on Agile Processes in Software Engineering and Extreme Programming, XP 2017* (pp. 3-19). Cologne, Germany, May 22-26, 2017 (pp. 3-19). Berlin, Germany: Springer Open. https://doi.org/10.1007/978-3-319-57633-6

Anwar, R., Rehman, M., Wang, K. S., & Hashmani, M. A. (2019). Systematic literature review of knowledge sharing barriers and facilitators in global software development organizations using concept maps. *IEEE Access*, *7*, 24231-24247. https://doi.org/10.1109/ACCESS.2019.2895690

Bablo, J., Marcinkowski, B., & Przybylek, A. (2023). Overcoming challenges of virtual Scrum teams: Lessons learned through an action research study. In C. J. Stettina, J. Garbajosa, & P. Kruchten (Eds.), *Proceedings of the 24th International Conference on Agile Software Development, XP 2023* (pp. 34-49). Amsterdam, The Netherlands, June 13–16, 2023. Berlin, Germany: Springer Nature. https://doi.org/10.1007/978-3-031-33976-9

Baham, C., & Hirschheim, R. (2022). Issues, challenges, and a proposed theoretical core of agile software development research. *Information Systems Journal*, *32*(1), 103-129. https://doi.org/10.1111/isj.12336

Bastiaansen, C. A. J., & Wilderom, C. P. M. (2021). Agile and generic work values of British vs Indian IT workers: a culture-clash case. *Journal of Strategy and Management*, *15*(3), 353-376. https://doi.org/10.1108/JSMA-03-2021-0071

Beck, K., Beedle, M., van Bennekum, A., Cockburn, A., Cunningham, W., Fowler, M., Grenning, J., Highsmith, J., Hunt, A., Jeffries, R., Kern, J., Marick, B., Martin, R. C., Mellor, S., Schwaber, K., Sutherland, J., & Thomas, D. (2001a). *Manifesto for agile software development*. http://www.agilemanifesto.org

Beck, K., Beedle, M., van Bennekum, A., Cockburn, A., Cunningham, W., Fowler, M., Grenning, J., Highsmith, J., Hunt, A., Jeffries, R., Kern, J., Marick, B., Martin, R. C., Mellor, S., Schwaber, K., Sutherland, J., & Thomas, D. (2001b). *Principles behind the agile manifesto*. http://agilemanifesto.org/principles.html

Berger, C. R. (2005). Interpersonal communication: Theoretical perspectives, future prospects. *Journal of Communication*, *55*(3), 415-447. https://doi.org/10.1111/j.1460-2466.2005.tb02680.x

Bhatti, M. W., & Ahsan, A. (2017). Effective communication among globally distributed software development teams: Development of an "effective communication" scale. *Journal of Global Information Management*, *25*(3), 40-62. https://doi.org/10.4018/JGIM.2017070103

Bickman, L., & Rog, D. J. (2009). Applied research design: A practical approach. In L. Bickman & D. J. Rog (Eds.), *The SAGE handbook of applied social research methods* (2 ed., pp. 3-34). New York, NY, USA: SAGE publications.

Bjarnason, E., Smolander, K., Engström, E., & Runeson, P. (2016). A theory of distances in software engineering. *Information and Software Technology*, *70*, 204-219. https://doi.org/10.1016/j.infsof.2015.05.004

Bjarnason, E., Wnuk, K., & Regnell, B. (2011). Requirements are slipping through the gaps—A case study on causes & effects of communication gaps in large-scale software development. In J. Mylopoulos (Ed.), *IEEE 19th International Requirements Engineering Conference, Trento, Italy.* (pp. 37-46). IEEE. https://doi.org/10.1109/RE.2011.6051639

Bundhun, K., & Sungkur, R. K. (2021). Developing a framework to overcome communication challenges in agile distributed teams–Case study of a Mauritian-based IT service delivery centre. *Global Transitions Proceedings*, *2*(2), 315-322. https://doi.org/10.1016/j.gltp.2021.08.006

