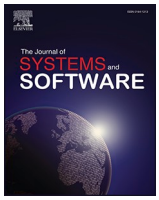
The Journal of Systems and Software 214 (2024) 112054

Contents lists available at ScienceDirect

The Journal of Systems & Software

journal homepage: www.elsevier.com/locate/jss



Examining the effect of software professionals' personality & additional capabilities on agile teams' climate

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ARTICLE INFO

Keywords:
Capability measures
Personality traits
Team climate prediction
Correlation analysis
Regression analysis
Agile software development

ABSTRACT

Context: Investigating factors influencing agile team climate is pressing given its impact on organizational performance. Despite previous studies, association between human aspects and team climate remains yet unexplored.
Objective: Exploring association between two human aspects, namely team member's capability measures and personality traits, and member's perceived team climate.
Method: 75 professionals (12 teams) from one division participated in the first survey iteration, second iteration in another division included 46 professionals (7 teams). We employed correlation analyses to measure association between human aspects and climate, and regression analyses to identify team climate predictors.
Results: In relation to team climate dimensions, we observed a significant negative correlation with *neuroticism* and a significant positive correlation with *responsibility*. Linear regression analysis showed capability measures accounted for 19.2% of variance in team climate. Multivariable regression analysis revealed capability measures and personality traits together accounted for 25.7% of variance in team climate.
Conclusion: An individual's propensity towards self-doubt (neuroticism) negatively affects perceived team climate, whereas individual's ability to be responsible and teamwork-oriented positively affect perceived team climate. The inclusion of both capability and personality variables as input for multivariable regression explained slightly more variance in team climate, compared to only capability measures (25.7% against 19.2%).

1. Introduction

The prevalence of agile software development (ASD) methods in today's software industry and the inclusive yet fluid nature of agile teams, collectively call for collaborative work requiring multidisciplinary skills, interpersonal skills and skills beyond technical competences (Lindsjørn et al., 2016; Lacher et al., 2015). In order to adapt to rapidly changing market needs and reducing lead times, ASD methods are heavily reliant on the capabilities of professionals (Abrahamsson et al., 2002). These capabilities relate to human aspects such as the features, qualities, social and methodological abilities that are crucial for personal and professional development (Vishnubhotla et al., 2021). In an agile team, members are expected to showcase capability in relation to methodological, social and creative aspects while they interact with teammates. However, inappropriate team composition is one of the main contributors towards project failure (e.g. Gilal et al., 2018; Kollmann et al., 2009; Truong and Jitbaipoon, 2016; Nizam, 2022); therefore, it is fundamental to understand how best to build high-performance software teams, without compromising team climate (Gilal et al., 2018; Bick et al., 2018; Dingsoeyr et al., 2019; Zolduoarrati et al., 2023).

Team climate can be understood as team members' perceptions in relation to "the extent to which a team makes use of structures, policies and practices supporting trust, cohesion and innovativeness" (Berraies and Chouiref, 2022). These perceptions can influence team members' performance, the quality of deliverables, personal relationships, and satisfaction (e.g. Acuña et al., 2015; Fay et al., 2004; Acuña et al., 2008). While team members' capabilities are known to influence team performance (e.g. Truong and Jitbaipoon, 2016) and project success (e.g. Tam et al., 2020; Radhakrishnan et al., 2022), research investigating the specific association between team members' capabilities and team climate is still, despite its significant importance, very sparse.

This is clearly supported by a recently published tertiary study that included 67 tertiary studies (2167 primary studies) focusing upon human aspects in Software Engineering (Zolduoarrati et al., 2023), and where team climate was investigated by solely 13 primary studies. As

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https://doi.org/10.1016/j.jss.2024.112054
Received 6 June 2023; Received in revised form 23 December 2023; Accepted 3 April 2024
Available online 5 April 2024

detailed later in Section 2, there has been, to date, no study that investigated the relationship between team members' capability and team climate, taking into account a wider set of capabilities beyond team members' personality traits. Therefore, this paper is the first to make such important contribution to both research and practice in ASD and SE.

Note that team climate is not the same as organizational climate. The latter represents "the shared perception of employees about the characteristics of the organization, including its policies, culture and practices" (Loh et al., 2019). It is a wider construct, when compared to team climate, and can have both positive or negative impact upon agile teams, in aspects that are not related to either team members' capabilities (e.g. motivation, ability to make good decisions, willingness to innovate), or the quality of the agile practices being used (Dutra and Santos, 2020).

The research detailed herein uses as basis our previous work in capability measurement, and extends our previous research on personality traits & team climate, in the following ways:

- Capability measurement. We have previously carried out a Systematic Literature Review (SLR) detailing a classification of capabilities for team and team members (S.D. Vishnubhotla et al., 2018). The SLR's results were then used as input to a survey investigation aimed to identify the state of practice of individual and team capabilities in ASD (Vishnubhotla et al., 2021). The top five capabilities that agile professionals perceived to be highly relevant for characterizing the capability of team members are: responsibility, listening skills, questioning skills, team participation skills and being teamwork oriented. These are the five capabilities investigated herein, in addition to personality traits, with regard to their association with team climate, and also their use as possible predictors of team climate. These five capabilities were identified by means of a combination of both state of the art and state of the practice in capabilities seen as the most relevant for ASD team formation. Devising a self-assessment questionnaire based on the aforementioned five capability measures and gathering results are one of the main contributions of this paper.
- Personality traits & team climate. The work detailed herein extends our previous work (Vishnubhotla et al., 2020) on personality traits and team climate by adding another five capability measures, in addition to five personality traits, to investigate their association with team climate, and their use as possible predictors of team climate. The five capability measures are those abovementioned, and personality traits are characterized via the five factor model (FFM) personality traits (Costa et al., 1992; Cruz et al., 2015); team climate is represented using the team climate inventory (TCI) (Anderson and West, 1998). The investigation presented herein, as far as we know, is the first to consider several capability measures and their association to team climate within an ASD context; this is, therefore, the second main contribution of this research.

In summary, the delta of this manuscript over the previous published paper (Vishnubhotla et al., 2020) is two-sided. This is an extension study to the previous publication by addition of a capability dimension, and secondly, this study reports the findings from two iterations of a survey performed in the same company as the previously conducted study. The novelty of the current study is to analyze the effect of capability and personality dimensions on team climate by using independent data sets from two divisions of a telecom company, acquired via two survey iterations. A total of 75 professionals from 12 teams from one of the divisions participated in the first iteration, followed by a second iteration in another division where 46 professionals from seven teams participated. We employed correlation analyses to measure the level of association between human aspects and climate, and later also used regression analyses to identify which human aspects were suitable team climate predictors.

A deeper understanding about the impact that human aspects have on team climate could perhaps support better team formation, and help going beyond solely handling project planning problems; it can aid towards revising the team selection strategies at our industrial collaborator's site. Furthermore, exploring the relationship between capability measures, personality traits and team climate dimensions within the specific context of ASD, can contribute towards team climate research in ASD, and agile team formation in industrial settings.

The remainder of this paper is structured as follows: Section 2 presents the related work on capabilities, personalities and team climate in SE. Section 3 discusses the methodological details of the study and Section 4 outlines the results of correlation analysis and regression analysis. In Section 5, we discuss the threats to validity of this study and in Section 6, we present the key findings from our results. Finally, Section 7 states the conclusions of this research.

2. Related work

Within SE, the findings from the studies where the voices of practitioners are acknowledged, would make a significant contribution to research and practice. Agile culture is about behaviors, attitudes, values, and beliefs of team members. Some of these aspects, however, are difficult to measure (Gregory and Taylor, 2019). Within ASD, the perceptions and attitudes of team members impact how software projects are run (Matthies et al., 2019). Lately, there has been an appreciable progress in research, within the field of ASD, involving human aspects such as, satisfaction of team members (Kropp et al., 2018; Kropp et al., 2020; Biddle et al., 2018), attitudes, beliefs, and experiences about ASD practices (Matthies et al., 2019; Biddle et al., 2018), diversity (Kohl Silveira and Prikladnicki, 2019), human challenges (Shameem et al., 2018), mindset (Ozkan and Gök, 2020), etc. On the other hand, there have been multiple studies that investigated the influence of human aspects in ASD towards achieving organizational outcomes such as team performance (Fagerholm et al., 2015), project success (Chow and Cao, 2008) and productivity (de O. Melo et al., 2013). Since this study aims to analyze the effect of capability and personality dimensions on team climate, the scope of the related work presented in this section is limited to the studies that investigated agile team members' capability (Section 2.1), personality (Section 2.2) and finally the studies that inspected the role of personalities on team climate (Section 2.3).

2.1. Studies investigating capability of agile team members

Capability refers to the features and qualities that can be developed or used by individuals and teams (Kettunen, 2013). However, there are also some studies where the definitions reported convey that capability pertains to the factors influencing success, productivity and performance (Čelar et al., 2014; Kettunen, 2014; Machuca-Villegas et al., 2022). In the wake of the need for assigning capable professionals to teams and projects (Čelar et al., 2014; Kettunen, 2014), and the significance of team members' capabilities in bringing agility to a development process (de O. Melo et al., 2013), we conducted an SLR (S.D. Vishnubhotla et al., 2018) to synthesize the state of the art relating to attributes and criteria for identifying which individual and team level measures would be appropriate for characterizing the capability of an agile team and its members.

In our SLR (S.D. Vishnubhotla et al., 2018), the initial search and selection process was conducted by executing a search string, comprising terms related to capability, over four online databases-Scopus, Science direct, ACM and Wiley. Subsequently, a secondary search was executed by using backward snowballing technique to identify more relevant studies. The search period was between 2001 and 2016, as 2001 was the year in which agile manifesto was published. In total, the search and selection processes retrieved 16 primary studies (14 from the initial search and 2 studies from secondary search), through which we gathered various individual and team capability measures that are specific to ASD, when targeting at team building criteria,

individual/team performance, productivity and successful teams. These capability measures pertained to professional, social and innovative aspects and were associated with knowledge, skills, personality characteristics, abilities, aptitudes and attitudes. For more comprehensive information on the search string, inclusion/exclusion criteria, quality assessment criteria, etc., readers are referred to our SLR (S.D. Vishnubhotla et al., 2018).

Furthermore, in our previous studies (S.D. Vishnubhotla et al., 2018; Mendes et al., 2018) we applied a qualitative research methodology by means of interviews, their recording, transcription and coding based upon grounded theory principles to investigate the capability measures and other criteria used by managers for assembling Scrum teams. Besides project specific factors and organizational factors, a study that was conducted at a small size software organization (S.D. Vishnubhotla et al., 2018) identified individual capability measures such as developers' domain knowledge, developers' own interest, previous deliverables' quality to be crucial while building teams. On the other hand, a case-study executed in a large size software company (Mendes et al., 2018) by means of interviewing 14 professionals, identified 10 individual capability measures (for example: application domain knowledge, previous formal education, etc.) and five team capability measures (for example: team velocity, competence diversity, etc.).

While our SLR (S.D. Vishnubhotla et al., 2018) gathered evidence on the state of the art pertaining to capability measurement in ASD, for the sake of exploring the state of the practice, i.e. to understand which capability measures pertain to software professionals' practice, in our subsequent study (Vishnubhotla et al., 2021), we conducted a survey by recruiting 60 agile professionals to examine what was the perceived relevance of various capability measures from their viewpoint. This study gathered perspectives from both research and practice towards identifying a meaningful intersection of capability measures. The survey results indicated that 127 individual and 28 team capability measures were perceived to be relevant by the majority of practitioners. The set of top measures vetted by agile practitioners as highly relevant for characterizing capability were further used in this study towards forecasting agile team climate at our partnering company, hereby referred to as company A.

In a recent publication by Machuca-Villegas et al. (2022), the perceptions of software professionals were analyzed to determine to what extent they consider the social and human factors to be influencing the productivity of a team. A survey was conducted by employing a 79-item questionnaire to gather and assess the perceptions on 13 social and human factors. Responses from 112 Colombian software professionals were gathered, where the responses were analyzed to determine whether respondents agree or disagree with the proposed items listed as influencing the productivity of teams. Since our SLR (S.D. Vishnubhotla et al., 2018) and previous survey (Vishnubhotla et al., 2021) also targeted at factors influencing the productivity of team members from the viewpoint of capabilities (but, specifically in relation to agile teams), some of the capability measures retrieved by our previous studies (Vishnubhotla et al., 2021; S.D. Vishnubhotla et al., 2018) were observed to be a subset of the items listed as influencing the productivity of teams in Machuca-Villegas et al.'s study (Machuca-Villegas et al., 2022). In relation to the top five capability measures identified by our previous survey (Vishnubhotla et al., 2021), we observed that at least 86% of the respondents in Machuca-Villegas et al.'s study agree that adhering to the characteristics of those capability measures would improve the productivity in the software development process (for responsibility, 27.7% of respondents agree (ag) and 72.3% strongly agree (st.ag), listening skills (ag: 48.2% and st.ag: 50.9%), questioning skills (ag: 38.4% and st.ag: 59.8%), team participation skills (ag: 53.8% and st.ag: 33.9%) and being teamwork oriented (ag: 62.5% and st.ag: 24.1%).

However, it is important to note that the respondents for Machuca-Villegas et al.'s (2022) survey were not strictly part of agile teams, as opposed to our previous survey's case (Vishnubhotla et al., 2021), where all the respondents were agile team members. So, it is not possible to draw conclusions for ASD context by comparing the perceptions of respondents between samples from both the studies. Further, the factors vetted by practitioners to be influencing productivity in Machuca-Villegas et al.'s (2022) survey cannot be taken into consideration for ASD context emphasized herein.

The related work reported in both SLR (S.D. Vishnubhotla et al., 2018) and previous survey (Vishnubhotla et al., 2021) present a comprehensive discussion on the studies that emphasized on capability of agile practitioners. For identifying studies that were published in recent years (i.e., studies published after our survey (Vishnubhotla et al., 2021) concluded (year 2021), we employed the forward snowballing technique over Google Scholar to search for the citations to our SLR (S.D. Vishnubhotla et al., 2018) and survey (Vishnubhotla et al., 2021). This led to the identification of two recent studies, the details of which are presented as follows.

Cunha et al. (2023) extended our original SLR (S.D. Vishnubhotla et al., 2018) (where search period was between 2001 and 2016) to expand its scope for including studies published until 2022. The authors emphasized on the same research questions as our original study and replicated its search and selection process to acquire recent measures and predictors related to individual and team capability. In total, 18 new primary studies were shortlisted, which not only validated a lot of the measures reported in the original study but also retrieved 37 new capabilities in relation to individuals and 58 related to teams. However, like the original SLR, the extended study also discussed that predicting the capabilities of professionals in ASD remains challenging as only one such study was retrieved from their search process, clearly indicating the research gap in this area.

Plant et al. (2022) discussed a capability measurement instrument that exclusively targeted cross-functional software delivery agile teams that use the DevOps approach. However, they focused upon organizational capability as the basis for their work, rather than upon team members' capability. They proposed an instrument based on the results from an SLR that looked at DevOps capabilities from an organizational perspective, rather than from a team level one. Their results were later on validated by five domain experts and six DevOps team members. Their SLR reported which organizational-driven capability measures and practices are relevant exclusively for DevOps teams, and presented five dimensions, covering seventeen measures like agility, quality assurance, rapid and frequent deployment, value creation, etc.

2.2. Studies investigating personality of team members

Exploring personality characteristics of software practitioners has been a prominent research area over the past years (Cruz et al., 2015). Despite the presence of multiple tests that can be employed to assess the personality profile of an individual (Restrepo-Tamayo et al., 2022), previous studies identified the FFM tests as salient, valid and reliable (Barrick and Mount, 1991; Barrick et al., 1998). The FFM focuses on a structure that categorizes dimensions of differences in human personalities, and categorizes five broad personality traits: openness to experience, conscientiousness, extraversion, agreeableness and neuroticism (Johnson, 2014).

Among the range of instruments measuring the FFM traits, the IPIP-NEO instrument was recognized to be covering six facets associated with each of the five broad domains of FFM (Johnson, 2014). In our previous study (Vishnubhotla et al., 2020), we employed the 120 item IPIP-NEO questionnaire as data collection instrument and used a survey methodology to gather personality characteristics by means of a Web-based questionnaire as instrument. Regarding the related work for this study, we limit our scope by focusing on the empirical studies that were published after our previous study (Vishnubhotla et al., 2020) and the ones that exclusively used the IPIP instrument for gathering the personality characteristics in SE context. For a wider discussion on other instruments used in combination with the FFM, readers are referred to our previous work (Vishnubhotla et al., 2020).

Caulo et al. (2021) conducted an empirical study to investigate the effect of personality traits on the productivity of software developers, in the context of distributed multiplatform Apps development in a GitHub project. Authors recruited master's students (31 students grouped into 13 teams) with computer science background as subjects, where the students adopted extreme programming agile methodology. Further, responses were gathered for the 120-item IPIP-NEO questionnaire and the metrics related to source code and commits were used as a proxy to measure productivity. A correlation analysis in this study identified that the most productive participants were those with the highest scores for the personality traits of agreeableness and conscientiousness.

