# Dealing With Cultural Dispersion: a Novel Theoretical Framework for Software Engineering Research and Practice

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## ABSTRACT

Software development is fundamentally a team-driven process; researchers in software engineering have identified various human and social factors that can significantly impact it. Culture emerged as a critical element, and the diversity deriving from cultural differences can be highly impactful both positively and negatively. Despite existing knowledge about how culture influences software development, limitations persist. Most importantly, a unified and comprehensive (grounded) theory of how cultural differences influence and are managed in software development has yet to exist. This lack has two significant consequences: (1) it makes research on culture fragmented, leading to the continual definition of new concepts that do not allow state of the art to advance significantly, and (2) it reduces the ability of the research to be transferred to practitioners since there is no framework designed to be understood and used by them. To address the above-mentioned limitation, this work proposed a theoretical framework of **"Dealing With Cultural Dispersion"**, which focuses on challenges and benefits originating from cultural differences and strategies for dealing with them. Such a framework was developed through a qualitative study using an iterative research approach, including interviews and socio-technical grounded theory for data analysis. The proposed framework was designed to reveal the tangible effects of practitioners' culture in software development, allowing software teams to (1) clearly understand the problem and (2) implement the correct strategy for addressing it. Additionally, researchers can use this framework as a foundation to (deductively) develop a more robust and comprehensive theory in this field.

## CCS CONCEPTS

• **Software and its engineering → Software organization and properties**; • **Social and professional topics → Cultural characteristics**; **Geographic characteristics**.


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## KEYWORDS

Global Software Engineering; Cultural Dispersion; Socio-Technical Grounded Theory

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## LAY ABSTRACT

Software development is a collaborative process influenced by human and social factors. Cultural diversity has a profound impact, both positively and negatively, on this dynamic field. However, current research lacks a unified theory addressing how cultural differences affect and are managed in software development, resulting in fragmented knowledge and limited applicability to practitioners. To bridge this gap, this study introduces the "Dealing With Cultural Dispersion" framework. Developed through qualitative research methods, including interviews and socio-technical grounded theory, the framework sheds light on challenges and benefits arising from cultural differences in software teams. It serves a dual purpose: providing practitioners with a tool to understand and address cultural issues in their projects, and offering researchers a foundation to develop a more comprehensive theory in the field. By employing a holistic approach, the framework allows software teams to gain a clear understanding of cultural influences and implement tailored strategies for effective collaboration. This not only addresses current limitations in research but also empowers practitioners with a practical framework for navigating cultural diversity in the realm of software development.

## 1 INTRODUCTION

At its core, software development is essentially a team-driven activity [5, 37]; researchers in software engineering have been delving into how the human and social aspects of the process can significantly impact the development journey. Their work has shown that managing these aspects is crucial, as they play a pivotal role in determining the ultimate success of a software project [6, 43]. Digging into these aspects, *culture*—i.e., shared motives, values, beliefs, identities, and interpretations or meanings of significant events

that result from common experiences of members of collectives and are transmitted across generations [29]—is emerging as a critical element that demands attention among software community members throughout the development lifecycle.

The Global Software Engineering (GSE) research community has established that culture plays a crucial role in every aspect of software development [7, 31, 32, 39, 42]. Efforts have been made to bridge differences and leverage the benefits of cultural diversity in this context [16, 36]. Given the complexity of the culture concept, research in this area can benefit from frameworks that break down culture into specific dimensions. One pertinent example, particularly relevant to this study, is the GLOBE framework [25].

Despite the presence of frameworks and a wealth of knowledge about how culture influences software development, several limitations persist. Previous research often simplified the concept of culture in ways that did not translate well to practical use by industry professionals [32, 44]. Furthermore, these studies frequently zoomed in on specific aspects of software development, like code review, rather than offering a broader and more holistic perspective [1, 4]. Moreover, there is currently no all-encompassing (grounded) theory that effectively explains the impact of cultural differences on software development and how these differences can be effectively handled. Such an absence has two important implications: first, it results in fragmented research, often leading to the creation of new contributions without significant advancements in the field; second, it limits the practical applicability of research findings in the software development industry, as no established framework can be easily understood and implemented by practitioners. Hence, having a more defined theoretical framework could be valuable, potentially addressing these limitations and offering practical benefits for practitioners and researchers alike.

To tackle the aforementioned limitations, we took a significant stride in understanding how cultural differences within software development teams impact the development process. To achieve this objective, we conducted a qualitative study that involved an iterative research approach. We gathered data through interviews [26] and employed socio-technical grounded theory for data analysis [18]. Through this analysis, we developed a new and preliminary theoretical framework that encapsulates categories and the effect of cultural diversity, offering strategies to mitigate the challenges faced by practitioners in such contexts.

This framework consisted of four main categories, where the most relevant one is titled **"Dealing With Cultural Dispersion"**, which describes situations in which a development community presents individuals behaving oppositely for a particular cultural background. The category encompasses six concepts associated with a specific cultural dimension expressed in the GLOBE framework [25]. For example, the concept *Uncertainty Avoidance Dispersion*—associated with the Uncertainty Avoidance dimension of GLOBE—describes situations in which the members of the same community approach uncertainty divergently. For each of those concepts, we identified caused effects (positive and negative), mitigation strategies for originated issues, and other helpful information. To sum up, the contributions of this research are as follows:

- We developed a preliminary theoretical framework of how practitioners deal with cultural dispersion;
- We identified a set of effects, both positive and negative, resulting from collaboration in culturally dispersed teams;
- We provided a set of strategies for dealing with cultural dispersion and its originated effects;
- We made our codebook publicly available for future deductive theoretical contributions [30].

The proposed framework has the potential to act as a catalyst, shedding light on the concrete impact of developer culture during software development activity. Professionals can leverage our work to gain insights into previously hidden challenges, address them effectively, and identify new opportunities they might have overlooked. Furthermore, researchers can use our framework as a foundation for building upon and expanding toward developing a more robust and comprehensive theory in this field.

## 2 BACKGROUND AND RELATED WORK

In this section, we delve into the GLOBE cultural framework [28], which serves as our foundation for discussing cultural concepts in our study. Additionally, we discuss related work on cross-cultural analysis in software engineering.