Calefato, F., Giove, A., Lanubile, F., & Losavio, M. (2020). A case study on tool support for collaboration in agile development. In P. Tell, I. Steinmacher, & R. Britto (Eds.),

Proceedings of the 15th IEEE/ACM International Conference on Global Software Engineering, ICGSE '20. Seoul, Republic of Korea, June 26 - 28, 2020 (pp. 11-21). ACM. https://doi.org/10.1145/3372787.3390436

Carmel, E., & Agarwal, R. (2001). Tactical approaches for alleviating distance in global software development. *IEEE Software*, *18*(2), 22-29. https://doi.org/10.1109/52.914734

Casey, V. (2010). Developing trust in virtual software development teams. *Journal of Theoretical and Applied Electronic Commerce Research*, *5*(2), 41-58. https://doi.org/10.4067/S0718-18762010000200004

Chang, H. H., Chuang, S.-S., & Chao, S. H. (2011). Determinants of cultural adaptation, communication quality, and trust in virtual teams' performance. *Total Quality Management*, *22*(3), 305-329. https://doi.org/10.1080/14783363.2010.532319

Christensen, L. T., & Cheney, G. (2015). Peering into transparency: Challenging ideals, proxies, and organizational practices. *Communication Theory*, *25*(1), 70-90. https://doi.org/10.1111/comt.12052

Ciancarini, P., Farina, M., Masyagin, S., Succi, G., Yermolaieva, S., & Zagvozkina, N. (2021). Non verbal communication in software engineering–an empirical study. *IEEE Access*, *9*, 71942-71953. https://doi.org/10.1109/ACCESS.2021.3075983

Cooren, F., Kuhn, T., Cornelissen, J. P., & Clark, T. (2011). Communication, organizing and organization: An overview and introduction to the special issue. *Organization Studies*, *32*(9), 1149-1170. https://doi.org/10.1177/01708406114108

Creswell, J. W., & Poth, C. N. (2016). Qualitative inquiry and research design: Choosing among five approaches. New York, NY, USA: SAGE publications.

DeFranco, J. F., & Laplante, P. (2018). A software engineering team research mapping study. *Team Performance Management: An International Journal*, *24*(3/4), 203-248. https://doi.org/10.1108/TPM-08-2017-0040

Defranco, J. F., & Laplante, P. A. (2017). Review and analysis of software development team communication research. *IEEE Transactions on Professional Communication*, *60*(2), 165-182. https://doi.org/10.1109/TPC.2017.2656626

Dennis, A. R., Fuller, R. M., & Valacich, J. S. (2008). Media, tasks, and communication processes: A theory of media synchronicity. *MIS Quarterly*, *32*(3), 575-600. https://doi.org/10.2307/25148857

Diegmann, P., Dreesen, T., Binzer, B., & Rosenkranz, C. (2018). Journey towards agility: Three decades of research on agile information systems development. In *Proceedings of the 39th International Conference on Information Systems. San Francisco, California, USA, December 13-18, 2018.* AIS. https://aisel.aisnet.org/icis2018/management/Presentations/4

digital.ai. (2022). *16th Annual State of Agile Report*. digital.ai. https://digital.ai/resource-center/analyst-reports/state-of-agile-report/

Dingsøyr, T., Fægri, T. E., & Itkonen, J. (2014). What is large in large-scale? A taxonomy of scale for agile software development. In A. Jedlitschka, P. Kuvaja, M. Kuhrmann, T. Männistö, J. Münch, & M. Raatikainen (Eds.), *Product-Focused Software Process Improvement.*

PROFES 2014. LNCS vol 8892. (pp. 273-276). Berlin, Germany: Springer. https://doi.org/10.1007/978-3-319-13835-0_20

Dorairaj, S., Noble, J., & Malik, P. (2011). Effective communication in distributed Agile software development teams. In A. Sillitti, O. Hazzan, E. Bache, & X. Albaladejo (Eds.), *Proceedings of the International Conference on Agile Software Development: Agile Processes in Software Engineering and Extreme Programming, XP 2011.* LNBIP 77 (pp. 102-116). Berlin, Germany: Springer. https://doi.org/10.1007/978-3-642-20677-1_8

Drechsler, A., & Breth, S. (2019). How to go global: A transformative process model for the transition towards globally distributed software development projects. *International Journal of Project Management*, *37*(8), 941-955. https://doi.org/10.1016/j.ijproman.2019.08.003

Dubin, R. (1978). *Theory Building*. Los Angles, CA, USA: The Free Press.