An exploratory study was conducted by Sturdee et al. (2022) for identifying the personality characteristics of game developers. They employed survey methodology to gather responses for the 50-item IPIP questionnaire by recruiting 123 game developers. One-way ANOVA was used to compare the findings with data from software developers. Their analysis identified that game development professionals tend to have higher levels of neuroticism than other software personnel and professionals in art, production and design. Other personality characteristics like openness to experience, agreeableness, conscientiousness and extraversion were observed to be comparatively low for game developers.

The relationship between decision-making style and personality was investigated by Mendes et al. (2021) within the context of software project development. By employing a survey, authors gathered data from 63 Brazilian software professionals. In their survey, the personality relevant information was gathered using the 120-item IPIP-NEO questionnaire. Whereas, the decision making style of professionals was measured using a 30-problems questionnaire. A correlation analysis performed between decision-making style and personality characteristics identified seven significant correlations. Moreover, a regression model built to predict decision-making style selected only agreeableness variable as a significant predictor to explain 4.2% of variation in decision-making style. Authors evaluated the model's accuracy, and it was deemed good enough.

Qamar and Malik (2020) evaluated the impact of software quality and team productivity on team homogeneity index by conducting a replication study. This index was computed on the basis of personality data gathered in the form of responses to the 50-item IPIP questionnaire. For this study, the authors recruited 35 software professionals and 215 students with computer science background. Besides team homogeneity index, a weighted team homogeneity index was also computed to determine if weights assigned to personality traits make any difference. Upon comparative analysis of the indices, it was identified that weighted index had a stronger correlation with team productivity and software quality in the case of teams with professionals.

Calefato and Lanubile (Calefato and Lanubile, 2022) assessed the performance of personality detection tools when applied to developers' e-mails that were acquired from public archives of the Apache software foundation. By employing an electronic version of the 20-item IPIP questionnaire, authors gathered 50 responses by sending invites to almost 1000 email IDs from the Apache archives. This self-assessed personality data from the IPIP questionnaire was regarded as ground truth and compared to the personality scores that were extracted by applying the four Big Five based tools to developers' e-mail dataset. The study's results showed a decrease in performance when general-purpose personality detection tools are used out of domain, as neither they agree with other tools nor with the self-reported personality scores. Further, the results suggested the need for personality detection tools that are specific to SE.

Penzenstadler et al. (Penzenstadler et al., 2022) explored the role of a neuroplasticity practice on attention awareness, perceived productivity, well-being and self-efficacy of computer workers. By means of employing the mini IPIP personality test, authors initially investigated whether personality traits would show any variation in how the participants' awareness shifted. However, in the analysis, the IPIP test did not reveal anything and did not lead to any conclusive evidence.

Calefato and Lanubile (Calefato and Lanubile, 2022) attempted to assess the performance of general purpose personality detection tools when applied to a corpus of developers' e-mails. For this, the authors relied on the emails from the public archives of the Apache Software Foundation. Upon analysis, the authors observed a general low accuracy of predictions and an overall disagreement among the personality detection tools. Next, two SE studies were replicated by replacing the personality detection tool with an electronic version of the 20-item Mini-IPIP, where the personality detection tool was used to infer developers' personalities from pull-request discussions and e-mails. However, performing replications by changing the tool used in the original study led to diverging conclusions and the original results could not be confirmed. The results from this study suggested a need for personality detection tools specially targeted for the software engineering domain.

Hidellaarachchi et al. (Hidellaarachchi et al., 2023) explored how the personality of software practitioners influence requirements engineering activities. The authors conducted a mixed-methods exploratory study starting with a personality test-based survey of 50 software practitioners associated with requirements engineering activities, followed by 15 interviews. To gather the personality profiles of professionals, the 120 item IPIP-NEO instrument was employed. Upon analyzing the personality profiles, the authors identified that most of the participants scored high in conscientiousness and agreeableness, and average in extraversion and neuroticism. By analysing interviews, the authors identified a range of impacts related to the personality traits of practitioners, their team members, and external stakeholders. These impacts were essentially categorized as impact on the requirements engineering activities, impact on the overall software development and impact related to people.

Among the recent studies, multiple studies used IPIP instrument for investigating the personality characteristics among professionals (Sturdee et al., 2022; Mendes et al., 2021; Calefato and Lanubile, 2022). While students were recruited in two studies (Caulo et al., 2021; Francese et al., 2021), professionals along with students were recruited for another two studies (Qamar and Malik, 2020; Penzenstadler et al., 2022). Except for Caulo et al.'s study (Caulo et al., 2021), the rest of the aforementioned studies were executed in other than ASD contexts. Although some studies employed the shorter versions of IPIP questionnaire to address the low response rate of SE surveys (Calefato and Lanubile, 2022), none among the shorter IPIP versions with 20, 50 and 100 items, were considered to be robust in relation to covering a wide range of facets. In essence, the shorter versions of IPIP cannot measure the six facets related to each of the FFM domains (Johnson, 2014). On the other hand, the 120-item IPIP-NEO was observed to validly and reliably represent the five broad personality domains (Vishnubhotla et al., 2020). We observed that only three recent studies (Caulo et al., 2021; Penzenstadler et al., 2022; Francese et al., 2021) employed the 120-item IPIP-NEO questionnaire.

2.3. Studies investigating team climate with focus on personalities

Team climate is related to the shared perception among team members in relation to the organizational policies and practices (Anderson and West, 1998). Due to the differences in the nature of tasks and activities within software development teams (Soomro et al., 2016), team climate in the case of SE teams might substantially differ from workforce associated to other domains. The shared perception with respect to the practices and policies of a team not only influences the personal relationships among members, but also affects the quality of software developed, satisfaction of team members and in turn the performance at the organizational level (Acuña et al., 2015; Fay et al., 2004; Acuña et al., 2008).

The TCI instrument was developed to examine the four-factor theory of team climate (Anderson and West, 1998). Upon repeated validations, the TCI instrument has been noticed to demonstrate consistent

psychometric properties (Mathisen et al., 2004; Ragazzoni et al., 2002). The four-factor theory, which is at the core of this instrument, focuses on four dimensions that are considered essential for propensity to innovation and effective team functioning (Anderson and West, 1998) - team vision, participative safety, task orientation and support for innovation.

The relationship between personality traits, team climate and team performance, within the context of SE, was initially investigated by Soomro et al. (Soomro et al., 2015). The authors employed the 120-item IPIP-NEO inventory for measuring FFM personality traits and used the 38-item TCI instrument to measure team climate. They gathered responses from 36 professionals by administering questionnaires to IT employees. The collected data was analyzed using a correlation and regression analyses and that led to identifying a significant positive relationship between the extraversion personality trait and team climate. Despite their focus on software development teams, upon closely inspecting their data collection mechanism, we can understand that the authors gathered personality and team climate data from completely disengaged professionals i.e., from respondents who were associated to disparate teams and different organizations. In such a case, collective analysis of personality and team climate scores do not make coherence neither at team level nor at organizational level and that therefore poses a threat to the validity of the study's results.

In a subsequent SLR conducted by Soomro et al. (Soomro et al., 2016) to study the relationship between personality, team climate and performance, the authors discovered very limited research towards identifying what personality compositions lead to a better team climate. In order to address this research gap, in our previous study (Vishnubhotla et al., 2020), we explored the association between FFM personality traits and team climate dimensions by conducting a survey at a large telecom company. In total, 43 members from eight agile teams took part in our survey and the data acquired was first utilized towards a correlation analysis to examine the relations between personality traits and team climate dimensions; followed by a regression analysis for fitting models based on the gathered data.

Upon analyzing our survey data (Vishnubhotla et al., 2020), a statistically significant positive correlation was observed between the openness to experience personality trait and the team climate dimension support for innovation ($r = 0.31$). Similarly, a significant positive correlation was observed between agreeableness personality trait and overall team climate ($r = 0.35$). In connection to the two significant correlations that were identified, we developed two regression models subsequently. From the regression models, results showed that the openness to experience trait could explain only 9.7% of variance in support for innovation team climate dimension, and the agreeableness trait could explain only 12.4% of the variance in the perceived team climate scores. These results implied further investigation was clearly necessary, and that therefore is the subject of the research detailed herein.

By performing, in our previous survey study (Vishnubhotla et al., 2020), backward and forward snowballing over the SLR conducted by Soomro et al. (2016), we have identified relevant SE studies that used the TCI instrument to study team climate at various contexts. For the sake of identifying additional studies that further investigated team climate in SE contexts from recent years, i.e. in order to search papers related to team climate in SE after our survey was published (year 2020), we used the forward-snowballing technique to review all the studies that cited Soomro et al.'s SLR (Soomro et al., 2016) in recent times, and our survey study (Vishnubhotla et al., 2020). The snowballing technique was iterated until no additional relevant studies were found and this led to the identification of four related studies, as elaborated next. The snowballing process was carried out by the first author.

Dutra et al. (2020) developed an instrument for understanding the influence of different factors on organizational climate of ASD teams. In their subsequent study (Dutra and Santos, 2020), more investigations were done in relation to how organizations assessed the organisational climate of agile teams and what challenges and benefits were associated with such assessments. A qualitative study with five Brazilian companies was executed and interviews were conducted with key people associated with organizational assessments. Their study uncovered 16 benefits and nine difficulties linked with organisational climate assessments. Their organizational climate instrument was designed to measure factors like communication, leadership and collaboration that are not emphasized in the TCI. However, results from such a study are understandable given that their goal was not, unlike the TCI, to understand climate at the team level.

Lee and Chen (2020) reported a conceptual study that employs propositional methodology with a review of existing literature in relation to software process tailoring (SPT), transactive memory system, absorptive capacity and TCI, for developing a theoretical model to foster SPT performance. This study reports that the team climate dimensions operate as positive moderators in promoting a dynamic learning process in a team. However, the study was solely conceptual without any empirical findings, where team climate was only considered as a contextual factor for understanding how it moderates the process to yield effective SPT performance.

Driven by the COVID-19 pandemic, Francese et al. (2021) studied the relation between personality traits and team climate in the context of distributed smart-working development. Authors recruited 53 graduate students (from 19 teams) with a background in computer science, where each individual answered the 120 item IPIP-NEO and TCI questionnaires. The gathered responses were used towards correlation and regression analyses. Correlation analysis identified extroversion to be related to team climate. Task orientation was the only team climate dimension to satisfy the normality assumption. So, by adopting a model-fit approach, the authors built a linear regression model for predicting task orientation using extraversion personality trait as independent variable. Extraversion could explain 13.96% of the variance in the scores of task orientation.

Although the objectives and the analyses adopted by Francese et al. (2021) look similar to those employed in our previous study (Vishnubhotla et al., 2020), Unlike our study, Francese et al. recruited student subjects and did not focus on industrial agile contexts. Further, a critical aspect that differentiates both studies is the emphasized domain. While Francese et al.'s (2021) motivation was to understand the relationship between personality and team climate dimensions in a distributed smart-working environment, our previous study (Vishnubhotla et al., 2020) was within the context of a telecom company. Moreover, they did not report any information about the effect sizes. While it would be ideal to compare the effect sizes observed between replications and original study, incomplete reporting makes it difficult to understand the extent to which a replication is confirmatory and the extent to which it yields additional knowledge to the SE community (Shepperd et al., 2018).

On account of aspects such as our industrial collaborator's need to investigate factors that contribute to better climate within their agile teams (Vishnubhotla et al., 2020) and addressing the research gap in relation to identifying factors affecting team climate in SE, this study uncovers how personalities and capability measures of agile professionals influence the team climate (Vishnubhotla et al., 2020). To the best of our knowledge, this is the first study investigating the effect of both personality and capability measures on agile team climate. Knowledge from such an analysis can guide managers on how to compose teams based on team member personalities and capability measures, and their effect upon team climate.

3. Research method

This study aims to explore the influence of both personality traits and capability measures on agile team climate in the context of a telecom company. When it comes to personality traits and team climate, like in our previous study (Vishnubhotla et al., 2020), this study also considers the FFM personality traits as independent variables (IVs), and the TCI's team climate dimensions along with the aggregate variable IPTC as

dependent variables (DVs). Additionally, with respect to the capability dimension, the top five measures that agile professionals vetted to be highly relevant for characterizing the capability of an agile team member (Vishnubhotla et al., 2021) were also considered as IVs for this study.

For the sake of gathering first-hand quantitative data in relation to the IVs and DVs, a methodology that elicits the viewpoint of agile practitioners must be employed. Therefore, we adopted a survey methodology for this study as it is a well-established means for gathering information on the experience and expertise affiliated with a reasonably well-defined community (Zhang and Budgen, 2013).

The survey was executed across two separate divisions of a telecom company that provides global telecom and multimedia services (company A). While the first iteration of the survey was conducted in connection with their swedish division (SD) in September 2020, the second iteration was carried out in association with their indian division (ID) in June 2021. Two product owners from each division helped us in the smooth execution of the study. These members played a strategic role where one of the responsibilities is recruiting members to teams.

Both divisions of company A hosted multiple agile teams that employed Scrum for developing software-intensive charging and billing systems for mobile networks. The charging and billing systems comprise a comprehensive software-intensive suite that enables telecom operators to manage their revenue streams and provide accurate billing services to their subscribers. The suite includes a variety of software applications that automate the entire billing process, from rating to invoicing. The charging part of the software suite is responsible for rating usage data generated by network elements and applies charging policies and calculates the final cost of services used by subscribers. On the other hand, the billing part of the software suite manages the entire billing process, from invoice generation to payment collection. Aspects such as subscriber management, invoicing and payment processing are digitally handled by the billing software applications. On the whole, the charging and billing software suite is designed towards helping telecom operators in reducing revenue leakage, improving billing accuracy and providing transparent billing experience.

The 120-item IPIP-NEO personality test (Cruz et al., 2015) was used to understand individuals' personality characteristics and the 38-item TCI instrument (Anderson and West, 1998) was employed to gather an individual's perception of team climate. Additionally, five capability measures (Vishnubhotla et al., 2021) that are highly relevant for characterizing the capability of an agile team member were also included for self-assessment together with the aforementioned questionnaires. To aid self-assessment of each capability measure, a statement was formulated using the respective measure's description from our previous study (Vishnubhotla et al., 2021). Respondents were asked to indicate the degree to which they agreed/disagreed with those statements. For example, the following statement was used to gather respondents' perception in relation to their listening skill - I believe I can accurately receive and interpret messages while communicating. The complete questionnaire can be found in the supplementary material.

In order to comply with ethical principles and acquiring a voluntary approval from respondents to participate in the research study, a consent form was also included. The consent included information about the study's goal, participant's rights, how the collected data will be stored and processed, and some demographic questions.

A five-point Likert scale was adopted for marking the responses to all the questions. The Likert scale for items in personality instrument ranged from "very inaccurate" to "very accurate". Whereas items in the TCI ranged from 1 (strongly disagree/to a very little extent) through 3 (neutral/ to a moderate extent) to 5 (strongly agree/to a very great extent). Assessment of the capability measures ranged from 'Strongly Disagree'(St.Dis) through 'Neither Agree Nor Disagree' (NAND) to 'Strongly Agree' (St.Agr).

In light of the COVID-19 pandemic, just like software professionals across different organizations (Russo et al., 2021), employees of company A also shifted from office work to working from home. Therefore, organizing in-person sessions for gathering data was not feasible. So, we adapted to the prevailing conditions by administering a Web-based questionnaire through formsite, a platform that not only provides secure storage and access for responses, but also offers flexibility for designing custom forms.

To make sure that the respondents interpreted the questionnaire correctly, the questionnaire's start page hosted a brief paragraph outlining the study's aim and presented the types of questions included in each section. In order to further ease interpretation of questions and terminology, we stated that an explanation for certain phrases could be found by hovering mouse pointer over the phrase (for example, "often feel blue" from IPIP-NEO). Further, respondents were informed that the responses would be stored anonymously and that, soon after their participation, all the response data from formsite would be downloaded and preserved securely on a separate computer that would not be accessible to anyone other than research team. Respondents had the freedom of answering questions in any order. However, all questions were marked as mandatory to avoid the incidence of unanswered questions.

Two professionals from a different organization with experience of working in ASD teams were requested to pilot our Web-based questionnaire. The professionals were asked to inspect whether the language used in the questionnaire was simple and concrete to improve the questionnaire's presentation and maximize its clarity. Their suggestions such as including a description with tooltips for some hard-to-interpret phrases and distributing the 120 questions of IPIP-NEO instrument across multiple pages, aided in improving the questionnaire's layout and were incorporated into the final version of the questionnaire.

After the online questionnaire was ready for circulation, the product owners were emailed a brief text presenting the aim of survey and the link to questionnaire. The product owners scrutinized the questionnaire and issued a formal approval for the study. Then, they selected participants for the study based on their workload and availability. Next, separate virtual meetings were arranged by product owners from Sweden and India, where our research team together with all the selected professionals from respective divisions were invited.

