Journal of Software Engineering Research and Development, 2021, 9:16, doi: 10.5753/jserd.2021.804

On a Preliminary Theory of Communication in Distributed Software Development: A Grounded Theory-Based Research

Nelson Leitão Júnior [**Federal University of Pernambuco** | ***ngslj@cin.ufpe.br***]
Ivaldir de Farias Junior [**Pernambuco University - Garanhuns Campus** | ***ivaldir.farias@upe.br***]
Hermano Moura [**Federal University of Pernambuco** | ***hermano@cin.ufpe.br***]
Sabrina Marczak [**Pontifical Catholic University of Rio Grande do Sul** | ***sabrina.marczak@pucrs.br***]

Abstract

Communication is one of the leading challenges faced by teams working in a distributed setting; yet, little has been theorized about how communication occurs in such context. Our long-term research goal is to construct a Communication Theory in Distributed Software Development, aiming to propose a theoretical foundation for future academic studies on the topic of communication and a reference for industry practitioners. To achieve this goal, we are using Grounded Theory, including an Exploratory Literature Review before the theory construction, to confirm the research gap. In this paper, we present a further preliminary version of the Communication Theory comprising six theoretical categories and 31 subcategories. The theory brings, up to know, a consolidated body of knowledge and points out the main concepts that define what communication is in distributed software teams.

Keywords: *Distributed Software Development, Communication in Software Teams, Grounded Theory*

1 Introduction

The research community on *Distributed Software Development* (DSD) have been identifying *effective communication* as one of the leading issues in distributed teams (Carmel, 1999; Herbsleb et al., 2005; Shah et al., 2012; Aranda et al., 2010; Clear and Beecham, 2019) for some time, especially when considering distribution in a global scale (Aranda et al., 2010), named *Global Software Engineering* (GSE). Several organizations have been adopting DSD despite the odds of its benefits and challenges such as communication breakdowns that impose risks for the implementation of development projects and affect the software process quality (Cruzes et al., 2016).

Given that the practice of DSD by software organizations dates from the mid 80s (Aoyama, 1997) and that the first edition of the most relevant conference on the topic *International Conference on Global Software Engineering* (ICGSE) has been hold for over a decade, we recognize that DSD is a business model that is no longer a future trend, but a reality in many software organizations. This context offers a mature scenario for better understanding communication in DSD.

By considering the inherent challenging nature of communication in DSD teams, due to aspects such as intensive asynchronous communication (Clear and Beecham, 2019), we argue that little or nothing was presented in the DSD literature about what communication is in those teams, in the form of a specific scientific theory. Moreover, we argue that the emergence of a Theory in Distributed Software Development to describe the phenomenon of communication in those teams is an essential step for supporting the future of DSD, as communication-related issues may lead to the disuse of this model. Thus, we expect that this theory is beneficial and can help to support the research effort in DSD area. First, by offering a scientific and theoretical foundation for future interventions on the improvement of communication in those teams. Second, by providing direct support for industry representatives on software engineering fronts, including risk, productivity, and people management in their DSD projects.

This paper contributes towards the definition of an analytical theory, i.e., to "analyze 'what is' as opposed to explaining causality or attempting predictive generalizations." (Gregor, 2006, p. 622). This theory has been developed using Grounded Theory from the ground up, including its self-evaluation embedded within the research process. A first preliminary version was already published (Leitão Júnior et al., 2019). Here, we present the evolution of this theory by adding a more advanced and detailed version of our theory, including one new theoretical category, refactored classes from the first version and new subcategories to the theory structure, as well as our full descriptive content of the communication phenomenon, based on the analysis of our most recent data.

The remainder of this paper is organized as follows. Section 2 presents the research method. Section 3 presents the results from the first research step, the exploration of the study gap. Section 4 shows the results from the usage of Grounded Theory for constructing the communication theory. Section 5 presents the further preliminary version of the Theory of Communication in Distributed Software Development Teams. Section 6 brings related work. Section 7 presents a discussion on findings, followed by Section 8, that brings the threats to validity and future work.

2 Communication and DSD

There are at least three different views on communication theory: communication as a one-way process of meaning construction, in which the sender attempt to construct or reconstruct the receiver's view; as a two-way process, in which two or more individuals construct meaning together; communication as an omnidirectional diachronic process, focused on the

development of meaning itself (Van Ruler, 2018). Furthermore, when considering communication as a "concept", authors had presented many views on this matter, and there had no agreement on what communication to "to communicate" is (Van Ruler, 2018). In Classical Latin, communication refer to "share with", to "share out", "to make generally accessible" or to "to discuss" (Glare, 1968). Further in time, modern authors bound the concept of communication to the concept of "meaning" and its usage to interpret events, such as proposed by Littlejohn (Littlejohn and Foss, 1992) and Rosengreen (Rosengren, 2000). Rosengreen sees communication as a process of meaning creation in psychological, social, and cultural ways, including understanding messages and ambiguities solution (Rosengren, 2000). At this point, we choose Rosengarden's (Rosengren, 2000) view on communication for this research work because we believe that communication as a "meaning creation" process relates closely to professional software development on its multiple demands.

In this context, how can we place the communication context in DSD teams? In DSD, communication plays a significant role in the success of those projects. It allows team members to share information with stakeholders and clarify issues (Farias Junior, 2014), both in the context of colocalized and remote team members. Therefore, DSD teams largely depend on communication among those involved in the project, either directly or indirectly. In this context, the means of communication have a significant influence in the projects in distributed environments (de Farias Junior et al., 2016), as challenges associated with communication increase when the media chose to support distributed teams are not as rich as what face-to-face (in person) communication offer (Herbsleb et al., 2001).

3 Related work

We highlight in this section three studies that we used as a reference to this one. Those studies supported our methodological decisions and research planning, as follows.

3.1 Gregor's work

Gregor (Gregor, 2006) presented a research essay on the structural nature of theory in *Information Systems* (IS). The author brought to light the issues of causality, explanation, prediction, and generalization that underlies theories in IS. At this point, Gregor proposed a taxonomy on the classification of Theories in IS according to their goals, thereby framing theories on distinct aspects of analysis, explanation, prediction, and prescription. This study served as a reference for a better understanding of Theories' different nature and based our decision to delimiting our Theory as an Analytic one. That's because our Theory aims to describe a broad phenomenon by using an extensive analytic process, i.e., a *Grounded Theory* (GT) research on Communication in DSD teams.

Table 1. Research Characteristics

Epistemology	Constructivist
Approach	Qualitative
Objectives	Exploratory and Descriptive
Method	Grounded Theory

3.2 Charmaz's work

Charmaz (Charmaz, 2014) presented in mid-1990s her *Grounded Theory* (GT) proposal based on the original ideas from Glaser and Strauss (Birks and Mills, 2011). Her GT was presented as a constructivist focused GT proposal (Charmaz, 2006; Morse et al., 2016), with a greater focus on the voice of participants and their experiences, in the co-construction of data (Breckenridge et al., 2012), and in the relativism of multiple social realities (Charmaz, 2000) (Charmaz, 2006). The GT from Charmaz was our main methodological choice, as it presents a proposal in line with our epistemological orientation. Furthermore, the Charmaz's GT brings a proposal compatible with a local context, focusing on the voice of the participants and their experiences, thereby providing the means for better understanding the Communication Phenomenon in DSD (see Chapter 4).

3.3 Adolph's work

Adolph (Adolph, 2013) Performed a field study to understand how software development is managed. In this context, the author used *Grounded Theory* (GT) for proposing a substantive theory. Adolph brought the discussion on the adequate moment for interacting with an extensive literature review before creating his Theory via GT, due to aspects of introduction biases. At this point, Adolf's work served as a reference for dealing with preexisting literature in this study. Base on Adolph, we performed a preemptive (exploratory) literature review before the theory construction and an extensive literature review after the theory proposal.

4 Research Method

This study proposal comes from a Constructivist philosophical (epistemological) instance, i.e., a philosophy that considers the knowledge as a result of social construction, the truth relative to its context, the interpretation of theoretical terms, a tendency for qualitative methods, and a tendency for proposing local theories (Easterbrook and Neves, 2007). From the point of view of how to approach the problem, this research is of a qualitative nature, as it considers a dynamic relationship between individuals and the real world that could not be translated into numbers (Kauark et al., 2010). Furthermore, from the perspective of its objectives, this research is an exploratory and descriptive. Exploratory since it aims the familiarity with the problem, making it explicit (Gil, 2002). Descriptive since it aims to describe the characteristics of a given population or phenomenon (Gil, 2002), i.e., the communication phenomena in DSD teams. Table 1 summarizes the characteristics of this research.

Considering that the primary goal of this research is the proposal of a new theory, we have been using the GT method since it is a research method oriented for the generation of theories based on rigorous analysis of data (Glaser and Strauss, 2009). The use of GT is appropriate when there is a lack of knowledge or theory on a certain topic (Glaser and Strauss, 1967), and when no existing theories offer solutions (Chenitz and Swanson, 1986). Among the theorists from the vanguard of the GT, including Barney Glaser, Anselm Strauss (Glaser and Strauss, 1967) and Juliet Corbin, and in the path of the evolution of this research method, Kathy Charmaz, as a former student of Glaser proposed in the 2000s a new *Constructivist Grounded Theory* (CGT) approach. This research was based on the original ideas from Glaser and Strauss (Birks and Mills, 2011), that when compared to its original form, was presented as a Constructivist focused GT one (Morse et al., 2016). Thus, in the light of our Constructivist orientation, we adopted the GT school of Charmaz (Charmaz, 2014) in this research.

4.1 An Overview of Charmaz's Grounded Theory

The constructivist grounded theory from Charmaz begins with the proposed research question, followed by the recruitment and sampling of participants, also known as "Initial Sampling,". Next comes the data collection, both initial and focused coding, and the categorization process. Thus, based on the emerged categories, the new theory may be proposed and disseminated. In parallel with the entire process (except for the research question specification), Charmaz includes the practice of memo writing, constant comparative method and theoretical sampling, which will support the specification and evolution of theoretical categories. This process goes on in spiral cycles, that will continue until the theoretical saturation, i.e., when fresh data no longer sparks theoretical insights. We detail the main research activities in GT, according to Charmaz (Charmaz, 2014), as follows:

i. Research problem and opening research questions: to be defined on an initial basis;
ii. Initial sampling: to provide an "a point of departure, not of theoretical elaboration and refinement" (Charmaz, 2014), to define the criteria and establish how data will be accessed. In the context of this research, to plan and start our data retrieval process;
iii. Gathering rich data (Data collection): to collect rich, detailed, and full data;
iv. Initial coding: to code data, i.e., to "label bits of data according to what they indicate" (Charmaz, 2014, p. 19), a closely word-by-word, line-by-line or segment-by-segment data study to begin conceptualizing the ideas;
v. Focused coding: to separate, sort and synthesize substantial amounts of data, i.e., to select initial codes that stand out and to identify others, as the result of code comparison;
vi. Memo writing: to help with the process of developing ideas by writing extended notes on codes that crystalize meanings. Memos are informal analytic notes to construct theoretical categories, specify their properties, define relationships between other categories, and identify gaps (Charmaz, 2014);
vii. Theoretical sampling: this kind of sampling differs from the initial sampling process, as stated by Charmaz: "Initial sampling in grounded theory gets you started; theoretical sampling guides where you go." (Charmaz, 2014, p. 197).

