

# The Double-Edged Sword Of Diversity: How Diversity, Conflict, and Psychological Safety Impact Agile Software Teams

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**Abstract**—Team diversity can be seen as a double-edged sword. It brings additional cognitive resources to teams at the risk of increased conflict. Few studies have investigated how different types of diversity impact Agile software teams. This study views diversity through the lens of the *categorization-elaboration model (CEM)*. We investigated how diversity in gender, age, role, and cultural background impacts team effectiveness and conflict, and how these associations are moderated by psychological safety. Our sample consisted of 1,118 participants from 161 teams and was analyzed with Covariance-Based Structural Equation Modeling (CB-SEM). We found a positive effect of age diversity on team effectiveness and gender diversity on relational conflict. Psychological safety contributed directly to effective teamwork and less conflict but did not moderate the diversity-effectiveness link. While our results are consistent with the CEM theory for age and gender diversity, other types of diversity did not yield similar results. We discuss several reasons for this, including curvilinear effects, moderators such as task interdependence, or the presence of a diversity mindset. With this paper, we argue that a dichotomous nature of diversity is oversimplified. Indeed, it is a complex relationship where context plays a pivotal role. A deeper understanding of diversity through the lens of theories such as the CEM may lead to more effective teamwork.

**Index Terms**—software teams, agile, diversity, psychological safety, conflict

## I. INTRODUCTION

Teams are increasingly crucial to organizations. This is particularly relevant to organizations that use Agile software methodologies. Agile represents a collaborative, iteration-based, and human-oriented approach to product development [1]. It originated in response to the perceived shortfalls of plan-based approaches in the face of complex problems typical in product development [2], [3]. Thus, “at its core, agile project management is about managing the impact of complexity and uncertainty on a project” [4, p. 281]. As a crucial aspect of project management, scholars have attempted to identify the factors and characteristics that influence the performance and productivity of teams. One factor that has gained increased attention in recent decades is team diversity [5], also in software engineering specifically [6]. *Team diversity* is generally defined as heterogeneity in member attributes, such as age, gender, cultural background, tenure, role, or personality traits [7].

While teams can be diverse on many attributes, most studies focus on demographic diversity (e.g., age, gender, cultural

background) or informational diversity (e.g., professional role, education, experience). Many researchers have theorized that diversity improves team performance [8], [9], [6]. However, studies have provided mixed support. Investigations of how diversity impacts teams [10], [11], [5], [12], [9], [6] generally show that the effects are not clear-cut, vary by type of diversity, and appear to be moderated by characteristics of the task, the team, and its environment. However, diversity may also negatively impact effectiveness through an increased conflict between members [5], [10]. Several competing mechanisms and integrated models have been proposed to explain these conflicting results [13], [14], which are discussed in Section II.

Specifically for software engineering and Agile methodologies, Silveira & Prikładnicki [6] and Rodríguez-Pérez, Nadri & Nagappan [15] concluded from literature reviews that our understanding of diversity in such teams still needs to be improved. They found that most studies have only investigated gender diversity [6] and argue that a broader exploration of how diversity impacts software engineering teams can be used to create better teams and better results. Furthermore, studies have yet to explore how diversity affects Agile methodologies and their effectiveness. A more comprehensive examination is vital to understand how to design more effective teams and achieve better results. Henceforth, our research question (RQ) is:

*RQ: How does diversity in Agile software teams impact their effectiveness?*

To answer our research question, we performed a quantitative cross-sectional study with 1,118 team members representing 161 Agile software teams. Covariance Based Structural Equation Modeling (CB-SEM or SEM in short) was used to test how four types of diversity (gender, age, cultural background, and role) and one social moderator (psychological safety) interact to impact team effectiveness and conflict in teams. Only age diversity was positively associated with team effectiveness. Concerning relational conflict, only gender diversity showed a significant positive association. A replication package is also openly available on Zenodo to support secondary studies.

The rest of the paper is structured as follows. In Section II, we review the related works of team diversity and how it impacts team outcomes. Subsequently, we clarify the research gap this study intends to address and develop relevant hypotheses in Section II-D. Section III clarifies how we use quantitative methods and a survey study to test our hypotheses.

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The study results are reported in Section III-C, followed by a comprehensive discussion of the results and their implications in Section V. Finally, we conclude our paper outlining future research opportunities in Section VI.

## II. RELATED WORK

Scholars from several disciplines have shown mixed results regarding how diversity impacts teams' performance. Tshetshema & Chan conclude from a review of 35 studies that "*a negative relationship between [demographic diversity] and team performance is inferred as the most reported result.*" [10, p. 9]. However, they note that investigations of individual dimensions of diversity often show a positive effect on team performance, particularly gender and age. The complex relationship between diversity and performance is also recognized by Patrício & Franco [5]. They argue from a review of 80 studies that diversity has a dual impact on performance. One is positive through expanding perspectives, and the other is negative through increased conflict. Bowers, Pharmed & Salas [11] performed a meta-analysis of 13 empirical studies and found the effects of team diversity on team performance to be dependent on task complexity and difficulty instead. Their results suggest that teams that perform tasks of low complexity may benefit more from homogeneity, whereas teams that perform complex tasks benefit from higher diversity. Another meta-analysis of 30 empirical studies by Horwitz & Horwitz [12] found no significant effect of demographic diversity (age, gender, or cultural background) on team performance but did find a significant moderate effect of role diversity.

We now turn to investigations of individual dimensions of diversity in teams commonly studied by scholars.

### A. Diversity dimensions

For **age diversity**, Tshetshema & Chan [10] found a positive effect on team performance in a review of empirical studies. However, a meta-analysis of 74 empirical studies by Schneid et al. [16] did not show a significant relationship, although modest differences occurred as a result of moderators like task complexity and team. Pesch, Bouncken & Kraus [17] attribute the positive effect of age diversity primarily to differences in tenure and work experience rather than age itself. They also note that this diversity is likely to increase tension and conflict in teams as members have to reconcile more diverse perspectives on completing tasks.

**Cultural diversity** is defined as heterogeneity in shared beliefs, norms and values [18]. It is often operationalized through surface-level ethnic or national diversity [10]. Tshetshema & Chan [10] inventoried studies that investigated the link between cultural diversity and team performance and inferred that a positive relationship is the most reported result. However, the relationship appears curvilinear: moderate cultural diversity is beneficial, but too little or too much adversely affects team performance [18].

Scholars define **gender diversity** as heterogeneity in the gender of team members. Most studies suggest a positive relationship with team performance [10], [8]. Nevertheless, too much diversity may lead to increased conflict, particularly

for complex tasks and high interdependence. Thus, Haas & Hartmut [19] argue that gender diversity should be avoided in such environments.

**Role diversity** is another dimension of diversity in teams that is frequently studied. It represents the heterogeneity in the functional disciplines and roles members bring to a team [20]. Agile software methodologies emphasize the need for role diversity in teams in order to solve complex problems [2], [1]. Empirical studies have shown mixed results, with some demonstrating positive effects and others negative [14]. Pelled, Eisenhardt & Xin [20] found that role diversity increases conflict due to the integration of diverse perspectives, which positively influences task performance. Homberg & Bui [21] found no significant effect of role diversity on the performance of management teams in a meta-analysis of 53 empirical studies. Instead, they attribute the mixed findings to publication bias. Horwitz & Horwitz [12] did find a modest effect on the quality of the work produced by teams in another meta-analysis, though not on performance.

The empirical link between diversity and team performance appears to be complicated. Several moderators have been found to strengthen the positive impact or dampen the negative impact, such as an inclusive team climate [22], task complexity and difficulty [11], [12], psychological safety [23], management support [24], or time [25].