Ebert, C., & Paasivaara, M. (2017). Scaling agile. *IEEE Software*, *34*(6), 98-103. https://doi.org/10.1109/ICGSE.2016.34.

Eckstein, J. (2013). Agile software development in the large: Diving into the deep. Boston, MA, USA: Addison-Wesley.

Edmondson, A. (1999). Psychological safety and learning behavior in work teams. *Administrative Science Quarterly*, *44*(2), 350-383. https://doi.org/https://doi.org/10.2307/2666999

Edmondson, A. C., & McManus, S. E. (2007). Methodological fit in management field research. *Academy of Management Review*, *32*(4), 1155-1179. https://doi.org/10.5465/amr.2007.26586086

Edmondson, S., & Chiu, Y.-T. (2020). Exploring the Impact of Mental Models on Scrum Outcomes: Insights from Scrum Teams in New Zealand Government. In *Proceedings of the Australasian Conference on Information Systems, ACIS 2020* (pp. 1-12). AIS. https://aisel.aisnet.org/acis2020/25

Eisenhardt, K. M., & Graebner, M. E. (2007). Theory building from cases: Opportunities and challenges. *Academy of Management Journal*, *50*(1), 25-32. https://doi.org/10.5465/amj.2007.24160888

Espinosa, A. J., Kraut, R. E., Lerch, J. F., Slaughter, S. A., Herbsleb, J. D., & Mockus, A. (2001). Shared mental models and coordination in large-scale, distributed software development. In *Proceedings of the 22nd International Conference on Information Systems, ICIS, paper 64* (pp. 513-518). December 16-19, 2001, New Orleans, Louisiana, USA. AIS. http://aisel.aisnet.org/icis2001/64

Espinosa, A. J., Slaughter, S. A., Kraut, R. E., & Herbsleb, J. D. (2007). Team knowledge and coordination in geographically distributed software development. *Journal of Management Information Systems*, *24*(1), 135-169. https://doi.org/10.2753/MIS0742-1222240104

Espinosa, J. A., & Carmel, E. (2003). The impact of time separation on coordination in global software teams: a conceptual foundation. *Software Process: Improvement and Practice*, *8*(4), 249-266. https://doi.org/10.1002/spip.185

Espinosa, J. A., Nan, N., & Carmel, E. (2015). Temporal distance, communication patterns, and task performance in teams. *Journal of Management Information Systems*, *32*(1), 151-191. https://doi.org/10.1080/07421222.2015.1029390

Fawole, O. A., Dy, S. M., Wilson, R. F., Lau, B. D., Martinez, K. A., Apostol, C. C., Vollenweider, D., Bass, E. B., & Aslakson, R. A. (2013). A systematic review of communication quality improvement interventions for patients with advanced and serious illness. *Journal of General Internal Medicine*, *28*, 570-577. https://doi.org/10.1007/s11606-012-2204-4

Florea, L., & Stoica, M. (2019). Exploration of team mental model characteristics to identify opportunities and hindrances in global virtual teamwork. *Management Revue*, *30*(1), 93-119. https://www.jstor.org/stable/26869687

Giuffrida, R., & Dittrich, Y. (2015). A conceptual framework to study the role of communication through social software for coordination in globally-distributed software teams. *Information and Software Technology*, *63*, 11-30. https://doi.org/10.1016/j.infsof.2015.02.013

González-Romá, V., & Hernández, A. (2014). Climate uniformity: Its influence on team communication quality, task conflict, and team performance. *Journal of Applied Psychology*, *99*(6), 1042-1058. https://doi.org/10.1037/a0037868

Gorard, S. (2013). Research design: Creating robust approaches for the social sciences. *Research Design*, 1-232. https://doi.org/10.4135/9781526431486

Gregor, S. (2006). The Nature of Theory in Information Systems. *MIS Quarterly*, *30*(3), 611-642.