4.2 Research Design

Our research design has been performed in two sequential steps. The first step is the *Gap Exploration Literature Review*. Such as performed by Adolf (Adolph et al., 2012) in his GT research, we performed a non-extensive (exploratory) literature review to confirm the absence of a specific theory for explaining the communication in DSD teams to sustain the choice of using GT as the main methodological approach. As the use of the GT method is appropriate when there is a lack of knowledge or theory of a topic (Glaser and Strauss, 1967), or when no existing theories offer solutions (Chenitz and Swanson, 1986). See Section 5 for the results of this research step. At this point, we avoided performing an extensive review prior to the theory construction, as we are aware of the discussion in the literature about using existing literature during a GT research and the possible inclusion of bias in the theory itself, i.e., in the theory to come (Dunne, 2011). Therefore, We plan to perform a later extensive literature review, as future work.

The second step is the *Theory Construction* via Grounded Theory, following Charmaz's specification (Charmaz, 2014). The GT approach is appropriated for this research for being a research method oriented for the generation of theories (Glaser and Strauss, 2009) and for allowing researchers to study social interactions and the people's behavior (Glaser and Strauss, 1967), in which the communication phenomenon resides. Furthermore, the specific Charmaz's GT proposal is the correct choice for this research context due to our constructivist philosophical (epistemological) orientation, i.e., as this approach has a greater focus on the voice of participants and their experiences, in the co-construction of data (Breckenridge et al., 2012) and in the relativism of multiple social realities (Charmaz, 2000).

4.3 Data Collection

We performed the data collection process via interview sessions according to Charmaz's Intensive Interviewing specification, i.e., open-ended interviews as one-sided conversations, gently guided by the interviewer, focusing on the interviewee's perspective, meanings, and experience (Charmaz, 2014). Therefore, we argue that the Intensive Interviewing in the context of GT is essentially a technique that aims at obtaining answers to the base question of "What's happening here?" (Glaser, 1978) and besides that, not necessarily relying on predefined questions, as the interviewer should further develop questions on the emerging concepts. Nevertheless, Charmaz recommends the construction of an interview guide for new researchers to help to think about the kinds of questions that help to achieve the research objectives (Charmaz, 2014, p. 62). Therefore, as this was our first incursion

Table 2. Characterization of the current research sample

ID	Sessions	IDs	α	β	γ	δ	ϵ	ζ	Role
A	1	i01	12	2	2	15	N	L	Portfolio Manager
B	1	i02	20	11	11	40	G	L	QA Lead.
C	1	i03	19	10	2	30	G	L	Designer
D	2	i04; i05	22	12	6	30	G	M	Proj. Mngr. (PM)
E	2	i06; i09	20	14	10	15	G	M	SW. Engineer
F	2	i07; i08	30	15	13	20	G	L	Tech. Lead.
G	1	i10	15	6	6	10	G	L	PM & Researcher

α Experience in IT (in years).

β Experience in DSD (in years).

γ Experience in DSD including Cultural Diversity (in years).

δ Maximum number of individuals in DSD project.

ϵ DSD Dispersion Level: National (N), Continental (C) or Global (G).

ζ Organization Size: (L) Large; (M) Medium; (S) Small; (m) Micro. According to *European Union* (EU) recommendation 2003/361.

Table 3. GT artifacts totals after 10 iterations

GT artifact	Totals
All quotations:	1167
Quotations in use:	858
Initial codes:	633
Focused codes:	42
Memos:	48
Theoretical categories:	6

on the GT method, we prepared an initial interview guide, followed by subsequent versions of this document. We present a sample of the questions that composed those the two initial versions of those guides, as follows.

i. *Please tell me about your work in DSD, how does it happen? How does the workflow and what is your role in this process?*;
ii. *How do you communicate with your boss or leader?*;
iii. *How does communication happen with your co-localized colleagues?*;
iv. *Communicating with your remote colleagues is different from communicating with co-localized ones? If that's true, it is different in which aspects?*;
v. *How do you feel in trying to communicate with your remote colleagues?*;
vi. *How is communicating with remote and local colleagues from a distinct culture?*;
vii. *How do you feel in trying to communicate with colleagues from other cultures?*.

Please keep in mind that we adapted those questions and created new ones during ongoing interviews and posterior ones, as emerging concepts demanded further data collection needs, i.e., as an operationalization of the Theoretical Sampling procedure (see Section vii.). In this context, we invited 12 DSD professionals, resulting in 5 rejections (or omissions) and the acceptance of 7 professionals who took part in 10 interviews. As we are also practitioners and researchers in Software Engineering, we used the help of our professional contacts in the software industry and the Linkedin social network for identifying and getting to professionals compatible with our research sample profile, i.e., professionals with relevant experience in IT and DSD teams, performing as practitioners or researchers. We first attempted an informal invitation for those professionals and later on, we proceeded for the formal invites. We achieved a response rate of 58.33%. Table 2 presents the professional characterization of these individuals, with emphasis on their professional DSD experience.

4.4 Data Analysis

This research is ongoing, and up to the elaboration of this paper, we performed 10 iterations of GT analysis, one for each interview transcript. We are using the Atlas.ti (available at atlasti.com) *Computer Assisted Qualitative Data Analysis Software* (CAQDAS) software tool, to help with the objective of this analysis, i.e., to assist in the process of uncovering the communication phenomenon within the interview scripts. In this context, we present in Table 3 an overall view of the current number of GT artifacts to better situate the ongoing analysis effort, based on metrics from the Atlas.ti tool. We performed the analysis process by codifying, writing memos, establishing relations, and comparing data. The theory is in its second preliminary version, emerged from data itself, grouped in the hierarchical concepts of initial codes, focused codes as subcategories, and focused codes as theoretical categories. Please notice that we did not perform any procedural approach for linking categories to subcategories, e.g., such as Axial Coding. At this point, we performed the link between those elements by establishing relations from data itself, without preconceived ideas or procedures, as an emerging rather than a procedural approach for linking data, just as suggested by Charmaz (Charmaz, 2014, p. 148).

5 Results from the Gap Exploration Review

To confirm the absence of a specific theory that explains the phenomena of communication in DSD teams, we performed an exploratory literature review. We used the IEEE Xplore, ACM Digital Library and Google Scholar knowledge bases,

Factors that influence communication in DSD (Santos, Farias Junior, Moura, and Marczak)			Theories (What do they potentially help to explain in DSD communication?)							
Category	Id	Factors	Social presence	Media richness	Media Synchronicity	Media Switching	Socio-Technical Theory of Coordination	Social network theory	Hofstede's cultural dimension theory	open-coopetition theory
Human factors	F01	Cultural Differences	N	N	N	N	N	N	Y	N
	F02	Language or Linguistic Barriers	N	N	N	N	N	N	N	N
	F03	Coordination	N	N	N	N	Y	N	N	N
	F04	Visibility or Perceiving	N	N	N	N	N	Y	N	N
	F05	Limited informal communication	N	N	N	N	N	N	N	N
	F06	Team awareness	N	N	N	N	Y	Y	N	N
	F07	Communication skills	N	N	N	N	N	N	N	N
	F08	Reduced contact networks	N	N	N	N	N	Y	N	N
	F09	Definition of roles and responsibilities	N	N	N	N	N	N	N	N
	F10	Size of personal networks	N	N	N	N	N	Y	N	N
	F11	Weak social relations	Y	N	Y	N	N	Y	N	N
Location and Infrastructure	F12	Geographic dispersion	N	N	N	N	N	N	N	N
	F13	Temporal distance	N	N	N	N	N	N	N	N
	F14	Infrastructure	Y	Y	Y	Y	N	N	N	N
	F15	Lack of face-to-face	Y	Y	Y	N	N	N	N	N
	F16	Synchronization of work schedules	N	N	N	N	N	N	N	N
Process and technology	F17	Definition of media communication	Y	Y	Y	Y	N	N	N	N
	F18	Application of agile approaches	N	N	N	N	N	N	N	N
	F19	Selection of communication technologies	Y	Y	Y	Y	N	N	N	N
	F20	Distribution of tasks	N	N	N	N	N	N	N	N
	F21	Collaboration tools	N	N	Y	N	N	N	N	N
	F22	High bandwith	N	N	N	N	N	N	N	N
	F23	Communication standards	N	N	N	N	N	N	N	N
	F24	Number of distributed teams	N	N	N	N	N	N	N	N
	F25	Communication policy	N	N	N	N	N	N	N	N
	F26	Different communication styles	Y	Y	Y	Y	N	N	N	N
	F27	Collaboration models	N	N	Y	N	N	N	N	Y
	F28	Multiple collaboration channels	N	N	Y	N	N	N	N	Y
	F29	Translation process and coding	N	N	N	N	N	N	N	N

Figure 1. Mapping between identified theories and communication factors in DSD.

Table 4. Search Results

Source	Matches
IEEE Xplore	13
ACM Digital Library	9
Google Scholar	6

with the search string as follows: (S1): *"theory" AND ("communication" OR "communicative") AND ("dsd" OR "distributed software development" OR "gsd" OR "global software development")*. Next, we adapted the search string (S1) to the required syntax of the search engine, maintaining the same semantics and executed each search string in the selected knowledge bases in both title and abstract fields. Table 4 presents the results.