### B. Diversity in Agile software teams

The importance of team diversity has also been recognized for Agile software teams specifically [15], [2]. The assumption is that diversity allows for a richer exploration of shared problems due to the availability of more perspectives [9], [6]. This is particularly relevant to the complex problem-solving in Agile software teams, which require creativity and the application of diverse skill sets [3]. Several studies have investigated whether this assumption holds up in practice. Lee & Xia [26] used a mixed-methods approach to investigate how role diversity and team autonomy influence the ability of Agile software teams to deliver on budget, on time, and on the scope. They found a significant positive effect of diversity in a survey study of 399 Agile software projects and follow-up case studies. However, they found that role diversity improves the quality of solutions emerging from problem-solving in teams, but not speed. They also found evidence for the dual impact of diversity, where diversity also increases conflict. Melo et. al. [27] performed a multiple-case study of Agile software teams in three large Brazilian software companies. Their results suggest that teams are more productive when there is diversity in the experience that members bring to the team. Another study by Russo & Stol [8] surveyed 483 software engineers to investigate how personality and gender influence the productivity of software teams. Their results show that men and women typically bring different positive and negative traits to teams, and they argue that this explains some part of why mixed-gender teams perform better. Rodríguez-Pérez, Nadri & Nagappan [15] conclude from a literature review that gender differences between developers contribute significantly to how they solve problems, debug issues, and work with

others. The authors also note that gender diversity is most frequently studied, but much less is known about how other types of informational and demographic diversity affect Agile software teams. A similar conclusion is reached by Silveira & Prikładnicki [6] in a review of the literature on diversity in Agile software teams. Thus, both groups of authors call for more research to guide decision-making on how to design better teams and generate better results.

### C. Theories and moderators of the diversity-performance link

Two mechanisms have been proposed by which diversity influences team performance [13]. The *similarity-attraction paradigm* [7] derives from social psychology and social categorization to argue that similarity between members increases mutual attraction, integration, and communication, which in turn improves performance. Diversity of members, on the other hand, results in more conflict and misunderstandings as people categorize themselves into different subgroups.

Alternatively, *cognitive resource diversity theory* derives from cognitive psychology. It treats teams as information processors where individuals process information and then elaborate and integrate it as a team [28]. In this conceptualization, diversity allows teams to bring varied cognitive resources to bear when information is processed individually and elaborated as a team, which allows a richer exploration of shared challenges.

Thus, both mechanisms offer conflicting predictions about how diversity will impact team performance. The former expects relational conflict to increase and performance to decrease, whereas the latter expects performance to increase. However, the evidence mentioned above does not consistently support one or the other. So the focus of academic inquiry has shifted toward identifying potential moderators that allow both mechanisms to be integrated [14], [29], [12], [13].

One potential group of moderators concerns task characteristics, like complexity and interdependence [13]. In this view, homogeneity benefits low-complexity tasks with few interdependencies, whereas heterogeneity benefits more complex tasks with many inter-dependencies. This is primarily consistent with findings from meta-analyses of the diversity-performance relationship [11], [16]. However, other studies have found both positive and negative effects of task interdependence on the relationship between diversity and performance [14].

Another potential moderator is psychological safety. Edmondson [23, p. 9] defines it as “a shared belief held by team members that the team is safe for interpersonal risk-taking”. Several studies have already shown that psychological safety contributes to more effective teamwork in software teams [30], [31], [32], [33]. However, psychological safety is also likely to moderate the relationship between diversity and team performance. Diegmann & Rosenkranz [34] theorize that psychological safety makes teams more resilient against the disruptive effect of high diversity, such as increased conflict, by providing a safe environment for members to elaborate task information. Similarly, Roberge & Van Dick [35] expect that psychological safety also interacts with the salience of a collective identity. Diversity only contributes to higher team performance when members feel safe and identify strongly with their team.

To date, few studies have empirically investigated the role of psychological safety as a moderator of the diversity-performance association. Singh, Winkel & Selvarajan [36] found that employee performance was higher among members of diverse teams that also exhibited high psychological safety. However, this study was contained to one organization and only considered racial diversity. Furthermore, Kirkman et al. [37] found that Communities of Practice (CoP) performed better when diversity was paired with high psychological safety. Virtual teams also experience fewer drawbacks from diversity when they can elaborate information in psychologically safe environments [38].

Van Knippenberg, De Dreu & Homan [14] have proposed the *categorization-elaboration model (CEM)* to integrate the double-edged nature of diversity in teams and potential moderators. The CEM is the most comprehensive model of work group diversity and its moderators at the time of writing and has received broad empirical support [39], [40], [41], [29], [42]. It distinguishes between moderators related to the task, like difficulty, complexity, and efficacy and moderators related to the team and the social processes in it, like trust and commitment. Both groups of moderators influence the ability of teams to leverage the informational advantage offered through diversity, though in different ways. In the case of task moderators, complex and challenging tasks are more likely to elicit extensive information processing in members [12], [43], which is consistent with *cognitive resource diversity theory*. There is also support for the moderating influence of task motivation through process accountability [44]. Another potential task moderator is task interdependence, which is generally defined as the degree to which the completion of tasks requires collaboration by team members [45]. Teams with low interdependence see less interaction and thus experience fewer opportunities to leverage the benefit of diverse cognitive resources. However, empirical studies have found positive and negative effects of task interdependence on the relationship between demographic and role diversity and team performance [29]. This suggests that the effect is either not linear or subject to other moderators.

At the same time, the CEM also proposes a mechanism by which diversity can harm teamwork. As members grow less similar and bring different perspectives to teamwork, this diminishes performance when the social context of a team encourages social categorization into subgroups and elicits negative inter-group biases and identity threat [29], [7]. This loss of social integration creates more potential for relational conflict and negatively impacts the ability of teams to elaborate information effectively and reduces their performance. However, social moderators like trust and psychological safety allow team members to integrate more effectively to bring diverse perspectives and information-processing together and elaborate on them, which is consistent with the *similarity-attraction paradigm*.

A strength of this integrated approach is that it may explain the conflicting results found in the literature. The different mechanisms behind both groups of moderators independently strengthen or diminish the ability of teams to leverage diversity and can work in concert or in opposition. Thus, the CEM broadens the discourse around team diversity from a one-

dimensional approach where it is either a risk or an asset to one where it can be both simultaneously. Finally, the CEM has clear, practical implications for diversity management that aim to reduce in-group bias, strengthen social moderators, and match diversity with the nature of the task [14].

#### D. Research Gap & Hypotheses

This study aims to address two related research gaps. The first is that we want to answer the call by Silveira & Prikładnicki [6] and Rodríguez-Pérez, Nadri & Nagappan [15] for more investigations into how diversity affects Agile software teams, and not limited to only gender diversity. A more comprehensive examination is vital to understand how to design more effective teams and achieve better results. The second research gap is that we want to investigate diversity in Agile software teams through the lens of the CEM theory and its opposing mechanisms.

To answer our research question, we will now develop seven hypotheses we aim to test in this study. Our first hypothesis is that diversity contributes to the effectiveness of Agile software teams. Because such teams collaborate on complex and interdependent tasks [3], [4], [2], they should benefit from the expanded cognitive resources allowed by heterogeneity in gender, age, cultural background, and role. This reflects one mechanism by which diversity influences team effectiveness and is in accordance with both *cognitive resource diversity theory* and the CEM that integrates it.

Hypothesis 1 (H1). *Agile software teams are more effective when they are more diverse in gender (H1a), age (H1b), cultural background (H1c), and role diversity (H1d).*

Our second hypothesis concerns the second and opposing mechanism of diversity. That is, we expect that increased diversity also results in more relational conflict in teams. This hypothesis reflects a core consequence of the *similarity-attraction paradigm* and the CEM that integrates it.

Hypothesis 2 (H2). *Agile software teams experience more relational conflict when they are more diverse in gender (H2a), age (H2b), cultural background (H2c), and role diversity (H2d).*

Furthermore, we hypothesize that the increased relational conflict, in turn, negatively impacts the effectiveness of teams. This is consistent with the outcome expected by the *similarity-attraction paradigm* and the CEM that integrates it.

