Unraveling the Drivers of Sense of Belonging in Software Delivery Teams: Insights from a Large-Scale Survey

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ABSTRACT

Feeling part of a group is a basic human need that significantly influences an individual's behavior, long-term engagement, and job satisfaction. A strong sense of belonging holds particular importance within software delivery teams, which grapple with challenges related to well-being and employee retention. However, the specific factors closely associated with the sense of belonging in the context of software delivery teams remain largely unknown. Without a clear understanding of these factors, organizations' efforts to promote a sense of belonging and diversity and inclusion more broadly may prove ineffective. Based on existing literature, we identified key factors potentially relevant to the sense of belonging in software delivery teams, such as work appreciation and psychological safety, and investigated the interrelation among these factors. We surveyed members of software delivery teams (n=10,781) of a major software delivery organization and used Partial Least Squares–Structural Equation Modeling (PLS-SEM) to evaluate a theoretical model to understand the factors that might contribute to a sense of belonging to the team. We also conducted a multi-group analysis to evaluate how the associations change based on individuals' leadership involvement and an importance-performance map analysis to find the most critical indicators of belongingness. Our findings indicate a positive association between psychological safety and work appreciation and belonging to the team. Women feel less belonging than men, especially those not in leadership positions. Authoritativeness is negatively associated with belonging, and tenure is positively associated with belonging regardless of the role. Through this research, we seek to provide insights into the sense of belonging to the team and foster a more inclusive and cohesive work environment.

KEYWORDS

diversity and inclusion, software engineering, sense of belonging, psychological safety, work appreciation

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1 INTRODUCTION

Sense of belonging refers to the extent to which individuals feel like they belong or fit in a given environment [65]. Maslow [47] posits belonging as a basic human need, and Hagerty et al. [23, 24] complements that sense of belonging represents a unique mental health concept that differs from other concepts such as loneliness, alienation, and social support. Hagerty et al. [23] define a sense of belonging as "the experience of personal involvement in a system or environment so that persons feel themselves to be an integral part of that system or environment" and delineate two defining attributes for belonging: (i) valued involvement, or the experience of feeling valued, needed, or accepted; and (ii) fit, the perception that the individual's characteristics match with the system or environment.

In the Software Engineering context, there is evidence that belonging to a team has been considered a need and a goal of members of software delivery teams [21], promoting identity, collaboration, and trust. The importance of the need to belong has also been demonstrated in the context of open source contributors [73, 74], and its motivational role and relationship with job satisfaction has been studied among software developers [17]. Sense of belonging, hence, represents an important retention factor related to the sustainability of software engineering teams. In a larger sense, the psychology, health care, and education literature acknowledge the importance of a sense of belonging and its relationship with job satisfaction [4–6, 45]. Still, the Self-Determination Theory [64] suggests that psychological safety, recognition, and belonging are interconnected psychological needs that promote motivation and engagement, leading to a positive and supportive work environment. Meeting these needs is essential for promoting optimal functioning and well-being in individuals, especially for those in underrepresented groups [15, 38, 71].

Although some previous studies tackled belongingness in software engineering [17, 74], it is still unknown how intrinsic factors of organizational context drives the sense of belonging in software delivery teams. The literature shows that the sense of belonging can be influenced by individual characteristics and factors of the surrounding environment [3]. In this study, we investigate the influence of organizational aspects of psychological safety and work appreciation on the sense of belonging to the team within software delivery teams.

The following research questions guided our study:

RQ1. *How are work appreciation and psychological safety related to the sense of belonging to the team?*

RQ2. *Does the relationship between work appreciation, psychological safety, and belonging to the team vary by leadership responsibilities?*

RQ3. *What are the most critical constructs associated with the sense of belonging to the team?*

We answer these questions within the context of software delivery teams from a large global tech company employing over 20,000 people across five continents, hereafter called TechCom (fictitious name). The company is specialized in customized software outsourcing. To answer RQ1, we drew on cross-discipline literature to identify factors associated with a sense of belonging and tested a theoretical model using Partial-Least Squares Structural Equation Modeling (PLS-SEM) with a survey with over 10,000 responses. For RQ2, we sought to understand whether the importance of these factors varies for leadership responsibilities. We compared the model for the subgroups through Multi-Group Analysis (MGA). Finally, for RQ3, we used Importance-Performance Map Analysis (IPMA) to identify to which degree the factors improve the sense of belonging. The IPMA extends the results of PLS-SEM by also taking the performance of each construct into account [28].

Our results show that psychological safety is more associated with the sense of belonging to the team than work appreciation. Women and those living in authoritative countries (with high values of power distance country culture) show a relatively low sense of belonging. On the opposite side, those who have more experience feel more belonging than novice members. Nevertheless, when examining the different roles (leaders and non-leaders), gender has a different impact on feelings of belonging. Women who do not occupy leadership positions feel less belonging than those who are leaders.

These findings have implications for organizations, as the two antecedents we studied can be acted upon by management. For example, management can actively create a team culture of recognizing achievements and having policies to form an inclusive and welcoming environment that promotes psychological safety, which may lead to a stronger sense of belonging among the team members.

2 THEORY DEVELOPMENT

Individuals' experiences in the workplace can trigger positive and negative psychological states [42]. Job experiences can positively influence belonging and engagement [53], especially when demands are high [7]—which is typically the case in software delivery teams. Therefore, in this paper, we draw on the Self-Determination Theory [64] suggestion that psychological safety, recognition, and belonging are interconnected psychological needs and investigate two intrinsic job experiences as antecedents of belongingness to a team: (i) work appreciation and (ii) psychological safety. In the following, we discuss how these antecedents potentially influence the sense of belonging and define our hypotheses and control variables.