A total of 19 agile teams participated in the virtual meetings. Among them, the meeting with SD involved participation from 12 teams and the rest of the seven teams participated in the meeting with ID. The virtual meetings started with a presentation explaining the overall goal of the study and how the findings could be helpful. Further, what kind of information would be gathered was also presented. Finally, professionals were informed that participation in the survey was voluntary. Subsequently, the Web link to the questionnaire was messaged to everyone on the call and respondents were informed to fill in the questionnaire at their own pace. Two members from our research group were present throughout each virtual meeting for answering questions regarding the study or questionnaire.

It is important to mention that the personality scores and team climate scores from both SD and ID samples were used in a former study (Vishnubhotla and Mendes, 2023) towards correlation and regression analyses with the goal of replicating a prior study (Vishnubhotla et al., 2020). Although the same samples were re-utilized in this study, the current study significantly varies from the former in terms of examining the impact of capability measures. Furthermore, while the former study aimed to generalize the relationship between personality traits and team climate, the current study emphasizes on whether (and to what extent) capability measures, either alone or alongside personality traits, can significantly predict team climate dimensions. The benefit of such an approach is it facilitates comparison of regression models across current and former studies. Such comparison informs whether the addition of capability measures as predictors improves the explanatory power of models and helps in determining significant predictors of team climate dimensions.

3.1. Subjects

In total, 121 software professionals participated in our survey. It is important to note that these are the total members from the 19 agile teams invited to participate and therefore, the response rate of our survey was 100%. Among the 121 respondents, within the sample acquired from SD, there were 75 subjects from 12 teams and from ID sample, there were 46 subjects from seven teams. Subjects from SD included 10 females (13.3%) and 65 males (86.7%) and subjects from ID comprised of 8 females (17.4%) and 38 males (82.6%).

Most subjects from SD were 31–35 years old (23%), followed by members who were 21–25 years old (21%). In the case of ID teams, most subjects belonged to age group of 31–35 years (46%), followed by members who were 26–30 years old (24%). An overview of age of subjects is presented in Table 1. The distribution from Table 1 shows that more than half of the subjects in our study were younger than 35 years.

In order to explore various dominant roles undertook by the sample of respondents, our survey included a question that explicitly sought input on the primary role (only the most prominent role) played by each respondent. The details of respondents in various primary roles are presented in Table 2. More than half of the subjects in this study played the role of software developer (SD: 68%; ID: 58.7%), followed by (SD: team lead (12%); ID: tester (17.4%), and technical expert (SD: 8%; ID: 8.7%).

In a large-scale agile development setting, where more than two teams are cooperating towards a common goal, the inter-team coordination becomes crucial. In such a context, it is important to note that Scrum usage is not limited to typical roles like developer and scrum master, but there can be additional roles (Ozkan and Kucuk, 2016) to handle the increased need for coordination (Mohagheghi and Lassenius, 2021). In other words, the agile community is famous for tailoring agile ways of working depending on the specific context (Gustavsson, 2017).

In company A, although the agile teams adhered to Scrum, they adapted it to their own context. Since there were multiple agile teams working on the development of software-intensive charging and billing systems, additional tailored roles (such as designer, team lead, technical expert, etc. from Table 2), as also reported in other SE case studies (Gustavsson, 2017), were necessary to facilitate management and coordination among teams.

In general, when more than one Scrum team work on a project, as the case in Company A, it is essential to have unifying roles at a higher level. Additionally, the project management is also obliged to plan adequate team capacities or team structures, specific to a project, for provisioning the resources necessary for the project. This needs to be managed from a level beyond and between the teams. Without such roles, the holistic view of products and services may be lost and there are risks such as, occurrence of re-works, challenges in communication, disputes during combination of separately developed pieces of code and challenges in management of dependency between works (Ozkan and Kucuk, 2016).

In relation to the country respondents felt they belong the most to, majority of the SD subjects answered Sweden (84%), followed by India (5.3%), Lithuania (2.6%), Spain (2.6%), England (1.3%), Iran (1.3%), Macedonia (1.3%) and Pakistan (1.3%). Whereas from ID, all subjects answered India.

Table 1
Distribution of respondents' age.

Age group	Number of professionals	
	Teams from Sweden (SD)	Teams from India (ID)
21 - 25 years	6 (8%)	4 (9%)
26 - 30 years	16 (21%)	11 (24%)
31 - 35 years	17 (23%)	21 (46%)
36 - 40 years	13 (17%)	8 (17%)
41 - 45 years	9 (12%)	1 (2%)
46 - 50 years	9 (12%)	1 (2%)
51 - 55 years	3 (4%)	–
56 - 60 years	2 (3%)	–

Table 2
Roles of software professionals.

Role	Number of professionals	
	Teams from Sweden (SD)	Teams from India (ID)
Designer	2 (2.6%)	–
Design lead	1 (1.3%)	–
Build master	1 (1.3%)	–
Domain expert	2 (2.6%)	3 (6.5%)
Software developer	51 (68%)	27 (58.7%)
Project manager	1 (1.3%)	1 (2.2%)
CI engineer	1 (1.3%)	–
Technical expert	6 (8%)	4 (8.7%)
Scrum master	1 (1.3%)	1 (2.2%)
Team lead	9 (12%)	2 (4.3%)
Tester	–	8 (17.4%)

To maintain consistency with earlier data extraction (Vishnubhotla et al., 2020), each person's responses to the personality test were entered into the online IPIP-NEO instrument, where an individual's scores are compared with reference personality data to generate scores that are percentile estimates after adjusting for age and gender (Johnson, 2022). Furthermore, the categorization as specified by the IPIP-NEO narrative report, where each person is classified as low, average or high in a personality trait, was used in our analysis. In the case of TCI responses, each question was answered on a five-point response scale (ranging from 1 to 5) and the scores of the four team climate dimensions were calculated by computing average over scores awarded to all the questions associated with a dimension. This way of calculating the scores for team climate dimensions reportedly maintains the original five-point scale even when the number of items/questions varies from dimension to dimension (Loewen and Loo, 2004).

After the scores for capability, personality and team climate dimensions were generated, statistical techniques such as descriptive analysis (to summarize observations from IVs and DVs), correlation analysis (correlations between IVs and DVs), and regression analysis (to understand predictors of team climate dimensions) were performed.

4. Results

This section discusses the findings from our statistical analyses. For all the analyses, we used R programming language and statistical software environment.

4.1. Descriptive analysis

4.1.1. Capability measures

Capability ratings were provided by the respondents by indicating the degree to which they agreed/disagreed with statements in relation to each of them. The frequency of responses for each Likert-item, also expressed in percentage, was computed for each capability measure and this information was used to plot heatmaps across different levels of measures, as shown in Table 3. Heatmaps aid in visualizing the overall responses of self-appraised measures and highlights the measures that received maximum appraisal.

On the whole, the heatmaps from Table 3, for both SD and ID, show that at least 78% of the members from both divisions regarded themselves to be capable or highly capable, as per the five individual capability measures. Upon comparing the frequency of responses received over the five capability measures (Table 3), we noticed that more than half of the respondents from ID *strongly agreed* (Str.Agr in Table 3) to be responsible (56.5%), teamwork oriented (52.1%) and possessing team participation skills (54.3%). Among SD members, except for responsibility, the percentage of members that chose the Likert-item *agree* for the rest of the capability measures was higher, when compared to the percentage that chose the Likert-item *strongly agree*. Whereas in the case

Table 3
Distribution of scores for capability measures across SD and ID samples.

Capability Measure	Teams from Sweden (SD)					Teams from India (ID)				
	St.Dis	Dis	NAND	Agr	St.Agr	St.Dis	Dis	NAND	Agr	St.Agr
Responsibility	0 (0%)	0 (0%)	1 (1.33%)	37 (49.33%)	37 (49.33%)	0 (0%)	1 (2.17%)	1 (2.17%)	18 (39.13%)	26 (56.52%)
Listening skills	1 (1.33%)	1 (1.33%)	8 (10.66%)	46 (61.33%)	19 (25.33%)	0 (0%)	0 (0%)	4 (8.69%)	22 (47.82%)	20 (43.47%)
Questioning skills	0 (0%)	3 (4%)	11 (14.66%)	38 (50.66%)	23 (30.66%)	0 (0%)	1 (2.17%)	9 (19.56%)	18 (39.13%)	18 (39.13%)
Team participation skills	0 (0%)	0 (0%)	12 (16%)	34 (45.33%)	29 (38.66%)	0 (0%)	1 (2.17%)	3 (6.52%)	17 (36.95%)	25 (54.34%)
Being teamwork oriented	0 (0%)	0 (0%)	13 (17.33%)	35 (46.66%)	27 (36%)	0 (0%)	0 (0%)	4 (8.69%)	18 (39.13%)	24 (52.17%)

of ID teams a different pattern was observed. Except for listening skills and questioning skills, the percentage of members that chose the Likert-item *strongly agree* for the rest of the capability measures was higher than the percentage that chose *agree*. The capability statements to which maximum members responded with neither *agree* nor *disagree* (NAND in Table 3) were, questioning skills (19.5% from ID) and being teamwork oriented (17.3% from SD).

Regarding the respondents from SD, except for one member who responded with NAND, all respondents perceived themselves to be responsible, answerable or accountable for things within their control (responsibility) (Table 3). There were an equal number of respondents (49.3%) that *agreed* (Agr in Table 3) and *strongly agreed* with the questionnaire item in relation to individual responsibility. Next to responsibility, around 86.6% of SD respondents agreed that they can accurately receive and interpret messages while communicating (listening skills). While 61.3% of members from SD *agreed* to possessing listening skills, around 25.3% members *strongly agreed* about their ability to listen. On the other hand, one member *disagreed* (Dis in Table 3) and another one *strongly disagreed* (Str.Dis in Table 3) with the statement on listening skills. Further, a significant portion of SD members (10.6%) responded with NAND.

The next capability measure on which the majority of the SD respondents *agreed* (83.9%) was team participation skills. Table 3 shows that around 38.6% of SD respondents *strongly agreed*, when compared to other members in their team, that they can work cohesively with a group of people towards achieving a common goal (team participation skills). The rest of the 16% members could NAND about their team participation skills. Further, around 81.3% of the SD respondents *agreed* (among whom, 30.6% *strongly agreed*) to be confident to express doubt and raise an objection to something (questioning skills). While 14.6% of the SD respondents were not decisive in relation to their ability to question, another 4% of the respondents expressed their dissent to questioning skills. A total of 82.6% SD respondents *agreed* (among whom, 36% respondents *strongly agreed*) in relation to their ability to work collaboratively with a group of people (being teamwork oriented). Whereas 13% of the SD respondents could NAND on being teamwork oriented.

Furthermore, among the respondents from ID, around 95.65% of the respondents perceived themselves to be responsible. One of the respondents *disagreed* to the statement on responsibility and another respondent could NAND. While the percentage of people who *agreed* to be responsible was higher for SD, respondents that *strongly agreed* to be responsible was higher for ID (56.5%), when compared to SD (49.3%). While 8.6% of the ID respondents could NAND on being teamwork oriented, a total of 91.3% ID respondents *agreed* (among whom, 52.1% respondents *strongly agreed*) to being teamwork oriented. The percentage of people who *agreed* to be teamwork oriented was higher for the ID teams than for the SD teams (82.6%).

Next, compared to SD (86.6%), a slightly higher proportion of ID respondents (91.2%) *agreed* to possessing listening skills. Around 8.6% ID respondents could NAND about their listening skills. However, the percentage of ID respondents who *strongly agreed* to possessing listening skills were significantly higher (43.4%) compared to those from SD (25.3%). A total of 91.2% of ID respondents *agreed* to possessing team participation skills and the proportion of respondents from ID who *strongly agreed* to possessing team participation skills (54.3%) was significantly higher than those from SD (38.6%). Around 78.2% of the ID respondents *agreed* to possessing questioning skills and this proportion was slightly less in comparison to respondents from SD (81.3%). The heatmap from Table 3 shows that a significant portion of members from ID could NAND in relation to questioning skills (19.5%), the highest percentage of responses received for the Likert-item.

On the whole, the heat map from Table 3 suggests that all the teams from both the divisions of company A at least agreed to possess all the five capabilities. While most of the SD teams agreed to having the five capabilities, most of the ID teams highly agreed to possessing the capabilities.

4.1.2. Personality traits

Similar to what has been done in some previous SE studies (e.g. Vishnubhotla et al., 2020; Soomro et al., 2015), the responses to the

IPIP-NEO personality questionnaire were analyzed using the online version of the test. For each respondent, the percentile estimates for the five personality traits were generated. The distribution of the percentile estimates for each personality trait across the SD and ID samples is presented in Fig. 1. The IPIP-NEO narrative report categorizes personality scores as low (0<score≤30), average (30<score≤70) and high (70<score≤99), and this has been the same classification used herein. It is worth noting that some parts of descriptive analysis (Section 4.1) and correlation analysis (Section 4.2) from the current study are also presented in one of our other studies (Vishnubhotla and Mendes, 2023) due to the samples SD and ID being common, as discussed under Section 3.

The distribution of personality scores for the SD members (Fig. 1) shows that for nearly 50% of the respondents (Q1 and median), the openness to experience scores were low. On the other hand, nearly 50% of the agreeableness scores were high (Q3 and maximum). In relation to extraversion, conscientiousness and neuroticism, most scores were within the average range; however, in the case of extraversion and neuroticism, slightly more than 25% of the scores were low. In relation to the distribution of scores, conscientiousness is the only trait that shows a very close to normal distribution. Whereas extraversion, neuroticism and openness to experience distributions are all right skewed, which indicates that there is a higher level of conformity among the scores below the median. The opposite applies in the case of Agreeableness.

The distribution of personality scores within the ID sample (Fig. 1) shows that at least 25% of the scores for neuroticism and openness to experience traits were low (minimum and some data points above Q1). On the other hand, in the case of extraversion, agreeableness and conscientiousness traits, most scores were either medium or high. Particularly, for conscientiousness, more than half of the scores were high (Median, Q3 and maximum). Except in the case of neuroticism and openness to experience traits, where the scores follow close to normal distribution, all the other distributions appear to be left-skewed, suggesting that there is a higher level of conformity among the scores lying above the median.

Upon comparing the distribution of personality scores among SD and ID samples (Fig. 1), we can notice that the medians for three personality traits i.e., extraversion, conscientiousness and openness to experience were relatively higher for the ID sample. Especially, the median levels of extraversion and conscientiousness traits were significantly higher for the ID sample, when compared to the SD sample. The scores of extraversion and conscientiousness traits were at least average for more than 75% of the subjects from the ID sample. However, the median of agreeableness was slightly higher for SD sample and for neuroticism, the median for SD and ID samples were almost similar.

The distribution of scores from Fig. 1 reveal that the subjects from SD and ID samples possess higher levels of agreeableness. The subjects from ID sample had relatively high levels of conscientiousness compared to SD sample. The median levels of scores with respect to all the five traits (see Fig. 1) fall at least in the range of scores classified as average by the IPIP-NEO narrative report. Hence, we can understand that, compared to people of similar age and sex, the professionals from SD and ID samples relish spending time with others as well as enjoy alone time (average extraversion). They not only care about the needs of others but are unwilling to sacrifice their responsibilities (average agreeableness). Further, professionals seem to be good at planning, organizing and are generally goal-oriented (average conscientiousness). While they can deal with frustrating situations (average neuroticism), they enjoy everyday work and are willing to try new things (average openness to experience).

4.1.3. Team climate dimensions

The responses to the 38 items from the TCI were used to compute the scores for the four team climate dimensions. Similar to former SE studies (e.g. Vishnubhotla et al., 2020; Soomro et al., 2015), the scores for each of the four team climate dimensions were calculated by computing average over the scores awarded to all of the questions associated with a dimension. The distribution of scores for the four dimensions with respect to SD and ID samples are presented in Fig. 2. The five levels of dotted lines in red color from Fig. 2 correspond to the scale points on which each item in the TCI was rated (level 1 (strongly disagree/to a very little extent) through level 3 (neutral/ to a moderate extent) to level 5 (strongly agree/to a very great extent).