Hypothesis 3 (H3). *Relational conflict reduces the effectiveness of Agile software teams.*

Following existing literature [30], [31], [23], [46], we expect that psychological safety is a critical factor in enabling team effectiveness through four different mechanisms. The first involves a direct effect where psychological safety makes teams more effective by creating more opportunities to openly elaborate information, reconcile conflicting viewpoints, and find creative solutions [30], [31].

Hypothesis 4 (H4). *Psychological safety increases the effectiveness of Agile software teams.*

In the second process, psychological safety decreases relational conflict in teams by providing more opportunities to air grievances and discuss the tension between members.

Hypothesis 5 (H5). *Psychological safety reduces the amount of relational conflict in Agile software teams.*

Concerning diversity, we expect that psychological safety is a social moderator of the association between diversity and team effectiveness. Consistent with the CEM and Diegmann & Rosenkranz [34], we anticipate that psychological safety is a social moderator that creates an environment where diverse teams can more effectively elaborate task-related information and experience less relational conflict than less diverse teams.

Hypothesis 6 (H6). *The relationship between diversity in gender (H6a), age (H6b), cultural background (H6c), and role (H6d) on the one hand and team effectiveness on the other is moderated by psychological safety.*

Hypothesis 7 (H7). *The relationship between diversity in gender (H7a), age (H7b), cultural background (H7c) and role (H7d) on the one hand and relational conflict on the other is moderated by psychological safety.*

Our hypotheses are visualized in Figure 1.

### III. RESEARCH DESIGN

We conducted a sample study with a sample of Agile software teams to answer our research question. We used Covariance-Based Structural Equation Modeling (CB-SEM) to test our hypotheses. This section discusses the sample (Sec. III-A), measurement instruments (Sec. III-B), and method of analysis (Sec. III-C).

#### A. Participants

We performed our data collection process through a customized online survey<sup>1</sup> between September 2021 and January 2022. In total, 1,827 members from 733 distinct Agile software teams completed the survey in that period. Because the survey is public and accessible to anyone, we cannot properly calculate a response rate. Scholars have emphasized that public surveys are more susceptible to careless response [47]. So we applied several strategies outlined in literature [47] to reduce potential biases. First, we emphasized the anonymous nature of our data collection. Second, we encouraged honest answers by providing teams with a detailed team-level profile and relevant feedback for their team upon completion. Third, we removed 118 participants with a completion time below the 5% percentile (6.87 minutes) or answered very few questions (< 20). Finally,

<sup>1</sup>The GDPR-compliant survey has been designed so that teams can self-assess their Agile development process. It is available at the following URL: [www.scrumteamsurvey.org](http://www.scrumteamsurvey.org).

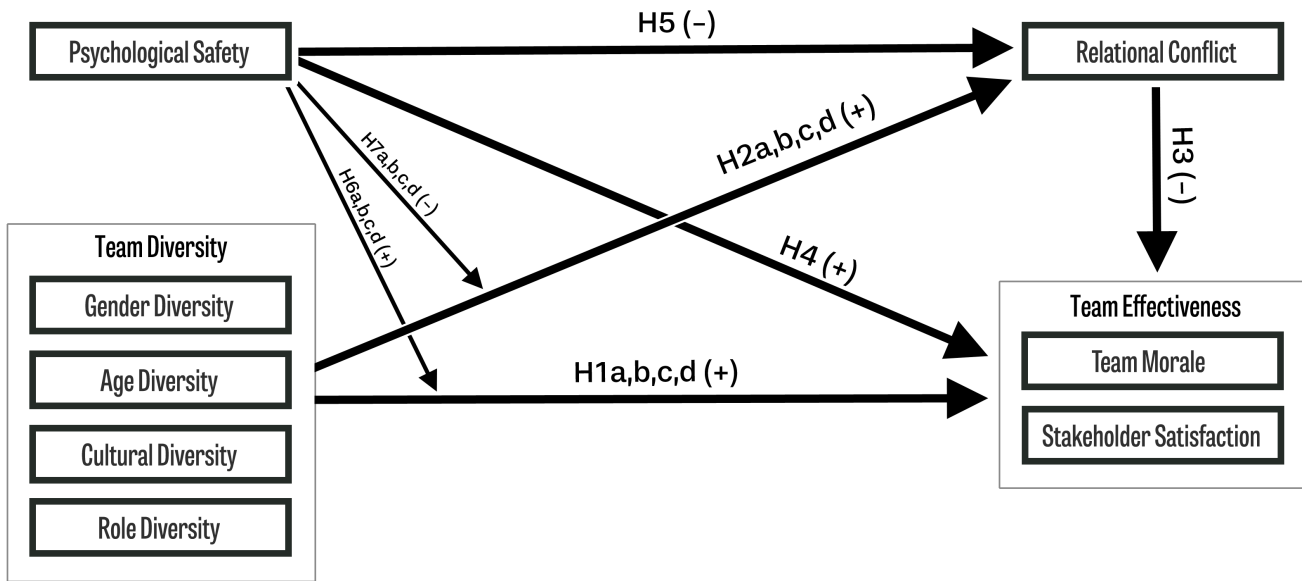


Fig. 1. Theoretical model and hypotheses. Sub-hypotheses are grouped, and control variables are omitted to retain visual clarity

we retained only those teams (161) with at least 4 participating members to ensure a meaningful diversity measurement. The composition of our sample is shown in table I.

Several variables in our model were measured at the individual level and aggregated to a higher (team) level in our analyses. Such aggregation is only reasonable when sufficient variance exists at the group level, not just between individuals. So we calculated the Intraclass Correlation (ICC) [48] to determine the proportion of variance at the higher level compared to the total variance. The ICC ranged between 35% and 45% for our independent variables, which exceeded the required threshold of 10% suggested by Hair et al. Since no data was missing, we did not deploy strategies to deal with missing data.

Finally, we performed a posthoc power analysis using G\*Power [49], version 3.1.9. We determined that the sample size allows us to correctly capture medium effects ( $f = .15$ ) with a statistical power of 96% ( $1 - \beta = .96$ ). In other words, the probability of correctly rejecting the null hypothesis is 96% given our sample. So we are confident that our sample is big enough to provide a reliable outcome.

### B. Measurements

**Age, gender, role, and cultural diversity:** To assess the impact of diversity on team effectiveness, we identified three dimensions of demographic diversity that are commonly studied (age, cultural background, and gender) and one informational dimension (role). The questions and the available categories are shown in Table 2 in the Appendix. Participants were asked to pick the most appropriate category for age, cultural background, and functional role. For cultural background, participants were asked to pick the region where they had lived the longest instead of their country or race. We assume that the region where one has lived the longest most substantially shapes the mental models and perspectives one brings to a team. Gender diversity was operationalized differently due to concerns that asking participants to identify their gender would be in violation

of the European General Data Protection Regulation (GDPR). Instead, the initiating participant of each team was asked to indicate the gender distribution of men and women at the team level. We recognize there are more genders. However, we had to take this shortcut to obtain a reliable statistical analysis.

A team-level indicator for diversity was then created by calculating a Gini-Simpson coefficient with the individual-level responses for age, role, and cultural diversity. A Gini-Simpson coefficient is a statistical indicator of the diversity of the members in a sample, ranging between 0 (no diversity) and 1 (maximum diversity) [50].

**Team Effectiveness** was operationalized similarly to Verwijns & Russo [30]. *Team effectiveness* is often defined as “the degree to which a team meets the expectations of the quality of the outcome” [51]. In this sense, stakeholder satisfaction is the evaluation of team outcomes from the external perspective of stakeholders (e.g., clients, customers, and users), whereas team morale is the evaluation of team outcomes from the internal perspective of team members. This is conceptually similar to how team effectiveness is defined in the “Team Diagnostic Survey (TDS)” [52]. For team morale, we used 3 items from the “Utrecht Work Engagement Scale” (UWES) scale [53] that were modified for use in teams by Van Boxmeer et al. [54]. For stakeholder satisfaction, we used a 4-item scale developed by the authors for another study [30]. Both measures are self-reported. Reliability analysis showed that Team Morale ( $\alpha = .910$ ) and Stakeholder Satisfaction ( $\alpha = 0.832$ ) were consistently measured across participants.