### 2.1 GLOBE Cultural Framework

The GLOBE (Global Leadership and Organizational Behaviour Effectiveness) project is a multi-phase, multi-method project examining the interrelationships between societal culture, organizational culture, and leadership [28]. Having been referred to as the most ambitious project in culture and leadership [34], the GLOBE team comprises 170 researchers worldwide and collected the data of 62 countries from different regions of the world [25]. A total of 17000 managers from telecommunications, food, and banking industries participated in the study [23].

The central premise of the model suggested by GLOBE is that attributes that distinguish a given culture from others predict organizational practices and accepted and enacted leadership behaviors. To distinguish one culture from the other, the GLOBE project conceptualized culture across nine dimensions. Overall, GLOBE culture dimensions reflect the frameworks introduced by Hofstede [21], Singelis [38] and McClelland [33] [2, 25]. It is therefore seen as a more extended and comprehensive version compassing a wider array of cultural dimensions.

**Performance orientation (PO):** it refers to the extent to which a society encourages and rewards its members for performance improvement and excellence; in direct relationship with entrepreneurship, it refers to the degree to which innovation is rewarded.

**Future orientation (FO):** it is associated to the degree to which individuals in societies engage in future-oriented behaviors such as planning and investing in the future. While future-oriented societies value perseverance and patience, societies that are low in this cultural dimension are more focused on short-term results.

**Power distance (PD):** it refers to the degree to which members of a society expect and accept unequal distribution of power. In high power distance societies, an unequal distribution of power is accepted. On the other hand, in low power distance societies, egalitarianism is emphasized.

**Uncertainty Avoidance (UA):** it refers to the extent to which members of a society attempt to avoid uncertainty by relying on

established social norms and practices. Cultures with high scores of uncertainty avoidance seek to reduce risk and ambiguity.

**Humane Orientation (HO):** it is the degree to which individuals in societies encourage and reward individuals for being fair, altruistic, friendly, generous, caring, and kind.

**In-group Collectivism (GC):** it is the degree to which individuals express cohesiveness in their families or close groups.

**Institutional collectivism (IC):** it reflects the degree to which societal institutional practices encourage and reward collective distribution of resources and collective action.

**Gender egalitarianism (GE):** it refers to the extent to which a society promotes gender equality and minimizes differences.

**Assertiveness (A):** it is the degree to which individuals in societies are confrontational and tough in social relationships. In societies with high assertiveness cultural scores, harmony is less emphasized than expressing ones' opinions directly and frankly.

## 2.2 Cross-Cultural Analysis in Software Engineering

Global Software Engineering researchers arose to investigate aspects related explicitly to distributed software development. Culture arose as a crucial factor, and researchers put effort into studying its impact on the entire lifecycle [4, 27, 44].

A first contribution is the one of Borchers [4], which delved into the influence of cultural factors on software engineering processes, such as code review, with a particular focus on three distinct countries: Japan, India, and the United States. The study operationalized the Hofstede cultural framework [21] and revealed how different cultures approached software engineering practices uniquely. For instance, Japanese developers were noted for their tendency towards a low level of risk tolerance, which led to a more deliberate decision-making process. Furthermore, Borchers underscored that cultural variations within software teams could also impact software architecture, thereby encouraging further exploration of this subject in contemporary research. A second contribution consisted of the one of Yasin et al. [44]; they conducted an empirical investigation involving experimentation and surveys to determine how group activities can mitigate the emergence of culturally-originated problems. Their discussion sessions and survey results revealed their ability to identify critical GSE challenges, especially those related to teamwork, in a simulated scenario. Moreover, Javed et al. [27] conducted a study for identifying and assessing mitigation strategies for cultural socio-cultural distance issues. Their study used a literature review and surveys, resulting in a framework of twenty-eight mitigation strategies for six issues.

In contrast to the previously mentioned works, our study took a different approach. Instead of examining culture as a whole, we analyze the different nuances of the cultures—the cultural dimensions—using the most recent and comprehensive theoretical framework from cross-cultural research, allowing us to explore each cultural dimension individually and relate to others. Furthermore, we presented a comprehensive view encompassing various aspects, including issues, impacts, and solutions, rather than concentrating on just one facet using Socio-Technical Grounded Theory [11]. Additionally, as far as we know, no grounded theory, whether socio-technical or otherwise, has been proposed in the existing literature.

# 3 RESEARCH PROCESS

The *goal* of this study was to provide a novel and preliminary theoretical framework that describes how cultural differences in software development teams influence the development lifecycle. The *purpose* was to provide new applicable and structured knowledge that practitioners could use to make more informed decisions and consequently improve the software project success rate. The *perspective* was of practitioners and researchers: the former could be interested in using strategies to better deal with diversity in their teams; the latter could be interested in identifying further research directions to increase the body of knowledge on the cultural impact on software development.

To reach the objective mentioned above, we formulated the following research question:

> **Research Question.** *How do cultural differences in software development teams influence the development lifecycle?*

To answer the research question, we conducted semi-structured interviews [9, 26] and applied *socio-technical grounded theory (STGT) for data analysis* [18]. Specifically, we interviewed ten practitioners—with experience in distributed software development over three data-gathering and analysis iterations—and performed open and axial coding for data analysis. Moreover, we reported organized this research paper using the *ACM/SIGSOFT Empirical Standards*.[1]

## 3.1 Semi-structured Interviews Design

In order to investigate our research question effectively, we conducted *semi-structured interviews* [9, 26] with experienced practitioners in the field of distributed software development. Semi-structured interviews combine specific questions (for studying the main topic to be covered by the research) and open-ended questions (to elicit unexpected types of information). This qualitative method is often used to gather in-depth information, opinions, and personal experiences from participants while maintaining consistency and comparability across interviews (as needed when conducting grounded theory-based research [11, 18, 41]). Given the complexity of the research topic (i.e., studying cultural influences in software development), semi-structured interviews emerged as the ideal method to gain insights from practitioners who possess valuable experience in distributed software development.

To design the semi-structured interview protocol, we relied on the guidelines provided by Hove and Anda [26]—more details about the questions are in the online appendix [30]. The protocol had three main sections, and it started with an introduction presenting the work objectives and privacy information.