Gregory, P., Strode, D. E., Sharp, H., & Barroca, L. (2022). An onboarding model for integrating newcomers into agile project teams. *Information and Software Technology*, *143*, 1-14. https://doi.org/10.1016/j.infsof.2021.106792

Griffiths, M., Fewell, M., Slusanschi, H., Matola, S., Rothman, J., Hartman, B., & Kauffman, B. (2017). *Agile Practice Guide.* Atlanta, GA, USA: Project Management Institute.

Hall, J. A., Horgan, T. G., & Murphy, N. A. (2019). Nonverbal communication. *Annual Review of Psychology*, *70*, 271-294. https://doi.org/10.1146/annurev-psych-010418-103145

Harris, T. E., & Sherblom, J. C. (2018). *Small Group and Team Communication*. Long Grove, IL, USA: Waveland Press.

Hennel, P., & Rosenkranz, C. (2021). Investigating the "socio" in socio-technical development: The case for psychological safety in agile information systems development. *Project Management Journal*, *52*(1), 11-30. https://doi.org/10.1177/8756972820933057

Herbsleb, J. D., & Mockus, A. (2003). An empirical study of speed and communication in globally distributed software development. *IEEE Transactions on Software Engineering*, *29*(6), 481-494. https://doi.org/10.1109/TSE.2003.1205177

Hidayati, A., Budiardjo, E. K., & Purwandari, B. (2020). Hard and soft skills for Scrum global software development teams. In K. Eko, K. Qin, & P. Lajbcygier (Eds.), *Proceedings of the 3rd International Conference on Software Engineering and Information Management, ICSIM '20* (pp. 110-114). https://doi.org/10.1145/3378936.3378966

Hoda, R., Salleh, N., Grundy, J., & Tee, H. M. (2017). Systematic literature reviews in agile software development: A tertiary study. *Information and Software Technology*, *85*, 60-70. https://doi.org/10.1016/j.infsof.2017.01.007

Hoffmann, M., Mendez, D., Fagerholm, F., & Luckhardt, A. (2022). The human side of software engineering teams: An investigation of contemporary challenges. *IEEE Transactions on Software Engineering*, *49*(1), 211-225. https://doi.org/10.1109/TSE.2022.3148539

Hummel, M., Rosenkranz, C., & Holten, R. (2013). The role of communication in agile systems development. *Business & Information Systems Engineering*, *5*(1), 343-355. https://doi.org/10.1007/s12599-013-0282-4

Jackson, V., van der Hoek, A., Prikladnicki, R., & Ebert, C. (2022). Collaboration tools for developers. *IEEE Software*, *39*(2), 7-15. https://doi.org/10.1109/MS.2021.3132137

Kadenic, M. D., de Jesus Pacheco, D. A., Koumaditis, K., Tjørnehøj, G., & Tambo, T. (2023). Investigating the role of Product Owner in Scrum teams: Differentiation between organisational and individual impacts and opportunities. *Journal of Systems and Software*, *206*, 111841. https://doi.org/10.1016/j.jss.2023.111841

Kelly, A. (2019). The Art of Agile Product Ownership. Berlin, Germany: Springer Link.

Kiely, G., Butler, T., & Finnegan, P. (2022). Global virtual teams coordination mechanisms: Building theory from research in software development. *Behaviour & Information Technology*, *41*(9), 1952-1972. https://doi.org/10.1080/0144929X.2021.1909141

Kipfelsberger, P., Raes, A., Herhausen, D., Kark, R., & Bruch, H. (2022). Start with why: The transfer of work meaningfulness from leaders to followers and the role of dyadic tenure. *Journal of Organizational Behavior*, *43*(8), 1287-1309. https://doi.org/10.1002/job.2649