After removing duplicates, we identified the relevance of identified papers for this research, according to the inclusion criterion (IC1): *Primary studies on the phenomenon of communication in DSD which propose a new theory in this context or which refers existing ones as part of their theoretical basis, methodological approach or research goals.* and exclusion criterion (EC1): *Non-English language papers*. Finally, by applying both IC1 and EC1 criteria, we selected 12 studies, and within those, eight of them referred to existing theories, as follows: *The Social Network Theory* (Travers and Milgram, 1967); *The Social Presence Theory* (Short et al., 1976); *Hofstede's Cultural Dimension Theory* (Hofstede, 1983); *The Media Richness Theory* (Daft and Lengel., 1986); *The Media Synchronicity Theory* (Dennis and Valacich, 1999); *The Media Switching Theory* (Robert and Dennis, 2005); *The Open-Coopetition Theory* (Teixeira, 2014); *The Social-Technical Theory of Coordination* (Herbsleb, 2016). Next, we included a mapping between all identified theories and a set of factors that influence communication DSD (Farias Junior, 2014, p. 110), as an additional procedure to this research step. By performing this additional procedure, we aimed at further deepening our findings through the identification of evidence of non-directly addressed concepts in DSD communication context. Those factors were based on the results of a Tertiary Systematic Literature Review on Communication in DSD projects (dos Santos et al., 2012), which aimed at consolidating knowledge about communication in this context. The study identified 29 factors based on 20 identified secondary studies, in the attempt to answer the research question of "Which factors influence communication in Distributed Software Development projects?" (dos Santos et al., 2012, p. 1). In this context, our mapping aimed at identifying whether each Theory addresses each communication factor, i.e., if the Theory appears to describe or explain each respective factor, as presented in Figure 1. Some DSD communication factors were addressed by one or more theories, such as the factor "Cultural Differences" by the "Hofstede's Cultural Dimension Theory" and the "Team Awareness" by the "Socio-Technical Theory of Coordination." On the other hand, factors such as "Language or Linguistic Barriers" and "Definition of Roles and Responsibilities" were not addressed by any of the theories (Figure 1). In short, we present as follows the main findings from this

mapping activity:

i. *None of the identified studies proposed a new and specific communication theory in DSD;*
ii. *None of the referred theories in the studies were specific for the DSD context;*
iii. *None of the referred theories addressed 14 of 29 communication factors in DSD;*
iv. *None of the referred theories could address alone, all the communication factors in DSD.*

At this point, we may notice that the first and more critical find for our exploratory review is that we identified no specific communication theories for DSD. This finding suggests a theoretical gap in the literature and supports the choice of GT as our primary research method. This situation is corroborated by the additional findings on the identified theories not being specific for DSD and on the 14 factors that did not appear to be part of their theoretical content. In this context, we may cite that at least some of those 14 factors are closely related to the communication context of DSD teams, i.e., to the diverse and distributed nature of its members. Among those we may cite: including the "Language or Linguistica barriers", "Communication skills", "Temporal Distance" and "Synchronization of Work Schedules". Those circumstances lead us to to the conclusion that a communication theory for the specific context of DSD teams will have its place in the literature.

6 A Further Preliminary Theory of Communication in Distributed Software Development

We present as follows a further version Preliminary Theory of Communication in Distributed Software Development Teams as an evolution of its first version (Leitão Júnior et al., 2019). The theory includes all its theoretical categories and subcategories as the constructs of the communication phenomenon (Figure 2). Next we present the descriptive content of all theoretical categories based on their memos, and together with Figure 2, the following content describes the communication phenomenon in DSD teams. Furthermore, as previously stated, we are constructing this theory via Charmaz's *Grounded Theory* (GT) proposal (see Section 4), i.e., all its contents are grounded in data itself, from all interview transcripts. Therefore, we also present along with each component some of the quotations that supported its emergence as a theoretical element.

6.1 Considering universal communication enablers (i)

DSD teams include distinct humane contexts, and the efficacy of communication in those teams is affected by the personality of individuals themselves, i.e., how they are, how they present themselves in their working teams, and the natural inclination to proximity in working relations. This theoretical category describes the role of universal communication enablers in DSD teams, i.e., factors that are relevant for the communication aspect in diverse professional and everyday humane contexts, including DSD teams, through its subcategories, as follows.

6.1.1 Communicating face-to-face (i.a.)

Traditional face-to-face (in-person) communication is part of the communication context of DSD teams. DSD team members recognize face to face as being more effective than other remote, or async communication means, even when those individuals perfect remote communication with time and effort. Communicating face to face, benefits from the usage of spatial resources, by being physically close to individuals, perceiving movements, and by using spatial elements such as physical boards and adhesive notes. Face-to-face communication enables the eye-to-eye contact in the communication act and supports a better understanding of the best moment for interrupting and stating other viewpoints, without running, or rushing. In this context, DSD team members perform face-to-face (in-person) meetings under circumstances that include: fast and colocalized discussions, project milestones presentations, discussion of complex matters, collecting feedback; review overall expectations with clients.

Examples of quotations in this component:

i. "Yeah, when you're hiding behind the computer, the chances of you're running over, of letting something pass, I think it's greater than when you're in person, looking and watching people." (translated);
ii. "I think that you, face-to-face, you have there, the exchange of looks, the person's posture, it is, you know the most assertive moment of you interrupting a reasoning and being able to talk about running over the other." (translated);
iii. "He spent two, three days together it flowed... we solved a number of things." (when questioned about face-to-face efficacy) (translated).

6.1.2 Communicating informally (i.b.)

Informality in the communication context in DSD teams refers to minor preoccupation with how the message will be received, i.e., a more relaxed and natural communication style between closer teammates. Communicating informally also refers to a natural and eventually ludic way of expressing oneself. This refers to a flat hierarchy, which supports better opportunities for everyone to speak. Additionally, it refers to usually not document the discussed matters. Informal communication occurs under circumstances that include fast and lightweight meetings such as daily ones. Under the circumstances of discussions after formal communication attempts on project scope, i.e., when the operational work begins, as well as under the conditions of working with colleagues under the same role, e.g., communicating between developers. Informal communication is a common communication approach in DSD teams. It has the potential to positively impact the efficacy of communication, as it supports the removal of communication barriers and the support of collaboration in those teams.

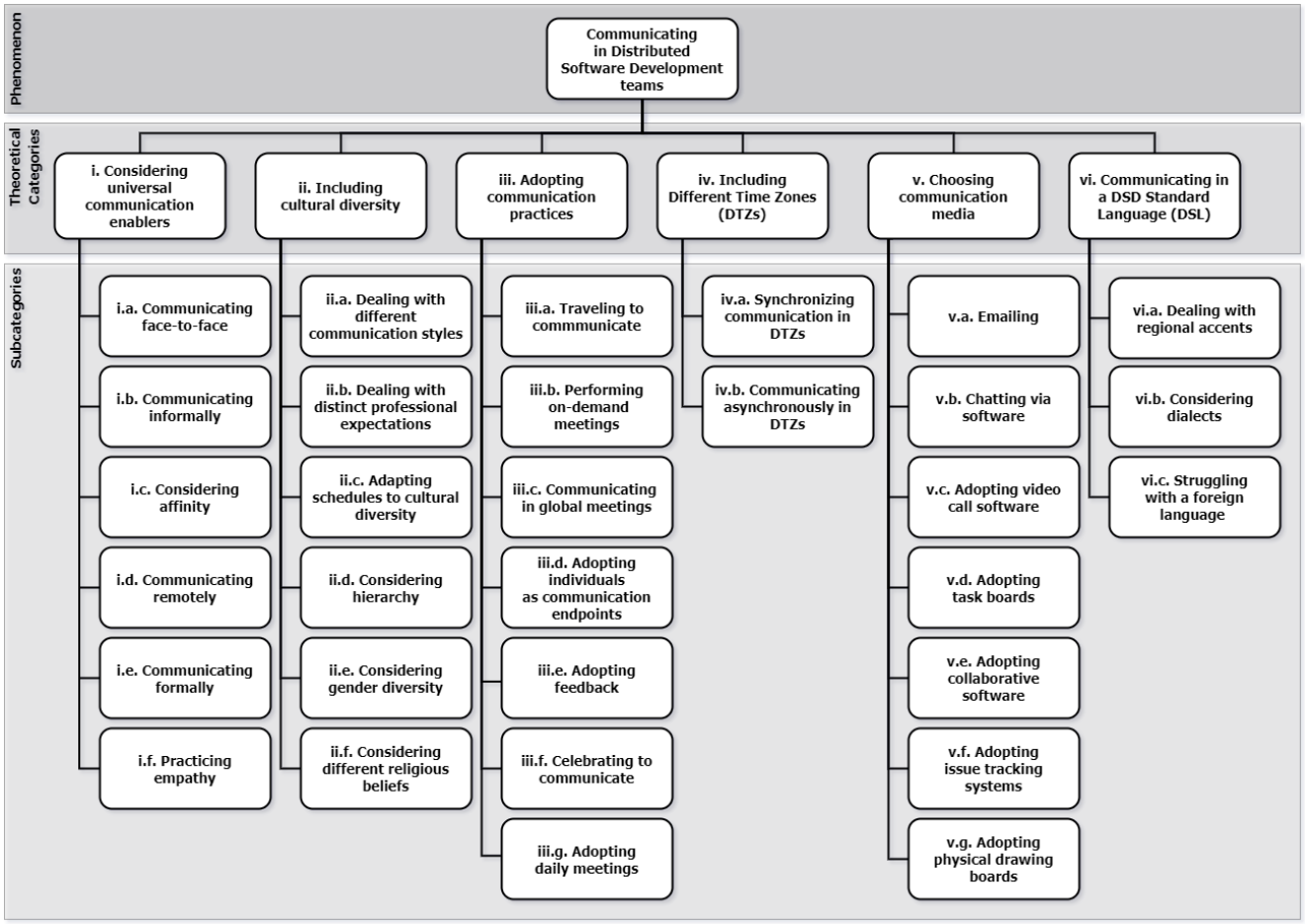

Figure 2. A taxonomical representation of the further preliminary version of the Theory of Communication in Distributed Software Development.

Examples of quotations in this component:

i. "When work begins, communication is completely informal!" (translated);
ii. "That, that is, 80% and 75% of the communication is informal!" (translated);
iii. "I would not say more effective, I do not know exactly if it was more effective, I would say it is more, it is ... Comfortable!" (When questioned about the efficacy of informal communication) (translated).

6.1.3 Considering affinity (i.c.)

The nature of affinity between members is part of the communication context in DSD as a relevant factor for communication efficacy in those teams. The affinity between DSD members support informal communication, i.e., communicating without worrying too much about how the message will be received, in a synergic relation. Eventually, the lack of affinity is associated with formality in the communication act. Affinity also emerges with time in the teamwork, e.g., through the interaction with good work-capable colleagues that support the integration of team members, even in challenging schedules. Additionally, affinity may come with the ones that bring knowledge and a sense of security to the team. Thus, DSD team members will probably develop an affinity with at least specific colleagues. Nevertheless, the lack of affinity leads to discomfort in the communication attempt, as a negative experience with barriers to effective communication, slower communication timing within those teams, and less availability of team members to communicate.

Examples of quotations in this component:

i. "So, the difference is, that person has less resistance to listen to your ideas, has less resistance to perform their work, has less resistance to help you, has less resistance to ask for help, it's a completely different job!" (when questioned about communicating with affinity)
ii. "It's that person that you say: "With this guy I'm safe!", Because he does everything, he is not afraid to work, he comes over the weekend, he, studies, he ... is the, this is the member of your team you want!" (when questioned about working with affinity) (translated)

6.1.4 Communicating remotely (i.d.)

DSD team members communicate remotely with colleagues in the circumstances of discussing professional matters with both remote and local individuals. This way of communicating is a distinct approach when compared with in-person communication. When colocalized, DSD members maintain an open channel with colleagues, which is eventually inevitable, supporting informal and non-work-related com-

munication as part of their work lifecycle. When colocalized, DSD team members are prone to identifying specific aspects of the everyday life of the colleagues in a healthy communication approach. Nevertheless, when communicating remotely, this day to day changes awareness of colleagues is hindered, as the communication occurs in sessions, in a non-continuous approach, difficulting the understanding of the organizational culture of remote DSD cells. Thus, DSD team members may recognize remote communication as a colder approach due to the distance between individuals. Also, remote communication may demand an extra effort to establish a proper communication channel in DSD teams, which can be seen by some as an issue to be dealt with.