2.1 Work Appreciation

Appreciation entails recognizing the significance and worth of individuals and their work [16]. Work appreciation is cognitive by nature [20] and can be expressed in the workplace by recognition and praise [14]. Work appreciation as recognition pertains to acknowledging the employee's services to their employer or organization and is a form of acknowledgment for the dedication and effort exerted by the worker throughout their employment tenure [77]. This recognition shows gratitude for the employee's loyalty and commitment to the company by staying with them and making consistent and dependable contributions. Tangible expressions of appreciation include job security, transparent career advancement opportunities, and some social welfare benefits for workers [68]. Previous research suggests that work appreciation help stimulate a sense of belonging to the team [11]. Hence, we propose:

H1. Work Appreciation is associated with higher levels of belongingness to the team

2.2 Psychological Safety

Psychological safety relates to the importance of a supportive workplace environment. When people find themselves in organizational environments that are clear regarding the outcomes of their behavior [56], being confident that expressing their true selves at work will not result in negative consequences such as damage to their self-image, status, or career [49], they experience psychological safety at work. Psychological safety allows employees to feel at ease taking risks, being authentic, and exploring new ideas without fearing adverse consequences [39]. Safe environments foster a sense of inclusion, respect, and open communication among all interprofessional team members, where everyone feels heard. Conversely, in unsafe environments, team members experience a lack of belonging, exclusion, and fear of punishment or retaliation [10]. Hence, we hypothesize that:

H2. Psychological safety is associated with higher levels of belongingness to the team

2.3 Control Variables

Various demographic factors can moderate the aforementioned hypotheses. Inspired by previous research [74], we included in our analysis gender, organizational tenure, and country culture of power distance as control variables for the sense of belonging.

Gender minorities, as indicated by prior research in computer science, experience a lack of sense of belonging [65, 74]. Women, in particular, are largely underrepresented in IT [67, 75, 76] and may potentially report a lower sense of belonging.

Organizational Tenure can be defined as the period of employment at an organization [50]. The duration of interaction with peers has been linked to the degree of exchange that occurs among individuals [59]. As an employee's affiliation with an organization lengthens, they are presented with more chances to integrate with others in the organization [40]. With increased tenure, they can participate in team activities and utilize organizational services and events, potentially bolstering their sense of belonging and integration within the team [48].

Country Culture can also influence the sense of belonging. Several classification models attempt to quantify cultural values, such as the work by Hofstede [33], Schwartz [66], and the GLOBE study [9]. In this study, we adopt Hofstede's classification, which was previously used to investigate the culture of software engineers [43], burnout [55], and sense of belonging [74]. Hofstede [33]

defined a framework with dimensions of culture per country that assume values from zero to one hundred [34]. We used the dimension of Power Distance, as prior research showed that job psychological states and involvement vary per country culture [51, 52], and people who live in countries that present a higher Power Distance can have a lower sense of belonging [74]. *Power Distance* refers to authority and hierarchy and expresses how less powerful members of a society accept and expect power to be distributed unequally. High power distance means accepting hierarchical orders and predetermined positions for individuals. Low power distance means a desire for an egalitarian distribution of power [34, 35].

3 RESEARCH DESIGN

Figure 1 presents an overview of the research design. After the theory development (Sec. 2), we developed a measurement model (Sec. 3.1), collected data (Sec. 3.2), evaluated the measurement validity (Sec. 4), and analyzed the data to answer each research question.

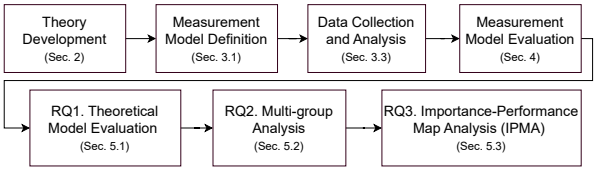

Figure 1: Research design

RQ1 (*How are work appreciation and psychological safety related to the sense of belonging to the team?*) seeks to answer how the variables of interest are related. Section 2 elaborates on the specific hypotheses we investigate. To test these hypotheses, we collected data via a survey at TechCom (fictitious name used due to confidentiality). We analyzed the data using Partial Least Squares–Structural Equation Modeling (PLS-SEM). SEM is a second-generation multivariate data analysis technique applied to a diverse range of software engineering phenomena using PLS-SEM, as indicated in a recent survey that also introduces the method [62]. PLS modeling is advantageous as it does not heavily rely on assumptions about the data distribution, such as a normal distribution. Instead, PLS packages use a bootstrapping approach to determine the statistical significance of path coefficients and the model is estimated for each subsample, generating a sampling distribution, which is used to determine a standard error [27]. We used SmartPLS version 4 for these analyses.

RQ2 (*Does the relationship between work appreciation, psychological safety, and belonging to the team vary by leadership responsabilities?*) seeks to establish whether the association of the variables identified in the theoretical model for RQ1 varies significantly per leadership responsabilities in the software delivery team. To that end, we used demographic data about the respondent's role to create subgroups and compared the model for the subgroups through Multi-Group Analysis (MGA).

The goal of R3 (*What are the most critical constructs associated with the sense of belonging to the team?*) is to find how critical each indicator is for different roles. We used the model from RQ1 and the groups from RQ2 to investigate the Importance-Performance Map of the constructs that are most important for belongingness, considering both the overall population and the groups.

The remainder of this section discusses how the various latent variables were measured (Sec. 3.1) and how data was collected (Sec. 3.2).

3.1 Measurement Model

The hypotheses we pose examine a number of theoretical concepts that cannot be directly observed (e.g., belonging to the team)—these concepts are represented as latent variables. A latent variable cannot be measured directly; therefore, we use a set of indicators or manifest variables. For the latent variables in this study, we adapted existing measurement instruments where possible. We define the constructs below and provide the questions in Table 3. The survey was co-designed with TechCom's HR department; consequently, pragmatic decisions were made, including an attempt to restrict the length of the questionnaire. All questions were measured using Likert-5 scale from Strongly Disagree to Strongly Agree.

- **Psychological Safety**'s items were inspired by the Team Psychological Safety Instrument [13] and adapted to better fit the company's context. The items included feeling safe to share bad news with the team, being themselves, and reporting improper behaviors.
- **Work Appreciation** was measured with questions intended to reflect the recognition aspect of Work Appreciation [14, 20]: *"I have found a reasonable balance between what I contribute to TechCom and what I get in return."*; *"My leaders recognize my work."* and *"My contributions make a difference for the company."*
- **Belonging to the Team** was measured by questions adapted from the Sense of Belonging Instrument (SOBI) [24], including feelings of trust, affect, acceptance, and value.