**Demographic Information.** In the first part, we presented ourselves and asked the interviewee to do the same; the goal was to break the ice and collect demographic information, including their project domains and experience.

**Culture and GLOBE.** In the second part, we presented to the interviewee the definition of cultural aspects and some behaviors that social science demonstrated as being influenced by cultural background [25]. **Recognizing the intricacies of discussing**

[1] Available at the following link: https://github.com/acmsigsoft/EmpiricalStandards. Given the nature of the study and the currently available standards, we followed the *"General Standard"*, *"Grounded Theory"*, and *"Qualitative Surveys"* guidelines.

**culture during interviews and the potential for misunderstandings, we took deliberate steps to ensure clarity and alignment with our interviewees.** For such a reason, we operationalized the GLOBE framework for cultural measurement [8, 24, 25] (detailed in Section 2) and provided the interviewee with a brief background on it and some examples of behaviors elicited from the nine dimensions. By doing so, we minimized the risk of misunderstandings and ensured a more precise exploration of cultural factors in the interviews.

**Experience with Culture.** The third part was the core part: We asked participants to provide their experience related to cultural factors during software development. Specifically, using a set of pre-defined questions, we asked participants (1) to provide some experience related to situations in which individuals with different cultural backgrounds work together, (2) what are the visible effects of such heterogeneity, and (3) what strategies the management put in place for supporting the benefits or mitigating the problems. Doing so leads the interviewee to tell us about past experiences and elicit information from them.

The interview protocol was initially designed by the first author of the paper and refined through meetings with the others. Then, the first draft was validated with two practitioners and two researchers from our network (in terms of understandability and clarity); using their feedback, we added a supporting slide presenting examples of technical and social problems state of the art demonstrated being impacted by cultural differences. The provided examples were highly abstract and general to avoid inserting biases in participants.

## 3.2 Participant Sample and Data Collection

Regarding participant selection, we utilized a convenience sampling approach [3, 13]. This method involves non-probabilistic sampling, where individuals are chosen based on factors like their proximity, availability, or willingness to take part in the research. Furthermore, participation in the study was entirely voluntary. While this approach allowed us to secure participants quickly, it does come with limitations in terms of the generalizability of our findings [13]. To address this limitation, we made a deliberate decision to exclusively reach out to individuals who met specific criteria, which included the following:

- Possessing experience with distributed teams.
- Having at least ten years of experience in the software industry.
- Having experience in managing software development teams.

We contacted 20 professionals within our network; 10 met the above-mentioned criteria and agreed to participate. All the interviews lasted approximately 60 minutes and were conducted remotely since the participants were globally distributed. Moreover, we asked and obtained permission to record the interview for data analysis purposes. According to the socio-technical ground theory methodology [18], we conducted different iterations of interviews. In this specific study, we conducted three iterations: the first with 5 participants, the second with 3, and the last with 2.

## 3.3 Applying STGT for Data Analysis

In the following, we briefly introduce the basics of our data analysis method and procedure.

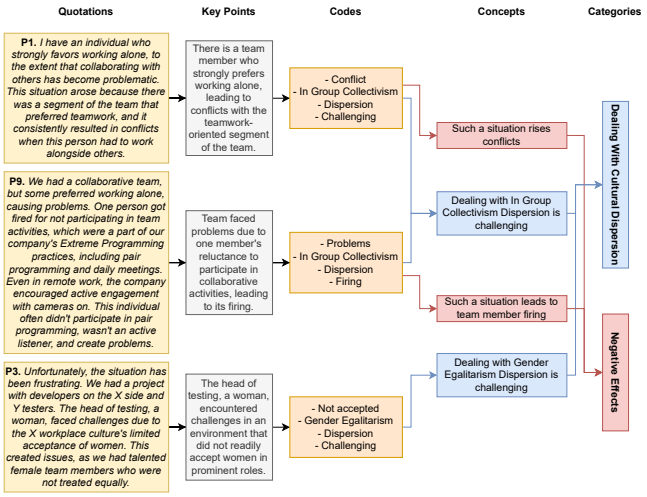


**Figure 1: Example of open coding and constant comparison method application.**

*3.3.1 The Method.* For performing data analysis, we relied on the *Socio-Technical Grounded Theory* (STGT) method designed by Hoda [18].[2] Specifically, we applied a limited part of the full STGT process, namely *STGT for Data Analysis*; it consists of the basic data analysis procedures of (1) *open coding*, (2) *constant comparison method*, and (3) *memoing*—combined with different research frameworks [18]. This approach was chosen in alignment with our study's objectives, as we aimed to present a novel theory rather than developing an exhaustive and comprehensive one.

*Open coding* is the process of assigning *codes* to fragments of text. Specifically, the first step consists of creating a summary—namely, *key points*—of the content of a text fragment (often called *quotation*); then, *codes*—i.e., a list of terms or short phrases describing some aspect arising from a text [19, 40, 41]—are associated to the quotation. Then, *constant comparison* is applied; it involves the ongoing examination of generated codes—both within a single source and across multiple sources—to discern significant trends in the data. This method is utilized to transform codes into abstract information called *concepts*. Then, concepts are ulteriorly aggregated into higher levels of abstraction, called *categories*. For the sake of clarity, Figure 1 reports an example of the application of open coding and constant comparison method that led to the identification of this work's main category: **"Dealing With Cultural Dispersion"** (better discussed in Section 4). The figure reports (1) the raw data (i.e., parts of our interviews), (2) the associated codes, (3) the concepts, and (4) the obtained category.

During the coding process, we reported considerations and ideas on *memos*. Such a process is called basic *memoing*, and it aims to stimulate the researchers to find connections between the identified concepts or categories [11, 18]. For example, the memo reported in the box below is related to the previously cited category, which guides the identification of a separate concept for each cultural

[2] STGT is a tailored version of Grounded Theory specifically designed to study socio-technical phenomena in the software development lifecycle and develop novel, useful, parsimonious, and modifiable theories.

dimension and the further relations between such category and the others identified.