Kittelman, S., Calvo-Amodio, J., & Martínez León, H. C. (2018). A systems analysis of communication: defining the nature of and principles for communication within human activity systems. *Systems Research and Behavioral Science*, *35*(5), 520-537. https://doi.org/10.1002/sres.2562

Kopczyńska, S., Ochodek, M., Piechowiak, J., & Nawrocki, J. (2022). On the benefits and problems related to using Definition of Done—A survey study. *Journal of Systems and Software*, *193*, 111479. https://doi.org/10.1016/j.jss.2022.111479

Kostin, D. (2021). *Effective communication in globally distributed Scrum teams* [Unpublished master's thesis]. Whitireia Polytechnic, New Zealand.

Kostin, D., & Strode, D. (2022) Effective communication in globally distributed Scrum teams. Proceedings of the Australasian Conference on Information Systems, ACIS 2022. https://aisel.aisnet.org/acis2022/5

Kristensen, S. H., & Paasivaara, M. (2021). What added value does a Scrum master bring to the organisation?—A case study at Nordea. In M. T. Baldassarre, G. Scanniello, & A. Skavhaug (Eds.), *47th Euromicro Conference on Software Engineering and Advanced Applications (SEAA)* (pp. 270-278). Palermo, Italy, *September 1-3, 2021.* IEEE. https://doi.org/10.1109/SEAA53835.2021.00041

Lampropoulos, G., & Siakas, K. (2018). Communication in distributed agile software development: Impact of social media–social networking. In P. Marchbank & G. Staples

(Eds.), *Proceedings of the Twenty Sixth International Conference on Computing and Quality SQM* (pp. 43-60). Southampton Solent University, UK.

Lechner, A., & Tobias Mortlock, J. (2022). How to create psychological safety in virtual teams. *Organizational Dynamics*, *51*(2). https://doi.org/10.1016/j.orgdyn.2021.100849

Leonardi, P. M. (2014). Social media, knowledge sharing, and innovation: Toward a theory of communication visibility. *Information Systems Research*, *25*(4), 796-816. https://doi.org/10.1287/isre.2014.0536

Lukusa, L., Geeling, S., Lusinga, S., & Rivett, U. (2021). Teamwork and project success in agile software development methods: A case study in higher education. In F. J. García-Peñalvo & A. García-Holgado (Eds.), *Eighth International Conference on Technological Ecosystems for Enhancing Multiculturality, TEEM'20, Salamanca, Spain* (pp. 885-891). ACM. https://doi.org/10.1145/3434780.3436648

Marinho, M., Camara, R., & Sampaio, S. (2021). Toward unveiling how SAFe framework supports agile in global software development. *IEEE Access*, *9*, 109671-109692. https://doi.org/10.1109/ACCESS.2021.3101963

Marlow, S. L., Lacerenza, C. N., Paoletti, J., Burke, C. S., & Salas, E. (2018). Does team communication represent a one-size-fits-all approach?: A meta-analysis of team communication and performance. *Organizational Behavior and Human Decision Processes*, *144*, 145-170. https://doi.org/10.1016/j.obhdp.2017.08.001

Maruping, L. M., & Matook, S. (2020). The multiplex nature of the customer representative role in agile information systems development. *MIS Quarterly*, *44*(3). https://doi.org/10.25300/MISQ/2020/12284

McChesney, I. R., & Gallagher, S. (2004). Communication and co-ordination practices in software engineering projects. *Information and Software Technology*, *46*(7), 473-489. https://doi.org/10.1016/j.infsof.2003.10.001

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis* (2 ed.). New York, NY, USA: SAGE Publications.