The survey instrument also included an open question that invited respondents to share their thoughts and experiences about the workplace. The demographic data about gender, organizational tenure, country of residence, and role were used from the company's pre-existing demographic data for its reporting requirements under government laws. Although we acknowledge that there are more genders than the binary set of men and women, the data offered just these two gender options, which we used in our analysis. Based on the respondents' country of residence, we used Hofstede's classification of power distance of national culture [33] to measure an authoritative national culture. *Power Distance* refers to authority and hierarchy and expresses the degree to which less powerful members of a society accept and expect that power is distributed unequally. High power distance means an acceptance of a hierarchical order in which people have a determined place. A low power distance signifies a preference for a more egalitarian distribution of power [34, 35]. In cultures characterized by high power distance, social hierarchy is explicitly established and enforced, often without apparent justification [18]. In Hofstede's classification [34], Argentina is an example of hierarchical societies with low Power Distance, while Mexico and India are examples of hierarchical societies with high Power Distance. Section 4 presents the results of a number of procedures to evaluate the validity of the measurement model.

3.2 Data Collection

TechCom administered the online questionnaire using an internal survey tool to be answered by members of software delivery teams at the company. The survey was sent to their corporate e-mail addresses and was available for one month. Answering the survey was optional, but team leaders encouraged their team members to complete the online questionnaire during regular meetings.

The questionnaire was answered by 10,971 people. However, since our analysis techniques require complete responses, we ended up removing 190 responses with missing values (less than 2% of the responses). Given the very large number of responses, the trade-off between introducing a potential bias versus increasing the usable sample size suggested taking a more conservative approach. We did not use imputation methods, which could introduce bias for multi-group analysis [25]. Therefore, the sample we used for data analyses contains 10,781 responses. We present demographics in Table 1. The questionnaire is available in the online replication package [8]. The dataset is not available due to confidentiality agreements.

4 MEASUREMENT VALIDITY

We employed several procedures to assess the validity of the measurement model presented in Sec. 3.1, including convergent validity, internal consistency reliability, discriminant validity, and collinearity, as discussed next.

4.1 Convergent Validity

We assessed whether the questions (indicators) that represent the latent variables are understood by the respondents in the same way as they were intended by the designers of the questions [41], i.e., we assessed the convergent validity of the measurement instrument. The assessment of convergent validity relates to the degree to which a measure correlates positively with alternative measures of the same construct. Our model contains three latent variables—all reflective—as functions of the latent construct. Changes in the theoretical, latent construct are reflected in changes in the indicator variables [27]. We used two metrics to assess convergent validity: the Average Variance Extracted (AVE) and the loading of an indicator onto its construct (the outer loading).

The AVE is equivalent to a construct's communality [27], which is the proportion of variance shared across indicators. A reflective construct is assumed to reflect (or "cause") any change in its indicators. The AVE should be at least 0.5, indicating that it explains most of the variation (i.e., 50% or more) in its indicators [27]. This variance is indicated by taking the squared value of an indicator's loading. All AVE values for both latent constructs in our model are above this threshold of 0.5 (see Table 2).

A latent variable is measured by two or more indicators; indicators with loading below 0.4 should be removed because this implies that a change in the latent construct that it purportedly represents (or 'reflects') does not get reflected in a sufficiently large change in the indicator [27]. An outer loading of 0.708 is considered sufficient (because $0.708^2 \approx 0.5$, which means at least half of the indicator's variance can be explained by the latent variable), and 0.6 is considered sufficient for exploratory studies [27]. The indicators of all latent constructs exceeded 0.67, as shown in Table 3.

Table 1: Demographics of respondents (n=10,781)

Attribute	N	Percentage
Country		
Colombia	2,582	23.9%
India	2,163	20.1%
Argentina	1,989	18.4%
Mexico	1,496	13.9%
Chile	709	6.6%
Peru	532	4.9%
Uruguay	359	3.3%
Brazil	300	2.8%
Spain	166	1.5%
USA	160	1.5%
Romania	88	0.8%
Ecuador	82	0.8%
Costa Rica	72	0.7%
Belarus	39	0.4%
UK	25	0.2%
Canada	8	0.1%
Poland	6	0.1%
Denmark	4	0.0%
France	1	0.0%
Role		
Developers	5,319	49.3%
Testers	1,904	17.7%
Project or Product Manager	1,496	13.9%
System Administrator	652	6.0%
Business Analyst	525	4.9%
UX or Design	457	4.2%
Database Administrator	428	4.0%
Organizational Tenure		
Less than 1 year	726	6.7%
1-3 years	7,492	69.5%
4-5 years	1,415	13.2%
Over 5 years	1,148	10.6%
Gender		
Men	8,185	75.9%
Women	2,596	24.1%

4.2 Internal Consistency Reliability

Second, we verified how well the different indicators are consistent with one another and able to reliably and consistently measure the constructs. A high degree of consistency suggests that indicators refer to the same construct. There are several tests to measure internal consistency reliability. We calculated both Cronbach's Alpha and Composite Reliability (CR); Cronbach's Alpha frequently shows

Table 2: Internal Consistency Reliability

	Cronbach's Alpha	CR	AVE
Work Appreciation	.647	.808	.584
Psychological Safety	.707	.820	.532
Belonging to the Team	.821	.882	.651

Table 3: Cross loadings of indicators on the constructs

		Work App.	Psyc. Safety	Belonging to the Team
WA1	I have found a reasonable balance between what I contribute and what I get in return	**.708**	.410	.376
WA2	My leaders recognize my work	**.816**	.458	.541
WA3	My contributions make a difference to the company	**.765**	.458	.484
PS1	I feel safe sharing bad news with my team	.363	**.729**	.461
PS2	I can be myself at TechCom	.463	**.755**	.515
PS3	I feel safe reporting improper behaviors such as discrimintaion or harassment	.368	**.668**	.397
PS4	I feel safe speaking up and taking risks	.484	**.762**	.479
BL1	I can trust people in my team	.502	.518	**.801**
BL2	I feel accepted by my co-workers	.470	.465	**.778**
BL3	I feel my co-workers value my opinion	.553	.574	**.826**
BL4	I have a good relationship with my team	.467	.491	**.820**