> **Memo titled "Dealing with Cultural Dispersion"**—*While recounting their experiences, respondents often categorized them into distinct cultural dimensions, labeling them as either challenging or non-challenging. Initially intended as a unified discussion on cultural differences, the realization that certain dimensions posed greater challenges led to a consideration of addressing differences in specific dimensions. The concept of cultural dispersion, as explored in quantitative studies, could complement this qualitative contribution. This approach allows the results to center on the impact of diverse cultural dispersions, one per dimension, on software development.*

*3.3.2 The Team.* Developing a solidly grounded theory—specifically in a socio-technical context—requires a research team with a heterogeneous background [11, 18]. Since the central topic of the research is complex and the intention of developing a well-funded theory, we organized a team of experts with different research backgrounds. Specifically, our research team was formed by researchers with experience in (1) software engineering and (2) cross-cultural management; moreover, all of the research team had experience in qualitative study, socio-technical research, and framework development. By doing so, we were confident of having set solid foundations for performing qualitative data analysis.

*3.3.3 Data Analysis Process.* In order to perform the analysis process, we used *Atlas.ti*—a well-known tool for qualitative data analysis.[3] Such an instrument allowed us to import the artifact derived from the interviews—i.e., transcripts and audio records—and associated codes to parts of them; moreover, the tool permitted us to organize codes in categories and folders, other than creating networks of related codes. As a final note, *Atlas.ti* let us to analyze code co-occurrences and obtain graphical statistics of the data.

After the recorded data were imported into *Atlas.ti*, the first author started to perform open coding, constant comparison, and memoing to analyze the data. During different meetings, the first author discussed and presented the findings to others, and the framework was refined according to the emerging discussions and insights. In the end, the authors identified a relationship between the elicited categories and represented them using networks (reported in the figures in the next section). No clear theoretical template emerged as a candidate for representing our findings; this is a common situation when performing preliminary steps of grounded theory and broadly exploring complex topics. For such a reason, we developed our own template, better described in Section 4.

# 4 FINDINGS

This section illustrates the participant's characteristics and the findings obtained using the *concepts* and *categories* identified during the analysis process.

## 4.1 Participant's Characteristics

Table 1 summarizes the characteristics of our participants. We successfully interviewed ten practitioners using convenience sampling and filtering [13]. Throughout the research, we tried to maintain gender balance, resulting in interviews with seven males (70%) and three females (30%), as such, we can consider our sample as realistic if compared to the recent statistics of girls and women in science, technology, engineering and mathematics (STEM)[4]. We also aimed to collect opinions from people growing up in different countries; our final sample was composed of practitioners from 4 different cultural groups (according to the GLOBE framework), i.e., clusters of countries exposing similar cultural behaviors and values [25]. Moreover, our participant pool was differentiated in terms of roles, comprehending three managers, two researchers, three software engineers, and two Data Engineers. They all had at least ten years of experience in the software industry. To sum it up, even though our sample may not have been as diverse as we initially hoped, it still represented a heterogeneous mix of participants, which gives us confidence in the potential for valuable insights from our study.

**Table 1: Background of participants.**

| ID | Gender | Role | Year of Exp. | Origin Country |
|---|---|---|---|---|
| P1 | Male | Project Manager | 19 | Germany |
| P2 | Male | Project Manager | 21 | Russia |
| P3 | Male | Researcher | 10 | The U.S. |
| P4 | Male | Software Engineer | 15 | Italy |
| P5 | Female | Researcher | 10 | The Netherlands |
| P6 | Male | Data Engineer | 10 | Brazil |
| P7 | Male | Product Manager | 20 | The Netherlands |
| P8 | Female | Software Engineer | 10 | Germany |
| P9 | Male | Data Engineer | 10 | Brazil |
| P10 | Female | Software Engineer | 14 | Italy |

## 4.2 Categories and Concepts

This section reports the *categories* identified during the analysis, the associated *concepts*, and the relationships between them. It is important to emphasize that in the subsequent section, we used the terms 'category,' 'concept,' and 'code' referring to the foundational elements of grounded theory research, as expounded in Section 3.3.1. Specifically, the analysis of the data led to the identification of four *categories* described as follows:

**"Dealing with Cultural Dispersion."** It refers to situations in which a difference in the team in terms of cultural behaviors led to some effect (both positive and negative). Each concept in this category expresses the act of dealing with dispersion in terms of a specific GLOBE dimension [25]. For example, the concept of Dealing with Power Distance Dispersion arose from quotations about a difference in terms of way of thinking and acting related to the distribution of power in a group (that is, the cultural behavior related to Power Distance Dimension).

**"Effects of Cultural Dispersion."** It describes the effect (positive and negative) deriving from situations in which there was collaboration between a team culturally dispersed. Each concept in this category expresses an effect, and each effect is associated

[3] *Atlas.ti website: https://atlasti.com/*

[4] Girls and women in STEM: https://www.industry.gov.au/news/second-national-data-report-on-girls-and-women-in-stem

with an attribute that expresses if it is positive or negative for the community members and its management.

**"Strategies for Dealing with Cultural Dispersion."** Such a category relates to how practitioners deal with cultural dispersion-originated issues in their teams and its consequent effects. Each concept in this category expresses a strategy (related to some effect of dispersion) for mitigating it.

**"Co-starring Dimensions."** It describes situations in which the effect caused by a culturally dispersed context was also caused by a cultural background divergent from the one indicated by the dispersion concept.

Each category arose as an aggregation of information called *concepts* in Grounded Theory. By *memoing*—deepened in Section 3.3.1—we identified relationships between concepts of different categories. As we look at the categorization mentioned earlier, it becomes clear that the first category, namely **"Dealing with Cultural Dispersion,"** stands out as a prominent focal point during the analysis and reporting phase. In fact, all the concepts within the other categories are mainly intertwined with those within the first category. For this reason, we decided to organize the discussion of the findings around each concept of **"Dealing with Cultural Dispersion."** Specifically, in each subsection of this, titled as one of the concepts of the main category, we inserted a picture of the relationships between one of the concepts of **"Dealing with Cultural Dispersion"** and the concepts of the other categories. Moreover, a textual description of those relationships is given; we include (1) the names of the concepts identified during the analysis (in bold and suitably edited to ensure fluency in reading) and (2) some of the participants' quotations supporting the concepts expressed. Moreover, when reporting on strategies, we evidenced the eventual "actor" that should perform it in *italic*. The complete codebook is available in our online appendix [30]. As a final note, we did not provide personal interpretations in the following sections, and all the reported relations arise directly from the data analysis. Discussions and insights from our work are reported in Section 5.