Mishra, D., Mishra, A., & Ostrovska, S. (2012). Impact of physical ambiance on communication, collaboration and coordination in agile software development: An empirical evaluation. *Information and Software Technology*, *54*(10), 1067-1078. https://doi.org/10.1016/j.infsof.2012.04.002

Mohammed, S., Ferzandi, L., & Hamilton, K. (2010). Metaphor no more: A 15-year review of the team mental model construct. *Journal of Management*, *36*(4), 876-910. https://doi.org/10.1177/0149206309356804

Mohr, J. J., & Sohi, R. S. (1995). Communication flows in distribution channels: Impact on assessments of communication quality and satisfaction. *Journal of Retailing*, *71*(4), 393-415. https://doi.org/10.1016/0022-4359(95)90020-9

Morrison-Smith, S., & Ruiz, J. (2020). Challenges and barriers in virtual teams: a literature review. *SN Applied Sciences*, *2*, 1-33. https://doi.org/10.1007/s42452-020-2801-5

Newell, S., David, G., & Chand, D. (2007). An analysis of trust among globally distributed work teams in an organizational setting. *Knowledge and Process Management*, *14*(3), 158-168. https://doi.org/10.1002/kpm.284

Orpen, C. (1997). The interactive effects of communication quality and job involvement on managerial job satisfaction and work motivation. *The Journal of Psychology*, *131*(5), 519-522. https://doi.org/10.1080/00223989709603540

Paasivaara, M., Durasiewicz, S., & Lassenius, C. (2008). Distributed agile development: Using Scrum in a large project. In F. Lanubile & B. Sengupta (Eds.), *Proceedings of the IEEE International Conference on Global Software Engineering, Bangalore, India.* (pp. 87-95). IEEE. https://doi.org/10.1109/ICGSE.2008.38

Petter, S., & Randolph, A. B. (2009). Developing soft skills to manage user expectations in IT projects: Knowledge reuse among IT project managers. *Project Management Journal*, *40*(4), 45-59. https://doi.org/10.1002/pmj.20

Pikkarainen, M., Haikara, J., Salo, O., Abrahamsson, P., & Still, J. (2008). The impact of agile practices on communication in software development. *Empirical Software Engineering*, *13*(3), 303-337. https://doi.org/10.1007/s10664-008-9065-9

PMI. (2021). The standard for project management and a guide to the project management body of knowledge (PMBOK Guide) (7 ed.). Atalanta, GA, USA: Project Management Institute.

Poole, M. S. (1999). Group communication theory. In L. R. Frey (Ed.), *The Handbook of Group Communication Theory and Research* (pp. 37-70). New York, NY, USA: SAGE Publications.

Pooley, J. D. (Ed.). (2016). *Communication theory and the disciplines*. Hoboken, NJ, USA: John Wiley & Sons, Inc. https://doi.org/10.1002/9781118766804.wbiect261.

Reunamäki, R., & Fey, C. F. (2023). Remote agile: Problems, solutions, and pitfalls to avoid. *Business Horizons*, *66*(4), 505-516. https://doi.org/10.1016/j.bushor.2022.10.003

Salas, E., Sims, D. E., & Burke, C. S. (2005). Is there a 'big five" in teamwork? *Small Group Research*, *36*(5), 555-599. https://doi.org/10.1177/1046496405277134

Sallin, M., & Kropp, M. (2022). Benefits of card walls in agile software development: A systematic literature review. In V. Stray, K. J. Stol, M. Paasivaara, & P. Kruchten (Eds.), *Proceedings of the International Conference on Agile Processes in Software Engineering and Extreme Programming. XP 2022. Lecture Notes in Business Information Processing, vol 445.* (pp. 3-18). Berlin, Germany: Springer. https://doi.org/10.1007/978-3-031-08169-9_1

Sarker, S., Xiao, X., & Beaulieu, T. (2013). Guest editorial: Qualitative studies in information systems: A critical review and some guiding principles. *MIS Quarterly*, *37*(4), iii-xviii.