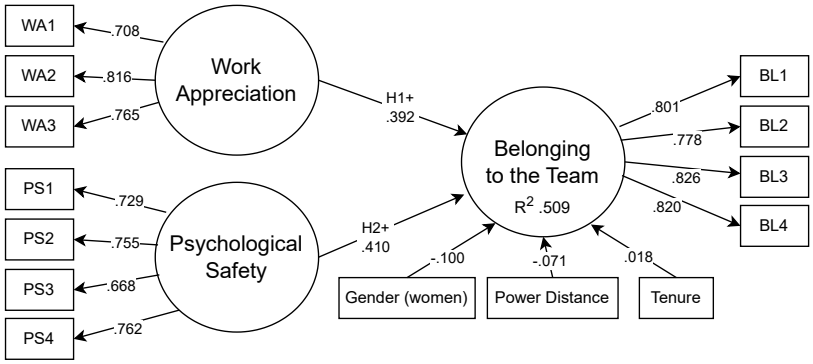

Figure 2: Item loadings and path coefficients

lower values, whereas the Composite Reliability (CR) may overestimate slightly [27]. A desirable range of values for both Cronbach's Alpha and CR is between 0.7 and 0.9 [27]. Values below 0.6 suggest a lack of internal consistency reliability, whereas values over 0.95 suggest that indicators are too similar and are not desirable. Our CR values were 0.808, 0.820, and 0.882 (see Table 2).

4.3 Discriminant Validity

Third, we verified whether each construct represented different concepts or entities through a discriminant validity test. A primary means to assess discriminant validity is to investigate the Heterotrait-monotrait (HTMT) ratio of correlations [31]. The discriminant validity could be problematic if the HTMT ratio exceeds 0.9 [31]. In our case, the HTMT ratio between the three latent constructs ranged between 0.81 and 0.84. We also assessed the cross-loadings of indicators, for which items should only load onto their 'native' construct, the one they purportedly represent (see Table 3). The procedure indicated that discriminant validity does not threaten this study.

4.4 Collinearity Assessment

Our theoretical model has two exogenous variables: Work Appreciation and Psychological Safety, and three control variables, Gender, Organizational Tenure, and Power Distance. We hypothesized that the exogenous and control variables are associated with the endogenous variable of belonging to the team. To ensure that the two exogenous constructs are independent, we calculated their collinearity using the Variance Inflation Factor (VIF). A widely accepted cut-off value for the VIF is 5 [27]; all VIF values of our variables are below 1.8.

5 ANALYSES AND RESULTS

We now address the research questions introduced in Section 1.

5.1 RQ1. Antecedents of Belonging to the Team

To answer RQ1 (*How are work appreciation and psychological safety related to the sense of belonging to the team?*), we evaluated the hypotheses using PLS-SEM.

5.1.1 Path Coefficients and Significance. Table 4 shows the results for the hypothesis testings, including the mean of the bootstrap distribution (*B*), the standard deviation (*SD*), the 95% confidence interval, and p-values. The path coefficients in Fig. 2 and Table 4 are interpreted as standardized regression coefficients, indicating the direct effect of one variable on another. Each hypothesis is represented by an arrow in the diagram in Fig. 2. For example, the arrow pointing from Psychological Safety to Belonging to the Team represents H2. Given its positive path coefficient (0.410), psychological safety is positively associated with belonging to the team. The path coefficient is 0.410; this means that when the score for psychological safety increases by one standard deviation unit, the score for belonging to the team increases by 0.410 standard deviation unit (the standard deviation is the amount of variation of a set of values). Based on the results, we found support for all hypotheses ($p < 0.001$), and all control variables were significantly associated with belonging to the team.

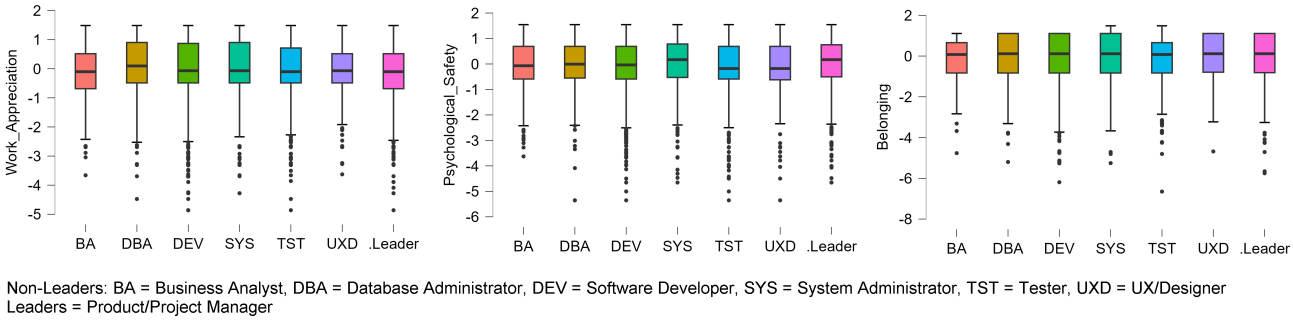

Figure 3: Descriptive analysis of latent constructs per role

Table 4: Standarized path coefficients, standard deviations, confidence intervals, and p-values. * means statistically significant

	B	SD	95% CI	p
H1. Work App.→ Belonging	.392*	.009	(.37, .41)	.010
H2. Psyc. Safety → Belonging	.410*	.010	(.39, .43)	.000
Control Variables				
Gender (women)→ Belonging	-.010*	.002*	(-.13, -.07)	.000
Power Distance→ Belonging	-.071*	.006*	(-.08, -.06)	.000
Org. Tenure→ Belonging	.018*	.006*	(.00, .03)	.000

5.1.2 Model Evaluation. We assessed the relationship between constructs and the predictive capabilities of the theoretical model using three evaluation measures: R^2, Q^2, and SRMR [27]. The R^2 value of the endogenous variable in our model (belonging to the team) was 0.508. We considered a threshold of 0.5 and our R^2 is above this threshold.