Examples of quotations in this component:

i. "...where you have people from all over the world, you are multicultural, then whatever, or with a colleague who is there next door, sit at the table next door or if I'm talking to someone on Skype, who's on the other side. (when questioned about remote communication) (translated);"
ii. "When you are communicating with, with a person remotely, there is the coldness of distance, so your interpersonal work it is twice as much, the energy you spend, if not triple is twice as much!" (regarding the effort to communicate remotely) (translated)."

6.1.5 Communicating formally (i.e.)

The concept of formality in DSD team communication refers to a mostly documented, or textual communication approach, for reasons such as the need to disclose problems, and as a need for establishing documentation with stakeholders for further reference. Email-based communication can eventually be characterized as formal and meetings that implicate some degree of documentation as well. Furthermore, formal communication also refers to a planned communication attempt, including the usage of strategies and protocols for a communication act. A well prepared formal communication attempt in DSD teams tends to be clear and less prone to noise, but those benefits will usually come with the price of an extra effort to DSD members, mostly in writing, documenting, and working with the available communication channels. Formal communication occurs under the circumstances that include communicating with clients that are not in everyday contact with the team, including those from different cultural contexts. Formal communication also occurs when communicating with colleagues from remote sites or different cultural contexts, with senior DSD team members, and with any stakeholders that are not in the everyday working context.

Examples of quotations in this component:

i. "Yeah, the, the change of... basically this is the definition of scope, let's put it this way, definition of scope, change or not, definition of scope uhh, the meeting is formal, so if there is, registration, if you have, uhh, written stories, it happens twice three times, you check with the team, uhh, you usually have two, three meetings, even when everyone is aware of what has to be done." (translated);"
ii. "...30, 25% to 20% of formal communication, it only exists when you are, discussing, opening or closing a milestone. " (translated);"
iii. "...if I talked on the phone, I send an email confirming everything, but there has to be some kind of record, not only verbal of what happened." (translated)."

6.1.6 Practicing empathy (i.f.)

Placing yourself in the other's perspective, i.e., with empathy towards others, is part of the communication context in DSD teams. DSD team members recognize that the practice of empathy supports better communication in their teams, as it is understood as an essential communication-oriented approach by some. Thus, DSD members may practice empathy towards colleagues for better communication results. The practice of empathy in DSD also supports culturally diverse teams by potentializing the communication in a foreign language, e.g., native speakers may place themselves in the place of foreign colleagues and recognize, as well as encourage their effort to communicate. Furthermore, the establishment of empathy between individuals comes easier when affinity takes place; nevertheless, other factors such as the lack of team spirit will hinder the development of empathy in DSD teams.

Examples of quotations in this component:

i. "..then he said: 'Just the effort of you are trying to talk to me, I already see something positive!"' (regarding the recognition of a stakeholder on trying to speak in a foreign language) (translated);
ii. "...yes, I already apply it several times, I applied it to this project, not only with the team, but with the client himself when, you know, he came with, yeah, it's some more delicate issue, I tried to understand their side, what kind of pressure he was under, the context he was working on." (when questioned about the practice of empathy) (translated);
iii. "You have to exercise this when you are in an environment of diversity, cultural, social, etc., you put yourself in the place of the other." (regarding the practice of empathy in cultural diverse teams) (translated).

6.2 Including cultural diversity (ii.)

Communicating in global DSD teams is a multicultural experience that eventually includes individuals from different parts of the world. Working and communicating in multicultural DSD teams can be a joyful experience, in both professional and personal dimensions, as for some DSD members, and enthusiasts, communicating in this context is a fluent and transparent experience. For those individuals, being exposed to different ideas and schools of thoughts, speaking other languages, and learning about the world is a fantastic experience. Nevertheless, communicating in cultural diversity can be a challenge, including the need to understand foreign languages, different availability expectations, and cultural differences. In this context, DSD organizations may include in-

stitutional directives for better dealing with cultural diversity and may even try to enlist professionals with inclination to the cultural diversity itself. Those organizations may also perform and effort to identify cultural-related misbehaviors of its members and try to correct those. This theoretical category describes the influence on the cultural diversity in the communication context in DSD teams through its subcategories, as follows.

6.2.1 Dealing with different communication styles (ii.a.)

Working under the circumstances of distinct cultural contexts in DSD teams includes Individuals that communicate in a way due to cultural-related reasons. Individuals may communicate more directly and objectively, i.e., speaking straight, bluntly, which may sound like rudeness for professionals with the lack of experience with other cultural contexts. Thereby disturbing communication in DSD teams and eventually supporting the feeling of discomfort and a withdrawn behavior among DSD members. The communication timing may also vary in those teams, as individuals from specific cultural contexts may act more timidly and avoid questioning about the development fronts, preferring to work right away. This behavior is in contrast with others that may try to exhaustively ask details on their tasks before beginning the development itself. DSD members may also include de usage of specific jargon that may impact the communication efficacy, even by not being a critical issue in DSD teams.

Examples of quotations in this component:

i. "So, this many times in communication generated a communication disorder, because we started to think that they were being reactive in things that we suggested, you know?" (concerning a stakeholder that communicated in what it felt like a blunt approach) (translated);
ii. "There was a person there who was very blunt, it started ... He passed things on to you, I don't know what, but you thought you were doing everything wrong, you were doing everything terrible and then the person... he did not praise us, but ultimately, everything was fine, everything was correct! I don't know what, then it got kind of confusing!" (concerning a stakeholder that did not communicate well his perception on colleagues' work) (translated);
iii. "They are so sincere that they offend and this has generated such heavy conflicts, especially with me, right?" (translated);"

6.2.2 Dealing with distinct professional expectations (ii.b.)

Individuals from different cultural contexts may also come with varying views of expected professional results and ambitions. Those may include a faster ascension of professional carrier and a clear plan for promotions, mostly when those individuals came from more densely populated areas. On the other hand, individuals from other cultural contexts may be reticent in being promoted and assume the extra responsibility that comes with it. Moreover, specific DSD team members may even react emotionally to the recognition of their work in the form of a promotion, i.e., being very moved, due to possible cultural related behaviors. Furthermore, expectations of professional availability to work and communicate, vary in the circumstances of different cultural contexts in DSD teams. Individuals from specific cultural contexts may expect an unrestricted, and eventually, non-concerned extra availability to work and communicate. This expectation may even be supported by the organizational culture of the DSD project clients. On the other hand, in a culturally diverse location, DSD members tend to be more respectful in what concerns the demand for increased availability of individuals, with extra attention to resting times and individual boundaries. Nevertheless, when an increased availability of its members is commonly required, some DSD organizations may apply an extra effort to mitigate this situation. Those differences in availability expectations may be poorly communicated within the team, however, with time, and further discussions on this matter, this misalignment can be mitigated. Thus, managing the professional expectations of team members, mostly in cultural diversity, is a necessity in the broader communication context of DSD teams.

Examples of quotations in this component:

i. "So yeah, sometimes the foreigners themselves from the company, not from the client, would send an e-mail, I don't know, at midnight, because they are working anytime!" (translated);
ii. "I'm not saying it's good, it's bad, but unintentionally, people manages expectations, assuming that employees are, yeah, yeah, are [always available]! Compared to..." (comparing avaiability expectations from individuals from a different country where he lives in) (translated);
iii. "Uhh, the other thing is ambition, so different cultures have different ambitions!" (translated);
iv. "Because there are people who are looking for promotion, so wanting to know what is going to happen for them to come up, in the company, uhh and that influences and has to be taken into consideration." (regarding colleagues from a different cultural context) (translated).

6.2.3 Considering gender diversity (ii.c.)

Working in DSD teams include communicating in gender diversity as a natural element in those teams. Communicating in gender diversity is not usually recognized as a problem in DSD teams, with almost no specificities or issues in the communication act. In this context, DSD team members acknowledge that communication impacts will not be usually associated with gender itself, but by the experience of the individuals in working and communicating in DSD themselves. Nevertheless, rare cultural related specificities may emerge in DSD teams, such as the impression that members in specific cultural contexts prioritize speaking times based on gender, e.g., women speaking after men in the circumstances of meetings. Also, as a rare occurrence, individuals can have

the impression of being lesser treated by colleagues in a culturally diverse team, in part for being a woman. Additionally, DSD members may expose the feeling that the leadership that is mostly performed by men only is unfortunate. In contrast with others, that may see a more gender-diverse team as good as a non-diverse one, as working with men in higher numbers has been an expected scenario in DSD teams and during IT studies.

Examples of quotations in this component:

i. "I think it has communication impacts of different kinds, yes, but regardless of gender." (on the participant's opinion on gender matters) (translated);
ii. "But I, I would say that you would have to be a little more careful with what you say, with the jokes you take" (regarding informal communication on gender matters) (translated);
iii. "Yes, there were two men and a woman on their team and, the woman always spoke last, yes, I don't know if it has to do with whether it was just a coincidence or not, but it always happened that way, you know?" (on the impression of unbalanced speaking times) (translated);

6.2.4 Considering different religious beliefs (ii.d.)

Working in DSD teams in cultural diversity includes communicating with members of different religious beliefs, usually not provoking relevant impacts or specificities in the communication act. In a culturally diverse location, DSD organizations may deal with the diversity of religious beliefs by stating organizational directives for respecting religious aspects of the employees (including DSD members). Those organizations may even include the right to DSD members to ignore specific organizational rules for religious-related reasons. Nevertheless, DSD members will eventually take part in religious practices or events that may interfere or support specific behaviors in their teams. In this context, eventual communication disturbances may come in the form of absences or restrictions due to religions-related reasons. Still, those situations will, in turn, be well handled by DSD leadership.

Examples of quotations in this component:

i. "But, because of beliefs, values, no, just misunderstandings." (regarding communication issues on different beliefs) (translated);
ii. "There are, there are people on the team who enter... and they are entering [on a religious ritual] so they cannot eat, they have to leave later, or earlier..." (translated);
iii. "There are, there are these things, religion and culture that affects, but it is not a serious problem, we adapt ourselves!" (translated);

6.2.5 Adapting schedules to cultural diversity (ii.e.)

The nature of dealing with specific and different schedules in DSD teams in cultural diversity is part of the broader communication context in some DSD teams. Even by not necessarily being a common situation, absences in the circumstances of specific cultural events, related cultural dates, e.g., grand sports events, the expectation of the frequency and the duration of vacations, cultural-related events such or religion-related absences can be eventually misunderstood in those teams, leading to conflicts and discomfort. Specific or national holidays can also impact DSD team schedules, e.g., holidays that can be included by a non-planned schedule; Christians can be unavailable during Christmas; the Chinese New Year may drive the attention of some members. Furthermore, in specific cultural contexts, individuals may lead to an overall expectation of the beginning of daily working hours much earlier than most of the members from other distinct cultural-based DSD sites, as well as leaving the office earlier. Additionally, some religious rituals may also occur during working hours, which will also drive the attention of DSD members. Thus, DSD leaders often adopt approaches such as a custom, and documented schedule for their projects in cultural diversity, to better work and support the communication on their teams.