Schmidt, C., Kude, T., Heinzl, A., & Mithas, S. (2014). *How agile practices influence the performance of software development teams: The role of shared mental models and backup.* 35th International Conference on Information Systems, ICIS 2014, Auckland, New Zealand, https://aisel.aisnet.org/icis2014/proceedings/ProjectManagement/15

Schreier, M. (2014). Qualitative content analysis. In U. Flick (Ed.), *The SAGE handbook of qualitative data analysis* (pp. 170-184). New York, NY, USA: SAGE Publications. https://doi.org/10.4135/9781446282243.n12

Schwaber, K. (1997). SCRUM development process. In J. Sutherland, C. Casanave, J. Miller, P. Patel, & G. Hollowell (Eds.), *Business Object Design and Implementation* (pp. 117-134). London, UK: Springer. https://doi.org/10.1007/978-1-4471-0947-1_11

Schwaber, K., & Beedle, M. (2002). *Agile software development with Scrum*. Hoboken, NJ, USA: Prentice Hall.

Schwaber, K., & Sutherland, J. (2020). *The Scrum Guide*. Scrumguides.org. https://www.scrumguides.org/docs/scrumguide/v2020/2020-Scrum-Guide-US.pdf

Sharp, H., & Robinson, H. (2010). Three 'C's of agile practice: Collaboration, coordination and communication. In T. Dingsoyr, T. Dyba, & N. B. Moe (Eds.), *Agile Software Development: Current Research and Future Directions*. Berlin, Germany: Springer. https://doi.org/10.1007/978-3-642-12575-1

Sinek, S. (2011). Start with why: How great leaders inspire everyone to take action. New York, NY, USA: Penguin.

Smart, J. (2018). To transform to have agility, dont do a capital a, capital t agile transformation. *IEEE Software*, *35*(06), 56-60. https://doi.org/10.1109/MS.2018.4321245

Šmite, D., Moe, N. B., & Gonzalez-Huerta, J. (2021). Overcoming cultural barriers to being agile in distributed teams. *Information and Software Technology*, *138*, 106612. https://doi.org/10.1016/j.infsof.2021.106612

Srivastava, P., & Jain, S. (2017). A leadership framework for distributed self-organized scrum teams. *Team Performance Management*, *23*(5/6), 293-314. https://doi.org/10.1108/TPM-06-2016-0033

Stavru, S. (2014). A critical examination of recent industrial surveys on agile method usage. *Journal of Systems and Software*, *94*, 87-97. https://doi.org/10.1016/j.jss.2014.03.041

Stray, V., Fægri, T. E., & Moe, N. B. (2016). Exploring norms in agile software teams. In P. Abrahamsson, A. Jedlitschka, A. Nguyen Duc, M. Felderer, S. Amasaki, & T. Mikkonen (Eds.), *Proceedings of the International Conference on Product-Focused Software Process Improvement. PROFES 2016. Lecture Notes in Computer Science, vol 10027.* (pp. 458-467). Springer. https://doi.org/10.1007/978-3-319-49094-6_31

Stray, V., & Moe, N. B. (2020). Understanding coordination in global software engineering: A mixed-methods study on the use of meetings and Slack. *Journal of Systems and Software*, *170*, 110717. https://doi.org/10.1016/j.jss.2020.110717

Stray, V. G., Lindsjørn, Y., & Sjøberg, D. I. (2013). Obstacles to efficient daily meetings in agile development projects: A case study. In *2013 ACM/IEEE International Symposium on Empirical Software Engineering and Measurement* (pp. 95-102). IEEE. https://doi.org/10.1109/ESEM.2013.30

Strode, D. E., Dingsøyr, T., & Lindsjorn, Y. (2022). A teamwork effectiveness model for agile software development. *Empirical Software Engineering*, *27*(56), 50. https://doi.org/10.1007/s10664-021-10115-0

Thorgren, S., & Caiman, E. (2019). The role of psychological safety in implementing agile methods across cultures. *Research-Technology Management*, *62*(2), 31-39. https://doi.org/10.1080/08956308.2019.1563436

Tyagi, S., Sibal, R., & Suri, B. (2022). Empirically developed framework for building trust in distributed agile teams. *Information and Software Technology*, *145*, 106828. https://doi.org/10.1016/j.infsof.2022.106828

Vallon, R., da Silva Estácio, B. J., Prikladnicki, R., & Grechenig, T. (2018). Systematic literature review on agile practices in global software development. *Information and Software Technology*, *96*, 161-180. https://doi.org/10.1016/j.infsof.2017.12.004

Wachsmuth, I., De Ruiter, J., Jaecks, P., & Kopp, S. (2013). *Alignment in communication: Towards a new theory of communication* (Vol. 6). Amsterdam, The Netherlands: John Benjamins Publishing.