Such conflicts represent interpersonal incompatibilities between team members that “typically includes tension, animosity, and annoyance among members within a group” [55, p. 258]. **Relational conflict** was operationalized by adapting three items from a scale developed by Jehn et al. [55] to measure relationship conflict. The items were adapted for use in teams by the authors. The reliability of measurements across participants was high ( $\alpha = .892$ ).

TABLE I  
COMPOSITION OF THE SAMPLE

Variable	Category	N (%)
Respondents		1,118
Teams		161
Respondents per team	4-6 respondents	82 (50.9%)
	7-9 respondents	64 (39.8%)
	10+ respondents	15 (9.3%)
Product Type	Product for internal users	89 (55.3%)
	Product for external users	72 (44.7%)
Scrum Team Size	1-4 members	1 (0.6%)
	5-10 members	129 (80.1%)
	11-16 members	26 (16.1%)
	>16 members	5 (3.1%)
Scrum Team Experience	Low	5 (3.1%)
	Moderate	75 (46.6%)
	High	81 (50.3%)
Organization Sector	Technology	40 (24.8%)
	Financial	29 (18%)
	Healthcare	18 (11.2%)
	Other	74 (46%)
Organization Size	1-50 employees	10 (6.2%)
	51-500 employees	44 (27.3%)
	501-5,000 employees	50 (31.1%)
	>5,000 employees	55 (34.2%)
	Unknown	2 (1.2%)
Role Diversity	Developer	534 (47.8%)
	Scrum Master	127 (11.4%)
	Product Owner	104 (9.3%)
	Tester	93 (8.3%)
	Analyst	73 (6.5%)
	Visual/UX Designer	38 (3.4%)
	Infrastructure	14 (1.3%)
	Marketeer or sales	2 (0.2%)
	Other	81 (7.2%)
	Unknown	52 (4.7%)
Age Diversity	18-25 years	79 (7.1%)
	26-35 years	494 (44.2%)
	36-45 years	308 (27.5%)
	46-55 years	128 (11.4%)
	56-65 years	39 (3.5%)
	66+ years	3 (0.3%)
	Unknown	52 (4.7%)
Cultural Diversity	Western Europe	581 (52%)
	Eastern Europe	104 (9.3%)
	North America	103 (9.2%)
	Central & South America	48 (4.3%)
	Middle East	30 (2.7%)
	South-East Asia	28 (2.5%)
	South Asia	27 (2.4%)
	East Asia	20 (1.8%)
	Oceania	7 (0.6%)
	Africa	2 (0.2%)
	Other	51 (4.6%)
	Unknown	11 (1%)
Gender Diversity	100% men or women	174 (15.6%)
	80% men and 20% women	766 (68.5%)
	50%-50% men and women	155 (13.9%)
	20% men and 80% women	16 (1.4%)

**Psychological Safety** was operationalized by adapting three items from the 'Inquiry & Dialogue' scale that was developed by Marsick & Watkins [56] as part of the *Dimensions of Organizational Learning Questionnaire (DLOQ)*. The items were adapted for use in teams by the authors. The reliability of measurements across participants was high ( $\alpha = .791$ ).

**Control Variables:** We included two items from the social responsibility scale (SDRS5) [57] to control for socially desirable answers and to control for common method bias [58].

### C. Analysis

We employed Structural Equation Modeling (SEM) with the AMOS software package [59] to analyze the data. A strength of SEM is that it is an inherently confirmatory approach that combines multiple linear regressions and confirmatory factor analysis (CFA) with Maximum Likelihood estimation (ML) to produce more consistent and less biased estimates than those derived through Ordinary Least Squares (OLS) that is typically used in multiple regression and ANOVA [48]. Furthermore, SEM allows researchers to simultaneously test both the structural part of a theory - the relationships between independent and dependent variables - and the measurement model - the inclusion of multiple indicators to measure latent factors [48], [60], [61]. This is particularly useful for psychometric scales that use multiple questions to operationalize an underlying construct, as we do in this study.

In SEM, the statistical model is evaluated through several "Goodness of Fit" indices and the statistical significance and effect size of individual paths. The aim is to arrive at a model as parsimonious as possible while providing a good fit (and thus explanatory power). We discuss the fit indices in section III-D

Next, we tested our data for the necessary statistical assumptions required for Structural Equation Modeling. First, we assessed normality by comparing our independent, dependent, and control variables against recommended thresholds for kurtosis ( $< 3$ ) and skew ( $< 2$ ) [62] in literature. This was satisfactory for all variables except cultural diversity, which distribution was strongly leptokurtic. This means that only a few teams showed some heterogeneity in cultural diversity, whereas most were completely homogeneous. Although statistical transformations can re-normalize such distributions, this also inevitably complicates their interpretation, especially the comparison with other effects in a model [48].

Our measure for gender diversity was not continuous but ordinal (no diversity, some diversity, or high diversity). We treated this variable as continuous in our analyses because such a model is more parsimonious than one that treats it as categorical [63]. It also simplifies the interpretation and retains more information than a model where the ordinal variable is treated as categorical. However, this requires that the relationship between the dependent variable and the ordinal independent variable is linear and that each step is approximately evenly spaced [63]. The relationship was linear, but the steps were relatively not evenly spaced (respectively .33 and .18 for both steps). However, the modest violation did not warrant using a less parsimonious model with categorical dummy variables for gender diversity instead of a single variable.

We assessed homoscedasticity by inspecting the scatter plots for all pairs of independent and dependent variables for inconsistent patterns but found none. Finally, multicollinearity was assessed by entering all independent variables one by one into a linear regression [64]. The Variance Inflation Factor (VIF) remained below the critical threshold of 10 [48] for all measures. However, we did observe modest multicollinearity of psychological safety with our indicators of diversity (age, cultural background, role, and gender) and our control variable

for the experience of teams with Scrum, with a VIF ranging between 6.38 and 7.77 for these variables.

Using a single method - like a questionnaire - introduces the potential for a systematic response bias where the method itself influences answers [65]. To control for such common method bias, the recommended approach in current literature is using a marker variable that is theoretically unrelated to other factors in the model [58]. We included two items from the social responsibility scale (SDRS5) [57] and found a small but significant unevenly distributed response bias. Following recommendations in the literature, we retained the marker variable “social desirability” in our causal model to control for common method bias [58].

We created a full latent variable model containing both the measurement and structural models. The measurement model defines relationships between indicator variables (survey items) and underlying first-order latent factors and effectively acts as a CFA-model [66]. The structural model defines the hypothesized relations between latent variables and is a regression model. This approach makes the results less prone to convergence issues because of low indicator reliability and offers more degrees of freedom to the analysis compared to a non-latent model [67]. We began by assessing the measurement model following the approach outlined in literature [60], [61], [48]. Psychological safety, relational conflict, team morale, stakeholder satisfaction, and psychological safety were entered as first-order latent factors, with their respective survey items as indicator variables. Once the measurement model exhibited a good fit (see section III-D), we added the structural part of the model.

In the structural part of the model, we created a second-order latent factor to reflect the composite nature of “team effectiveness”. The first-order latent factors for team morale and stakeholder satisfaction were modeled as indicators, similar to Verwijns & Russo [30]. We calculated interaction terms by multiplying each team’s standardized factor score for psychological safety with their standardized scores for each diversity indicator (age, gender, role, cultural background) [68]. The diversity indicators and the interaction terms were entered into the model as exogenous variables. The exogenous variables for psychological safety, the diversity indicators, and their interaction terms were allowed to co-vary. No covariances were allowed between endogenous variables as our model predicted specific paths between them.