Examples of quotations in this component:

i. "But, because of beliefs, values, no, just misunderstandings." (regarding communication issues on different beliefs) (translated);
ii. "There are, there are people on the team who enter... and they are entering [on a religious ritual] so they cannot eat, they have to leave later, or earlier..." (translated);
iii. "There are, there are these things, religion and culture that affects, but it is not a serious problem, we adapt ourselves!" (translated);

6.2.6 Considering hierarchy (ii.f.)

The concept of the hierarchy of stakeholders is part of the communication context of some DSD teams. This concept is not necessarily a cultural trace, but it has a higher relevance under the circumstances of multicultural teams. Communicating with individuals in different hierarchical levels may impact the communication or speaking timings for expressing opinions. Thus, as a cultural trace, senior members may have a larger window to communicate than junior ones. Those hierarchical differences may even prevent effective communication between individuals from specific cultural contexts. Colleagues in lower hierarchical levels can eventually omit opinions, and the ones from higher hierarchical members may be automatically accepted without further discussion. Thus, lower hierarchical individuals may act in a withdrawal behavior on trying to express themselves, being afraid of a wrong understanding of the colleagues in a higher hierarchical status.

Examples of quotations in this component:

i. "So, of course, like this, you have ... there is this hierarchy that you respect but at the same time you will not change your opinion so now, in another culture I no longer know if I would give the same opinion or be quiet!" (translated);
ii. "Uhh, there were, there were situations like that, that I didn't agree with... that I thought was not correct. But because the person was at a higher level of hierarchy and

the person had more experience, I ended up doing ok, so that's it, but it brings discomfort, for sure." (translated);
iii. "Because, what I see and this is a very big cultural difference, is that, you have to respect your level of... if you are more senior, you will speak more, if you are junior, you will speak less, so you have to respect that." (translated);

6.3 Adopting communication practices (iii.)

DSD team members include distinct communication practices in their communication context. Those individuals may communicate in checkpoints, that is, specific moments during the DSD project in which the overall status needs to be aligned and codify messages by documenting and publishing to effectively disseminate new versions of software artifacts for the whole DSD team, among others. This theoretical category describes the communication aspects of adopting communication practices in DSD teams through its subcategories, as follows.

6.3.1 Traveling to communicate (iii.a.)

Traveling to communicate is a common practice in DSD teams. DSD team members travel to remote DSD cells to perform face-to-face (and in-person) communication with their remote colleagues and clients. Those travels will support a closer communication style that can eventually be seen as a practice to supplement remote communication. DSD members will travel for working and communicating during one or more weeks or in a smaller time frame, for important in-person meetings, e.g., kickoff meetings, and for organizational events or celebrations, also, for knowing in-person remote members and support the process of team building in those projects. Working and communicating during those travels supports a better understanding of the organizational culture of remote DSD sites, such as internal meetings, the physical structure, and the organizational bureaucracy, which are usually not clear in remote communication. Traveling to those remote teams also includes the purpose of learning about cultural diversity, i.e., by placing DSD members in different cultural contexts for a longer period and expect that they will understand better the host culture.

Examples of quotations in this component:

i. "Every three, four weeks, we went there, physically in Rio to make deliveries and do more conversations, even face-to-face conversations, to complement these, these, remote integrations." (translated);
ii. "Yes, yes, many times when there will be Kickoffs, from projects, or when even celebrations after the end of the project, they travel, they come here..." (translated);
iii. "...and every three or four weeks he had face-to-face communications." (translated);

6.3.2 Performing on-demand meetings (iii.b.)

Communicating on-demand meetings, i.e., promoting meetings under overall circumstances of project needs, is included in the communication context in DSD teams. DSD team members perform those meetings for reasons that include the definition of the scope to be developed, the understanding of project challenges, project tracking, and the refinement of the design of solutions in their teams. Those meetings can be a valuable tool for evidencing the lack of understanding and misunderstandings, including the identification of wrong directions in the development, under the circumstances of supporting the work progress in those teams. Nevertheless, some DSD members may feel that in some instances, on-demand meetings are not the right approach for communicating. That's because those meetings may lead to excessive discussions, mostly at the beginning of the project, and DSD organizations may eventually impose a time limit for performing those meetings.

Examples of quotations in this component:

i. "Uhh, you don't, you don't, you spend more time but then you have a 15-minute, 20-minute, 30-minute meeting, you spend up to an hour, the person is solving the problem, go ahead, go back..." (translated);
ii. "Then, for example, it is, sometimes the developers, they, based on, yeah, the features they were doing, they did it as if it were a tech session, to make the alignment of what they were discussing." (translated);
iii. "So, I have several meetings with them to clarify, direct the tests they do." (translated);

6.3.3 Communicating in global meetings (iii.c.)

DSD team members also perform communication in global meetings, i.e., meetings that include members for all, or multiple DSD sites. Those may be segmented to a specific technical aspect and may consist of participants from various DSD projects for sharing knowledge and obtain feedback. DSD members will perform global meetings in circumstances that include relevant project dates, such as the end of a sprint. Those meetings are justified for reasons that include presenting or sharing the completed development to all DSD teams, with a focus on the teamwork, and not the individuals by themselves. Still, and as an exception, global meetings may be used as an approach for the public and positive feedback for individuals that made the difference in the current development cycle or delivery. Nevertheless, global meetings may be seen with a lack of appreciation from some team members. That is because those meetings may include the diverse range of matters under discussion, which may be out of the specific context of specific DSD sites, without any noticeable impact on the work of those teams.

Examples of quotations in this component:

i. "At the company I think there are... designers worldwide and if I remember correctly, what happens, there is a global meeting of the leading designers of company that are, I think, 20, no, 15 no, 18 designers." (translated);
ii. "...the sprint took time, it varied, but it was usually three weeks, we did a review, a review meeting, then all the teams got together and, yes, one representative or two of

each team is, presented what was done, and then it was a more global event, there were people from all over the world." (translated);

6.3.4 Adopting individuals as communication endpoints (iii.d.)

Communicating in DSD teams may be performed by team representatives acting as communication endpoints in the circumstances of institutional meetings and development fronts with clients. Those individuals may represent a DSD site, clients, a whole region of DSD cells in their respective areas of knowledge, e.g., Interface Design in Latin America, or even the organization itself. Communication endpoints may be recognized as an effective approach for communicating in DSD teams, and in this context, leaders have the potential to fulfill the requisites to become communication endpoints. Those endpoints will usually be required to discuss critical matters in DSD teams and interdisciplinary matters. Organizations may adopt communication endpoints as part of their culture or directives; nevertheless, a communication endpoint may only be adopted at the beginning of a DSD project. That is because, with time, the team members may feel the need to extinct this role, as communication may become decentralized in their teams.

Examples of quotations in this component:

i. "They have a central representative of the company who speaks for all locations and some of these people, as they have something to bring, something to discuss, they show up at these meetings, so it's, like, by a mediator, like a responsible person." (translated);
ii. "I hold meetings with the client, I take questions that the, yeah, the testing team raises." (translated).

6.3.5 Adopting feedback (iii.e.)

DSD members adopt feedback practices in their teams as part of their communication context. Feedback in those teams may be used as an approach for dealing with failed communication attempts or the lack of availability of specific members for communicating, as an attempt for changing unwanted behaviors in those teams. DSD team members usually perform this practice with a certain degree of anonymity. In this context, DSD teams may even avoid the usage of software tools for better protecting the identity of individuals. DSD teams adopt distinct approaches for collecting feedback data, including enlisting DSD members for individual, one to one feedback, and using organizational surveys. Those teams may eventually apply a consistent effort in tracking the welfare level of DSD members and may even include matters discussed in feedback sessions in the agendas for the meetings to come, as part of an organizational effort. Feedback sessions are usually performed in the circumstances of on-demand in-person meetings, after important milestones such as postmortem meetings or in a pre-accorded schedule. Practicing feedback comes with the potential to achieve better communication results, mostly when those sessions are communication-oriented ones.

Examples of quotations in this component:

i. "Yes, uhh, no, I can't tell you about the quality, but the concern with communication, yes!" (regarding impacts on communication quality on the adoption of feedback) (translated);
ii. "We used to do feedback practices in person, we avoided them, and maybe more because of a culture, ours, we avoided making these feedbacks, yeah, remote." (translated);
iii. "Yes, yes, especially when the feedback was on this topic, you know, I, I remember for example that, what we discussed a lot, is, the way people should be participating in a remote meeting." (regarding impacts on communication quality on the adoption of feedback) (translated);

6.3.6 Celebrating to communicate (iii.f.)

DSD members perform the practice of celebrating together in their teams. That is a common practice in some cultural contexts and a less eventual in others. DSD organizations support the aspect of celebrations by giving up of working hours from DSD members to participate in those events, and by promoting, and eventually, financing this practice according to their budget. Supporting celebrations in DSD teams is justified by reasons that include supporting closer relations, dealing with the isolation of some members, and encouraging teamwork, all in a relaxed out of the routine situation. Those celebrations have the potential to support the outside-work informal communication between DSD team members, to know each other better, and thereby support the establishment of empathy between those individuals. Furthermore, even when an organizational intention is not in place for supporting celebrations in DSD teams, those may also be promoted by the DSD members themselves. Celebrations will usually occur under the circumstances that include the achievement of milestones or other relevant project victories in DSD teams.

Examples of quotations in this component:

i. "But all of this has a reason, apart from social issues, which is a little different, but apart from that, it's basically to strengthen uhh, the connections, uhh, interpersonal, communication, uhh, empathy, sympathy..." (translated);
ii. "It helps, you know, on a daily basis, we talk and have more, have a better relationship, right, at work." (translated);
iii. "But up to a limit, part was part of the project." (regarding the organizational support on celebrations) (translated);

6.3.7 Adopting daily meetings (iii.g.)

Daily meetings are part of the communication context in DSD teams, i.e., SCRUM based ones. Those meetings are performed locally, remotely, and eventually globally, with all sites, including remote members, with the help of

software tools. This practice is justified for daily activities tracking, as those meetings support the visibility of current, and specific work status of the colleagues and from the team as a whole. Daily meetings in DSD teams are usually well-executed, with the right frequency, and with a well-defined scope, and DSD members recognize those meetings as a good approach for communicating. DSD team members will usually not document those meetings, but exceptions include registering eventual emerged technical related debts. Daily meetings may involve all team members, but in some cases, DSD team members may perform those with representatives from DSD sites, i.e., with an optional presence of some members. DSD members may eventually cancel specific daily meetings, due to reasons that include performing team training or other specific and longer meetings. In this situation, those members will usually accumulate matters for the next daily meeting session.