#### 4.2.1 *Dealing with In-Group Collectivism Dispersion.*

In-group collectivism was the most discussed topic during interviews (which analysis is depicted in Figure 2); five participants reported experience related to this dimension, but the most interesting one arose from P1, P9, and P10.

⛔ *Rise Conflict.* Most reported effects were associated with situations in which individuals who wanted to collaborate strictly and individuals who preferred to work in isolation worked together. Such a situation could lead to the **rise of conflicts** between the first type of individual and the second one due to the second's incapacity to correctly collaborate when needed. On this, P9 said, 💬 *"As a team, we emphasized collaboration, but occasionally faced challenges with individuals leaning towards a solo mentality. A notable incident led to the termination of an employee who resisted participating in team activities, including extreme and pair programming. While remote work was encouraged with open camera interactions, this person did not comply, causing tension in the team. His reluctance to engage in pair programming and reluctance to keep an open camera conflicted with the team's principles and discussions, ultimately leading to his dismissal."*. To address this problem, 🔧 **letting individualists be individualist** by "isolating" the team member that is causing the friction is a valuable strategy; P10 said, 💬 *"There are always tasks that can be done alone, right? He was really good at it. By doing this, he did not need to cooperate with others, and everyone's productivity increased."*. By doing so, two positive—related—effects emerged:

⊕ frictions decreased, making **team members happy**, and
⊕ the overall **productivity increased**.

⛔ *Evaluating Team Member Productivity.* Always related to the coexistence of individuals who want to collaborate strictly and individuals who prefer to work in isolation, P9 said, 💬 *"Pair programming served as our strategy for long-term onboarding, providing individuals with an opportunity to showcase their skills. In a remote setting, it was crucial for assessing a person's effectiveness. This approach facilitated natural evaluations as team members paired up and shared insights about each other's capabilities. However, for those consistently working alone without actively promoting their skills, evaluation became challenging. The lack of visibility into their abilities in such situations posed a problem, highlighting the importance of collaborative practices for effective assessment."*. From this quotation, we elicited that, particularly in a full-agile context, being an individualist working in a collectivistic setting could lead to the inability to show their skills. We named such a negative effect concept **It makes it difficult to evaluate team member work and productivity**.

⛔ *Discouraged and Uncomfortable Individuals.* Related to the collectivistic people, P1 reported that being in a context in which working alone is highly incentivized could lead them **to be discouraged** and **not feel comfortable**; he said, 💬 *"The other aspect is an individual who really wants to work in a team. I had difficulty finding a project for this person because he wanted to work in a team environment. He wants to work in an environment where meetings take place on a daily basis and that kind of thing. So it was very difficult because I do not have such teams. Most of my teams are people working in groups on specific modules of a project. I find that, based on that, they automatically isolate themselves and don't feel comfortable."*. For such a situation, our participants explicitly expressed that 🔧 **no mitigation strategies** seem to exist.

#### 4.2.2 *Dealing with Assertiveness Dispersion.*

Assertiveness was one of the most discussed dimensions during our data-gathering step. As shown in Figure 3, participants reported two negative effects and five mitigation strategies—considered effective—associated with community dispersed in terms of this dimension.

⛔ *Misunderstanding During Communication.* In general, three participants (P2, P3, and P8) reported that situations involving practitioners exposing opposite behaviors regarding the Assertiveness dimension could escalate into **misunderstanding during communication**. In order to mitigate such a negative effect, different strategies were proposed. P1 said that 🔧 **moderating communication as a manager** could be a first try, even if it drains productivity from the manager. Moreover, P4 reported that 🔧 **ending each meeting by clearly repeating the tasks and duties each person has to do** is essential in teams comprehending individuals with different levels of assertiveness; undoubtedly, this mitigates the risk of incomprehension during communication.