#### D. Model fit evaluations

We assessed reliability, convergent, and discriminant validity for the resulting measurement model before testing for the model fit. The individual steps involved in the model-fitting process are in Table 1 in the Appendix. Discriminant validity was assessed by analyzing the heterotrait-monotrait ratio of correlations (HTMT) with a third-party plugin in AMOS [69] and following the approach outlined in literature [48], [70]. This ratio between trait correlations and within trait correlations should remain below  $R = .90$  to indicate good discriminant validity from other constructs in different settings. This was the case for all measures. We assessed convergent validity by

inspecting composite reliability (CR) and average extracted variance (AVE). The AVE remained above the rule of thumb of  $> .50\%$  [48] for all pairs of factors, ranging between .621 and .890. The CR was equal to or above the threshold of .70 [48] for all scales.

We then proceeded with the fitting procedure. We investigated local fit by inspecting the residual covariance matrix. A standardized residual covariance is considered large when it exceeds 2.58 [60]. This indicates that an item does not sufficiently measure (only) its intended factor. One item from Stakeholder Satisfaction (SH3) showed poor local fit, and we removed it.

The overall goodness of fit was evaluated with indices recommended by recent literature [66], [60], [48]; the Comparative Fit Index (CFI), the Root Mean Error of Approximation (RMSEA), the Standardized Root Mean Residual (SRMR) and the Tucker Lewis Index (TLI). A commonly used index that we reported but did not test for was  $\chi^2$  (CMIN) and its corollary CMIN/df. These indices are highly susceptible to type I errors in larger samples ( $N > 400$ , [48]). So instead, we used the Comparative Fit Index (CFI) [71], which offers a similar test but with consideration of the sample size and its reliable properties have made it the most commonly used index today [48]. A cut-off value of .95 or higher is generally considered to indicate good fit [60], [48], [72]. The Root Mean Error of Approximation (RMSEA) by Steiger & Lind [73] also provides an index that considers sample size but adds to this a parsimony adjustment that leads it to favor the simplest model out of potential models with the same explanatory power [66]. A value below .05 is generally considered to indicate a good fit [60], [48]; additionally, we follow the advice to report the confidence interval in addition to only the absolute value [74]. The Standardized Root Mean Residual (SRMR) calculates a standardized mean of all the differences (residuals) between each observed covariance and the hypothesized covariance between variables [48]. A value below .08 is indicative of a good fit. We also inspected local fit by looking at the standardized residuals between pairs of variables, with values beyond 2.58 as a cut-off value for poor local fit [60]. Finally, we report and test the Tucker-Lewis Index (TLI). This is another incremental fit index, like the CFI, that compares the relative improvement of the hypothesized model from a model where all variables are uncorrelated. Hair et al. [48] considers a value of .97 or above sufficient to conclude a good model fit. In addition to overall model fit, we also evaluated our model on the percentage of variance that is explained in team effectiveness by all other variables in the model.

The measurement model fitted our data well ( $Chi^2(79) = 127.650$ ;  $TLI = .973$ ;  $CFI = .980$ ;  $RMSEA = .062$ ;  $SRMR = .0516$ ). A Confirmatory Factor Analysis (CFA) is reported in the Appendix (Table 3) that shows that all items loaded primarily on their intended factors, except for PS2. This item also loaded negatively on the factor for Relational Conflict. The cumulative Eigenvalues of 5 factors explain 78% of the total observed variance, which is well beyond the recommended threshold of 60% [48].

We then tested the path model for the effects we predicted from our theory. Our hypothesized theoretical model

TABLE II  
 SCALES USED IN THE SURVEY STUDY, ALONG WITH ATTRIBUTION, NUMBER OF ITEMS, AND RELIABILITY (CRONBACH'S ALPHA) BASED ON RESPONDENT-LEVEL RESPONSE DATA ( $N = 1,118$ )

Construct variable	Items adapted from	# Items	Alpha
Psychological Safety	Adapted from 'Inquiry & Dialogue' scale in DLOQ [56]	5	.791
Relational Conflict	Adapted from Jehn [55]	3	.892
Stakeholder Satisfaction	Created by authors from our case studies	4	.874
Team Morale	Adapted from Van Boxmeer et. al. [54] and Schaufeli [53]	3	.910
Social Desirability	Highest-loading items from SDRS-5 scale [57]	2	.672

fits the data well on each fit indices, as described in Table IV:  $Chi^2(129) = 156.282$ ;  $TLI = .981$ ;  $CFI = .988$ ;  $RMSEA = .036$ ;  $SRMR = .051$ . The predictors in our model explain respectively 40.7% of the variance in the latent factor representing team effectiveness. For studies in the social sciences, values above 26% are considered large [75].

#### IV. RESULTS

We now turn to the results and hypothesis testing. The means, standard deviations, and Pearson correlations of all variables are reported in Table III-D. Significant effects are also visualized in Figure 2. Following recommendations in statistical literature [60], [66], we used a bootstrapping procedure with 2,000 samples and 95% bias-corrected confidence intervals to more accurately estimate parameters and their  $p$ -values for direct effects, factor loadings, and the hypothesized indirect effects. This resulted in a standardized, bias-corrected estimate ( $\beta$ ) for each path, along with a  $p$ -value to test whether the null hypothesis can be rejected. The parameter estimates relevant to our hypotheses are reported in Table V.

Our results allowed us to reject the null hypotheses for 4 out of 19 (sub)hypotheses. The primary hypothesis of this study is that diversity makes Agile software teams more effective because it broadens the cognitive resources available for information processing (H1a-d). This is partially true for our results, as only age diversity significantly contributes to team effectiveness (H1b,  $\beta = .213, p < .05$ ). Agile software teams seem slightly more effective when there is greater age heterogeneity. Nevertheless, heterogeneity in gender, cultural background, or role does not appear relevant to team effectiveness (H1a,c,d).

We also hypothesized that relational conflict in teams would increase as heterogeneity increases and members become less similar. This is also partially true, as only gender diversity significantly contributes to relational conflict (H2a,  $\beta = .161, p < .01$ ). Thus, there appears to be more conflict as teams grow more heterogeneous in gender. There is no discernible effect of diversity in age, cultural background, or functional role on conflict. (H2b,c,d).

Contrary to our expectations, we did not find a significant effect between relational conflict and team effectiveness (H3). Teams that experience more relational conflict do not seem to be more or less effective than teams that experience less conflict. However, the results show a strong positive effect of psychological safety on team effectiveness (H4,  $\beta = .660, p < .01$ ). Teams that experience more psychological safety are more

effective in that they have reported more satisfied stakeholders and higher team morale. Psychological safety also strongly decreases the amount of relational conflict reported by teams (H5,  $\beta = -.636, p < .01$ ).

Finally, we hypothesized that psychological safety moderates the strength by which diversity contributes to team effectiveness and relational conflict. However, none of the interactions were significant (H6a-d; H7a-d).

#### V. DISCUSSION

This study investigated how diversity in age, role, cultural background, and gender influences the effectiveness of Agile software teams. 1,118 respondents from 161 Agile software teams participated in our study. Overall, our results provide mixed support for both the benefits and the risks of member heterogeneity in teams.

According to the *categorization-elaboration model* (CEM)[14] and *cognitive resource diversity theory*, we hypothesized that Agile software teams benefit from diversity as it expands the cognitive resources available for information processing. However, only age diversity directly improves team effectiveness directly. This finding is consistent with the conclusions from a recent review of the literature by TshetsHEMA & Chan [10], and a meta-analysis of 74 studies by Schneid et al. [16], particularly for complex tasks. However, another meta-analysis of 35 studies by Horwitz & Horwitz [12] found no positive impact of demographic diversity (age, gender, race). So our results are more nuanced than the overall positive effect of team diversity that is reported by Lee & Xia [26] for Agile software teams. We also did not find a positive effect of gender diversity or cultural diversity, whereas others did [10], [8]. All in all, the association between demographic diversity and team effectiveness is more complicated than the direct, positive effects we hypothesized.