In relation to the SD sample, we can notice from the box-and-whiskers plot in Fig. 2 that the distribution of scores for all the four dimensions were negatively skewed. In specific, negative skewness is more distinguishable in the case of participative safety and support for innovation. This indicates that there was a higher conformity among the scores above the median for all four dimensions. Looking at the median levels for the four dimensions, we can notice that participative safety presented a slightly higher median than the other three dimensions; conversely, support for innovation showed the lowest median. In the case of team vision, we can observe the interquartile range in the box-and-whiskers plot to be more compact than in the other dimensions, representing greater conformity among those scores. The data points falling outside the box-and-whiskers plot in the case of SD indicate data

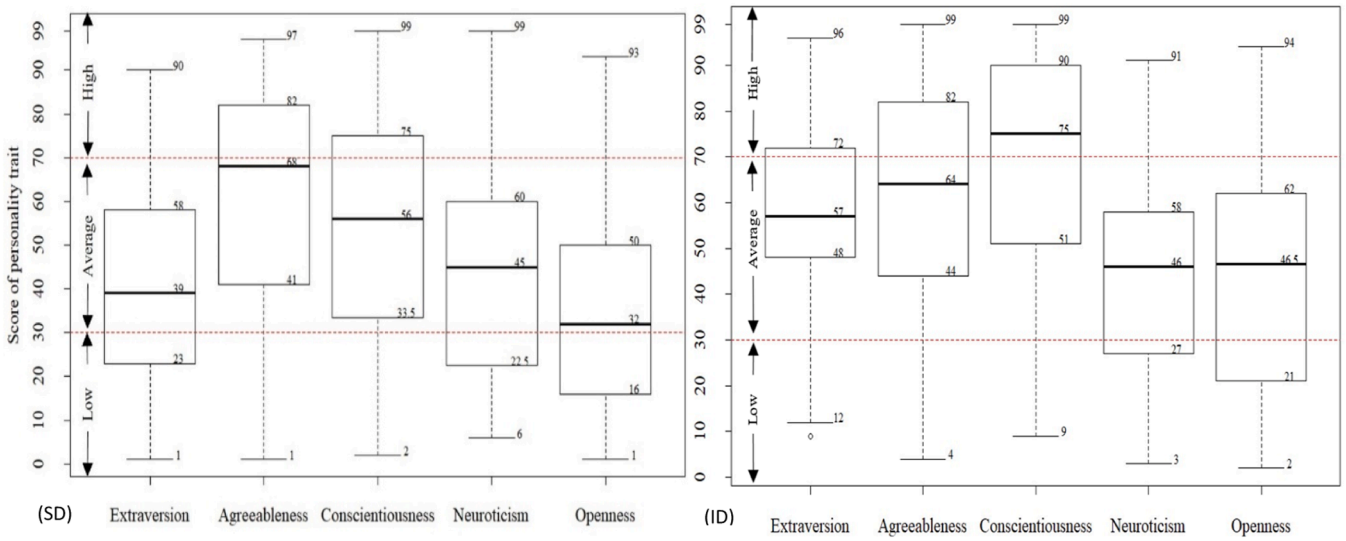

Fig. 1. Distribution of personality traits' scores across SD and ID samples.

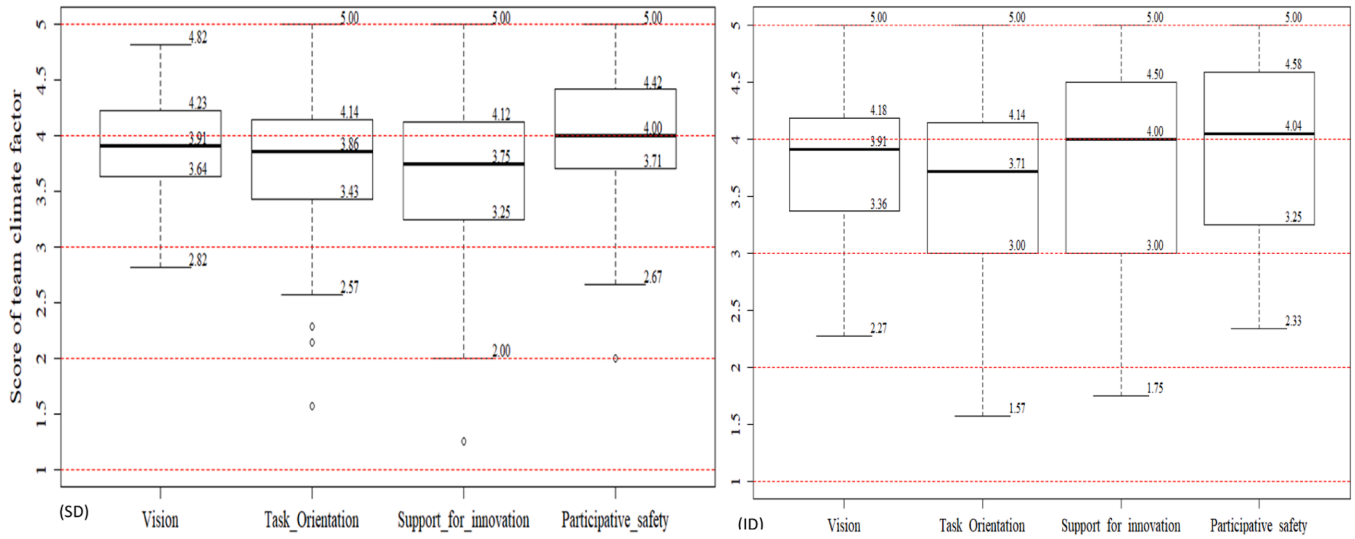

Fig. 2. Distribution of team climate dimensions' scores across SD and ID samples.

points that are numerically distant from the rest of the data. However, these data points were not excluded as they were legitimate and they affect the climate score computed at team level.

In close similarity with the observations from the SD sample, the distributions of scores for the ID sample, regarding all four team climate dimensions are negatively skewed. The skewness is more pronounced for task orientation and once again for support for innovation. The median values for participative safety and support for innovation were practically the same (respectively 4 and 4.04), and just slightly higher than for Vision. was the highest and the lowest median was observed for task orientation.

Upon inspecting the box plots from Fig. 2, we can see that within the SD and ID samples, the trends across the four team climate dimensions followed a similar pattern with respect to skewness. However, upon comparing the size of the boxes and whiskers in Fig. 2, we can notice that the sizes are relatively compact for the SD sample when compared to those for the ID sample. This indicates that there was higher level of conformity among the team climate scores within the SD sample. On the whole, the observations from the distribution of team climate dimensions' scores, for both the SD and ID samples, showed that subjects from either sample regarded the atmosphere in their team to provide them with a safe forum for generating ideas where all the team members' views are likely to be heard and acknowledged (high participative safety).

4.2. Correlation analysis

In order to further explore herein the relationship between the human-aspects (capability and personality) and team climate & its dimensions, we performed two instances of correlation analysis. The first instance was characterized by a correlation analysis to investigate the association between capability measures and team climate & its dimensions. The second instance of correlation analysis explored the relation between personality traits and team climate & its dimensions. As will be detailed later, the correlation analysis techniques that we employed in this paper were chosen based upon the scales of the analyzed data, and sample size.

With regard to calculating the overall team climate (TCI) score for each respondent, some of the former studies that examined the relationship between team climate and other aspects used either total TCI score or mean TCI score for their analyses. While the total TCI score was calculated by aggregating scores of all the items in the TCI questionnaire (Soomro et al., 2015; Pirola-Merlo et al., 2002; Gosling and Westbrook, 2002), the mean score was calculated based on the scores of the four team climate dimensions with the goal of maintaining the original five-point scale of the TCI questionnaire (Gosling and Westbrook, 2002). Although the aim of both approaches is to represent overall team climate perception, the latter approach enables the comparison between overall team climate scores and the scores of the other team climate dimensions. Therefore, we also used the same approach to obtain the overall team climate score for each subject, and called it the individual's perceived team climate (IPTC). The IPTC was computed as the average of the four team climate dimensions, and used in the correlation analyses together with other team climate dimensions.

To determine the strength of the relationships, the resulting correlation coefficients were further compared against Cohen's rules (Cohen, 1988). According to Cohen's rules, an effect size is deemed small if the correlation coefficient value is around 0.10, medium if the coefficient value is around 0.30 and large if the coefficient value is around 0.50. A large effect size informs us that the associations uncovered in the study are highly likely to be observed in other investigations conducted within a similar context; whereas a medium effect size informs us that the associations are likely to be observed in other cases. We pre-set the level of significance (α) at 0.05 to reduce false positives, and also pre-set the effect size as medium. Both are in line with previous studies (e.g. Vishnubhotla et al., 2020).

4.2.1. Correlation between capability measures and team climate dimensions

The data collected for the capability measures over a five-point Likert-scale is categorical in nature. Whereas the scores computed for the team climate dimensions are numerical. Therefore, we used the Spearman rank-order correlation (Schober et al., 2018) as it is suitable test to understand the association between these two types of data. Before proceeding with the correlation analyses, several checks were performed to ensure that the assumptions for using the Spearman correlation were met. This included ensuring that the variables between which the correlation is studied represented paired observations and verifying the existence of a monotonic relationship between variables by plotting scatter plots. The information about Spearman correlation coefficients (ρ) observed for various combinations of variables is presented in Table 4.

In relation to the SD sample, results were the following:

There was a medium size positive effect between *responsibility* and all the team climate variables (*team vision* ($\rho = 0.28$), *task orientation* ($\rho = 0.16$), *support for innovation* ($\rho = 0.16$), *participative safety* ($\rho = 0.24$) and

Table 4
Spearman correlation matrix for capability measures and team climate dimensions.

	Team climate traits									
	Team vision		Task orientation		Support for innovation		Participative safety		IPTC	
Capability measures	SD	ID	SD	ID	SD	ID	SD	ID	SD	ID
Responsibility	0.28*	−0.01	0.16*	−0.06	0.16*	−0.13	0.24*	0.05	0.25*	−0.07
Listening skills	0.15	0.12	0.18	0.07	0.13	0.06	0.21	0.29	0.23*	0.15
Questioning skills	0	0.01	0.02	0.06	0.14*	0.17	0.19	0.25	0.09	0.15
Team participation skills	0.20	0.27	0.15	0.16	0.13	0.14	0.21	0.33*	0.27*	0.25
Being teamwork oriented	0.15	0.41**	0.13	0.22	0.19	0.19	0.13	0.37*	0.19	0.33*

** $p < 0.01$ and * $p < 0.05$.

IPTC ($\rho = 0.25$)). All the five correlations were statistically significant at the 0.05 level. The positive direction of the relationship between *responsibility* and other variables indicates that a rise in a person's perception of being answerable and accountable (*responsibility*) corresponded to a rise in the person's perceived level of team climate aspects such as clarity in terms of the goals defined by team (*team vision*), effort exerted by team towards achieving excellence (*task orientation*), idea sharing within a team (*support for innovation*), considering team as a safe nonthreatening forum for discussing ideas (*participative safety*) and the overall perception of climate within a team (*IPTC*).

Next, the capability measure *listening skills* only had a statistically significant relationship (α=0.05) with *IPTC* ($\rho = 0.23$), and with a medium size positive effect. This results suggests that a rise in a person's abilities such as accurately receiving and interpreting messages corresponded to a rise in the person's perceived level of team climate.

A small size positive effect was observed between *questioning skills* and *support for innovation* ($\rho = 0.14$), where the correlation was significant at the 0.05 level. This means that a rise in one's ability to be confident for expressing doubt and raising an objection corresponded to a rise in idea sharing within one's team (*support for innovation*).

Team participation skills had a medium size positive effect ($\rho = 0.27$) with IPTC (α=0.05), suggesting that an increase in a person's abilities such as working cohesively with other people to achieve a common goal corresponded to an increase in a person's perceived level of team climate. Finally, there was no statistically significant relationship between *being teamwork oriented* and *IPTC* or any of its dimensions.

With regard to the ID sample, the following results were found:

No statistically significant relationships were found between *responsibility, listening skills, questioning skills* and *IPTC* or any of its dimensions. As for *team participation skills*, results showed a medium size positive effect between this capability measure and *participative safety* ($\rho = 0.33$), where the correlation was significant at 0.05 level. This medium size positive effect means that the rise in a person's ability to work cohesively with other people towards a common goal (team participation skills) corresponded to perceiving team as a safer and more nonthreatening forum for discussing ideas (participative safety).

Finally, statistically significant associations were found for the capability measure *being teamwork oriented*. It was positively correlated with *team vision, participative safety* and *IPTC* variables. A medium size positive effect was found between this capability measure and both *participative safety* ($\rho = 0.37$) and *IPTC* ($\rho = 0.33$) variables. These correlations were significant at the 0.05 level. A relatively large yet medium size effect was observed with *team vision* ($\rho = 0.41$) variable, where the correlation was significant at the 0.01 level. The correlations mean that a rise in a person's ability to work collaboratively with a group of people (being teamwork oriented) corresponded to a rise in the person's perceived level of team climate aspects such as clarity in terms of the goals defined by team (team vision), considering team as a safe nonthreatening forum for discussing ideas (participative safety) and the overall climate within the team.

When looking at the correlation analysis results for the ID group, our hypothesis is that respondents see their capability skills relating to *responsibility, listening skills* and *questioning skills* as suitable (See Table 3), and independent from being happy or not with their teams. Conversely, this does not seem to apply to the SD respondents, as statistically significant positive associations were identified between *responsibility* and all the four dimensions of team climate, plus *IPTC; listening skills* and *team participation skills* had a significant positive association with IPTC, and *questioning skills* with *support for innovation*.

4.2.2. Correlation between personality traits and team climate dimensions

The data gathered for personality traits and team climate dimensions was measured on an interval scale (Vishnubhotla et al., 2020). Therefore, like former SE studies (Vishnubhotla et al., 2020; Soomro et al., 2015), we employed Pearson product-moment correlation to study the relationship between personality and team climate variables. Before initiating the correlation analyses, checks were performed to ensure the assumptions for Pearson correlation were met. This included using Q-Q plots, performing Shapiro-Wilk test by setting the level of significance to 0.01 ($\alpha = 0.01$) (Vishnubhotla et al., 2020), to assess whether the data was normally distributed, and plotting scatter plots to investigate the relation between variables.

With regard to the SD sample, the Shapiro-Wilk test showed that all personality traits, except for the *agreeableness* trait, presented scores that complied with a normal distribution. That is, in relation to *extraversion* ($p = 0.049$), *conscientiousness* ($p = 0.027$), *neuroticism* ($p = 0.013$) and *openness to experience* ($p = 0.052$) traits, the data were normally distributed. We performed different transformations over the scores of the *agreeableness* variable using square root, cube root and logarithmic functions; however, none of the transformations contributed to bringing the distribution closer to a normal shape distribution. In relation to team climate scores, all the variables were normally distributed, with the following scores for *team vision* ($p = 0.047$), *task orientation* ($p = 0.036$), *support for innovation* ($p = 0.017$), *participative safety* ($p = 0.064$) and IPTC ($p = 0.055$).

As for the ID sample, the Shapiro-Wilk test showed that scores of all the personality traits, except for *conscientiousness*, were normally distributed. The p-values observed for the personality traits are *extraversion* ($p = 0.46$), *agreeableness* ($p = 0.063$), *neuroticism* ($p = 0.83$) and *openness to experience* ($p = 0.074$). Like the aforementioned case, we have applied several transformation functions to bring the *conscientiousness* variable scores closer to a normal distribution; however, there was no significant improvement in its normality. In relation to the team climate dimensions, all the scores were normally distributed, with the following p values: for *team vision* ($p = 0.623$), *task orientation* ($p = 0.162$), *support for innovation* ($p = 0.028$), *participative safety* ($p = 0.013$) and *IPTC* ($p = 0.355$). The details of Pearson correlation coefficients (r) for the various combinations of variables are shown in Table 5, and the information on respective effect-sizes, based on Cohen's rules, are discussed next:

With regard to the SD sample, it is worth noting that we noticed a significant medium size negative effect between *neuroticism* and all the team climate variables (*team vision* ($r = -0.24$), *task orientation* ($r = -0.25$), *support for innovation* ($r = -0.26$), *participative safety* ($r = -0.27$) and *IPTC* ($r = -0.30$)). While the correlation with *IPTC* was significant at the 0.01 level, the rest of the correlations were significant at the 0.05

Table 5
Pearson correlation matrix for personality traits and team climate dimensions.

Team Climate	Team vision		Task orientation		Support for innovation		Participative safety		IPTC	
Personality traits	SD	ID	SD	ID	SD	ID	SD	ID	SD	ID
Extraversion	0.13	0.21	0.12	−0.01	−0.04	0.12	−0.02	0.23	0.02	0.16
Agreeableness	–	0.18	–	0.01	–	0.01	–	0.02	–	0.06
Conscientiousness	0.19	–	0.07	–	−0.02	–	0.19	–	0.12	–
Neuroticism	−0.24*	−0.09	−0.25*	−0.12	−0.26*	−0.06	−0.27*	−0.34*	−0.30**	−0.19
Openness	−0.02	0.06	−0.06	−0.03	−0.06	0.09	−0.08	0.23	−0.10	0.11

** $p < 0.01$ and * $p < 0.05$.

level. The negative direction of the relation between neuroticism and team climate variables informs us that a rise in the level of a person's anxiety (*neuroticism*) corresponded to a decrease in the person's perceived level of team climate aspects such as, clarity in terms of the goals defined by team (*team vision*), the effort exerted by team for achieving excellence (*task orientation*), idea sharing within a team (*support for innovation*), treating team as a safe and nonthreatening forum for discussing ideas (*participative safety*) and the overall perception of climate within a team (*IPTC*).