Examples of quotations in this component:

i. "So, we have, daily meetings with everyone together, of course, only those who have a reason to show up!" (translated);
ii. "And with the team, we had remote meetings every day, quick meetings, also via Skype, to follow the project." (translated);
iii. "that dynamic was this; daily meetings with remote teams, the client interacted extensively at any time..." (translated);

6.4 Including Different Time Zones (DTZs) (iv.)

Working in DSD teams include communicating across Different Time Zones (DTZs), which can be a challenge for DSD members, as communicating in this context can lead to problems in DSD teams. This theoretical category describes the communication is different time zones in DSD teams through its subcategories, as follows.

6.4.1 Synchronizing communication in DTZs (iv.a.)

DSD team members eventually work with members from remote sites in which their work hours may not occur at the same moment, e.g., the beginning of the workday of a DSD cell may be the middle or the end of another one. Communicating in DTZs in DSD supports information and activities desynchronization. Thus, to mitigate the communication desynchronization, DSD team members do their best to communicate synchronously, by aligning and planning their overall schedules to enable meetings. Nevertheless, attempts to synchronize communication efforts in this context can be hampered by the limitation of availability of DSD members themselves, and attempts to work around those limitations can lead to discomfort for those individuals. Thus, when communication synchronization is not possible, DSD members may still insist on communicating synchronously, by adopting strategies such as accumulating by themselves all the matters to later discussions.

Examples of quotations in this component:

i. "So, it had this kind of impact, but we were organizing, trying to schedule moments, that is, it was a regular time for both teams, right, so, it impacted, but we were resolved." (regarding the impacts of synchronous communication in DSD teams) (translated);
ii. "...there was the question of the time zone and the question of the times was summer time in one place and it wasn't, so we always changed this time a lot, but whenever it was possible for everyone to participate." (regarding daily meetings in different time zones) (translated);
iii. "It is, it is, complicated, it is difficult, and I often want to leave, it's my time to leave and they are talking to me because it's at the beginning of their working day, you know?" (translated).

6.4.2 Communicating asynchronously in DTZs (iv.b.)

Working in DSD teams includes communicating asynchronously between DSD sites across DTZs as a common approach. DSD team members will usually adopt asynchronous media for communicating with individuals from remote sites, i.e., communication software channels such as e-mail, issue tracking, and chat tools. Nevertheless, communicating via those tools will demand the effort of DSD team members to state their working status, and the lack of this effort can lead to communication failures in DSD teams.

Examples of quotations in this component:

i. "I remember this workflow well, yeah, the first thing that happened early in the morning was if, look, yeah, there in the development tools what it was done because, yeah, our team was well distributed..." (translated);
ii. "Yes, it is asynchronous, at the time I think it was the Messenger that we used the most and e-mail, right?" (translated).

6.5 Choosing communication media (v.)

DSD project members communicate via a diverse range of options as communication media, including specific sets of software-based media for better communication results. Those options are identified by aspects such as the expectative of time to obtain responses, the communication speed, among others. In this context, DSD members feel that the chosen media may impact the degree or the efficacy of communication in their teams, e.g., adopting approaches such as a text-based communication as an attempt to hinder the noise. This theoretical category describes the communication media in DSD teams through its subcategories, as follows.

6.5.1 E-mailing (v.a.)

Despite its age, communicating via e-mail is a common approach in DSD teams. DSD team members recognize the e-mail communication as a formal and objective approach, as well as the preferred choice for some of those individuals for asynchronous communication. Additionally, when

communicating via e-mail, DSD members mitigate misunderstanding issues with accents in the standard language of choice in those teams, i.e., the DSD Standard Language, when it is a foreign language. Nevertheless, e-mail communication can be prone to misinterpretations when not correctly written. Thus, e-mail users must be cautious of its or their recipients and try to understand their perspective.

Examples of quotations in this component:

i. "There is communication by e-mail for more formal things..." (translated);
ii. "Now, when they were more common subjects that could wait for one day, it didn't deman to everybody know about it, synchronously, that was the e-mail..." (translated).
iii. "The, the differences are, are bigger, the difference in accent is bigger, so, by e-mail, uhh, yeah, it's more interesting!"

6.5.2 Chatting via software (v.b.)

DSD members also use chat-based software as a choice for communicating in their teams e.g., Instant Messaging (IM). Those tools are usually used with a high frequency in DSD, with both local and remote members. Chat tools are the media of choice in the circumstances that include weekly and daily meetings. Furthermore, those tools are used for reasons that include communicating and sharing knowledge, project tracking, and as a support for the collaborative process in DSD teams. Furthermore, even by being an informal oriented communication media, i.e., a more natural communication approach, without worry on the form of the text itself, those are also used by DSD team members as a way for documenting conversations for further reference. Modern Chat tools include communicating via audio and video calls, which are also adopted by DSD members as communication media. Additionally, those tools include the possibility of communicating to a specific group or specialized channel, which may address a group of individuals involved in particular project events or tasks via simple short messages, e.g., a deployment activity. Even by not being as immediate as in-person communication, chat-based communication is usually well accepted in DSD teams for being a fast communication media.

Examples of quotations in this component:

i. "But for quick things, we have an IM, business system that is only local, where we talk a lot, create, yeah, very similar to the old IRC." (translated);
ii. "We create one for the release 1 of, of, such project, another, QA group, the other, the leadership group of the such team, so, we create several different channels, or direct messages." (regarding the usage of specialized chat channels) (translated).

6.5.3 Adopting video call software (v.c.)

Video calls are part of the communication process in DSD as a common approach in those teams. DSD members perform video calls in the circumstances of every day (on-demand) remote face-to-face communication or specific global meetings. Video calls may be demanded by DSD organizations as an institutional communication practice. Additionally, this media may include the support of visual sharing of working artifacts (e.g., sharing screens) as part of the communication attempt. The lack of face to face, in person or via video calls, has the potential to hinder the communication efficacy, as the lack of eye-to-eye contact can lead to some degree of misunderstanding about how the message was received between the parts, leading to discomfort in this communication act. In this context, DSD members perform video calls for reasons that include mitigating or even replacing in person's face to face contacts. Video calls have the potential of being an effective way of communicating, as the gestures and body language may be included in the video. Nevertheless, even by simulating an in-person face-to-face contact, video calls can still be considered by DSD members as an impersonal way of communicating when compared with its physical contra part.

Examples of quotations in this component:

i. "...we did audio and video often, shared the screen, the computer... I think main point of collaboration between teams right?" (translated);
ii. "I believe so, so it was often necessary to have a video call with the people there" (regarding the usage of video calls for complementing previous communication attempts) (translated);
iii. "Uhh, it helps, because, body language and gestures they go along with the video, right, so it's not just how to write an email or send a message." (regarding the usage of video calls to mitigate the lack of in person communication) (translated)

6.5.4 Adopting task boards (v.d.)

DSD members adopt task boards as communication media in their teams. Those individuals will eventually register development tasks in the form of adhesive notes to compose their boards. At this point, task boards enable a spatial and explicit message exchange, without the need for further software related steps, i.e., loading a software tool and authenticating. Task boards are used for reasons that include the tracking of the ongoing development in DSD teams. Some DSD teams will abdicate of using physical task boards in the circumstances that include a high dispersion of DSD members. Nevertheless, specific software tools make feasible the usage of task boards with remote teams, including additional features such as a graphical representation of the undergoing development (that, in turn, will require updating the development process for correct results). Those software-based boards will usually clearly present their contents, i.e., in an understandable way. The usage of task boards in DSD teams supports the process of sharing the understanding of the proposed activities with all team members.

Examples of quotations in this component:

i. "Yeah, we added tickets with as much detail as possible, and they are sent on, on our Board there to be tested... by our team here." (translated);
ii. "Look, we use post it and use the board, especially when we are going to have a meeting, to define how the new feature will be..." (translated).

6.5.5 Adopting collaborative software (v.e.)

Collaborative software tools are part of the communication context in DSD. Collaboration can be performed in these software tools by the discussion in threads, which demands the constant interaction of DSD members for effective communication attempts. DSD organizations may adopt organizational or custom collaborative tools for reasons that include the need to document meetings in those teams. Communicating via those tools is mostly performed in DSD standard language, in a less informal and more direct (i.e., closer to real-time) style when compared with e-mails. Still, the adoption of collaboration tools is not absolute, and some DSD projects proceed without those tools.

Examples of quotations in this component:

i. "So, yeah, I think there are a lot of collaboration tools, you know? For collaborative work." (translated);
ii. "...we used Slack for communication, there were often giant threads of discussions about something that was, lack of understanding, you know?" (translated).

6.5.6 Adopting issue tracking systems (v.f.)

Communication in DSD teams also occurs via documented information in Change Requests (CRs) from Issue Tracking Systems. Those tools may be adopted on an institutional level, and CR registers may contain requirements and technical details for the implementation of the proposed fix or feature and its current development state.

Examples of quotations in this component:

i. "We use Jira." (translated);
ii. "So, the product manager initially go to the customer and take the requirements and put into a Excel Sheet and from there, the product owner uhh ... make sense by sitting with the product manager and putting into the Jira, as a card." (translated);
iii. "...I don't remember if we were using Jira or if it was Mantis yet" (translated).

6.5.7 Adopting physical drawing boards (v.g.)

DSD team members use physical, white, or blackboards as a communication media in their teams. Using free boards in DSD teams are considered by DSD members as a useful approach for communicating, as the message persists in the physical environment. This approach supports exposing ideas and the evolution of its concepts in those teams. DSD teams may, for example, communicate via free drawing in those boards, not necessarily using a specific pattern of diagrams.

Examples of quotations in this component:

i. "We you draw a lot on the board, you don't follow any kind of pattern, unless you have to know how to write and read, of course!" (translated);
ii. "...but draw, try to organize your thinking in a logical way, with diagrams, almost, all kinds of diagrams" (translated);
iii. "Some people use UML, others don't, without any kind of reinforcement to use specific methodologies." (translated).

6.6 Communicating in a DSD Standard Language (DSL) (vi.)

DSD team members will eventually communicate in a standard or common language in their teams, a DSD Standard Language (DSL). Using a common and distinct language in this context can be a manageable approach for some individuals, i.e., a less demanded requirement, but not a straightforward process for others, supporting communication issues. Bad DSL communication leads to longer and complicated meetings in DSD teams, as well as supporting the weakening of relations due to limited or bad communication between DSD members, thereby, leading to negative feelings for those involved.

Examples of quotations in this component:

i. "Ok, we also have language issues, because, as the company's head office is American, all meetings are in English, and it is, of course, the common language for most people." (translated);
ii. "...the official standard language is Spanish" (translated).
iii. "So, I, I, 100% of the time had to speak Spanish..." (translated);

6.6.1 Dealing with regional accents (vi.a.)

Communicating in DSD teams in the circumstances of multicultural teams includes dealing with regional accents. In this context, communicating is for some members is a straightforward experience, but for others, a relevant challenge, with the possibility of hindering the communication act. DSD members with some degree of capabilities on multiple foreign languages will better understand regional accents, but, as an overall understanding, with time and experience, as DSD professionals will improve their capabilities to understand different accents.