We also inspected the model's predictive relevance by means of Stone-Geisser's Q^2 [70] value, which is a measure of external validity [27]. This measure can be obtained through the PLS-Predict procedure (available within the SmartPLS software). PLS-Predict is a holdout sample-based procedure that generates point predictions on both the item level and the construct level, dividing the sample data into k subgroups (referred to as folds) of roughly the same size and combining k-1 folds into a training sample that is used to estimate the model. The remaining fold serves as a holdout sample used to assess the model's predictive power [26]. Q^2 value is calculated only for the endogenous variable belonging to the team, which led to 0.50. Values larger than 0 indicate the construct has predictive relevance, while negative values show the model does not perform better than the simple average of the endogenous variable would do. Therefore, our model is also adequate according to this evaluation.

Finally, we report the Standardized Root Mean Square Residual (SRMR), a common fit measure to detect misspecification of PLS-SEM models [62]. SRMR is the square root of the sum of the squared differences between the model-implied and the empirical correlation matrix, or the Euclidean distance between the two matrices [29]. A value of 0 for SRMR indicates a perfect fit, and values less than 0.08 (conservative) or 0.10 (more lenient) are considered a good fit [30]. Our results suggest a very good fit of the empirical data in the theoretical model (SRMR = 0.067).

The resulting latent variable scores from PLS-SEM algorithm are unique to each respondent and determine the case values of each observation [57]. We exported the latent variable scores of the endogenous variable of our PLS-SEM model (Belonging) and compared their values for roles using descriptive statistics (Fig 3). The averages of Psychological Safety and Belonging to the Team were very similar between roles. When examining Work Appreciation, the averages for Testers and UX/Designers are lower than the other roles. While Belonging to the Team had a similar average, it was more consistently answered by Testers and business Analysts than the other roles, as they had a lower spread than the other roles.

Research Question 1

How are work appreciation and psychological safety related to the sense of belonging to the team?
Our analysis reveals significant associations between psychological safety and work appreciation with the sense of belonging within software delivery teams. Notably, psychological safety exhibits a stronger correlation with the sense of belonging compared to work appreciation.

5.2 RQ2. Belonging across Roles

To answer RQ2 (*Does the relationship between work appreciation, psychological safety, and belonging to the team vary by leadership responsibilities?*), we performed a Multi-Group Analysis. We evaluated the theoretical model for groups of respondents according to their role in their software delivery team. To conduct a multi-group analysis, Hair et al. [28] proposed three steps: (1) group creation; (2) invariance test; and (3) result analysis.

5.2.1 Group Creation. We grouped our participants to observe heterogeneity according to their leadership role (project or product managers = 1; developers, testers, system administrators, business analysts, database administrators, or UX/designers = 0). The distribution of roles is presented in Table 1.

5.2.2 Evaluation of Measurement Invariance of Composite Models (MICOM). Measurement invariance is a mechanism to assess whether the loadings of the items that represent the latent variables differ significantly across different groups. In other words, we want to assess whether the differences can be attributed to the theoretical constructs and not to how we measured those constructs [28].

Comparing group-specific model relationships for significant differences using a multi-group analysis requires establishing configural and compositional invariance [28, 32]. Configural invariance does not include a test and is a qualitative assessment to ensure that all of the composites (such as equivalent indicators per measurement model, equivalent treatment of the data, and equivalent algorithm settings or optimization criteria) are equally defined for all of the groups. The configural invariance is established in our model. Following that, compositional invariance exists when the composite scores are the same across both groups and is statistically tested to assess whether the composite scores differ significantly across the groups. For this purpose, the MICOM procedure examines the correlation between the composite scores of both groups and requires that the correlation equals 1. We ran the permutation test in SmartPLS and verified that compositional invariance is established for all latent variables in the PLS path model. We established partial measurement invariance and thus the multi-group analysis is suitable [58].

5.2.3 Groups Comparison and Analysis. Path coefficients generated from different samples are usually numerically different, but the question is whether the differences are statistically significant. We analyzed the differences between the coefficients' paths for the groups. If they are significant, they can be interpreted as having moderating effects.

As presented in Table 5, parametric tests showed no statistical difference regarding the groups of leaders and non-leader-related roles for H1 and H2 (both hypotheses are supported for both groups). When comparing the two groups (leaders and non-leaders), we found a statistical difference regarding the control variable of gender. Women who are not leaders (B=-.121) showed significantly lower feelings of belonging to the team than leaders.

Table 5: Multi-Group Analysis: coefficients marked with $*$ are statistically significant; gray lines show a significant difference between groups (i.e. leaders/non-leaders)

	Role		Orig.
Group	Leaders	Non-Leaders	All
Sample size (N)	1,496	9,285	10,781
Belonging to the Team (R^2)	.474	.516	.509
H1. Work App. → Belonging	.360*	.399*	.392*
H2. Psych. Safety → Belonging	.417*	.407*	.410*
Control Variables			
Gender (women) → Belonging	**-.015**	**-.121***	.010*
Org. Tenure → Belonging	.010	.018*	.018*
Power Distance → Belonging	-.039	-.071*	-.071*

Research Question 2

Does the relationship between work appreciation, psychological safety, and belonging to the team vary by leadership responsibilities?

Work appreciation and psychological safety are significantly associated with a sense of belonging regardless of leadership responsibilities. However, women who are not in leadership positions reported a significantly lower sense of belonging to the team when compared to women leaders.