As for the ID sample, we observed only one statistically significant association, which was a medium size negative effect between *neuroticism* and *participative safety* ($r = -0.34$). This correlation was significant at the 0.05 level. Neuroticism is associated with a person's emotional stability. While a less neurotic person tends to appear confident and poised, a highly neurotic person is likely to be apprehensive and insecure (Vishnubhotla et al., 2020). On the other hand, participative safety dimension relates to the level of trust a person sees within a team while expressing one's opinions and ideas (Vishnubhotla et al., 2020). The negative direction of the relation between neuroticism and participative safety informs us that the increase in a person's anxiety levels corresponded to the fall in the person's perception about their team being a safe platform for sharing ideas.

Upon comparing the correlation coefficients from the two samples in Table 5, *neuroticism* is shown to be the only personality variable where significant correlations were found in relation to team climate variables. Furthermore, no significant correlations were observed in relation to the remaining personality traits and team climate, for both SD and ID samples. We can further see from Table 5 that the medium size negative effect between *neuroticism* and *participative safety* variables is common to both SD and ID samples.

4.3. Regression analysis

In order to investigate whether the scores of capability measures (IVs), either alone or combined with personality traits' scores (IVs), can predict the scores of team climate dimensions (DVs), we performed regression analyses. We used a manual stepwise procedure based on residuals to develop the prediction models for team climate dimensions. This procedure was proposed by Kitchenham (1998), and uses information about residuals to tackle relationships among IVs. More importantly, it only selects the input variables (IVs) that jointly have a statistically significant effect on the DV, effectively avoiding any multi-collinearity issues. Finally, this technique also enables one to check whether residuals are homoscedatic or not.

The regression analysis from the current study significantly varies from our former studies (Vishnubhotla et al., 2020; Vishnubhotla and Mendes, 2023) in terms of examining the impact of capability measures over team climate dimensions. Our former studies aimed to generalize the relationship between personality traits and team climate. Whereas the main contribution from this study is to examine whether (and the extent to which) capability measures, either alone or alongside personality traits, can significantly predict team climate dimensions. What is new about such analysis is it informs us whether the addition of capability measures as predictors improves the explanatory power of models and helps in determining the significant predictors of team climate dimensions.

The input variables for the stepwise process can be categorical or numerical in nature (Kitchenham, 1998). With respect to categorical variables, the distinct Likert-scale values of a variable are called levels. For example, the categorical variable responsibility has five levels - strongly disagree (St.Dis), Disagree (Dis), neither agree nor disagree (NAND), Agree (Agr) and strongly agree (St.Agr). The manual stepwise regression procedure comprises the following steps (Kitchenham, 1998).

Step 1: Identify the categorical variable that has a statistically significant effect on the DV. If more than one variable is statistically significant at same level, choose the one that gives the smallest error term (mean square within groups) or where the F-statistic is high. This is obtained by applying ANOVA or simple analysis of variance using each categorical variable (CV1).
Step 2: Remove the effect of the most significant categorical variable to gather residuals (Res1). This involves, for each level of the most significant variable, subtracting the level mean of IV from the DV values.
Step 3: Apply ANOVA using each of the remaining categorical variables in turn by measuring their effect on Res1.
Step 4: Any categorical variables that had a statistically significant effect on DV in step 1 but have no statistically significant effect on Res1 are regarded as variables related to CV1. They offer no additional information about the dependent variable and can therefore be eliminated from the stepwise regression process.
Step 5: Identify the next most significant categorical variable from step 4 (CV2). Choose the variable that minimizes the error term when there are several statistically significant variables.
Step 6: Remove the effect of CV2 for obtaining residuals (Res2).
Step 7: Apply ANOVA using each of the remaining categorical variables to measure their effect on Res2.
Step 8: Any categorical variables that had a statistically significant effect on Res1 but have no statistically significant effect on Res2 are regarded as variables related to CV2. They offer no additional information about the dependent variable and can therefore be eliminated from the stepwise process.
Step 9: Repeat the stepwise procedure until all statistically significant categorical variables are removed or none of the remaining variables has a statistically significant effect on the current residuals.

Besides categorical variables, the impact of numerical variables on DV can be assessed using linear regression and obtaining the mean squares for the regression model and residuals. In cases where a numerical variable is the most significant, its effect has to be removed i.e., the obtained residuals have to be the ones analyzed further. Furthermore, it is important at every stage of the stepwise procedure to check whether the residuals are normally distributed by means of residual and P-P plots. A residual plot allows us to investigate if the residuals are random and normally distributed (Kitchenham, 1998), whereas P-P plots are generally employed to verify if the distribution of a variable is consistent with the normal distribution. Finally, for constructing the full regression model, apply multivariate regression using just the variables

that have been selected from the manual stepwise procedure. The findings in relation to performing the manual stepwise procedure and building the regression models are presented in the next sub-sections.

4.3.1. Predicting team climate dimensions using capability measures and personality traits

In the first phase of the regression analyses, we performed a manual stepwise procedure using capability measures (IVs) and personality traits (IVs) to develop prediction models in relation to each of the team climate dimensions (DVs). The results of applying ANOVA to categorical and numerical IVs for team vision DV are presented in Table 6.

With regard to the SD sample (case: SD), Table 6 shows that only the *responsibility* and *neuroticism* variables had a significant effect on the DV. Among these, the categorical variable *responsibility* is the most significant where the p-value (0.017) for the F-statistic (4.529) was the lowest ($\alpha = 0.05$). Next, residuals were computed to remove the effect of the *responsibility* variable from the DV (team vision) values. The residual and P-P plots showed no indication that the residuals were non-normal. The resultant residuals (Res1) were further used for the second cycle in the stepwise procedure. Note, the variables without any significant effect on DV have been eliminated from the stepwise procedure after cycle 1 (see Table 6).

The result of applying ANOVA to the numerical variable *neuroticism* is presented under cycle 2 in Table 6 and it shows that *neuroticism* is statistically significant even at the second cycle of the stepwise procedure. Since *neuroticism* was the only variable that had statistically significant effect on Res1 in cycle 2, the stepwise procedure concludes here. The residual and P-P plots found no evidence of non-normality in relation to the *neuroticism* variable. The final step is to construct the prediction model for *team vision* using a multivariable regression analysis using only the input variables selected by the aforementioned manual stepwise procedure – *responsibility* and *neuroticism*.

Similar to Table 6 (DV: *team vision*), the ANOVA data for the 10 IVs (five capability measures and five personality traits) in relation to each of the other four DVs (rest of the team climate dimensions together with *IPTC*), for both SD and ID samples, are presented in Table 7 (DV: *task orientation*), Table 8 (DV: *support for innovation*), Table 9 (DV: *participative safety*) and Table 10 (DV: *IPTC*). In these tables, for every regression cycle, the F-statistic and the significance level of the statistically significant variables are highlighted in bold. The coefficients for the regression models in relation to the DVs are presented in Table 11 (for SD sample) and Table 12 (for ID sample).

4.3.1.1. Predicting team vision. The ANOVA data from Table 6, in relation to the SD sample, shows that *responsibility* and *neuroticism* were selected as input variables for the regression analysis from the manual stepwise procedure. Whereas the ANOVA data in relation to the first cycle of the stepwise procedure for the ID sample (see case: ID from Table 6) shows that both *team participation* and *teamwork oriented* variables were significant. However, among them, the *teamwork oriented* variable was the most significant and residuals were computed to remove the effect of the variable. The residual and P-P plots found no evidence of non-normality and the residuals (Res1) were subsequently used for the second cycle of the stepwise procedure. The ANOVA data for the second cycle shows that the *team participation* variable had no statistically significant effect on the Res1, while it had a significant effect on *team vision* in cycle 1. This indicates that the *team participation* variable is related to the *teamwork oriented* variable and offer no additional information about the DV *team vision*. This variable can therefore be eliminated from the stepwise procedure. Finally, for the ID sample, *teamwork oriented* was the only IV that qualified as input towards constructing the regression model for *team vision*. The estimates for *team vision* models presented in Table 11 (model 1) and Table 12 (model 6) correspond to SD and ID samples, respectively.

In relation to SD (model 1 from Table 11), we can notice the intercept along with the coefficient values for the *neuroticism* and *responsibility* variables. The intercept (2.916) is essentially the expected value of the *team vision* variable, for SD, when the subjects are not neurotic (zero neuroticism) and do not perceive themselves to be responsible (no responses over St.Agr and Agr levels). Furthermore, the regression coefficient for *neuroticism* (−0.005) indicates that, on average, the *team vision* score drops by 0.005 points for every one-point increase in the score of *neuroticism*. The regression coefficient in relation to strongly agree level of the *responsibility* variable (1.322) means that, on average, the perceived *team vision* for a subject who strongly agreed to be *responsible* was 1.322 points higher than ones who did not strongly regard to be *responsible*. Similarly, the regression coefficient in relation to agree level of *responsibility* variable (1.135) means that, on average, the perceived *team vision* for a subject who agreed to be *responsible* was 1.135 points higher than ones who did not regard to be *responsible*.

However, the residual standard error (Res Std Er) value indicates that, on average, the actual *team vision* score, in relation to SD, could deviate from the true regression line by approximately 0.455 points. Taking into account the intercept value of 2.916 and the residual standard error of 0.455, we can estimate that any prediction from this model would still be off by 15.6% (percentage error). Importantly, the coefficient of determination (R-squared) value indicates that 17.7% of the variance found in *team vision* scores from the SD sample could be explained by *neuroticism* and *responsibility* variables.

With respect to the ID sample (model 6 from Table 12), the intercept (3.204) is the expected value of *team vision* variable, for ID, when the subjects do not perceive themselves to be teamwork oriented (no responses over St.Agr and Agr levels). The regression coefficient in relation to strongly agree level of *teamwork oriented* variable (0.833) means

Table 6
ANOVA for IVs in relation to team vision for SD and ID samples.

	Case: SD				Case: ID			
	Cycle: 1 DV: Team vision		Cycle: 2 DV: Res1 Removed effect: Responsibility		Cycle: 1 DV: Team vision		Cycle: 2 DV: Res1 Removed effect: Teamwork oriented	
	F-test	Significance level	F-test	Significance level	F-test	Significance level	F-test	Significance level
Responsibility	**4.529**	**0.017***			0.847	0.476		
Listening skills	0.687	0.603			0.158	0.854		
Questioning skills	0.24	0.868			0.337	0.799		
Team participation	1.176	0.314			**3.164**	**0.034***	1.36	0.268
Teamwork oriented	0.822	0.444			**5.101**	**0.010***		
Extraversion	1.235	0.270			1.962	0.168		
Agreeableness	2.358	0.129			1.415	0.240		
Conscientiousness	2.720	0.103			0.939	0.337		
Neuroticism	**4.309**	**0.037***	**3.983**	**0.496***	0.347	0.558		
Openness to experience	0.042	0.837			0.154	0.695		

* $p < 0.05$.

Table 7
ANOVA for IVs in relation to task orientation for SD and ID samples.

	Case: SD				Case: ID	
	Cycle: 1 DV: Task orientation		Cycle: 2 DV: Res1 Removed effect: Responsibility		Cycle: 1 DV: Task orientation	
	F-test	Significance level	F-test	Significance level	F-test	Significance level
Responsibility	**3.715**	**0.029***			0.917	0.441
Listening skills	0.651	0.628			0.502	0.609
Questioning skills	0.607	0.613			0.072	0.975
Team participation	0.826	0.442			0.886	0.456
Teamwork oriented	0.373	0.69			0.849	0.435
Extraversion	1.131	0.291			0.003	0.953
Agreeableness	0.820	0.367			0.008	0.927
Conscientiousness	0.350	0.555			0.155	0.695
Neuroticism	**4.940**	**0.293***	**7.576**	**0.007****	0.637	0.429
Openness to experience	0.264	0.608			0.050	0.823

** $p < 0.01$ and * $p < 0.05$.

Table 8
ANOVA for IVs in relation to support for innovation for SD and ID samples.

	Case: SD				Case: ID	
	Cycle: 1 DV: Support for innovation		Cycle: 2 DV: Res1 Removed effect: Neuroticism		Cycle: 1 DV: Support for innovation	
	F-test	Significance level	F-test	Significance level	F-test	Significance level
Responsibility	**2.344**	**0.040***	**4.629**	**0.012***	1.027	0.391
Listening skills	1.107	0.36			1.103	0.341
Questioning skills	**3.934**	**0.039***	2.038	0.116	0.809	0.496
Team participation	1.182	0.312			0.623	0.604
Teamwork oriented	0.697	0.501			0.853	0.433
Extraversion	0.097	0.756			0.595	0.444
Agreeableness	1.138	0.289			0.005	0.942
Conscientiousness	0.019	0.888			0.126	0.723
Neuroticism	**5.251**	**0.024***			0.140	0.709
Openness to experience	0.264	0.608			0.357	0.553

* $p < 0.05$.

Table 9
ANOVA for IVs in relation to participative safety for SD and ID samples.

	Case: SD				Case: ID			
	Cycle: 1 DV: Participative safety		Cycle: 2 DV: Res1 Removed effect: Neuroticism		Cycle: 1 DV: Participative safety		Cycle: 2 DV: Res1 Removed effect: Neuroticism	
	F-test	Significance level	F-test	Significance level	F-test	Significance level	F-test	Significance level
Responsibility	**3.739**	**0.028***	**4.799**	**0.011***	0.588	0.626		
Listening skills	1.599	0.184			1.887	0.164		
Questioning skills	1.611	0.195			1.246	0.305		
Team participation	0.907	0.408			**2.375**	**0.083 .**	1.9	0.144
Teamwork oriented	0.308	0.736			**3.73**	**0.032 ***	**2.741**	**0.075 .**
Extraversion	0.033	0.856			2.452	0.124		
Agreeableness	**3.131**	**0.081 .**	1.916	0.170	0.016	0.899		
Conscientiousness	2.631	0.109			**5.655**	**0.021***	1.571	0.216
Neuroticism	5.637	0.020*			**5.774**	**0.020***		
Openness to experience	0.473	0.493			2.505	0.120		

* $p < 0.05$ and . $p < 0.1$.

that, on average, the perceived *team vision* for a subject who strongly agreed to be working collaboratively with people was 0.833 points higher than one who did not strongly regard to be *teamwork oriented*. Similarly, the regression coefficient in relation to agree level of *teamwork oriented* variable (0.416) means that, on average, the perceived *team vision* for a subject who agreed to be working collaboratively with people was 0.416 points higher than one who did not regard to be teamwork oriented. The residual standard error informs us that on average, the actual *team vision* score, in relation to ID, can deviate from the true regression line by approximately 0.573 points. Further, the percentage error for this model informs us that any prediction from this model would be off by 17.8%. Finally, the coefficient of determination value indicates that 19.1% of the variance found in *team vision* scores from ID sample could be explained by the *teamwork oriented* variable.

IV(s) found to be predictor(s) of DV: *Responsibility* and *neuroticism* (SD sample). *Teamwork oriented* (ID sample)

4.3.1.2. Predicting task orientation. With respect to the DV *task*

Table 10
ANOVA for IVs in relation to IPTC for SD and ID samples.

	Case: SD				Case: ID	
	Cycle: 1 DV: IPTC		Cycle: 2 DV: Res1 Removed effect: Responsibility		Cycle: 1 DV: IPTC	
	F-test	Significance level	F-test	Significance level	F-test	Significance level
Responsibility	**7.614**	**0.005****			0.939	0.43
Listening skills	1.252	0.297			0.853	0.433
Questioning skills	1.871	0.142			0.391	0.76
Team participation	1.106	0.337			1.997	0.129
Teamwork oriented	0.353	0.704			**2.9**	**0.065 .**
Extraversion	0.063	0.801			1.230	0.273
Agreeableness	2.016	0.159			0.155	0.695
Conscientiousness	0.703	0.404			1.583	0.214
Neuroticism	**5.334**	**0.008****	**11.419**	**0.001****	1.618	0.21
Openness to experience	0.623	0.432			0.578	0.450

** $p < 0.01$ and . $p < 0.1$.

Table 11
Summary of regression models for predicting team climate dimensions in relation to SD sample.

Case: SD	Model 1 DV: Team Vision			Model 2 DV: Task orientation			Model 3 DV: Support for innovation			Model 4 DV: Participative safety			Model 5 DV: IPTC		
	Est.	SE	p	Est.	SE	p	Est.	SE	p	Est.	SE	p	Est.	SE	p
Intercept	2.916	0.456	<0.001	2.208	0.594	<0.001	2.073	0.666	<0.01	2.728	0.570	<0.001	2.334	0.475	<0.001
Neuroticism	−0.005	0.002	<0.1	−0.008	0.612	<0.01	−0.009	0.003	<0.01	−0.007	0.002	<0.01	−0.008	0.002	<0.01
Responsibility (Agr)	1.135	0.470	<0.1	1.892	0.610	<0.01	1.987	0.686	<0.01	1.528	0.587	<0.1	1.790	0.489	<0.001
Responsibility (St.Agr)	1.322	0.467	<0.01	1.959	0.002	<0.01	2.079	0.683	<0.01	1.703	0.584	<0.01	1.908	0.487	<0.001
R^2	0.177			0.182			0.176			0.182			0.257		
F	5.073			5.285			5.044			5.269			8.191		
P	0.003			0.002			0.003			0.002			0.000		
Res Std Er	0.455			0.594			0.665			0.569			0.474		

Table 12
Summary of regression models for predicting team climate dimensions in relation to ID sample.