Weber, R. (2012). Evaluating and developing theories in the information systems discipline. *Journal of the Association for Information Systems*, *13*(1), 1-30. https://doi.org/10.17705/1jais.00284

Wilkinson, N. L., & Moran, J. W. (1998). Team charter. *The TQM Magazine*, *10*(5), 355-361. https://doi.org/10.1108/09544789810231234

Wolf, C., Godulla, A., Beck, L., & Neubert, L. S. (2022). The role of internal communication in start-ups: State of research and practical approaches. *International Journal of Strategic Communication*, *16*(2), 255-272. https://doi.org/10.1080/1553118X.2021.2023544

Yagüe, A., Garbajosa, J., Díaz, J., & González, E. (2016). An exploratory study in communication in Agile global software development. *Computer Standards & Interfaces*, *48*, 184-197. https://doi.org/10.1016/j.csi.2016.06.002

Yates, J., & Orlikowski, W. (2002). Genre systems: Structuring interaction through communicative norms. *The Journal of Business Communication (1973)*, *39*(1), 13-35. https://doi.org/10.1177/002194360203900102

Yu, X., & Petter, S. (2014). Understanding agile software development practices using shared mental models theory. *Information and Software Technology*, *56*(8), 911-921. https://doi.org/10.1016/j.infsof.2014.02.010

Yue, C. A., Men, L. R., & Ferguson, M. A. (2019). Bridging transformational leadership, transparent communication, and employee openness to change: The mediating role of trust. *Public Relations Review, 45*(3), 101779. https://doi.org/10.1016/j.pubrev.2019.04.012

Appendix A: Participant Selection Questionnaire

The questionnaire in Table 1 was used to check that the participant was suitably qualified and experienced in communication in globally distributed Scrum teams.

	Question
1	Name
2	Do you have experience in the coordination of globally distributed Scrum team(s), including managing the team's remote communication? • Note: You can answer "Yes" if at least one team member was located in another country while Scrum practices were applied.
3	Please choose the Scrum practices you use/used with the globally distributed Scrum team (GDST) • "Sprint" concept • Sprint Demo • "Sprint backlog" concept • "Product backlog" concept • Daily Scrum meetings • Scrum Master role in the team • Product Owner role in the team
4	How many years of such experience have you had? • Less than 1 year • 1-3 years • 3 years or more
5	What is/was your official position in the organisation while coordinating GDST?
6	What country and city do/did you live in (when participating in the GDST) and where the headquarters of your organisation is/was located (while participating in GDST)?

Table 3. Selection questionnaire

Appendix B: Semi-structured Interview Schedule

The questions in Table 4 show the interview questions and the purpose of each question.

	Interview question	Purpose
1	What is your role in the organisation (i.e., what work do you carry out)?	To learn about the Scrum role and how it relates to the official position
2	How is your globally distributed Scrum team organised (where are the developers, where are the managers, where are the customers located)?	To understand how the team is distributed and realise the potential challenges in communication
3	What type of software tools do you use in your team for communicating? Do you find them effective and why or why not?	To understand what tools contribute to communication and how effective they are for the people
4	Based on your experience, what Scrum practices do you consider to be effective in a globally distributed Scrum team?	To understand what Scrum practices are effective in a GDST
5	Based on your experience, what are the main communication challenges in globally distributed Scrum teams?	To realise the main challenges that prevent effective communication

6	How have you resolved these challenges? What challenges have you not been able to resolve?	To get recommendations to improve communication quality
7	How do you define effective communication in your projects? And why?	To understand the meaning of effective communication
8	How do you keep communication effective in GDST?	To get recommendations to keep communication effective
9	Are the challenges the only reason for non-effective communication in GDST?	To understand other potential reasons for non-effective communication

Table 4. Interview schedule