5.3 RQ3. Importance-Performance Map

To answer RQ3 (*What are the most critical constructs associated with the feelings of belonging to the team?*), we employed Importance-Performance Map Analysis (IPMA). IMPA combines the analysis of the importance and performance dimensions of the PLS-SEM investigation [58] and has been used in the software engineering domain [61]. IPMA enables researchers to gain richer and more precise insights from their findings because it simultaneously considers both the path coefficients estimates and the average values of the latent variable scores. In our study, the PLS-SEM analysis performed for RQ1 and RQ2 allowed us to understand the magnitude of the effects of the two independent variables, work appreciation and psychological safety, on belonging to the team. However, this analysis did not evaluate the average values of these two independent variables. In other words, it did not consider whether, according to participants' ratings, belongingness performed well or not in terms of work appreciation and psychological safety. The joint evaluation of these constructs' importance (i.e. of their effects on belongingness) and performance (i.e. of their average values) enabled us to complement PLS-SEM results with relevant insights to guide managerial action. We investigate the extent to which the indicators from the constructs *Work Appreciation* and *Psychological Safety* associate with the target construct, i.e., *Belonging to the Team*.

Both *Work Appreciation* and *Psychological Safety* constructs present a very high performance (above 77%) (see Table 6). The outcome is remarkable, particularly when taking into account that conventional models rooted in the Technology Acceptance Model [12] show construct performance that ranges from 50% to 70% [54]. The importance of indicators ranged between 0.10 and 0.18 (see Table 7), which is comparable with those of other mature models (between 0.10 and 0.35) [54].

Table 6: IMPA: Performance referred to Belonging to the Team

Latent Construct	Performance (%))
Work Appreciation	77.13%
Psychological Safety	78.56%
Belonging to the Team	85.89%

Table 7: IPMA: Importance (Effects) referred to Belonging to the Team

	Role		
	Leaders	Non-Leaders	All
Work Appreciation	.360	.399	.392
WA1	.122	.140	.137
WA2	.172	**.202**	**.197**
WA3	**.174**	.176	.176
Psychological Safety	.417	.407	.410
PS1	.144	.138	.139
PS2	.148	**.156**	.156
PS3	.121	.119	.120
PS4	**.149**	.144	.145

Figure 4 represents the combination of the constructs' importance and performance. This figure implies that a one-unit point

increase in *Psychological Safety* performance increases the performance of *Belonging to the Team* by the value of *Psychological Safety* total effect on *Belonging to the Team*, which is 0.410 (ceteris paribus). In other words, our data suggest that a one-unit increase in *Psychological Safety* performance from 78.56 to 79.56 would increase the performance of *Belonging to the Team* by 0.41 points, from 85.89 to 86.30.

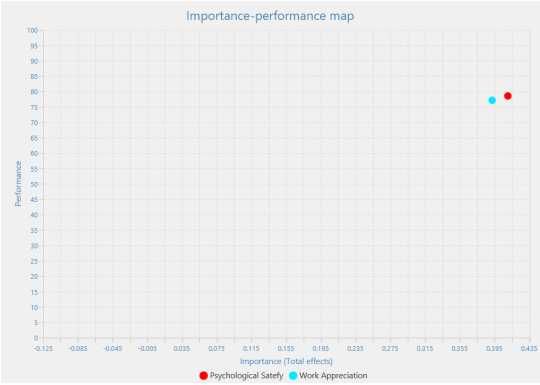

Figure 4: Importance-Performance Map Analysis of Belonging to the Team

When examining the indicators' level for the combination of constructs' importance and performance for leaders and non-leaders (Fig.5), we see that, for leaders, WA3 ("My contributions make a difference to the company") is the most critical indicator. For non-leaders, WA2 ("My leaders recognize my work") is the most critical indicator of belongingness.

Therefore, our results suggest that if the management's goal is to increase non-leaders belonging to the team they should prioritize strengthening the work appreciation aspect of recognition by leadership. On the other hand, if the management is focused on increasing leaders' belonging to the team, they should prioritize transparency about how their contributions impact the business. We discuss the results in the next section.

Research Question 3

What are the most critical constructs that associated with the feelings of belonging to the team?
For leaders, the perception of making a difference in the company is the strongest predictor of their sense of belonging. Conversely, for non-leaders, being recognized by their leaders emerges as the strongest predictor influencing their sense of belonging to the team.

6 DISCUSSION

In this section, we discuss our findings, threats to validity, and implications. To illustrate the discussion, we bring exemplar quotes from the respondents' responses to the final open question of the survey.

6.1 Discussion of Findings

6.1.1 H1. Work Appreciation → Belonging to the Team. Work Appreciation was positively associated with belonging to the team (H1, *B*=.392). Achieving a satisfactory equilibrium between contributions and rewards (WA1), being recognized by leadership (WA2), and perceiving own contribution with a meaningful impact on the company (WA3) are positively associated with belongingness to the team. One participant who was neutral with WA1 but strongly agreed with WA2 and agreed with WA3, reported having an amazing experience in the team, mentioning to *"feel that [his] work is being appreciated and well-supported by [his] leaders, making [him] confident in what [he] is delivering"*. Another respondent who works as a Designer corroborates the association between Work Appreciation and belonging to the team: *"Thank you for appreciating my work every day and for allowing me to be part of this team."*

The findings of this study support the notion put forth by Self-Determination Theory (SDT) [64], which states that individuals who feel competent in their social interactions are more likely to establish positive connections with others, which may enhance their sense of belonging and connectedness within the team. SDT suggests that the need for competence is associated with individuals feeling a sense of mastery and control over their social environment. This can lead to greater confidence and a more positive outlook in social situations [63]. For instance, team members who feel competent are likely to feel more comfortable expressing themselves during team interactions and building positive relationships with others, contributing to their sense of belonging. In contrast, individuals who lack confidence in their social skills may feel excluded or disconnected from the team, leading to feelings of alienation. Failure on the part of leadership to recognize the personal investment of workers, such as their practical intelligence and enthusiasm for their job responsibilities, may result in a significant sense of injustice among the employees.