Case: ID	Model 6: Team Vision			Model 7: Participative safety			Model 8: IPTC		
	Est.	SE	p	Est.	SE	p	Est.	SE	p
Intercept	3.204	0.286	<0.001	3.676	0.456	<0.001	3.138	0.331	<0.001
Teamwork oriented (Agr)	0.416	0.316	<0.05	0.618	0.394	<0.05	0.551	0.366	<0.05
Teamwork oriented (St.Agr)	0.833	0.309	<0.05	0.885	0.388	<0.05	0.819	0.357	<0.01
Neuroticism	–	–	–	−0.009	0.004	<0.1	–	–	–
R^2	0.192			0.220			0.128		
F	5.101			3.952			2.900		
P	0.010			0.014			0.065		
Res Std Er	0.573			0.705			0.662		

orientation, the ANOVA data from Table 7 for SD shows that both variables *responsibility* and *neuroticism* were respectively selected as input variables for the regression analysis from the first and second cycles of the stepwise procedure. The residual and P-P plots found no evidence of non-normality in relation to those variables. On the other hand, in the case of the ID sample, no significant IVs were observed in the first cycle of the stepwise procedure and therefore, for this sample, developing a regression model was not feasible. The findings from the regression analysis are presented under model 2 (Table 11) for the SD sample.

In relation to the SD sample (model 2 on Table 11, in Section 4.3.1.5), the intercept (2.208) is the expected value for the *task orientation* variable when the subjects are not neurotic (zero neuroticism) and do not perceive themselves to be responsible (no responses over St.Agr and Agr levels). The regression coefficient for *neuroticism* (−0.008) indicates that, on average, the *task orientation* score drops by 0.008 points for every one-point increase in the score of *neuroticism*. The regression coefficient in relation to strongly agree level of the *responsibility* variable (1.959) means that, on average, the perceived *task orientation* at team level for a subject who strongly agreed to be responsible was 1.959 points higher than for subjects who did not strongly regard themselves to be responsible. Similarly, the regression coefficient in relation to the agree level for the *responsibility* variable (1.892) means that, on average, the perceived level of *task orientation* for a subject who agreed to be responsible was 1.892 points higher than the ones who did not regard themselves as responsible. Furthermore, we can notice that, on average, the actual *task orientation* score, can deviate from the true regression line by approximately 0.594 points and any prediction from this model would be off by 26.9%. The coefficient of determination indicates that 18.2% of the variance found in the *task orientation* scores could be explained by the *responsibility* and *neuroticism* variables.

IV(s) found to be predictor(s) of DV: *Responsibility* and *neuroticism* (SD sample).

4.3.1.3. Predicting support for innovation. With respect to the *support for*

innovation DV, the ANOVA data from Table 8 for the SD sample shows that *responsibility, questioning skills* and *neuroticism* were significant based upon the first cycle of the stepwise procedure. However, in the second cycle, it can be noticed that only the *responsibility* variable was significant; *questioning skills* was associated to *neuroticism* and did not offer any additional information about the DV. Therefore, effectively, only *neuroticism* and *responsibility* were selected as input variables for the regression analysis. The residual and P-P plots showed no indication that the residuals for both *neuroticism* and *responsibility* deviated from a normal distribution. The findings from the regression analysis are presented under model 3 (Table 11) for SD sample.

In the case of the ID sample, no significant IVs were observed in the first cycle of the stepwise procedure and therefore, building a regression model was not feasible.

With regard to model 3 (Table 11, in Section 4.3.1.5), the intercept (2.073) is the expected value of *support for innovation* when the subjects are not neurotic (zero neuroticism) and do not perceive themselves to be responsible (no responses over St.Agr and Agr levels). The regression coefficient for *neuroticism* (−0.009) indicates that, on average, the *support for innovation* score drops by 0.009 points for every one-point increase in the score for *neuroticism*. The regression coefficient in relation to strongly agree level for *responsibility* (2.079) means that, on average, the perceived level of *support for innovation* at team level for a subject who strongly agreed to be responsible was 2.079 points higher than for subjects who did not strongly regard themselves to be responsible. Similarly, the regression coefficient in relation to the agree level for the *responsibility* variable (1.987) means that, on average, the perceived level of *support for innovation* for a subject who agreed to be responsible was 1.987 points higher than the ones who did not regard themselves as responsible. Furthermore, we can notice that, on average, the actual *support for innovation* score, can deviate from the true regression line by approximately 0.665 points and any prediction from this model would be off by 32%. The coefficient of determination indicates that 17.5% of the variance found in the *support for innovation* scores could be explained by the *neuroticism* and *responsibility* variables.

IV(s) found to be predictor(s) of DV: *Responsibility* and *neuroticism* (SD sample).

4.3.1.4. Predicting participative safety. In relation to the *participative safety* DV, the ANOVA data from Table 9, for the SD sample, shows that *neuroticism, agreeableness* and *responsibility* were significant, based upon the first cycle of the stepwise procedure. However, after removing the effect of *neuroticism*, the second cycle showed that the *responsibility* variable alone was significant because *agreeableness* was found to be associated with *neuroticism*, and in this way did not offer any additional information about the DV. Therefore, effectively, *neuroticism* and *responsibility* were the two variables resulting from the stepwise procedure, to be used as input for the regression analysis. The residual and P-P plots for these two variables showed no evidence of non-normality. The findings from the regression analyses are presented under model 4 (Table 11, in Section 4.3.1.5).

The ANOVA data from Table 9, for the ID sample, shows that *team participation, teamwork oriented, conscientiousness* and *neuroticism* were significant based on the first cycle of the stepwise procedure. After removing the effect of the most significant variable (*neuroticism*), the second cycle showed that only *teamwork oriented* was significant, because *team participation* and *conscientiousness* were associated to *neuroticism*, and hence did not offer any additional information about the DV. So, *neuroticism* and *teamwork oriented* were the two variables selected from the stepwise procedure, and used as input for the regression analysis. The residual and P-P plots showed a normally distributed pattern for the residuals for both *neuroticism* and *teamwork oriented*. The findings from the regression analyses are presented under model 7 (Table 12, in Section 4.3.1.5).

With respect to SD, model 4 in Table 11 (Section 4.3.1.5) indicates that the intercept (2.728) is the expected value of *participative safety* when the subjects are not neurotic (zero neuroticism) and do not perceive themselves to be responsible (no responses over St.Agr and Agr levels). The regression coefficient for *neuroticism* (−0.007) indicates that, on average, the *participative safety* score drops by 0.007 points for every one-point increase in the score of *neuroticism*. The regression coefficient in relation to the strongly agree level of the *responsibility* variable (1.703) means that, on average, the perceived level of *participative safety* at team level for a subject who strongly agreed to be responsible was 1.703 points higher than subjects who did not strongly regard themselves to be responsible. Similarly, the regression coefficient in relation to the agree level of the *responsibility* variable (1.528) means that, on average, the perceived level of *participative safety* for a subject who agreed to be responsible was 1.528 points higher than the ones who did not regard themselves as responsible. Further, we can notice that, on average, the actual *participative safety* score, in relation to SD, can deviate from the true regression line by approximately 0.569 points and any prediction from this model would be off by 20.8%. The coefficient of determination indicates that 18.2% of the variance found in *participative safety* scores from SD sample could be explained by the *neuroticism* and *responsibility* variables.

Upon inspecting model 7 for ID, in Table 12 (Section 4.3.1.5), we have the intercept (3.676) indicating the expected value of the *participative safety* variable when the subjects are not neurotic (zero *neuroticism*) and do not perceive themselves to be *teamwork oriented* (no responses over St.Agr and Agr levels). The regression coefficient for *neuroticism* (−0.009) indicates that, on average, the *participative safety* score drops by 0.009 points for every one-point increase in the *neuroticism* score. On the other hand, the regression coefficient for the strongly agree level of the *teamwork oriented* variable (0.885) means that, on average, the perceived level of *participative safety* at team level for a subject who strongly agreed to be working collaboratively with people was 0.885 points higher than for one who did not strongly regard him (her)self to be *teamwork oriented*. Similarly, the regression coefficient in relation to the agree level of the *teamwork oriented* variable (0.618) means that, on average, the perceived *participative safety* for a subject who agreed to be working collaboratively with people was 0.618 points higher than for one who did not regard to be *teamwork oriented*. Further, we can notice that, on average, the actual *participative safety* score, in relation to SD, can deviate from the true regression line by approximately 0.705 points, and any prediction from this model would be off by 19.1%. Finally, the coefficient of determination value indicates that 22.01% of the variance found in *participative* scores from ID sample could be explained by both *neuroticism* and *teamwork oriented* variables.

IV(s) found to be predictor(s) of DV: *Responsibility* and *neuroticism* (SD sample). *Neuroticism* and *teamwork oriented* (ID sample).

4.3.1.5. Predicting IPTC. With respect to the *IPTC* DV, the ANOVA data for SD in Table 10 shows that the *responsibility* and *neuroticism* variables were selected as input variables for the regression analysis from the first and second cycles of the stepwise procedure, respectively. On the other hand, in the case of the ID sample, *teamwork oriented* was the only IV that qualified as input towards constructing the regression model for *IPTC*. The residual and P-P plots showed no evidence of non-normality in relation to *neuroticism, responsibility* and *teamwork oriented* variables. The findings from the regression analyses are presented under model 5 (Table 11) for SD, and under model 8 (Table 12) for the ID sample.

In relation to SD (model 5 in Table 11), the intercept (2.334) is the expected value of the overall perceived team climate variable (*IPTC*) when the subjects are not neurotic (zero neuroticism) and do not perceive themselves to be responsible (no responses over St.Agr and Agr levels). The regression coefficient for *neuroticism* (−0.008) indicates that, on average, the *IPTC* score drops by 0.008 points for every one-point increase in the score of *neuroticism*. The regression coefficient in relation to the strongly agree level of the *responsibility* variable (1.908)

means that, on average, the *IPTC* for a subject who strongly agreed to be *responsible* was 1.908 points higher than for subjects who did not strongly regard themselves to be *responsible*. Similarly, the regression coefficient in relation to the agree level for the *responsibility* variable (1.790) means that, on average, the *IPTC* for a subject who agreed to be responsible was 1.790 points higher than for those who did not regard themselves as *responsible*. Further, we can notice that, on average, the actual *IPTC* score, in relation to SD, can deviate from the true regression line by approximately 0.474 points, and any prediction from this model would be off by 20.3%. The coefficient of determination indicates that 25.7% of the variance found in *IPTC* scores from the SD sample could be explained by the *responsibility* and *neuroticism* variables.

With respect to ID (model 8 in Table 12), the intercept (3.138) is the expected value of the *IPTC* variable, for ID, when the subjects do not perceive themselves to be *teamwork oriented* (no responses over St.Agr and Agr levels). The regression coefficient in relation to the strongly agree level of the *teamwork oriented* variable (0.819) means that, on average, the *IPTC* for a subject who strongly agreed to be working collaboratively with people was 0.819 points higher than for one who did not strongly regard to be *teamwork oriented*. Similarly, the regression coefficient in relation to the agree level of the *teamwork oriented* variable (0.551) means that, on average, the *IPTC* for a subject who agreed to be working collaboratively with people was 0.551 points higher than for one who did not regard to be *teamwork oriented*. The residual standard error informs us that on average, the actual *IPTC* score, in relation to ID, can deviate from the true regression line by approximately 0.662 points. Further, the percentage error for this model informs us that any prediction from this model would be off by 21%. Finally, the coefficient of determination value indicates that 12.8% of the variance found in the *IPTC* scores, for the ID sample, could be explained by the *teamwork oriented* variable.

IV(s) found to be predictor(s) of DV: *Responsibility* and *neuroticism* (SD sample). *Teamwork oriented* (ID sample).

4.3.2. Predicting team climate dimensions using capability measures

The second phase of the regression analyses involved considering only capability measures as IVs and performing a stepwise manual regression to develop prediction models for each of the team climate dimensions (DVs). Such two-phase approach facilitates comparison of the explanatory powers of regression models (from Section 4.3.1 and Section 4.3.2) and enables us to understand which IVs account to a maximum variance in the DVs.

4.3.2.1. Predicting team vision. With respect to the DV *team vision*, the ANOVA data for SD, in Table 6, shows that *responsibility* was the only IV (among capability measures) that had a statistically significant effect on the DV. So, a regression analysis was performed to predict *team vision* by considering the *responsibility* variable as input. On the other hand, for the ID sample, the ANOVA data from Table 6 shows that *team participation* and *teamwork oriented* variables were the only IVs significant in relation to the first cycle of the stepwise process; after the second cycle, *teamwork oriented* was the only IV that qualified as input towards the regression analysis for predicting *team vision*. The residual and P-P plots showed no evidence of non-normality and subsequently, the regression analysis was completed. The findings from the regression analyses for the SD sample are presented under model 9 (Table 14), and, for the ID sample, under model 6 (Table 12).

In relation to the SD sample (model 9 in Table 14), we have an intercept of 2.872. This is essentially the expected value of the *team vision* variable, when the subjects do not perceive themselves to be responsible (no responses over St.Agr and Agr levels). Furthermore, the regression coefficients in relation to the strongly agree (1.141) and agree (0.924) levels of the *responsibility* variable mean that, on average, the perceived *team vision* for a subject who strongly agreed/agreed to be responsible was higher, by a factor equivalent to the corresponding level's coefficient, than for those who did not agree to be responsible at a similar level. Any prediction from this model would still be off by 16.3% (percentage error) and the coefficient of determination value indicates that 10.7% of the variance found in the *team vision* scores could be explained by the *responsibility* variable.

IV(s) found to be predictor(s) of DV: *Responsibility* (SD sample). *Teamwork oriented* (ID sample).

4.3.2.2. Predicting task orientation. In relation to the *task orientation* DV, the ANOVA data for the SD sample in Table 7 shows that *responsibility* was the only IV (among capability measures) that had a statistically significant effect on the DV. The residual and P-P plots showed no evidence of non-normality. So, a regression analysis was performed to predict *task orientation* by considering the *responsibility* variable as input. On the other hand, for the ID sample, the ANOVA data from Table 7 shows that there were no significant IVs in the first cycle of the stepwise process and therefore developing a regression model in relation to the *task orientation* DV was not feasible. These findings are presented under model 10 (Table 14).

Here we discuss the results for the SD sample. The model 10 in Table 14 shows an intercept of 2.142, which essentially represents the expected value of the *task orientation* variable when subjects do not perceive themselves to be responsible (no responses over St.Agr and Agr levels). Furthermore, the regression coefficients in relation to the strongly agree (1.691) and agree (1.579) levels for the *responsibility* variable mean that, on average, the perceived *task orientation* for a subject who strongly agreed/agreed to be responsible was higher, by a factor equivalent to the corresponding level's coefficient, than for those who did not agree to be responsible at a similar level. Any prediction from this model would still be off by 28.9% and the coefficient of determination value indicates that 9.3% of the variance found in the *task orientation* scores could be explained by the *responsibility* variable.

IV(s) found to be predictor(s) of DV: *Responsibility* (SD sample).

4.3.2.3. Predicting support for innovation. In relation to the *support for innovation* DV, Table 8 shows the ANOVA data in relation to the first cycle of the stepwise process for the SD sample, indicating that *responsibility* and *questioning skills* (among the capability measures) had a statistically significant effect on the DV. Therefore, the stepwise procedure was conducted exclusively by considering capability measures as IVs and the ANOVA data in relation to it is presented in Table 13. From the first cycle of the stepwise procedure (Table 13) we can notice that the *questioning skills* variable was most significant, and its effect was removed in the second cycle. The *responsibility* variable further turned out to be significant in the second cycle also. The residual and P-P plots did not suggest any non-normality and a regression analysis was performed to predict the *support for innovation* variable by considering *questioning skills* and *responsibility* variables as input. In the case of the ID sample, the ANOVA data from Table 8 shows that there were no significant IVs in the first cycle of the stepwise process and therefore developing a regression model using *support for innovation* as DV was not feasible.

These details relate only to the SD sample. There was a significant number of respondents who answered NAND and disagree for *questioning skills*. Developing a regression model by employing all the significant levels of the variable generates a large percentage error (around 71.6%). Therefore, due to the limited data on NAND and disagree scale points, and also to minimize the aforementioned error, we replaced the variable levels strongly disagree, disagree and NAND, in relation to questioning skills, with a dummy level named 'not agree'. The dummy level 'not agree' groups all the values of questioning skills variable that are other than agree and strongly agree under a similar category/level. The dummy level further acts as a reference level while interpreting the coefficients of the regression model. The findings from the regression analysis that includes the dummy level are presented under model 11

Table 13
ANOVA for capability measures as IVs in relation to support for innovation and participative safety.