In addition to demographic diversity, we also investigated how role diversity improves team effectiveness. Agile software methodologies emphasize this type of diversity as an important characteristic of autonomous teams [78], [2]. In line with *cognitive resource diversity theory*, role diversity allows teams to leverage more perspectives and broader informational resources to resolve complex problems [14], [13]. When members bring more functional roles to their work together (e.g., analyst, tester, developer, designer), their shared mental models will be richer than when all members hold the same role (e.g., developer) [11], [79]. However, we did not find evidence for this. Teams with high role diversity were not



TABLE III  
MEANS, STANDARD DEVIATIONS, SKEWNESS, KURTOSIS AND CORRELATIONS (PEARSON) FOR CONTINUOUS VARIABLES. CORRELATIONS MARKED WITH \* ARE SIGNIFICANT AT  $p < 0.01$

Variable	Mean	SD	Skewness	Kurtosis	1	2	3	4	5	6	7	8
1 Gender Diversity	1.97	.55	-.02	.33	1.00							
2 Age Diversity	.71	.20	-.78	.75	.26*	1.00						
3 Cultural Diversity	.05	.16	2.97	7.98	.03	.00	1.00					
4 Role Diversity	.61	.22	-1.06	1.01	-.07	.02	-.06	1.00				
5 Psychological Safety	5.54	.66	-.80	1.29	.10	-.06	.04	-.03	1.00			
6 Team Effectiveness	5.36	.71	-.38	-.50	.17	.06	.08	.04	.72*	1.00		
7 Relational Conflict	2.45	.98	1.16	1.56	.06	.00	-.01	-.07	-.71*	-.50*	1.00	
<i>Control Variables</i>												
8 Social Desirability	5.72	.48	-.17	-.03	.16	.11	.02	-.02	.59*	.56*	-.40*	1.00

TABLE IV  
MODEL FIT INDICES

Model fit index	Value	Interpretation
Chi-Square ( $\chi^2$ )	156.282	n/a
Degrees of freedom (df)	129	n/a
CMIN/df	1.211	A value below 5 indicates an acceptable model fit [76], below 3 a good fit [77]
Root Mean Square Error of Approximation (RMSEA)	.036	Values $\leq .05$ indicates good model fit [60]
RMSEA 90% Confidence Interval	.000-.055	
$p$ of Close Fit (PCLOSE)	.873	Probability that RMSEA $\leq 0.05$ , where higher is better
Comparative Fit Index (CFI)	.988	Values $\geq .97$ indicates good model fit [48]
Tucker Lewis Index (TLI)	.981	Values $\geq .97$ indicates good model fit [48]
Standardized Root Mean Square Residual (SRMR)	.051	Values $\leq .08$ indicates good model fit [48]
Variance explained by predictors ( $R^2$ ) of Team Effectiveness	40.7%	Values $\geq 26\%$ indicates large effect [75]

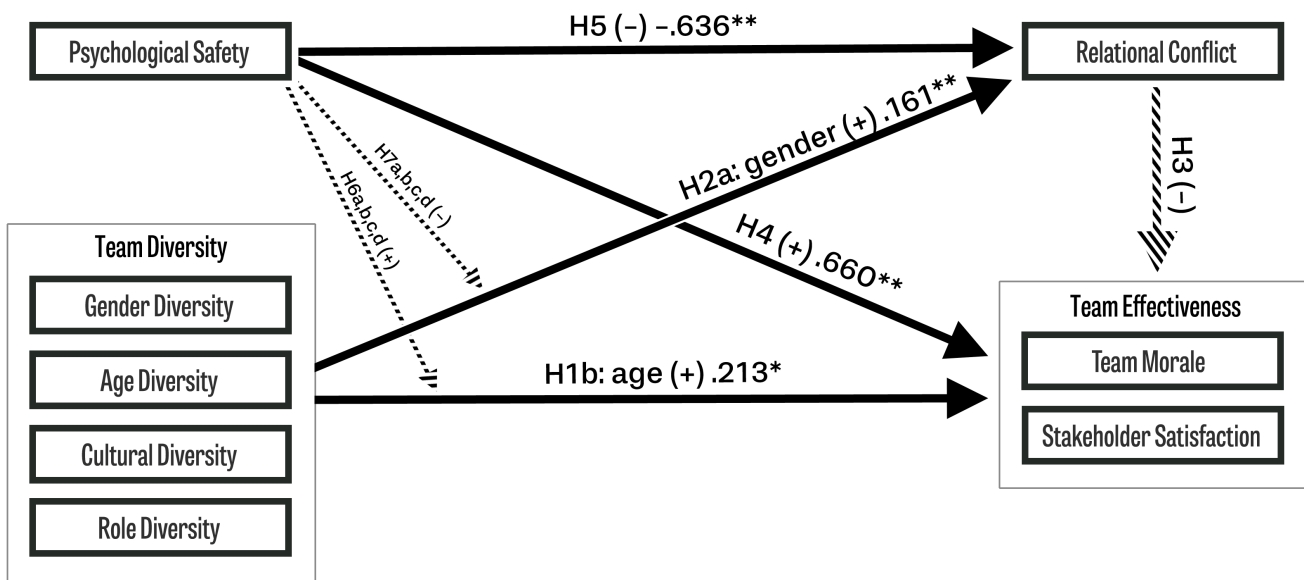


Fig. 2. Standardized path coefficients for the model (\*\* :  $p < .01$ , \* :  $p < 0.05$ ). The dotted lines represent non-significant results. Indicator items and non-significant paths for sub-hypotheses are omitted to improve readability. A detailed overview of the individual hypotheses is reported in Table V.

TABLE V

PARAMETER ESTIMATES, CONFIDENCE INTERVALS, STANDARD ERRORS, STANDARDIZED COEFFICIENTS FOR DIRECT EFFECTS, INTERACTION TERMS AND INDIRECT EFFECTS FOR HYPOTHESES (STATISTICALLY SIGNIFICANT HYPOTHESES AT  $p < 0.05$  ARE SET IN BOLDFACE), AND FACTOR LOADINGS

Parameter	Unstandardized	95% CI	SE	<i>p</i>	Standardized
<i>Direct Effects</i>					
H1a: Gender Diversity → Team Effectiveness	.037	(-.075, .123)	-.075	.622	.056
<b>H1b: Age Diversity → Team Effectiveness</b>	<b>.391</b>	<b>(.077, .800)</b>	<b>.077</b>	<b>.041</b>	<b>.213</b>
H1c: Cultural Diversity → Team Effectiveness	.024	(-.382, .542)	-.382	.872	.010
H1d: Role Diversity → Team Effectiveness	.022	(-.315, .290)	-.315	.956	.013
<b>H2a: Gender Diversity → Relational Conflict</b>	<b>.241</b>	<b>(.108, .417)</b>	<b>.108</b>	<b>.008</b>	<b>.161</b>
H2b: Age Diversity → Relational Conflict	-.490	(-1.178, .026)	-1.178	.118	-.117
H2c: Cultural Diversity → Relational Conflict	.032	(-.824, 1.022)	-.824	.855	.006
H2d: Role Diversity → Relational Conflict	-.332	(-.834, .199)	-.834	.306	-.087
H3: Relational Conflict → Team Effectiveness	.035	(-.091, .181)	-.091	.747	.081
<b>H4: Psychological Safety → Team Effectiveness</b>	<b>.574</b>	<b>(.300, .927)</b>	<b>.300</b>	<b>.004</b>	<b>.660</b>
<b>H5: Psychological Safety → Relational Conflict</b>	<b>-1.262</b>	<b>(-1.888, -.727)</b>	<b>-1.888</b>	<b>.001</b>	<b>-.636</b>
<i>Interactions</i>					
H6a: Gender Diversity * Psychological Safety → Team Effectiveness	-.018	(-.093, .037)	-.093	.550	-.052
H6b: Age Diversity * Psychological Safety → Team Effectiveness	.007	(-.069, .086)	-.069	.885	.020
H6c: Cultural Diversity * Psychological Safety → Team Effectiveness	-.042	(-.159, .061)	-.159	.388	-.081
H6d: Role Diversity * Psychological Safety → Team Effectiveness	.026	(-.070, .082)	-.070	.550	.076
H7a: Gender Diversity * Psychological Safety → Relational Conflict	-.057	(-.138, .054)	-.138	.416	-.072
H7b: Age Diversity * Psychological Safety → Relational Conflict	.014	(-.095, .129)	-.095	.812	.017
H7c: Cultural Diversity * Psychological Safety → Relational Conflict	.133	(-.047, .377)	-.047	.206	.112
H7d: Role Diversity * Psychological Safety → Relational Conflict	-.044	(-.162, .046)	-.162	.406	-.057
<i>Factor loadings from first to second-order factors</i>					
Team Effectiveness → Stakeholder Happiness	.752	(.144, .614)	.114	.003	.389
Team Effectiveness → Team Morale	1.000	(.618, 1.800)			.873

more or less effective than teams with lower role diversity. This is partially consistent with extant literature. Homberg & Bui [21] found no evidence for a link between role diversity and team performance in a meta-analysis of other empirical studies. Horwitz & Horwitz [12] also did not find an effect on performance, although they did find one on the quality of work done by teams.