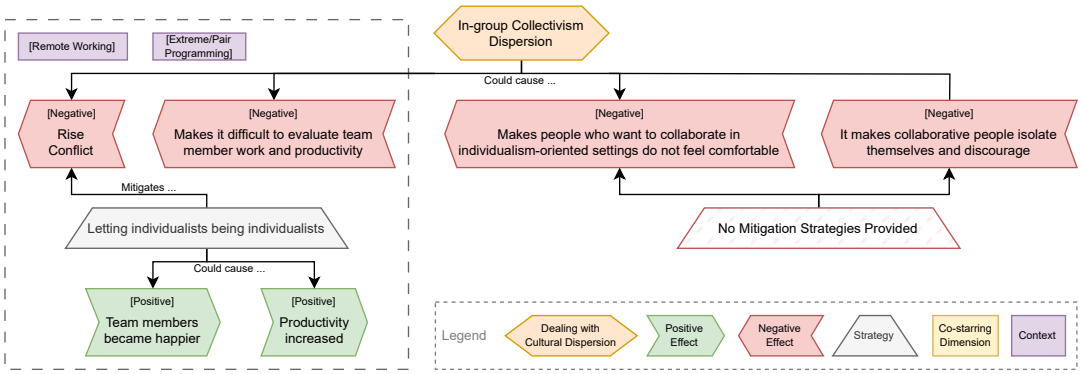


**Figure 2: In-group Collectivism Dispersion Relations.**

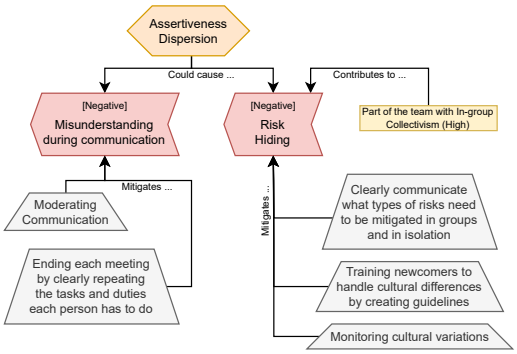


**Figure 3: Assertiveness Dispersion Relations.**

⛔ *Risk Hiding.* Going deeper into our data, it appeared that the misunderstanding mentioned above was more related to the risk management side of software development. We named such a concept misalignment among team members on potential risks (abbreviated as Risk Hiding). Related to this, P3 reported a situation in which one part of the team exposed low assertiveness while the other had a high level. In such a situation, the first one used to hide potential risks—trying to manage by themselves—because they were educated not to be assertive and confrontational with others. This became a problem when the second part assumed that everything was good while it was not, and the risk occurred without any mitigation strategies applied or contingency prepared. As a consequence of this, management put in action on-the-fly plans, and productivity decreased. P3 said, 🗨 *"In my experience, when individuals from a confrontation-averse culture collaborate with those from a culture that encourages it, challenges may arise. In a team with a prevailing aversion to risk and conflict, members tended to conceal issues until the last moment, leading to last-minute plan revisions to meet deadlines. While in Culture X, frequent excuses might be accepted, Culture Y expects proactive problem-solving and compensation for inconveniences. The divergence in cultural expectations often resulted in misunderstandings and the need for adjustments to align with different approaches to addressing challenges."*. Moreover, P3—similarly to P8—said that 🗨 *"In X cultures, people tend to be and live in a community and try not to affect the community with their problems as much as possible. Therefore, they tend to deal with problems by stacking up risks, that is, internalizing them."*. Starting from these quotations, we identified **In-group collectivism as a co-starring dimension** for risk hiding.

Related to such a negative effect, we elicited three strategies:

- **Clearly communicate what types of risks need to be mitigated in groups and in isolation.** As a *manager*, it is crucial for the team to state clearly which problems should be managed in isolation and which should be externalized. To do this, separate problems into categories—e.g., technical issues with new technologies, problems with tools, and testing—could help. On this, P3 said, 🗨 *"When combining the two cultures, it is very important to maintain the balance where there is an internal solution to problems, where you can try to solve them yourself instead of trying to ask for help, and, at the same time, the ability to identify those where you can ask for help. As the old saying goes, having the wisdom to distinguish between the two."*.
- **Training newcomers to handle cultural differences by creating guidelines.** As a *company*, it seems effective to organize a task force able to identify the differences between the various cultures and provide guidelines to perform training. On this, P8 said, 🗨 *"It was a systematic problem, and what we found effective was, first of all, getting some senior people from both sides to sit together and figure out what kind of cultural differences we had and how we could handle them. We selected individuals with the right background to solve the problem. And then, basically, there was a strike team to identify where the cultures were different, find the solutions, and turn them into written guidelines. Then we trained the newcomers using those guidelines."*.
- **Monitoring cultural variations:** Consequentially to the previous strategy, as a *business*, allocating resources for monitoring cultural variations in the development community is mandatory for determining whether the situation is good.

#### 4.2.3 *Dealing with Gender Egalitarianism Dispersion*.

Discussing gender egalitarianism is a nuanced and intricate subject, which might explain the limited number of quotes related to its dispersion. However, we managed to gather valuable insights from participants P3, P6, and P9, as shown in Figure 4).

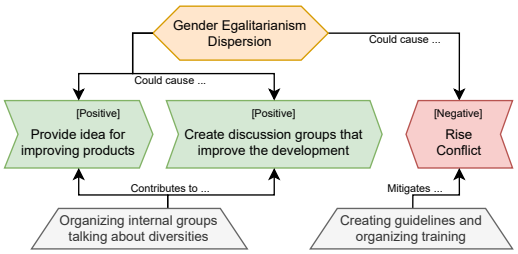


**Figure 4: Gender Egalitarianism Dispersion Relations.**

⊕ *Reveal What Was Ignored.* As a first positive effect, P9 reported that **organizing an internal group talking about diversity in the team** could bring concrete support by (1) allowing the team to **develop new ideas** and (2) identifying potential ways to **improve already existing products** (e.g., making them more accessible). Specifically, P9 said, 🗨 *"This diversity led us to hold internal team talks and discuss this diversity. Many new ideas came out of these discussions, and we began to incorporate them into our workflow; in addition, the diversity allowed our web team to develop sites in a more accessible way because new aspects were taken into account."*.

⊖ *Rise Conflict.* Conflict is natural if the difference is not managed and properly addressed. For example, P3 said, 🗨 *"We had the developers on the Y side and the testers on the other side. The testers were placed on our side, on the X one, and the head of testing was a talented woman, but the Y culture doesn't accept women in the workplace very much, and they were completely unreceptive."*. Moreover, P9 added that 🗨 *'And usually people were not against it (promoting more gender egalitarianism). Of course, some people argue strongly that we should have more egalitarianism and more diversity. And there were other people who simply said that things are the way they are because they are the way they are. It's just a systemic fact. So there's not much we can do about it. In some cases, we had some arguments, I would say even heated arguments, because some people argued that, for example, we should have adopted hiring practices that involved opening a position for women."*. From these quotations, it appeared clear that gender egalitarianism is—still—a complex field to approach. In this case—as P8 for Assertiveness Dispersion mentioned—P3 and P9 reported that **collaboratively developing a set of guidelines** for managing such a difference is the only effective strategy.

#### 4.2.4 *Dealing with Performance Orientation Dispersion*.

Dispersion in terms of Performance Orientation mainly involved two participants (P10 and P9), one from the first cycle and the other from the last one. As shown in Figure 5, interviewees reported two negative effects such a dispersion concept could lead to.

⊖ *Misunderstanding during communication.* Different opinions on how to reward performance improvement and excellence could lead to **misunderstandings** that could quickly escalate into conflict. Imagine a situation in which a group of individuals proposes to reward people—in terms of money—for improved performance; on the first hand, all is right for the team, while people face the fact that such benefits are for single individuals rather than groups. Then, complaints arise, and the team divides into two factions with different opinions. On this, P9 reported that 🗨 *"Our company was bought by another company that proposed giving employees bonuses yearly. Great, no one will complain about getting extra money. And then, they started discussing how that would happen, and the problem was born. And then, the other company proposed both general and individual criteria. At that point, our colleagues rebelled, saying they were crazy and wanted to incentivize internal competition. We have a nice collaborative culture, and this could not happen. We discussed it and ended up eliminating all personal criteria. We said, either we succeed as a team or we don't succeed."*. From this quotation naturally arose the **co-starring role of the in-group collectivism dimension**; analyzing the data for people of the second company (the one that was bought) revealed a high level of such a dimension.