	Case: SD				Case: ID			
	Cycle: 1 DV: Support for innovation		Cycle: 2 DV: Res1 Removed effect: Questioning skills		Cycle: 1 DV: Participative safety		Cycle: 2 DV: Res1 Removed effect: Teamwork oriented	
	F-test	Significance level	F-test	Significance level	F-test	Significance level	F-test	Significance level
Responsibility	**2.344**	**0.040***	**4.208**	**0.018***	0.588	0.626		
Listening skills	1.107	0.36			1.887	0.164		
Questioning skills	**3.934**	**0.039***			1.246	0.305		
Team participation	1.182	0.312			**2.375**	**0.083 .**	0.226	0.878
Teamwork oriented	0.697	0.501			**3.73**	**0.032 ***		

* $p < 0.05$ and . $p < 0.1$.

(Table 14) for SD sample. From model 11 in Table 14, we can notice the percentage error for the regression model to be 35.9%. Introducing a dummy level was able to bring down the percentage error for the regression model by almost half (from 71.6% to 35.9%) and this way the percentage error, in comparison to other models from Table 14, is not very high (and remains close to the range 15.6% to 28.9%).

IV(s) found to be predictor(s) of DV: *Responsibility* and *questioning skills* (SD sample).

4.3.2.4. Predicting participative safety. In relation to the *participative safety* DV, the ANOVA results for the SD sample (see Table 9) show that *responsibility* was the only IV (among capability measures) that had a statistically significant effect on the DV. The residual and P-P plots suggest no evidence of non-normality. So, the regression analysis was carried out using *participative safety* as DV and *responsibility* as IV, and its results are shown as model 12.1 (Table 14).

With regard to the ID sample, the ANOVA data in relation to the first cycle of the stepwise process (see Table 9) showed that the IVs *team participation skills* and *being teamwork oriented* (among capability measures) had a statistically significant effect on the DV. Therefore, the stepwise procedure was conducted exclusively by considering capability measures as IVs and the ANOVA results are shown in Table 13. The first cycle of stepwise procedure (see case: ID in Table 13) shows that the *teamwork oriented* variable was the most significant, and its effect was removed in the second cycle. However, in the second cycle, *team participation skills* had no significant effect on the current residuals. Therefore, the regression analysis was performed using as DV *participative safety* and *teamwork oriented* as IV. The findings from the regression analysis are presented under model 12.2 (Table 14).

Model 12.1 in Table 14 shows an intercept of 2.666, which is essentially the expected value of the *participative safety* variable, when subjects do not perceive themselves to be responsible (no responses over St.Agr and Agr levels). Furthermore, the regression coefficients in relation to the strongly agree (1.448) and agree (1.229) levels of the *responsibility* variable mean that, on average, the perceived *participative safety* for a subject who strongly agreed/agreed to be responsible was higher, by a factor equivalent to the corresponding level's coefficient, than that for one who did not agree to be responsible at a similar level. Any prediction from this model would be off by 22.3% and the coefficient of determination value indicates that 9.4% of the variance found in the *participative safety* scores could be explained by the *responsibility* variable.

In relation to model 12.2 in Table 14, the intercept (3.104) is essentially the expected value of the *participative safety* variable, when subjects do not perceive themselves to be *teamwork oriented* (no responses over St.Agr and Agr levels). Furthermore, the regression coefficients in relation to the strongly agree (1.038) and agree (0.733) levels of the *teamwork oriented* variable mean that, on average, the perceived *participative safety* for a subject who strongly agreed/agreed to be teamwork oriented was higher, by a factor equivalent to the corresponding level's coefficient, than that for those who did not agree to be *teamwork oriented* at a similar level. Any prediction from this model would be off by 23.4% and the coefficient of determination value indicates that 14.7% of the variance found in *participative safety* scores could be explained by the *being teamwork oriented* variable.

IV(s) found to be predictor(s) of DV: *Responsibility* (SD sample). *Teamwork oriented* (ID sample).

4.3.2.5. Predicting IPTC. With respect to the *IPTC* DV, the ANOVA data from Table 10 for SD shows that *responsibility* was the only IV (among capability measures) that had a statistically significant effect on the DV. So, a regression analysis was performed to predict *IPTC* by considering the *responsibility* variable as input. The residual and P-P plots found no evidence of non-normality. On the other hand, for ID sample, the ANOVA data from Table 10 shows that *teamwork oriented* was the only IV significant in relation to the first cycle of the stepwise process and it was used as input towards the regression analysis to predict *IPTC*. The findings from the regression analyses are presented under model 13 (Table 14) for the SD sample, and under model 8 (Table 12) for the ID sample.

Model 13 in Table 14 has an intercept of 2.270. This is essentially the expected value of the *IPTC* variable when the subjects do not perceive themselves to be *responsible* (no responses over St.Agr and Agr levels). Furthermore, the regression coefficients in relation to the strongly agree (1.645) and agree (1.482) levels of the *responsibility* variable mean that, on average, the perceived level of *overall team climate* (*IPTC*) for a subject who strongly agreed/agreed to be responsible was higher, by a factor equivalent to the corresponding level's coefficient, than that for those who did not agree to be *responsible* at a similar level. Any prediction from this model would be off by 22.3% and the coefficient of determination value indicates that 13.4% of the variance found in *IPTC* scores could be explained by the *responsibility* variable.

IV(s) found to be predictor(s) of DV: *Responsibility* (SD sample). *Teamwork oriented* (ID sample).

5. Threats to validity

The discussion on research validity is important as it determines to what extent the results from our study can be trusted and can be generalized to a wider context in the real world. This section discusses some of the threats that could affect the validity of our findings and mentions how we attempted to mitigate some of those.

Subjects usually try to portray themselves as better when asked for their opinions on personality, how they perceive their capabilities and team climate. This is called evaluation apprehension. On the other hand, response bias relates to a subject's tendency to respond in-accurately (Vishnubhotla et al., 2020). In our study, we mitigated both evaluation apprehension and response bias by informing subjects upfront that there were no right or wrong answers to any of the questionnaire items. Additionally, subjects were informed clearly about how their data will be processed and stored and were notified that raw data from the survey will not be shared with any stakeholders from company A. Importantly,

Table 14
Summary of regression models for predicting team climate dimensions using capability measures as IVs.

	Model 9 (case: SD) DV: Team Vision			Model 10 (case: SD) DV: Task orientation			Model 11 (case: SD) DV: Support for innovation			Model 12.1 (case: SD) DV: Participative safety			Model 12.2 (case: ID) DV: Participative safety			Model 13 (case: SD) DV: IPTC		
	Est.	SE	p	Est.	SE	p	Est.	SE	p	Est.	SE	p	Est.	SE	p	Est.	SE	p
Intercept	2.872	0.471	< 0.001	2.142	0.621	< 0.001	1.962	0.734	<0.01	2.666	0.595	< 0.001	3.104	0.364	<0.001	2.270	0.508	< 0.001
Responsibility (Agr)	0.924	0.477	<0.1	1.579	0.629	< 0.05	1.659	0.734	< 0.05	1.229	0.603	< 0.05	–	–	–	1.482	0.515	< 0.01
Responsibility (St.Agr)	1.141	0.477	<0.05	1.691	0.629	< 0.01	1.791	0.723	< 0.05	1.448	0.603	< 0.05	–	–	–	1.645	0.515	< 0.01
Questioning (Agr)	–	–	–	–	–	–	0.035	0.022	–	–	–	–	–	–	–	–	–	–
Questioning (St.Agr)	–	–	–	–	–	–	0.037	0.202	–	–	–	–	–	–	–	–	–	–
Teamwork oriented (Agr)	–	–	–	–	–	–	–	–	–	–	–	–	0.733	0.402	<0.05	–	–	–
Teamwork oriented (St.Agr)	–			–			–			–			1.038	0.393	<0.01	–		
R^2	0.107			0.093			0.085			0.094			0.147			0.134		
F	4.329			3.715			1.638			3.739			3.730			5.614		
p	0.016			0.029			0.044			0.028			0.032			0.005		
Res Std Er	0.471			0.621			0.706			0.595			0.728			0.508		

all the subjects were informed that the data from our survey would be anonymized and were clearly briefed regarding their right to opt out from participating in our survey.

The threat in relation to construct validity deals with issues that could arise due to the improper design of the survey instrument. Although the validity and reliability of the IPIP-NEO and TCI questionnaires were evaluated by several studies rigorously (Vishnubhotla et al., 2020), since both the questionnaires were transformed to be part of a Web survey together with additional questions on capability measures, ensuring that the survey instrument ultimately measures what it is intended to measure is highly crucial. To address this, we requested two professionals from another organization, both with experience of working in an agile team, to pilot our Web-based survey. They were requested to assess the survey instrument and their suggestions on the clarity and presentation of the instrument were addressed appropriately.

The threat to the internal validity of the study that could arise due to irrelevant survey respondents, who could potentially introduce a bias or systemic error in the study results, was primarily mitigated by mentioning the survey intentions on the homepage of the survey. It was clearly mentioned that the survey was intended for gathering capability, personality and team climate specific information from people working in ASD teams. Some additional measures, such as requesting respondents to specify their role and team ID, were taken to crosscheck and make sure no irrelevant responses were received. The questions in relation to role and team ID were answered by all the respondents and thus we are confident about no irrelevant participation. Further, the threat in relation to evaluation apprehension among respondents was mitigated by informing them about anonymizing results and emphasizing that the questionnaire items have no right or wrong answers.

One of the threats related to the external validity of our study is the extent to which our results can be generalized to a wider context. The generalizability of our findings depends majorly on (a) the size of the sample i.e., the number of respondents who took part in our study, (b) the sampling strategy (e.g. random), and (c) the effect size.

With regard to (a), (b) and (c), we have the following: both data collections (Swedish Data and Indian Data) were carried out in collaboration with an industry partner (Company A), with whom we had an ongoing research project funded by the Swedish Knowledge Foundation. Therefore, we were bound by the availability of subjects provided by the industrial partner, and also by the duration of the project. In other words, we could not impose upon the industrial partner a requirement for a minimum sample size. And we could not wait for another year or even longer in order to obtain additional data from other teams, as the project would have expired by then. The industrial sites from where the data was gathered were those in which there was interest in understanding to what extent team members' capabilities would relate to their perception of team climate, and also whether capabilities could be used to forecast team climate. These were the main drivers of such collaboration, and, as already stated, we had to abide by the existing constraints in terms of available agile teams to participate in the data collection, and the research project's duration. Product owners from company A handled the recruitment of subjects to our survey (b), so making the sampling strategy purposeful, not random. Finally, effect size was assumed as medium, and informed by our previous investigation (Vishnubhotla et al., 2020).

In relation to sample size, the two samples analyzed in our study – Swedish dataset (SD) and Indian dataset (ID), had 75 and 46 subjects, respectively. The ID dataset is similar in size to the dataset previously used in our previous study (Vishnubhotla et al., 2020), whereas the SD dataset is relatively larger. With regard to the results for the SD dataset, a post-hoc analysis with G*Power (Faul et al., 2009) using our set alpha (0.05), estimated effect size (medium) and actual sample size, resulted in a post-hoc power of 0.75. This is within an acceptable range (0.70 to 0.90), as per the existing literature (e.g. Maier and Lakens, 2022).

With regard to the ID dataset, a post-hoc power analysis, using the set alpha (0.05) and medium effect size, provided power of 0.54. We do

acknowledge that such small power is far from ideal; however the issue of small sample size does not apply solely to our study (e.g. Ampatzoglou et al., 2020). This is a common issue in Software Engineering, as many industrial settings do not have large samples of participants to collaborate in joint research projects. Such constraints, which are often beyond researchers' control, affect the external validity of findings, which need to be interpreted with caution.

However, the results from our study can tentatively be generalized to ASD teams working under similar contexts. Further investigation is needed to be able to generalize the findings for wider contexts, i.e., our research needs to be replicated in other organizations in the telecom domain and, perhaps at a later stage, also to organizations outside such domain. Replication facilitates the realization of a larger sample by means of aggregation, which could increase the statistical power of models and lead to statistically significant results.

Most subjects from the SD sample responded as belonging to Sweden, and all the subjects from the ID sample indicated as belonging to India. The issue with a majority of respondents belonging to a specific country within each sample may also pose a threat to the generalizability of our results. This threat can be mitigated by recruiting subjects from other nationalities too.

In relation to the confirmability of results i.e., the threat related to the degree to which results could be confirmed or corroborated by others was mitigated by organizing a seminar with stakeholders from our partnering company. The stakeholders (product owners) were responsible for managing the teams recruited for our study. During the seminar, the results from our study were discussed for validation and their feedback was gathered. Overall, our study received a positive response from the stakeholders.

6. Discussion

The principles of agility promote shared responsibility and self-management among team members. Agile practices encourage voluntary and proactive participation from all team members, where members are required to communicate (Gutierrez et al., 2019; Shen and Xu, 2015). This seems to be the reason why at least 78% of the members from both the SD and ID samples (Table 3) agreed to possessing the abilities in relation to the top five factors that were vetted by agile practitioners as highly relevant for characterizing the capability of an individual working in an agile team (Vishnubhotla et al., 2021).

By comparing the median levels of personality traits' scores (Fig. 1) we can observe that, for the SD sample, the level of agreeableness was relatively the highest, followed by conscientiousness and other traits. Whereas, in the ID sample, the conscientiousness level was the one relatively the highest, followed by agreeableness and other traits.

Agreeableness is regarded as an important factor for team progress (Balijepally et al., 2006) and performance (Baumgart and Hummel, 2022). The scenario of low agreeableness levels in teams is considered detrimental to their performance since the presence of even one disagreeable member could disrupt the cooperation and dynamics within a team (Lee and Park, 2020; The bad apple spoils the bunch, 2023). In ASD teams, the presence of team members who are not very different from each other in terms of agreeableness levels is desirable (Balijepally et al., 2006). And results showed that this seems to be the case for both SD and ID samples (see Fig. 1). The box plots show that more than 75% of the subjects presented at least an average level of agreeableness.

Conscientiousness is reported to influence individual job performance (Balijepally et al., 2006), contribute to work satisfaction and promote perseverance towards accomplishing team goals (Neuman and Wright, 1999). On the other hand, low conscientiousness levels in a team are expected to lower its performance, as members high on this trait may detest loafing by low conscientious members (Balijepally et al., 2006). However, results suggest that this was not the case for both SD and ID samples. Conscientiousness levels were at least on *average* for more than 75% of the subjects from SD, in the case of ID subjects, the conscientiousness levels were *high* for more than 50% of them. Conscientiousness essentially is a positive trait for any kind of work situation including ASD teams (Balijepally et al., 2006).

In comparison to the level of neuroticism among subjects from our previous study (Vishnubhotla et al., 2020), the level of neuroticism was relatively higher among subjects from both SD and ID samples. Low levels of neuroticism correspond to improved coordination and stability within a team (Neuman et al., 1999), and to task cohesion and team performance (Barrick et al., 1998). Conversely, high neuroticism levels may not be conductive to team work because an emotionally unstable person could impair team performance by affecting the cooperation and cohesion among members (Balijepally et al., 2006). Despite Fig. 1 displaying the median for neuroticism scores under average levels with respect to the reference personality data from respective countries, the fact that the median levels were high in SD and ID samples, when compared to the case in our previous study (Vishnubhotla et al., 2020), reveals that the stress levels of subjects were relatively high.

This rise in stress levels could be partly attributed to lockdowns and the 'working from home' situation due to the COVID 19 pandemic, which took place during the times of execution of both surveys. Some of the typical causes of stress result from working on unplanned additional tasks, planning deficits and scarce resources (Pfeiffer et al., 2019). A study conducted to understand software developers' wellbeing and productivity during the pandemic times mentions stress as a detrimental factor to respondents' wellbeing. The study also discussed that, when working from home, stress-related factors showed the most significant harm during the pandemic (Russo et al., 2021). Higher levels of stress among agile practitioners have been found to be detrimental to many software quality outcomes too, such as low defect rate and good software architecture (Meier et al., 2018). The negative association between neuroticism and team climate/teamwork has also been identified in other studies outside the context of ASD and even SE. Some of these studies are introduced next.

Şahin et al. (2019) investigated the relationship between a school principals' personality traits and its climate, where climate was measured based upon 171 school teachers' perception. Results, based upon correlation analysis, showed a statistically significant relationship between school climate and its principal's personality traits. More specifically, one of their findings, which directly relates to ours herein, was that neuroticism predicted school climate negatively.