Diversity in teams is often considered a double-edged sword in the literature on diversity [13]. The CEM proposes that diversity can also harm team effectiveness through the *similarity-attraction paradigm* [7]. As members grow less similar and bring different perspectives to teamwork, there is more potential for tension and conflict. This decreases the ability of teams to elaborate information effectively and reduces their performance. Concerning the first assertion, our results show that gender diversity does increase relational conflict but not other kinds of diversity. This finding is consistent with some studies [19], but not others [8], [10]. Regarding the second assertion, we failed to find any impact of relational conflict on team effectiveness. So while it appears true that gender diversity increases relational conflict in teams to some extent, we cannot conclude that this also harms team effectiveness (i.e., the double-edged sword).

The CEM attempts to reconcile the conflicting results by drawing attention to social- and task-related moderators that shape how diversity impacts team performance. We investigated one social moderator frequently associated with diversity, relational conflict, and team effectiveness: psychological safety. We hypothesized that a psychologically safe environment

would make it easier for diverse teams to elaborate on task information effectively. Although psychological safety reduced relational conflict and improved team effectiveness, we could not reject the null hypotheses for psychological safety as a moderator of the diversity-effectiveness link. In summary, our results show some benefits of diversity (age) on team effectiveness and some risks of diversity through relational conflict (gender). Psychological safety also reduces relational conflict and increases team effectiveness, but we found no evidence for a moderating role in the diversity-effectiveness link or the diversity-conflict link.

#### A. Alternative explanations

The mixed evidence suggests that there are factors at work that moderate or mediate the effects of diversity on effectiveness and conflict. Diversity alone does not make teams more effective because it broadens cognitive resources, just as it does not inherently and consistently create conflict because members are less similar.

This study investigated psychological safety as one potential social moderator of the diversity-effectiveness link. Our mixed results suggest that other moderators are at play. One example of this is task interdependence. A core element of Agile software methodologies is that teams work together on complex tasks [80], [2], [1]. Collective elaboration of task-related information and the pooling of skills to accomplish tasks is also a common thread in the definition of teamwork [51], [81]. Without task interdependence, the two mechanisms of

diversity diminish. Because there is less collective elaboration, the benefits of the broadened cognitive resources that are offered by diversity diminish. Furthermore, a major source of conflict between members is removed because they spend much less time together processing information. Members may have more skin in the game when they feel they depend on others in their team to be successful. Paradoxically, this may surface as a higher degree of relational conflict than teams with very low interdependence. In this sense, psychological safety is likely only relevant as a moderator of the diversity-effectiveness link in teams with high task interdependence but not low task interdependence. Future studies can investigate if the effects of diversity and psychological safety are more pronounced when controlling for task interdependence.

Another explanation may be that the effect of diversity on team effectiveness is not linear. Several authors [82], [83] have argued for curvilinear models where diversity contributes to performance only when it is moderated (inverted U) or when it is either low or high (upright U). Which model applies varies by diversity type. For example, Dahlin, Weingart & Hinds [43] found that educational diversity contributed to team performance when it was either low or high (inverted U) but found the opposite for national diversity (upright U). Richard et al. [84] found that management teams with moderate gender diversity performed better than teams with low or high diversity, but only in high-risk settings (upright U). However, diversity in terms of age, gender, or function may contribute to learning behavior in teams more strongly when diversity is low or high but not moderate (inverted U) [85]. So while there is some support for the curvilinear effects of diversity, the relationship is complex. To further complicate matters, the shape of the relationship may also be moderated by the expectations that teams themselves have of the benefits of diversity [29]. We performed a posthoc test to assess whether a curvilinear relationship between dimensions of diversity and team effectiveness better fitted the data. This was not the case. A quadratic regression model was not significant for the following diversity dimensions: age ( $R^2 = .004$ ,  $F(2, 158) = .321$ ,  $p = .726$ ), gender ( $R^2 = .021$ ,  $F(2, 158) = 1.695$ ,  $p = .187$ ), culture ( $R^2 = .008$ ,  $F(2, 158) = .664$ ,  $p = .516$ ), and role ( $R^2 = .000$ ,  $F(2, 158) = .025$ ,  $p = .975$ ). Thus, the possibility of a curvilinear relationship rather than a linear one does not appear to explain the lack of results in this study.

We often assume that diversity in age, gender, function, and cultural background inherently leads to a different understanding of the task and potential solutions. This is both the strength and the weakness of diverse teams. In the day-to-day practice of teams, such differences in understanding may also lead to conflict if members need to adequately express their view and integrate it with other members into a synthesized solution. In addition to those mentioned above, task-related and social moderators, it is reasonable to expect that communication and conflict navigation skills are also highly relevant, as well as the presence of an environment where such different understandings can be elaborated effectively. Few studies have investigated such moderators, particularly for Agile software teams [6]. Furthermore, this ties into team members' beliefs about diversity, how to deal with it and

whether or not it benefits teamwork. Van Knippenberg et al. [42], [29] call this a "Diversity Mind-Set". Several studies have shown that teams and organizations can better leverage diversity when they recognize it as a strength and have learned how to appreciate and deal with the resulting informational diversity [86], [84], [29].

**For practitioners**, it is important to notice that our results are broadly consistent with existing research, showing that team diversity is not unequivocally beneficial or harmful. Although we found a positive effect of age diversity, the effects of other types of diversity appear to be more conditional on moderating factors. Several factors have been proposed to date, like the autonomy that teams have [26], task difficulty [11], psychological safety [23], team climate [22] and the beliefs that teams have about diversity [29]. *This suggests that context is just as important as diversity alone.*

### B. Limitations

In the following section, we will discuss the threats to the validity of our sample study.

**Internal validity** Internal validity refers to the confidence with which changes in the dependent variables can be attributed to the independent variables and not other uncontrolled factors [87]. We employed several strategies to maximize internal validity. First, we recognize that online questionnaires are prone to bias and self-selection as a result of their voluntary (non-probabilistic) nature. We counteracted this by embedding our questions in a tool that is regularly used by Agile software teams to self-diagnose their process and identify improvements. Team members were invited by people in their organization to participate. Second, we thoroughly cleaned the dataset of careless responses to prevent them from influencing the results. Third, we did not inform the participants of our specific research questions to prevent them from answering in a socially desirable manner. We also controlled for social desirability in participants' responses, as well as common method bias introduced when a single method is used to collect data.

Despite our safeguards, there may still be confounding variables that we were unable to control for. This is particularly relevant to the operationalization of team effectiveness, which is based on self-reported scores on team morale and the perceived satisfaction of stakeholders. Mathieu et al. [88] recognize that such affect-based measures may suffer from a "halo effect". Future studies could ask stakeholders to rate their satisfaction with team outcomes directly. This does not entirely rule out a halo effect but is conceptually closer to what matters to organizations. Future studies could also find more objective measures for team effectiveness.