Examples of quotations in this component:

i. "Ok, we also have language issues, because, as the company's head office is American, all meetings are in English, and it is, of course, the common language for most people." (translated);
ii. "...the official standard language is Spanish" (translated).
iii. "So, I, I, 100% of the time had to speak Spanish..." (translated);

6.6.2 Considering dialects (vi.b.)

Dialects are part of the communication context in DSD teams. Those can emerge as variations of languages that include the English, the Chinese, and the Indian, among others. Those dialects include specific pronunciation styles, and a subset of terms, justified by the circumstances of distinct origins of DSD members. The presence of different dialects in DSD teams may hinder the communication act. Even for a business standard language as the English language, regional variations can support misunderstandings, even for native speakers. Therefore, even by choosing the English language as the DSL option in DSD teams, DSD members may need to get used to eventual dialects and try to learn about them, demanding some time for better communication effectiveness. On the other hand, some languages may be less prone to dialects, i.e., presented more uniformly in DSD teams. Furthermore, previous experiences of DSD members in dealing with different languages and cultural contexts will support a better understanding of dialects in those teams.

Examples of quotations in this component:

i. "...invariably, English may be the official language, but you're going to have to learn multi dialects of English." (translated);
ii. "...you have to understand how to communicate with the Chinese, then you fail! Because there is no single Chinese..." (translated).

6.6.3 Struggling with a foreign language (vi.d.)

DSD members tend to identify by themselves rationally their limitations on the chosen DSL as a foreign language, as well as able to identify the limitations of their colleagues. Eventually, DSD members may present themselves without the capacity to master a foreign spoken DSL. This situation can lead to the omission from the participation in discussions during meetings, as those individuals may not understand the spoken matters. The lack of adequate capabilities in the chosen DSL may lead to frustration in the communication act. Without those capabilities, DSD members may find themselves with the impression that they could contribute more effectively than they did. Also, by the sensation that colleagues are "giving up" to communicate due to those limitations. The lack of capabilities in the DSL may also lead to discomfort of individuals in DSD teams, as this situation can support feelings of incapability, and in fewer circumstances, inferiority. Overall, limitations in the chosen DSL can lead to communication delays, noise, and misunderstandings of meanings. Nevertheless, bad DSL capabilities will not necessarily make recurrent meetings such as daily ones, unfeasible, but may add barriers to effective communication, whether using a native language would probably not.

Examples of quotations in this component:

i. "...for example, when I was working on the other project that was also with DSD, he, we have a problem of being able to understand the English of some people..." (translated);
ii. "But, yeah, it was certainly different than if everyone had been speaking their native language, right?" (translated).
iii. "...it was not so comfortable, because each of us has a different level of English, right? And many times we could not capture everything that was said by another person..."

7 Discussion

In what concerns the Study Gap Consolidation (see Section 4.2), and based on the presented findings, whereas no specific DSD communication theory was identified, and as it seems, indicating explanation gaps in DSD communication, we identified that a new and specific DSD communication theory has its place in literature.

As for the current state of our theory, we highlight that when compared with its first preliminary version (Leitão Júnior et al., 2019), this version of our theory brings to light additional theoretical content on the aspects of the diversity of cultural expectations, on the effort to deal with different schedules in cultural diversity, on the adoption of physical drawing boards as communication media, and mostly, on a new Language-based dimension and its new components. This version also included some refactoring on theoretical concepts that were represented by specific components such as the "reports" as media and the "accepting cultural diversity", which now had part of their contents revised for better represent communication-related aspects and some of its contents reallocated to other theoretical components of the theory.

This Further Preliminary Theory of Communication in Distributed Software Development Teams, brings with its theoretical contents the concept that communicating in DSD teams comprises distinct and multidisciplinary concepts, including cultural and behavioral elements, hence, suggesting multiple research fronts on this phenomenon in distributed software development teams in a multidisciplinary strategy. In this context, and in what concerns the cultural diversity in DSD teams, we can trace a parallel of those findings with Toomey and Dorjee (Ting-Toomey and Dorjee, 2018), who state that to communicate appropriately and effectively, individuals have to manage diverse sociocultural identity memberships, adaptively, and with Gurung and Prater (Gurung and Prater, 2017), who states that dealing with cultural differences in DSD is a contemporary challenge.

We also identified that dealing with a foreign language in DSD teams is still a challenge for many individuals due to limitations in language capabilities itself and the possibility of interaction with different accents and dialects that may come with it. Additionally, we also identified that the nature of communication practices and the right choice of media for communicating also plays a relevant role in those teams, as DSD stakeholders have been adopting strategies and choosing spatial and software-based tools for better communication in their teams for some time, suggesting that the construction of new methodologies, or software-based tools for the improvement of communication can be well received by DSD members, as approaches as such are usually well incor-

porated by them in their daily work environment.

Furthermore, when considering the factors that influence communication in DSD teams according to Santos and Coauthors (dos Santos et al., 2012) we identified direct references to the theoretical content of the emerged theory with six factors that were not apparently addressed by any of the theories that we identified during our exploratory literature review, as follows.

i. *Language of linguistic barriers*: this factor is directly addressed by the "Struggling to communicate with a foreign language" component. That's because the respective component includes theoretical contents on aspects such as the challenging nature of mastering a foreign language, using this language as the language of choice in DSD teams, and considerations on the effects of insufficient communication capabilities on this foreign language. Additionally, we may trace a parallel between this factor and the "Considering dialects" components, as the second one includes theoretical content on the diversity of dialects that may permeate DSD teams;
ii. *Limited informal communication*: we argue that this factor is addressed by the "Communicating informally" component. This component brings to light theoretical content on the nature of informal communication in DSD teams by the perspective of a more relaxed and natural communication style in those teams. Additionally, the component also includes considerations on the circumstances of the adoption of informal communication, with a brief intersection on the hierarchical context in those teams;
iii. *Temporal distance*: this factor relates directly with the components below the "Including Different Time Zones" dimension. This dimension brings to light communication-related aspects of the interaction of DSD teams members between different time zones. Additionally, this dimension brings the view of communication as a challenge to be tacked by DSD members in their teams.
iv. *Synchronization of work schedules*: we may trace parallels between this factor and on the effort of DSD team members to synchronize the work in different time zones, as presented by the "Synchronizing communication in DTZs" component. Furthermore, we may also trace parallels between this factor and the "Adapting schedules to cultural diversity" and "Considering different religions beliefs", on the effort of DSD team members to do their best on trying to manage fluctuations in work schedules due to cultural or religions reasons;
v. *Distribution of tasks*: we may argue some intersection between this factor and the "Adopting issue tracking systems" and "Adopting physical drawing boards" components, as both present theoretical content on the effort of DSD team members to distribute and better communicate tasks in their teams;
vi. *Communication skills*: we argue that this factor relates to diverse aspects of the emerged theory, but mostly on the positive outcomes in the communication context on the practice of empathy, as presented by the "Practicing empathy" component, on the better understanding of the diversity of communication styles in cultural diversity as described by the "Dealing with different communication styles" component, and on the considerations on the capabilities on communicating in a foreign language as presented by the components below the "Communicating in a DSD Standard Language (DSL)".

Those findings lead us to the conclusion that the emerged theory has the potential to contribute to the DSD literature as it brings knowledge to the communication context of DSD teams, even on its preliminary version. Furthermore, we may thereby conclude that the usage of the Grounded Theory has been a rich choice for uncovering the communication phenomenon in DSD.

Additionally, we propose some actions to DSD managers and other practitioners for better communicating in DSD teams, as follows.

i. *Consider "soft" skills*: the practice of empathy and a better understanding of the established affinity between DSD members will help to support a healthier communication context in DSD teams;
ii. *Understand cultural aspects*: managers need to be aware of the cultural diversity that permeates global DSD teams and consider this aspect when planning communication. People from different origins will bring different ambitions, expectations, and communication styles with them. Therefore, DSD managers in this context must do their best to understand those circumstances in order to avoid future communication problems;
iii. *Do not forget in-person communication*: when possible, managers shall consider communicating in person with important stakeholders, mostly in the beginning and in critical moments of DSD projects;
iv. *Do not overuse asynchronous communication*: asynchronous communication is a trend in DSD due to the nature of this model. Still, managers and team members need to do their best to make synchronous communication feasible in their teams;
v. *Support informal communication*: informal communication has the potential to remove communication barriers in DSD teams. Therefore, and even by not forgetting the value of formal communication, DSD members shall support informal communication for better communication results in their teams.

8 Limitations and Threats to Validity

We consider as the first limitation to this study our decision to not use procedural techniques such as the "Axial Coding" for bringing back data, i.e., for linking subcategories (dimensions) to subcategories (components). We related those components by the data that those represent, as a non-procedural approach exemplified by Charmaz (Charmaz, 2014, p. 148). Nevertheless, as also stated by the author, this approach may also lead to some degree of ambiguity. Thus, even by exhausting the process of defining categories and relating those to subcategories, we accept that some degree of ambiguity may exist in the hierarchical representation of our categories and

subcategories. Still, we believe that those circumstances will not compromise the abstraction of data itself and the robustness of the emerging theory's theoretical content.

As an overall threat to this research work as a qualitative one and mostly, for being a GT research, we believe that bringing preconceived ideas from literature into the emerging theory could, potentially, represent a threat, i.e., a "biases" aspect. At this point, we decided to plan our extensive literature review to a later stage of this research, after constructing the new theory to mitigate biases effects on the emerged concepts, even by not necessarily being a problem from Charmaz's perspective. Furthermore, we remark the possibility of including some degree of implicit biases in the emerging theory due to our Software Engineering area experience. We are researchers in DSD, with experience in the software industry. I'm a Researcher and Practitioner in the Software Engineering industry with more than 20 years of experience in diverse roles, including Coding, Testing, Requisites, Elicitation, and Analysis. Our coauthors are both Lecturers and Researchers with extensive experience with Project Management, Quality, Maturity, and Capacity models, among other Software Engineering fronts. Still, we believe that our experience will not pose a significant risk of biases in the emerged theory, as we followed the strict Charmaz's GT specification. Regarding this topic, Charmaz stated that "Researchers typically hold perspectives and possess knowledge in their fields before they decide on a research topic" as even "Examining committees expect such expertise, funding agencies require it." (Charmaz, 2014, p. 306). Thereby, we believe that we got to the same page as Charmaz, who understood this scenario as a natural and eventually a necessary one.

8.1 Future Work

Our first challenge to tackle as future work is to collect further data, continue to perform the constant comparative method and review our codes, classes and sub-classes until achieving "Theoretical Saturation" (see Section 4.1). By performing this effort, we aim at evolving the current state of the theory and thereby, conclude the application of the GT method.