⊖ *Rise Conflict.* P5 provided his experience on dispersion in terms of performance orientation; 🗨 *"The situation was that we had a group of individuals who were constantly focused on performance and one who preferred to keep to his own. When they were in charge, what typically happened was that they demanded that the team do things that most did not consider important. This situation quickly escalated into conflict, and I got the impression that it depended on the fact that no measurable limits were given for the work to be done and everyone acted according to his or her personal background."*. Such a quote perfectly introduces the last effect identified in our analysis, i.e., if not correctly managed, differences in how rewarding performance **could lead to conflicts in the team**.

#### 4.2.5 *Dealing with Power Distance Dispersion*.

Power Distance arose as a point of discussion mainly in the second and third cycles of interviews (P7 and P10). As reported in Figure 5, two negative effects are associated with such a cultural dispersion; both refer to communication and collaboration between people with differences in hierarchical rank (e.g., a manager and a developer).

⊖ *Information Hiding.* Consider the situation in which team members expose a high level of power distance while the management—or leading group—exposes a low one. In such a situation, the first one can be tempted to hide some information to avoid being stupid or inefficient; this becomes problematic when leaders expect the team members to communicate doubts to them, so they approach risk management activities thinking of having all the information while it is untrue. On this, P7 said, 🗨 *"In some workplaces, hierarchy is minimal, and everyone is encouraged to voice their opinions freely. Do you feel a sense of equality with your boss, right? However, in some cultures, it's often customary to show respect to your boss by not challenging their decisions openly and following their instructions, even if you may have reservations about them."*.

⊖ *Lose Trust.* Related to the situations previously described, if the leader (presenting a high level of Assertiveness) exposes his/her limits and deficits, team members with high power distance could untrust him. Such a situation is dangerous since, without a correct and clear exposure of the trust loss, it could exacerbate collaboration and a consequent increase of the previously discussed behavior, i.e., information hiding. On this, P10 said, 🗨 *"As a product manager, I know that I am not the expert in their specific field, and I rely on their insights. So they need to tell me, they need to advise me, and then discuss with me the options so that we can have an informed*

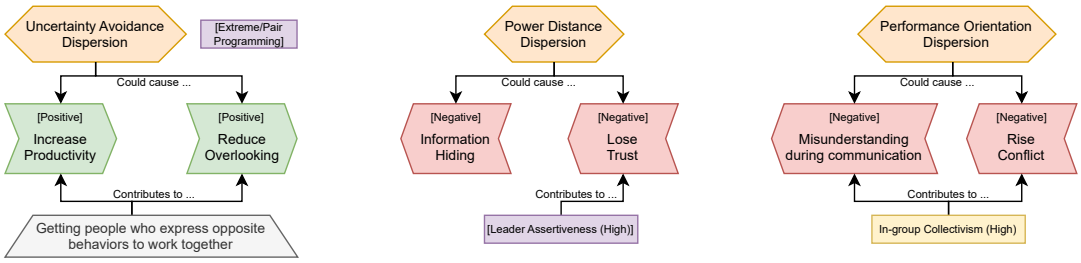


**Figure 5: Uncertainty Avoidance, Power Distance, and Performance Orientation Dispersion Relations.**

*discussion and then make a decision together. However, I know that in their view, typically I look as a weak leader, thus losing trust.".*

*4.2.6* ***Dealing with Uncertainty Avoidance Dispersion.*** P5 cited Uncertainty Avoidance during our first cycle of interviews. Figure 5 reports the two positive effects associated with such a cultural dispersion. Both are associated with an experience of agile development and are related to the benefits of having a manager implementing a collaboration of people thinking oppositely.

⊕ *Reduce Overlooking.* The concept titled **"It reins the tendency to overlook important things"** arose (using in-vivo coding) from the words of P5 talking about a collaboration with another team geographically distributed; he/she said, 🗨 *"We collaborated with them who tend to be less risk tolerant. Collaboration thus allowed us to curb our natural tendencies and see things that, by temperament, we might tend to overlook.".* As reported by the participant, having someone to limit the team's tendency to underestimate potential problems was beneficial to the project's success. From this, it could be that the opposite—i.e., being able to avoid focusing too much on things that might turn out to be unnecessary—might also be beneficial. As a final note, it is essential to report that the positive effect arises from a management choice of 🔧 **supporting collaboration between culturally divergent people**.

⊕ *Increase Productivity.* P5 reported, 🗨 *"...it just seems to me that working with low-risk tolerant people has the advantage of helping us to focus on the right things at the right moment, thus improving our productivity.".* This aspect is undoubtedly related to the previous one and concretizes the benefit of the discussed dispersion on the whole team's productivity.

**? How do cultural differences in software development teams influence the development lifecycle?**

Our findings suggest that the impact is nuanced, with both positive and negative effects, contingent on the level of managerial effort invested in managing these differences effectively. Nevertheless, our theoretical framework associates each effect to a specific context, allowing practitioners and researchers to precisely identify the origin of the problem/benefit. Such relationships lead to the definition of the **"Dealing with Cultural Dispersion"** theory as a starting point for further analysis. While some strategies for managing cultural differences exist, they have not been thoroughly explored or documented.

# 5 DISCUSSION

## 5.1 Reflections and Future Directions

*Different Cultural Frameworks.* Researchers in cultural studies have dedicated efforts to crafting frameworks, such as those by Hofstede [22], Hall [14], Hampden-Turner [15], and House [25]. This work operationalizes the GLOBE framework, an extension of Hofstede's research [15, 22]. However, to comprehensively navigate cultural diversity, testing and considering multiple frameworks is essential for adaptability and accuracy. Future research could delve into other dimensions. For instance, Hofstede's *Individualism* contrasts with GLOBE's *Institutional* and *In-Group Collectivism*. Trompenaars' *Universalism vs. Particularism* explores whether cultures adhere to universal rules (universalism) or adapt rules to specific situations (particularism), a dimension absent in GLOBE, which emphasizes organizational and leadership aspects. Hadwick's comparison between Hofstede and GLOBE [12] offers insights for extending this work.