Leaders and non-leaders: From the Importance-Performance Map Analysis (see Fig.5), we found that the most critical indicator of work appreciation for non-leaders' belongingness to the team is being recognized by leadership (WA2). This finding was corroborated by a quote from one of our respondents: *"an organization can't help when we do not have a leader who is not able to recognize."* This finding reinforces the idea that effective leadership is one of the key drivers of business and project success in software engineering and has a strong power to engender a sense of belonging to the team [21]. On the other side, the most important aspect of work appreciation for leaders' belongingness is related to a sense of purpose, or perceiving a meaningful impact of their contributions to the company (WA3). This finding also aligns with the Self-Determination Theory [63] and is corroborated by a quote from a respondent who works as a Project Manager: *"I am proud to be part of something that feels an important project."* Organizations interested in fostering a sense of belonging in their teams may focus on their leaders, raising awareness about the importance of recognizing the work of their subordinates and providing feedback about the importance of their work to the company.

6.1.2 H2. Psychological Safety → Belonging to the Team. We found support for the link between psychological safety and belonging to the team (H2, *B*=.410). This association also aligns with the Self-Determination Theory (SDT) [63], which proposes that psychological safety is closely aligned with belonging to a team because when team members feel psychologically safe, they are more

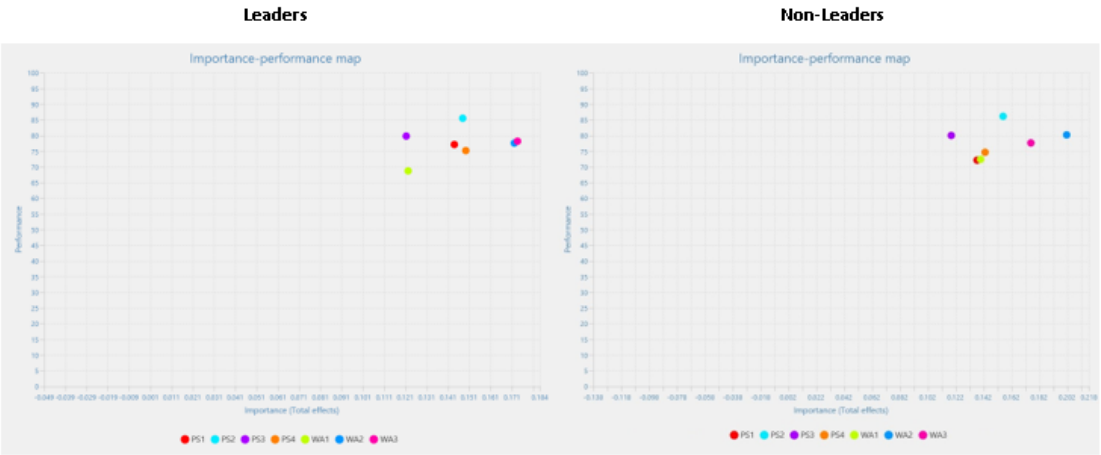

Figure 5: Importance-Performance Map Analysis of Belonging to the Team, per leadership position

likely to express their ideas and opinions without fear of negative consequences. This situation creates a climate of trust and mutual support, which fosters a sense of relatedness among team members.

Leaders and non-leaders: From the Importance-Performance Map Analysis (Fig.5), the most important aspect of Psychological Safety for non-leaders' belongingness is their ability to be themselves (PS2), as illustrated by a respondent: *"I feel safe and lucky to be in an environment where I can be myself and where my actions speak louder than my looks—and where looks don't speak at all."*)

On the other side, the most important aspect of psychological safety for leaders' belongingness to the team is feeling safe to take risks (PS4), almost tied but higher than PS2. Believing that it is safe to take risks in the workplace is the main aspect of Psychological Safety [2] and is related to autonomy, as mentioned by a respondent who works as a Product Manager: *"There isn't real autonomy, which is essential for intrinsic motivation and is about of being able to make decisions about how to help the company to do a better job for our clients."*

Leaders from our dataset include project and product managers—who make decisions that can directly influence the team members or the software. Every decision involves risk-taking, and our results suggest that leaders from our dataset feel they belong to their teams when they feel safe to take risks. When managers feel psychologically safe, they are more likely to take calculated risks, share innovative ideas, and encourage creativity in their teams.

6.1.3 Control Variables: Gender, Organizational Tenure, and Power Distance. Consistent with prior research on open source software [74], team belonging is positively associated with organizational tenure and negatively associated with being a woman (gender minority) and authoritativeness (power distance). The longer employees work for the company, the higher their sense of belonging to the team. In contrast, higher levels of power distance in national culture are associated with lower feelings of belonging to the team.

Leaders and non-leaders: Among those respondents who do not hold leadership positions, the link between being a woman and a sense of belonging was 8 times more significant than in the case of project or product managers. Women who do not have decision-making authority or managerial responsibilities may perceive a stronger disconnect or feeling of not fitting in with their team compared to women who are in leadership positions. This finding indicates that the *lack of representation in leadership positions could contribute to a more pronounced sense of exclusion or marginalization for women within the organization.* The finding highlights the importance of promoting gender diversity in leadership roles to foster a more inclusive and supportive environment where all employees, regardless of gender, feel a sense of belonging and engagement with their team and the organization.

6.2 Threats to Validity and Limitations

External Validity. We conducted this study at a single organization, which may affect the generalization of the results. Nevertheless, our data captures a large variety of situations. Given the very large sample of respondents, who were distributed across the globe, it is likely that different teams of TechCom have their own culture, which may be influenced by the national culture of the country where a division is located [33]. Leadership recognition (part of work appreciation) can change more readily than an organization's culture through leadership change. Even if there is a specific "TechCom culture," respondents had different experiences.

Internal Validity. We included two latent and three control variables in our measurement model. Nevertheless, we acknowledge that besides the investigated variables, other factors can play a role in belongingness, and our results represent a starting point for future studies.