Next, we aim at strengthen the validity of this study by performing additional research steps. At this point, we may cite Golafshani (Golafshani, 2003), who defines validity in quantitative research as "whether the means of measurement are accurate and whether they are actually measuring what they are intended to measure." But the author, however, also states that this concept is viewed differently by qualitative researchers, who consider these terms inadequate in their research contexts. Supporting the need for some qualifying check or measure for validity for their qualitative work, including data or method triangulation. Thus, to better deal with those risks, we propose an additional third research step as future work. This new and last step includes a later extensive literature review in the format of a *Systematic Mapping Study* (SMS). This new step will also have an evaluation process, based on a Focus Group session followed by the verification of a set of credibility criteria on the construction process of the theory itself, as an approach for validating GT studies. In this way, we are trying to characterize a triangulated method approach (GT, *Systematic Mapping Study* (SMS) and Focus Groups), which enhances the strength of qualitative studies (Patton, 1990) as ours. We detail the activities of this additional step as follows.

i. *Systematic Mapping Study*: As stated by Kitchenham and Charters (Kitchenham and Charters, 2007), a *Systematic Mapping Study* (SMS) allows the identification of evidence in a domain at a larger scale of granularity. The authors also affirm that these studies allow the identification of evidence clusters and deserts to direct the focus of future Systematic Literature Reviews and to identify areas for future primary studies. Therefore, we propose a SMS to confront the emerged theory with the literature and situating it. We expect that this SMS will provide a selection of studies about communication in DSD and an extensive view of communication theories used in this context, to allow the comparison of the emerged theory with other studies in an extensive approach;
ii. *Focus Groups Sessions*: We propose one Focus Groups session with practitioners from the Software Industry in DSD for verifying if the emerged theory reflects the real communication context in those teams. Focus Group is a technique for data collection based on group interactions, in which a researcher suggests a topic for further discussions (Morgan, 1997) and collects the emerging data. Focus Group is a technique for primary explore the group perception instead of the individual's ones; thus, when using this technique, a researcher must be focused on the consensus and the exceptions exposed by the group (Sim, 1998);
iii. *Theory Evaluation*: We propose the evaluation of the new theory by reflecting our theory development process with a set of evaluation criteria for GT and other Scientific Studies. Additionally, we propose using the findings from the SMS study and the feedback on the new theory collected via the Focus Group session. In this context, we propose using the set of criteria proposed by Charmaz (Charmaz, 2014), as it comes from our leading methodological choice. Charmaz states that the line between process and product becomes blurred for our audiences, as other scholars will likely judge the GT process as an integral part of the product (Charmaz, 2014). The author also states that expectations for a GT study may vary (Charmaz, 2014), but the following list of criteria may give some ideas to grounded theorists: *Credibility*, *Originality*, *Resonance*, and *Usefulness*.

References

Adolph, S. (2013). *Reconciling Perspectives: A Substantive Theory of How People Manage the Process of Software Development*. PhD thesis, Thesis (Doctorate in Computer Engineering) - Faculty of Graduated Studies (Electrical and Computer Engineering) at University of British Columbia, Vancouver, Canada.

Adolph, S., Kruchten, P., and Hall, W. (2012). Reconciling Perspectives: A Grounded Theory of How People Manage

the Process of Software Development. *Journal of Systems and Software*, 85(6):1269–1286.

Aoyama, M. (1997). Agile software process model. In *Proceedings of the Twenty-First Annual International Computer Software and Applications Conference*, pages 454–459, Washington, DC, USA. IEEE.

Aranda, G. N., Vizcaíno, A., and Piattini, M. (2010). Analyzing and Evaluating the Main Factors that Challenge Global Software Development. *The Open Software Engineering Journal*, 4:14–25.

Birks, M. and Mills, J. (2011). *Essentials of grounded theory*. Sage London.

Breckenridge, J., Jones, D., Elliott, I., and Nicol, M. (2012). Choosing a methodological path: Reflections on the constructivist turn. *Grounded Theory Review*, 11(1):64–71.

Carmel, E. (1999). *Global Software Teams: Collaborating Across Borders and Time Zones*. Prentice Hall, Upper Saddle River, NJ, USA, 1 edition.

Charmaz, K. (2000). Grounded theory: Objectivist and constructivist methods. nk denzin, ys lincoln, eds. handbook of qualitative research. *Thousand Oaks, CA, Sage Publications*, 509:535.

Charmaz, K. (2006). *Constructing grounded theory: a practical guide through qualitative analysis*, volume 10.

Charmaz, K. (2014). *Constructing Grounded Theory*. SAGE Publications, Kindle Edition, Rohnert Park, USA, 2 edition.

Chenitz, W. C. and Swanson, J. M. (1986). *From practice to grounded theory: Qualitative research in nursing*. Addison-Wesley, Menlo Park, CA.

Clear, T. and Beecham, S. (2019). Global software engineering education practice continuum. *ACM Transactions on Computing Education: Special Issue of the ACM Transactions on Computing Education*, 19(2):7.

Cruzes, D. S., Moe, N. B., and Dybå, T. (2016). Communication between Developers and Testers in Distributed Continuous Agile Testing. In *Proceedings of the IEEE 11th International Conference on Global Software Engineering*, pages 59–68, Irvine, CA, USA. IEEE.

Daft, R. L. and Lengel., R. H. (1986). Organizational Information Requirements, Media Richness and Structural Design. *Management science*, 32(5):554–571.

de Farias Junior, I., Marczak, S., Santos, R., and Moura, H. (2016). Communication in Distributed Software Development: A Preliminary Maturity Model. In *IEEE 11th International Conference on Global Software Engineering (ICGSE)*, pages 164–173, California, USA. IEEE.

Dennis, A. and Valacich, J. (1999). Rethinking Media Richness: Towards a Theory of Media Synchronicity. In *Proceedings of the Annual Hawaii International Conference on Systems Sciences. 1999*, page 10, Maui, Hawaii. IEEE.

dos Santos, A. C., de Farias Junior, I. H., de Moura, H. P., and Marczak, S. (2012). A Systematic Tertiary Study of Communication in Distributed Software Development Projects. In *Proceedings of the International Conference Global Software Engineering*, pages 182–182, Porto Alegre, RS, Brazil. IEEE.

Dunne, C. (2011). The Place of the Literature Review in Grounded Theory research. *International Journal of Social Research Methodology*, 14(2):111–124.

Easterbrook, S. and Neves, B. (2007). Seminar 2 : Epistemology & Ethics.

Farias Junior, I. H. D. (2014). *C2M - A Communication Maturity Model for Distributed Software Development*. Doctoral dissertation (doctorate in computer science), CIn, UFPE University, Recife, Brazil.

Gil, A. C. (2002). Como classificar as pesquisas. *Como elaborar projetos de pesquisa*, 4:44–45.

Glare, P. G. (1968). *Oxford latin dictionary*. Clarendon Press. Communication.

Glaser, B. G. (1978). *Theoretical Sensitivity: Advances in the Methodology of Grounded Theory*. The Sociology Press, San Francisco, 1 edition.

Glaser, B. G. and Strauss, A. L. (1967). *The Discovery of Grounded Theory: Strategies for Qualitative Research*. Transaction Publishers, London, UK, 1th edition.

Glaser, B. G. and Strauss, A. L. (2009). *The Discovery of Grounded Theory: Strategies for Qualitative Research*. Transaction Publishers, London, UK, 7th edition.

Golafshani, N. (2003). Understanding Reliability and Validity in Qualitative Research. *The Qualitative Report*, 8(4):597–607.

Gregor, S. (2006). The Nature of Theory in IS Research. *MIS Quartely*, 30(3):611–642.

Gurung, A. and Prater, E. (2017). A research Framework for the Impact of Cultural Differences on IT Outsourcing. In *Global Sourcing of Services: Strategies, Issues and Challenges*, pages 49–82. World Scientific.

Herbsleb, J. (2016). Building a socio-technical theory of coordination: Why and how (outstanding research award). In *Proceedings of the 2016 24th ACM SIGSOFT International Symposium on Foundations of Software Engineering*, FSE 2016, pages 2–10, New York, NY, USA. ACM.

Herbsleb, J., Herbsleb, J. D., Moitra, D., and Moitra, D. (2001). Global Software Development. *IEEE software*, 18(4):16–20.

Herbsleb, J., Paulish, D., and Bass, M. (2005). Global Software Development at Siemens: Experience From Nine Projects. In *Proceedings of the International Conference on Software Engineering*, pages 524–533, Saint Louis, MO, USA, USA. IEEE.

Hofstede, G. (1983). National Cultures in Four Dimensions: A Research-Based Theory of Cultural Differences Among Nations. *International Studies of Management & Organization*, 13(1-2):46–74.

Kauark, F. d. S., Manhães, F. C., and Medeiros, C. H. (2010). *Metodologia da pesquisa: um guia prático*. Via Litterarum.

Kitchenham, B. and Charters, S. (2007). Guidelines for Performing Systematic Literature Reviews in Software Engineering Version 2.3. *Engineering*, 45(4ve):1051.

Leitão Júnior, N., Farias Junior, I., and Moura, H. P. (2019). A Preliminary Theory of Communication in Distributed Software Development Teams. *Journal of Convergence Information Technology*, 14(2):30–41.

Littlejohn, S. W. and Foss, K. A. (1992). *Theories of human communication*. Waveland press, 4 edition.

Morgan, D. (1997). *Focus Groups as Qualitative Research*. SAGE Publications, London, UK, 2 edition.

Morse, J. M., Noerager, P., Juliet, S., Bowers, B., Charmaz, K., and Clarke, A. E. (2016). *Developing Grounded Theory: The Second Generation*. Routledge, New York, USA.

Patton, M. Q. (1990). *Qualitative Evaluation and Research Methods*. SAGE publications, Thousand Oaks, California, USA, 2 edition.

Robert, L. P. and Dennis, A. R. (2005). Paradox of Richness: A Cognitive Model of Media Choice. *IEEE Transactions on Professional Communication*, 48(1):10–21.

Rosengren, K. E. (2000). *Communication, an introduction*. Sage publications., London, UK.

Shah, Y. H., Raza, M., and Ulhaq, S. (2012). Communication Issues in GSD. *International Journal of Advanced Science and Technology*, 40:69–76.

Short, J., Williams, E., and Christie, B. (1976). *The Social Psychology of Telecommunications*. John Wiley and Sons Ltd, London, United Kingdom.

Sim, J. (1998). Collecting and Analysing Qualitative Data: Issues Raised by the Focus Group. *Journal of Advanced Nursing*, 28(2):345–352.

Teixeira, J. (2014). Understanding Collaboration in the Open-source Arena: the Cases of WebKit and OpenStack. In *Proceedings of the International Conference on Evaluation and Assessment in Software Engineering*, pages 52:1–52:5, London, England, United Kingdom. ACM.

Ting-Toomey, S. and Dorjee, T. (2018). *Communicating Across Cultures*. Guilford Publications, New York, NY, USA.

Travers, J. and Milgram, S. (1967). The small World Problem. *Psychology Today*, 1(1):61 – 67.

Van Ruler, B. (2018). Communication theory: An underrated pillar on which strategic communication rests. *International Journal of Strategic Communication*, 12(4):367–381.