**Construct validity** Construct validity refers to the degree to which the measures used in a study measure their intended constructs [87]. We adapted items from established scales to measure psychological safety [89], team effectiveness [30], relational conflict [55] and social desirability [57]. A confirmatory factor analysis (CFA) showed that all items were loaded primarily on their intended scales (see Table 3 in the Appendix). A heterotrait-monotrait (HTMT) analysis confirmed discriminant validity for all measures. The reliability for all

TABLE VI  
SUMMARY OF KEY FINDINGS & IMPLICATIONS

Findings	Implications	
<b>Diversity &amp; team effectiveness</b>	Based on existing theory, we developed a Structural Equation Model for how diversity and psychological safety interact to impact team effectiveness and relational conflict. The model fitted the data well ( $Chi^2(129) = 156.282$ ; $TLI = .981$ ; $CFI = .988$ ; $RMSEA = .036$ ; $SRMR = .051$ ). Age diversity showed a positive association with team effectiveness ( $\beta = .213, p < .05$ ), but not diversity in gender, role, or cultural background.	Teams with members of different age groups will likely benefit from the broader range of tenure and work/life experience. The benefits of other types of diversity appear more conditional on moderating factors. Organizations can assess the extent to which teams are diverse. However, psychological safety, communication skills, and a diversity mindset seem important moderators that organizations need to provide and encourage teams to leverage it.
<b>Diversity &amp; relational conflict</b>	Gender diversity was positively associated with relational conflict in Agile software teams ( $\beta = .161, p < .01$ ). However, diversity in role, age, or cultural background did not. In turn, relational conflict did not significantly affect team effectiveness.	When teams grow more diverse, members' different perspectives may lead to more conflict and friction. This appears particularly relevant to gender diversity. Such negative consequences of diversity may be counteracted when teams learn to see their diversity as a strength and recognize that different perspectives can be reconciled through open dialogue and elaboration.
<b>Psychological safety &amp; team effectiveness</b>	Psychological safety was positively associated with team effectiveness ( $\beta = .660, p < .01$ ) and negatively associated with relational conflict ( $\beta = -.636, p < .01$ ).	Teams that operate in environments where members can openly and safely elaborate information are more effective than other teams, regardless of their diversity. They also experience much less relational conflict. Organizations do well to develop the skills, support structures, and management styles that foster psychological safety in and around teams
<b>Psychological safety as a moderator</b>	Psychological safety did not significantly moderate the association between diversity and team effectiveness, nor between diversity and relational conflict.	Psychological safety is paramount, but it does not appear to strengthen the cognitive benefits of team diversity, nor does it appear to buffer against negative consequences.

measures exceeded the cutoff recommended in the literature ( $CR \geq .70$  [48]), except social desirability. Thus, we are confident that we reliably measured the intended constructs.

A limitation of our measure for team effectiveness is that it only addressed (self-reported) stakeholder satisfaction and team morale. Although both are reasonable and relevant aspects of team effectiveness and are commonly used in team research [51], effectiveness is also a more-faceted construct [90].

Finally, we could not directly ask participants for their gender due to privacy concerns. So it was not possible to calculate a Gini index as we did for the diversity measures. The resulting measure was ordinal instead of continuous, limiting our analysis's resolution for this variable. Future studies do well to use a more continuous measure of gender distribution.

**Conclusion validity** Conclusion validity assesses the extent to which the conclusions about the relationships between variables are reasonable based on the results [91]. We used Structural Equation Modeling to test the entire model simultaneously [66], [60]. The resulting model fits the data well on all fit indices recommended by statistical literature and explains a substantial amount of variance in the dependent variables. Our sample was also large enough to identify medium effects ( $f = .15$ ) with a statistical power of 96%.

We published team-level data and syntax files to Zenodo for reproducibility.

**External validity** Finally, external validity concerns the extent to which the results actually represent the broader population [92]. First, we assess the ecological validity of our results to be high. Our questionnaire was integrated into a more general tool that Agile software teams use to improve their processes. Participants were invited by people in their

organization, usually Scrum Masters. Thus, the data is more likely to reflect realistic teams than a stand-alone questionnaire or an experimental design.

We do not know how well our sample reflects the total population. However, our sample composition (Table I) shows that a wide range of teams participated in the questionnaire, with different levels of experience from different parts of the world and different types of organizations. We also observed a broad range of scores on the various measures. This provides confidence that a wide range of teams participated. Furthermore, our sample size and the aggregation of individual-level responses to team-level aggregates reduce variability due to non-systematic individual bias.

## VI. CONCLUSION

A common thread in Agile software methodologies is their emphasis on teams as the primary units where complex work is performed. So it is not surprising that much research has focused on what makes such teams more effective (i.e. [30], [31], [93], [27], [94]). Although diversity is increasingly investigated in the broader literature on teams, scholarly knowledge on how it impacts Agile software teams is still limited [6], [15]. Such understanding can better equip organizations and teams to leverage diversity more effectively or learn when and how diversity is beneficial. Because what seems to be clear about diversity is that while it brings more extensive cognitive resources to teams, it can also bring more conflict as members become less similar [13]. Several models have been proposed to explain this "double-edged sword" of diversity, with the *categorization-elaboration model (CEM)* [14] as the most comprehensive one.

In this study, we explored how diversity impacts the effectiveness of Agile software teams through the lens of the CEM theory. Our sample consisted of 1,118 team members representing 161 Agile software teams. Our results show that age diversity contributes to more effective teamwork but not diversity in gender, role, or cultural background. This may reflect the value of having more varied levels of experience in teams. Furthermore, the CEM also predicts a negative effect of diversity through social categorization and identity threat, which can surface through increased conflict. While our results support this effect, we only found evidence for gender diversity. Finally, the CEM predicts that task- and social moderators influence the impact of diversity. One such moderator that is frequently studied is psychological safety [23]. While our results show that it contributes to more effective teamwork and less conflict in teams, it did not moderate the link between diversity and effectiveness or diversity and conflict. Thus, the presence of psychological safety in a team does not in itself allow teams to leverage their diversity better. Despite the strong focus on role diversity and cross-functional teamwork in Agile software methodologies [80], [2], we found no apparent effect on team effectiveness. So while our results are broadly consistent with the CEM for age and gender diversity, it is surprising that heterogeneity in role or cultural background did not produce similar effects. One moderator that may be particularly relevant here is task interdependence. Teams vary broadly in the degree to which members actually (need to) work together on tasks and, thus, the opportunities that arise to leverage the broader cognitive resources of diverse teams.

This study has several implications for future studies of how diversity impacts the effectiveness of Agile software teams. First, the role of task-related and social moderators should be investigated more thoroughly. The *categorization-elaboration model* [14] provides a valuable framework for such research because it integrates the opposing mechanisms of diversity proposed by *cognitive resource diversity theory* and the *similarity-attraction paradigm*. From a practical viewpoint, such research can also drive the development of training and methods to help teams and organizations to leverage their diversity on all sorts of dimensions, and not limited to gender, age, cultural background, and functional role. Second, more attention should be paid to the beliefs that teams have about diversity and its effects. Such a “Diversity Mind-Set” [29] can act as a powerful moderator by making teams aware of their diversity and how it can expand their experience as a team. Finally, future research should investigate broader definitions of performance and effectiveness. In this study, we mainly focused on stakeholder satisfaction and team morale. Since effectiveness is a multi-faceted construct [90], we likely missed aspects that are affected by diversity in teams, like speed, quality, or innovativeness.

#### ACKNOWLEDGMENT

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#### VII. SUPPLEMENTARY MATERIALS

A replication package for the sample study is available at the following DOI to support Open Science: <https://www.doi.org/10.5281/zenodo.7537784> under a CC-BY-NC-SA 4.0 license. The package includes the model definitions (AMOS), syntaxes for SPSS, and a fully anonymized, cleaned, and aggregated dataset of the analyzed teams.

#### VIII. RESPONSIBLE DISCLOSURE

Data has been collected and stored according to the policy for research data management of Aalborg University, respecting the total anonymity of informants.

Christiaan Verwijs has a financial interest in The Liberators BV.

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