Although it is expected that there exist different frameworks "competing" with each other in the culture-specific field of research, the Software Engineering community could largely benefit from a unified view. In this sense, it could be helpful to develop a sort of "adapter" that generalizes the concepts of the various frameworks and a consequent theory based on it. A way to reach this could be to develop different **"Dealing with Cultural Dispersion"** theories for each framework.

*The* ***Behavior*** *category.* During our investigations, we transitioned naturally from mapping dispersion concepts to understanding their impact on software development teams. This progression aligns with the cause-and-effect mapping approach and draws inspiration from Strauss and Corbin's coding paradigm model [40], a framework also employed by related works [17, 35]. However, we encountered a situation where a specific behavior seemed associated with more than one cultural dispersion category, creating an intermediary concept between Dispersion and Effect. An example is the *Risk Hiding Behavior*, initially considered separate but eventually translated into an effect (**Misalignment among team members on potential risks**). This decision stemmed from a lack of similar occurrences in the potential Behavior category, though further examination and data may reveal additional concepts, potentially leading to the inclusion of a new category in the theoretical framework.

**Memo titled "Risk Hiding Behavior"**—*In our initial understanding, we perceived Risk Hiding (RH) as distinct from Uncertainty Avoidance (UA). Participants clarified that RH wasn't merely about risk tolerance but involved concealing risks to safeguard the community. This behavior intricately connects with various dimensions, such as In-Group Collectivism (those inclined to protect the community avoid exposing risks), Performance Orientation (individuals driven by performance rewards tend to independently manage and conceal risks), Humane Orientation (those raised in less altruistic environments may hesitate to seek help), and Assertiveness (as per P8, the decision to hide risks correlates with this dimension). This suggests a multifaceted nature, with the behavior arising from multiple dimensions of cultural dispersion.*

## 5.2 Implications and Value Proposition

The main contribution of our work consisted of the theoretical framework for dealing with cultural dispersion.

*Implications for Researchers.* As mentioned earlier, the provided theoretical framework is still in a preliminary but nevertheless significant form. This means that there is room for both expansion and a more in-depth exploration. For instance, it is possible to broaden the framework by conducting further research using different cultural frameworks [14, 15, 22]. Additionally, there is an opportunity to delve deeper into the existing categories within the framework by studying alternative strategies for mitigating the negative effects. Finally, researchers have the potential to quantitatively investigate the impact of cultural dispersion on software development. This quantitative approach would contribute to building a robust and comprehensive body of knowledge on this topic.

*Implications for Practitioners.* When it comes to practitioners, our framework is deliberately crafted to be practical and readily applicable. The concepts within the primary category, **"Dealing with Cultural Dispersion,"** serve as an instrument for identifying the conceptual landscape in which conflicts may arise within a team. For instance, if a manager is grappling with discussions about adopting new technologies, it may indicate a case of *Uncertainty Avoidance Dispersion*. Recognizing this context, the manager can pinpoint potential negative effects and implement the recommended strategies for mitigation. Furthermore, the manager can leverage the framework to gain insights on turning the situation into a positive outcome.

# 6 LIMITATIONS

This section reports the limitations of our study.

*External Validity.* This threat regards the transferability of the obtained findings. First, most of our participants worked in an agile or hybrid context; our results could be highly related to this context. Nevertheless, today, most software development projects are the same [20]. Moreover, we asked the participants to talk about their past experiences, and they often specified the context in which the reported experience occurred. Second, our sample does not encompass individuals from all over the globe—neither from all the clusters defined by the GLOBE framework [25]; findings could not capture patterns that occur in all the software development teams. To partially mitigate this, we tried to reach individuals in culturally- and geographically-distributed teams; our sample encompasses practitioners from 4 cultural clusters over 10. Third, the sample comprises 10 participants, which could be considered few for developing a theory. Nevertheless, it is essential to say that in grounded theory studies, the criteria is not the number of participants but rather the reaching of theoretical saturation [11, 41]; the *categories* found confirmation by more than one participant, and the number of arising *concepts* decreased at the end of the second iteration. Moreover, our theoretical foundation is preliminary; we plan to conduct further interviews in the future and validate the findings through a mixed-method approach [10].

*Internal Validity.* Such limitation refers to potential and unexpected factors that could influence the outcome of the study. As a first note, conducting and analyzing interviews is a complex and effort-intensive activity, in addition to being exquisitely qualitative; the risk of incomprehension during the process is concrete. For this reason, we implemented two strategies to reduce the risk of potential incomprehensions or biases. First, during the interview, we used a set of slides containing information helpful for the interviewee to stay focused on the topic (these slides are available in the online appendix [30]); for example, we put a slide containing the list of behaviors that researchers demonstrated being related to the culture of individuals. Second, we verified each insight and clarified each potential incomprehension through a follow-up clarification question to the interviewee. Furthermore, it is worth noting that errors in the transcription of interviews can potentially lead to misunderstandings. To minimize this possibility, we analyzed our data in both video and text formats. Moreover, the coding process was conducted by the first author, which could introduce biases. To address this concern, we held meetings to discuss the theoretical framework and incorporated feedback from all team members to refine it. This collaborative approach aimed to enhance the framework's reliability and reduce potential biases.

# 7 CONCLUSIONS

The impact of individual cultural factors on software development practices remains a relatively unexplored area. To address this gap in research, we took a first step toward a qualitative study with the aim of developing a preliminary and innovative theory for managing cultural diversity within software development teams. In this theory, we delve into the challenges and consequences posed by cultural variations within these teams while also proposing strategies for addressing potential issues. To enhance its practicality, we drew inspiration from the GLOBE framework of culture, thus centering it on the category of **"Dealing With Cultural Dispersion."**

Regarding our future agenda, the validation of our theory takes a central role; we plan to (1) conduct further interviews to obtain more results, (2) perform the advanced step of STGT [18] to obtain a more robust and mature theory, and (3) perform confirmatory quantitative study—e.g., surveys—to strengthen our findings [10]. Finally, we plan and encourage other researchers to expand the provided theoretical framework by investigating the role of other cultural dimensions [14, 15, 22] in the software development lifecycle.

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