The decision made by TechCom to utilize an internal survey system that requires employee authentication sacrifices anonymity and can also be seen as a threat to the validity of the results. The organization uses non-anonymous surveys to avoid asking redundant demographic questions already available in the HR database, streamlining the questionnaire, reducing response time, and avoiding survey fatigue. Nevertheless, we acknowledge that without anonymity, respondents may feel inclined to provide answers that align with what they believe the company wants to hear, potentially leading to biased responses. However, respondents at TechCom are used to non-anonymous surveys and were aware that managers and researchers would not have access to identifiable information and that the data would be aggregated to support company-wide

research. Additionally, to help mitigate the risk of biased responses, TechCom made participation in the survey optional for employees.

We also acknowledge that the binary gender options available in the dataset do not represent the complete set of identities. This may have influenced the results since those who do not identify as binary may be misrepresented in the analysis.

Construct validity. We adopted and tailored existing measurement instruments when possible and developed measurement instruments for some constructs based on prior literature. We developed a new construct called work appreciation, which we defined as having three aspects (see Sec. 3.1). The internal consistency reliability for the whole instrument performed very well (see Table 2).

Conclusion validity. Our hypotheses propose associations between different constructs rather than causal relationships, as the present study is a cross-sectional sample study [69].

6.3 Implications for Practice

Our findings have significant implications for practice. By replicating our survey, other companies may diagnose how they are regarding the variables investigated and the employees' belongingness, which would guide their efforts. This survey has been carefully crafted to avoid fatigue, ensuring that responses remain accurate and meaningful. Therefore it is possible to derive targeted actions, ultimately creating a culture that values inclusion and fosters a sense of belonging among the employees. As our results imply, investing in training leaders to regularly acknowledge and appreciate their teams' accomplishments is important. This recognition is expected to motivate team members and enhance their sense of belonging and value to the company.

TechCom itself is applying targeted actions based on the results. In one of the initiatives, all leaders have to undergo training via a series of bootcamps. These training sessions cover a wide range of topics, including processes, recognition practices, social awareness, effective communication with the team, delivering negative news, and creating a culture of psychological safety for employees to express their opinions. Still, to monitor the effectiveness of these measures, TechCom will conduct a short monthly survey consisting of three targeted questions designed to gather data on any aspects of a lack of belongingness among employees.

We understand that belonging needs to be cultivated from the beginning. A way to do so is by creating programs to mentor and introduce the organizational culture to newcomers. This mentorship program would provide a platform for the mentor to share ideas, advice, and cultural knowledge about the team and the company, fostering a sense of inclusion and belonging among new employees. Additionally, TechCom is planning orientation sessions to refresh the company's cultural values, open to all employees regardless of their role or position.

Increasing the frequency of interactions within the company by creating internal communities and organizing on-site events can be good ways to increase Psychological Safety and Sense of Belonging. These initiatives allow individuals with similar interests to connect, exchange knowledge, and build a supportive and enjoyable atmosphere. By fostering a culture of collaboration and inclusivity, software companies can create workplaces where all employees feel valued and connected to the company's mission and vision.

7 RELATED WORK

The drivers of the sense of belonging have been extensively explored in education, encompassing both positive and negative aspects. Research in this area has examined the experiences of individuals from various minority groups and their belongingness in different contexts. For instance, studies on women in math [19] and Latinx individuals facing a hostile racial climate [36] have revealed the difficulties to belong faced by minority groups. In software engineering, most studies aimed to improve the student learning experience in software engineering courses (e.g., [46, 60]). A notable exception is the work from Trinkenreich et al. [74], who analyzed how the sense of belonging is connected to intrinsic motivation to contribute to open source software. To the best of our knowledge, no previous work has investigated the antecedents of the sense of belonging in the software industry, where software developers work in-person and online, are paid employees, and are distributed in cross-functional teams. In our present study, we also delved into the influence of gender on the sense of belonging within the team. Our findings indicate that being a woman can have a detrimental effect on feelings of belonging, particularly for those not in managerial roles. This highlights the significance of addressing gender-related factors to create a more inclusive and supportive team environment.

On the other hand, the antecedents we investigated are largely explored in the field of behavioral software engineering [22, 37, 44], especially after the COVID-19 pandemic. According to Timothy Clark [10]'s book, psychological safety and belongingness are interconnected feelings, as the foundation of psychological safety lies in the moral principles of respecting and embracing every team member, granting them *permission to belong*. In this context, Tkalich et al. [72] investigated Norwegian software developers and discovered that transitioning to remote work harms psychological safety. Aagren et al. [1]'s study further support this finding by highlighting the consequence of group maturing debt when teams return to the office after the pandemic, which is caused by the lack of psychological safety. Our study corroborates the importance of psychological safety, providing empirical evidence about the positive association between psychological safety and belonging to the team.

8 CONCLUSION

This study presents a theoretical framework with two organizational factors (work appreciation and psychological safety) and three diversity aspects (gender, tenure, and country culture) influencing the sense of belonging within software delivery teams. To investigate these associations, we collected data through a survey involving over 10,000 participants. Our findings indicate that work appreciation, psychological safety, and organizational tenure are positively associated with the sense of belonging to software delivery teams. Conversely, being a woman and residing in a country with a high index of power distance in cultural norms are negatively associated with feelings of belonging to such teams.

Our study revealed notable differences in these associations when considering different leadership positions within software delivery teams. Among non-leaders in our sample, the relationship between being a woman and belonging to the team was less

pronounced compared to that observed among leaders. Work appreciation showed distinct critical aspects for non-leaders, with recognition from leadership being of higher importance, along with the ability to be themselves. On the other hand, for leaders, the most critical aspects of work appreciation were perceiving their contributions as impactful to the company, while feeling safe to speak up and take risks emerged as the most critical components concerning psychological safety. These findings shed light on the varying dynamics of factors influencing the sense of belonging based on leadership responsibilities within software delivery teams.

This study suggests different links between antecedents of belongingness for men and women who work on software delivery teams. Non-binary genders and other diversity aspects (race, English familiarity, disabilities, etc.) can be investigated in future work.

Future work could also examine the consequences of belongingness (or lack thereof) to the team, such as attrition and productivity, evaluate strategies to increase the sense of belonging and expand this research to a cross-section of the IT industry.

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