Dillon at al. (2021) have investigated the relationship between personality traits and communication during multidisciplinary obstetrical simulation. This was a prospective observational study based upon data from 22 multi-disciplinary simulations on postpartum haemorrhage, and including 270 staff working on labour and delivery, and from four different disciplines. Some of the results, which relate to the research detailed herein, showed that neuroticism was statistically negatively associated with increased teamwork, and positively associated with increased communication scores.

Another context where neuroticism is associated with teamwork relates to operator teams for nuclear power plants. Here, Juhász (2010) gathered data for 17 operator teams, which included data on their personality traits, team process, and team output. Results revealed that neuroticism presented a statistically negative association with work-team performance. Furthermore, team members' emotional stability (the low end of neuroticism) was statistically positively associated with team productivity, i.e., less neurotic members were more productive. Finally, teams with a negative pro-social behaviour of its members (negative neuroticism) were characterised by higher rates of absenteeism.

Finally, Lim et al. (2023) aimed to predict teamwork using personality traits as predictors by using an agent-based model. For this, they gathered data from 3698 participants (593 groups) enrolled as students for London Business School MBA (master of business administration). Further, via a genetic algorithm, they aimed to identify how traits

correlate to best and worst performing teams, for a problem that is characterised by different levels of uncertainty. Some of the results were that neuroticism negatively predicts team performance, i.e., performance decreases as neuroticism increases.

The team climate scores for both SD and ID samples ranged from 3.5 to 5 (Fig. 2), indicating that the perceived climate among all the teams varies between positive to highly positive. Among the four team climate dimensions, the median levels of participative safety were relatively high across both samples. The higher the participative safety levels, the higher the indication that subjects display tendencies for avoiding cognitive conflicts that could arise during discussions (Reiter-Palmon et al., 2012). Further, higher scores also inform us about subjects' state of 'feeling safe to share opinions among teams'; and such an environment can prompt members to be more expressive, and as a consequence, lead them to propose novel ideas (Acuña et al., 2015).

The correlation between neuroticism and participative safety was statistically significant in both samples (Table 5), where a medium size negative effect was observed in both cases. Similarly, in the SD sample, a statistically significant medium size negative effect was identified between neuroticism and perceived team climate (IPTC). The negative correlation in the aforementioned cases seems coherent because neuroticism is the tendency to negative emotions such as sadness, anxiety and depression (Balijepally et al., 2006). Neurotic people are reactive and susceptible to stress and tend to show emotionally unstable behavior. Therefore, neurotic members are typically less enthusiastic and not so confident about sharing ideas. Consequently, they could feel their ideas are not likely to be acknowledged well and hence would not perceive their team as a safe platform for discussing ideas. These feelings in turn could adversely influence their perception of the overall climate within their team.

In our correlation analysis with respect to capability and team climate variables, *responsibility, team participation skills* and *being teamwork oriented* variables showed significant effect on multiple team climate dimensions. Within SD sample, we observed eight instances of significant positive correlations, among which seven were medium sized and one was small sized. Whereas in the case of ID sample, we observed four instances of medium sized positive correlations between capability variables and team climate dimensions. On the other hand, in our correlation analysis with respect to personality and team climate variables, six instances of medium sized negative effect were observed between *neuroticism* and team climate dimensions.

Results from the regression analyses for the SD sample (Table 11) show neuroticism and responsibility variables to be statistically significant predictors for each of the five models that were constructed to predict the team climate variables. The neuroticism and responsibility variables in four out of five models could account for only less than 19% of the variance in the team climate variable (except 25.7% in model 5). Whereas in the case of the ID sample (Table 12), the variable 'being teamwork oriented' turned out to be the common significant predictor in relation to models predicting team vision, participative safety and IPTC. However, this variable accounted for less than 20% of the variance in the team vision and IPTC variables.

In relation to the regression models where the capability measures alone were used as predictors, the *responsibility* variable turned out to be the common significant predictor for each of the five models built, using the SD dataset, to predict the team climate variables (see Table 14). This capability variable accounted for 13.4% of the variance in the team climate variable. In psychology studies the coefficient of determination's value is reportedly lower than 50% as people are simply hard to predict (Agrawal and Agrawal, 2017).

Across all the regression models (Tables 11–14), the regression coefficient in relation to the 'strongly agree level' of a capability variable was relatively higher compared to the same variable's coefficient for the 'agree level'. This suggests that the perceived level of a team climate dimension (DV) can significantly increase when a person strongly agrees (rather than just agree) to possessing a particular ability.

To determine which IVs (i.e., either capability variables alone or together with personality variables) could better explain the variance in the scores of team climate dimensions, the key findings from the regression models with respect to each team climate dimension were segregated and presented in Table 15 (for the SD sample) and Table 16 (for the ID sample). Upon comparing the coefficients of determination for each team climate DV from Tables 15 and 16, we can understand that the coefficients were relatively high in cases where both personality and capability variables were used as IVs. While the coefficients of determination for all regression models based upon the SD sample, using as IVs either personality or capability variables, were significant at the 0.05 level (Table 15), the coefficient of determination for the regression models that used as IVs both personality and capability variables were significant at a higher level (at least at 0.01 level). The higher confidence level indicates that the observed relationship is less likely to be due to chance.

Furthermore, when comparing the current regression models' findings with the findings from our previous study (Vishnubhotla et al., 2020) (model S and model I presented in Table 15. Note: Models S and I correspond to the models from Vishnubhotla et al. (2020) for predicting Support for innovation (S) and IPTC (I) variables), where personality variables alone were used as IVs for predicting team climate variables, using another dataset, we can observe that in relation to support for innovation and IPTC DVs, when considering both capability variables and personality variables as IVs, the coefficient of determination improves significantly. Although the significant improvement in the coefficient of determination values could partly be attributed to recruiting a relatively large sample for the current study (SD sample), the inclusion of capability dimension to the regression analysis alongside personality traits also seem to play a major role in improving the coefficients.

In essence, the findings from Tables 15 and 16 showed that the inclusion of both capability and personality variables as input for regression analyses explains more variance in the team climate DVs. Although the values of the coefficient of determination observed from the regression analyses were small, the coefficients of determination observed in other studies investigating human aspects (e.g. Vishnubhotla et al., 2020; Francese et al., 2021; Licorish and MacDonell, 2018) were also observed to be small and in line with our findings.

7. Theoretical and practical implications

Our study gathered and analyzed self-assessed capability measures pertaining to team members. Each of the respondents provided capability ratings by indicating the degree to which they agreed/disagreed with statements in relation to themselves. Upon reviewing the heatmaps presented in Table 3, we can understand that, although the majority of the respondents had a clear choice in their self-assessment i.e., they either agreed (Agr and St.Agr) or disagreed (Dis and St.Dis) with statements, there was still a fraction of respondents who neither agreed nor disagreed (NAND). To cope with such cases, it would be beneficial to consider an additional source of data. For further research, it is worthwhile to additionally take into account the voices of managers or others who are responsible for selecting people to team. In cases such as company A, where Scrum practices are adapted to the company's context and managers' decision is involved in selecting personnel to teams, we recommend employing a capability-centric agile support tool (S.D. Vishnubhotla et al., 2018). Such a tool facilitates managers to periodically assess the capability measures of members alongside composing teams. In cases where team members clearly (agree or disagree) self-assess capability measures, the assessments from managers can be used to calculate the inter-rater reliability (perhaps, using weighted Kappa (Harvey, 2021)) to check if the responses from both the parties line up with each other. These assessments aid in quantifying an individual's or team's skills and, in turn, help in differentiating precise personnel.

Higher levels of agreeableness and neuroticism, and lower levels of

Table 15
Comparison of regression model parameters for various input variables (case: SD).

Case: SD	DV: Team vision			DV: Task orientation			DV: Support for innovation			DV: Participative safety			DV: IPTC		
Personality IVs & capability IVs	Model 1	R^2 0.177**	Err% 15.6%	Model 2	R^2 0.182**	Err% 26.9%	Model 3	R^2 0.176**	Err% 32%	Model 4	R^2 0.182**	Err% 20.8%	Model 5	R^2 0.257***	Err% 20.3%
Capability IVs	9	0.107*	16.3%	10	0.093*	28.9%	11	0.085*	35.9%	12.1	0.094*	22.3%	13	0.134**	22.3%
Personality							S	0.097*	16.07%				I	0.124*	11.4%

*** $p < 0.001$, ** $p < 0.01$ and * $p < 0.05$.

Table 16
Comparison of regression model parameters for various input variables (case: ID).

Case: ID	DV: Team vision			DV: Participative safety			DV: IPTC		
Personality IVs & capability IVs	Model	R^2	Err%	Model 7	R^2 0.220*	Err% 19.1%	Model	R^2	Err%
Capability IVs	6	0.192*	17.8%	12.2	0.147*	23.4%	8	0.128*	21%

*$p < 0.05$.

extraversion and conscientiousness were observed in the current study (SD sample) when compared to the Swedish sample from the original study (Vishnubhotla et al., 2020). Whereas the median levels of all scores were relatively high in the Indian sample (ID sample). This variation in trends across the samples can be attributed to the change in context associated with the execution of each survey instance. Although all the samples were acquired from two divisions of the same company, each sample consisted of new respondents associated with different projects. Further, factors like age of respondents, their ethnicity, work culture, and contemporary factors such as stress due to the COVID-19 pandemic could be potential reasons behind the shift in trends (Kang et al., 2006). Therefore, additional data through further replications would be essential to analyze the trends reported in this study. For future research, we recommend executing investigations in different contexts as that would aid in not only obtaining robust knowledge but also a larger dataset, and assist towards generalizing findings to a wider group.

Self-management is a defining characteristic of the Scrum methodology, where a team is usually accorded authority for deciding about ways to achieve goals (Colomo-Palacios et al., 2012; Moe et al., 2010), and this entails a highly charged and stimulated environment. However, in such a collaborative environment, there is a risk of conflicts occurring due to disagreements and differences of opinions (Balijepally et al., 2006). The ability to cope with conflicts depends on one's personality (Balijepally et al., 2006). Thus, managers should perhaps consider the personalities of members as an additional dimension while assembling teams. By making sure the anonymity and secure storage of the sensitive personality data, as explained in Section 3, investigating the personality profiles of both happy (good team climate) and unhappy teams would be a logical first step. This helps in gathering cumulative evidence that not only can be useful for fine-tuning team-building criteria, but also informs management about the need for additional support to improve existing personality traits that are not so favorable towards a good team climate.

From the correlation analyses between capability variables and team climate variables (Table 4), we can see that in all the cases where a significant correlation exists, the direction of relationship between variables was positive. Similarly, the incidence of medium size negative effects in the case of correlation analyses between neuroticism personality trait and team climate variables, in both the samples analyzed in this study (Table 5), gives us a good idea of the direction of the relationship between the variables. Such uncovered common relationships would have implications for both research and practice. These findings contribute to the research on human factors (like capability measures and personality traits) and team climate in ASD. While it is highly likely to observe such effects in other divisions of company A, the findings from our study present a strong case for hypothesis testing, to see if the relationships hold within the context of other telecom companies.

Managers can employ two approaches, namely elevation and variability (Balijepally et al., 2006), to assemble agile teams using the scores of team members' capability measures and personality traits. Elevation of a variable (capability measure or personality trait) involves measuring the average of individual scores within a team. In this approach, it is implicit that the high score of a team member on a particular variable would compensate for the low score of another member. Variability, on the other hand, indicates the homogeneity or heterogeneity of a variable in a team. The coefficient of variance, discussed in our previous studies (Vishnubhotla et al., 2020; Vishnubhotla and Mendes, 2023), is a measure of dispersion of scores around mean. By comparing the coefficient of variance for various configurations of team members, dispersions in the scores of a variable can be observed.

In cases where the elevation of a particular variable is essential, the elevation of the corresponding positively correlated variable can be performed to indirectly influence the level of the particular variable. In the presence of a negative effect between variables, the elevation of a particular variable could be accomplished by demotion/reduction in the corresponding negatively correlated variable. Such changes in the variables are feasible and even in a short timeframe (Allemand and Flückiger, 2017; Stieger et al., 2021).

Low levels of neuroticism were reportedly related to an improved coordination, a relaxed team atmosphere, and stability within teams. Variability in neuroticism may not be conducive to team work as even one emotionally unstable person could impair the team performance by affecting cohesion and cooperation (Balijepally et al., 2006; Baumgart and Hummel, 2022). From the results of correlation analyses, the negative direction of the relationship between neuroticism and team climate variables (Table 5) informs us that, in practice, demoting one variable i.e., if a manager could work towards demoting/reducing the neuroticism levels within a team, this would indirectly contribute to the elevation in the overall climate perceived within the team. On the other hand, when the direction of the relationship between variables is positive, such as the positive correlation between team participation skills and overall perceived team climate (IPTC) shown in Table 4, the elevation in team members' ability to cohesively work with others towards a common goal (*team participation skills*) would lead to an elevation in the overall climate perceived within the team.

On the whole, the majority of the significant correlations observed in the current study were tending towards a medium size effect. Despite the significant effects, the medium effect sizes signify that the associations uncovered in our study might or might not occur in some ASD teams under similar contexts. Therefore, further replications are important to

have a wider perspective on the phenomena being investigated, and ideally to identify patterns that may generalize to wider contexts.

The comparison of various regression models, discussed under Section 4.3 and Section 6, clearly indicated that the inclusion of capability dimension to the regression analysis alongside personality traits seemed to play a major role in improving the explanatory power of a model. So, it would be interesting for further research in this direction to investigate the influence of additional capability measures. For this, researchers can recruit new measures from the list of capability measures (Vishnubhotla et al., 2021) that were vetted by agile practitioners as highly relevant for characterising one's capability. Subsequently, the stepwise regression analysis discussed in Section 4.3 can be employed to determine which input variables (IVs) would jointly have a statistically significant effect on the DV, effectively avoiding any multi-collinearity issues.

In our regression analyses, the IVs (capability measures together with personality traits) accounted for at most 25% variance in DVs (team climate variables). So, it is important to note that the relationships identified herein may or may not materialize under industrial contexts similar to this study. In this regard, due to very few studies emphasizing on exploring the relationship between human-factors and agile team climate, it is imperative for future research in this direction to replicate this study and explore the extent to which the relationships herein would be valid in other contexts. Moreover, long-term inspection of personality traits, capability measures and team climate characteristics within one context would aid in acquiring more detailed knowledge necessary to establish robust prediction models.

8. Conclusions

This study explores the relationship between capability measures, personality traits and agile team climate within the context of a telecom company. The five capability measures that were examined herein are responsibility, listening skills, questioning skills, team participation skills and being teamwork oriented. The five-factor model personality traits considered are openness to experience, conscientiousness, extraversion, agreeableness and neuroticism. Finally, the team climate dimensions investigated are team vision, task orientation, support for innovation, participative safety and overall perceived team climate.

By performing two iterations of a Web-based survey at geographically distant divisions of a telecom company, we surveyed members from 19 teams (12 teams in the first iteration, followed by seven teams). By means of correlation analyses, the survey data was used to study how capability measures and personality traits are associated with team climate dimensions. Subsequently, the data was further used for regression analyses to examine which human-aspect(s), either capability measures alone or together with personality traits, serve as significant predictors of team climate dimensions.

The correlation analyses in this study uncovered significant negative relationships between neuroticism and team climate factors (team vision ($r = -0.24$), task orientation ($r = -0.25$), support for innovation ($r = -0.26$), participative safety ($r = -0.27$ and $r = -0.34$ in different samples) and overall team climate ($r = -0.30$)). Further, significant positive associations were identified between responsibility and team climate factors (team vision ($\rho = 0.28$), task orientation ($\rho = 0.16$), support for innovation ($\rho = 0.16$), participative safety ($\rho = 0.24$) and overall team climate ($\rho = 0.25$). All the correlations observed in relation to the neuroticism and responsibility were significant at 0.05 level.

Upon performing regression analyses over the data gathered from 12 teams (first iteration of survey), the neuroticism and responsibility variables were observed to account to 25.7% variance in the overall perceived team climate scores. The coefficient of determination for this regression model was significant at the 0.001 level. The regression analyses over the data gathered from the rest of the seven teams (second iteration of survey) showed the teamwork oriented variable to account to 12.8% variance in the overall perceived team climate scores, where the coefficient of determination was significant at the 0.05 level.

In essence, the variables neuroticism, responsibility and teamwork oriented were observed to be significant predictors of overall perceived team climate score. However, the results from our regression analyses indicate the need for analyzing more data. A possible avenue for future work could be to improve the generalizability of the results. This can be done by replicating the current study in other telecom companies and also in other contexts.

Supplementary material

Supplementary material for this paper is available at: https://urn.kb.se/resolve?urn=urn:nbn:se:bth-25764

CRediT authorship contribution statement

Sai Datta Vishnubhotla: Conceptualization, Data curation, Formal analysis, Investigation, Writing – original draft. **Emilia Mendes:** Data curation, Supervision, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The authors do not have permission to share data.

Acknowledgement

We would like to thank all those who participated in the surveys that were detailed in this study. This research was partially funded by the KK-stiftelsen-HÖG AGILE research project.

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