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TACT: An insTrument to Assess the organizational ClimaTe of agile teams - A Preliminary Study

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Abstract

Background: Measuring the organizational climate of agile teams is a challenge for organizations, mainly because of the shortages of specific instruments to agile methodologies. On the other hand, finding companies willing to participate in the preliminary validation of an instrument is a challenge for researchers of the organizational climate. The preliminary validation allows identifying problems and improvements in the instrument. *Objective:* We present the preliminary evaluation of TACT. TACT is an instrument to assess the organizational climate of agile teams. Its initial version comprises the Communication, Collaboration, Leadership, Autonomy, Decision-Making, and Client Involvement dimensions. *Method:* We planned and executed a case study considering three development teams. We evaluated TACT using open-ended questions, quantitative methods, and TAM dimensions of Intention to Use, Perceived Usefulness, and Output Quality. *Results:* TACT allowed to classify the organizational climate of the teams for the Communication, Collaboration, Leadership, Autonomy, Decision-Making, and Client Involvement dimensions. Some items were assessed negatively or neutrally, which represent points of attention. TACT captured the lack of agile ceremonies, the difficulty of the product owner in planning iterations, and the distance in leadership. In addition, TACT dimensions presented high levels of reliability. *Conclusions:* TACT captured the organizational climate of the teams adequately. The team leaders reported intention of future use. The items that compose TACT can be used by researchers investigating the influence of human factors in agile teams and practitioners who need to design organizational climate assessments of agile teams. By using an instrument adapted to assess the organizational climate of agile teams, an organization can better identify issues and improvement actions aligned with agile values, principles, and practices.

Keywords: *Organizational climate, Agile software development, Human factor influence*

1 Introduction

Several factors can influence the organizational climate of agile software development teams, such as trust, openness, respect, team engagement, a culture of action and change, innovation, leadership, communication, personality, software quality, performance, support from management and the availability of resources for the project (Acuña et al., 2008; Soomro et al., 2016; Grobelna and Stefan, 2019; Serrador et al., 2018; Vishnubhotla et al., 2020). Curtis et al. (2009) propose that organizations should periodically identify each person's opinion on their working conditions. The authors recommend the organizational climate survey to learn and understand the factors influencing teams, their activities, and, consequently, the software's quality (Curtis et al., 2009).

The instrument used in the assessment of the organizational climate must consider the most critical factors in the domain, as the organizational climate is evaluated through behavior, attitudes, feelings, policies, practices, and procedures that characterize life in the organization (Lenberg et al., 2015; Schneider et al., 2014). Vishnubhotla et al. (2020) point out the need for further studies to investigate the influence of human factors on the organizational climate of agile teams. Both academia and industry suggest that collaboration, communication, autonomy, decision-making, client involvement and leadership are critical human factors that influence agile software development projects (Chagas et al., 2015; Dybå and Dingsøyr, 2008).

To assess the organizational climate of agile teams, organizations should select the organizational climate instruments that measure the desired factors. Many organizations may find it difficult to select instruments for copyright reasons. Hiring a specialized consulting company can aid this process. However, Dutra et al. (2012) report that many consulting companies do not disclose details of how the instrument was designed, its reliability, nor the statistical procedures adopted to its validation.

Several studies have investigated the impact of human factors in agile projects (Chagas et al., 2015; Vishnubhotla et al., 2018), including surveys with members of agile teams (Grobelna and Stefan, 2019). However, the literature review we conducted did not identify studies that report the design of scales, models, or questionnaires specific to assess the organizational climate of agile teams. Some studies use generic scales/questionnaires that can be used in different business domains (Acuña et al., 2008; Vishnubhotla et al., 2020). Other studies only present factors that exert some influence on the organizational climate of agile teams (Serrador et al., 2018; Soomro et al., 2016).

In previous work, Dutra et al. (2020) presented the initial version of TACT: *"an insTrument to Assess the organizational ClimaTe of agile teams"*. TACT was devised

and validated preliminary for the Communication, Collaboration, and Leadership dimensions. The instrument dimensions showed high reliability. In the current work, we extended the initial study by adding the Client Involvement, Autonomy, and Decision-Making dimensions, creating new items to measure the organizational climate of the teams considered in the previous study, and expanding the users of TACT to include a third team. Moreover, we increased the literature background to show the constructs (Delgado-Rico et al., 2012) considered to guide the creation of TACT items, and we used Factor Analysis to identify the most influential items for each dimension considered in the case study.

This study aims to evaluate TACT preliminarily for the Communication, Collaboration, Leadership, Autonomy, Decision-Making, and Client Involvement dimensions. TACT was built considering the main human factors that influence agile teams. Two specialists confirmed the validation of the TACT items for agility. The data collection procedures used in the case study showed that TACT evaluated the organizational climate correctly for the three teams. The quantitative analysis indicated the most influential items by each dimension in the case study. TACT items showed high factor loading. TACT showed excellent psychometric indices, for example, high correlation inter items in the Spearman correlations (ρ) and high alfa Cronbach value (> 0.8). Practitioners can use TACT items in their organizational climate assessment. Researchers can explore new evidence of reliability and validity of the TACT dimensions.

The paper is organized as follows: Section 2 discusses the organizational climate in agile teams; Section 3 presents the design of TACT; Section 4 deals with the study planning; Section 5 presents the results; In Section 6, we discuss the results; Section 7 addresses the study limitations and threats to validity; finally, Section 8 shows our final considerations.

2 Background

2.1 Specific Characteristics for the Formation of the Organizational Climate of Agile Teams

The organizational climate is the meaning that employees attribute to the policies, practices, and procedures they experience, besides the behaviors they observe being rewarded, supported, and expected (Schneider et al., 2014). As such, members of agile teams expect the values, practices, adopted procedures, and, even, the behavior of those involved to reflect the values, principles, and practices of the "agile philosophy" (Hohl et al., 2018; Beck et al., 2001).

Agile methods differ from traditional development methods in several aspects (Dybå and Dingsøyr, 2008; PMI and Agile Alliance, 2017). Leadership, collaboration, communication, autonomy, decision-making, and client involvement are examples of factors that demand different behaviors among those involved, as they impact the adoption and use of agile methods (Dybå and Dingsøyr, 2008; Chagas et al., 2015; Noll et al., 2017; Jia et al., 2016).

Schneider et al. (2014) claim that leadership is a crucial point in the formation of the climate in organizations. In agile development, the leadership is based on the role of the Servant Leader (PMI and Agile Alliance, 2017). PMI and Agile Alliance (2017) argue that servant leadership is the practice of leading by service, focusing on the team members' comprehension, development as well as meeting their needs to enable them to perform at their best. Dybå and Dingsøyr (2008) argue that, in traditional methodologies, the management style is based on command and control with highly bureaucratic and formalized organizational structures, while in agile methodologies, the management style must be collaborative and the structure of the organization is organic (Dybå and Dingsøyr, 2008).

Chagas (2015) reports that collaboration in agile methodologies takes place between team members and the customer. In agile methodologies, the project is divided into small cycles, called iterations, which are planned and specified according to the client and based on the team's development capacity (PMI and Agile Alliance, 2017). This negotiation is based on the communication and collaboration the team has while executing the development tasks. A process of communication and collaboration between members of the agile team in the iteration planning and the development tasks execution positively impacts the project's success (Chagas et al., 2015).

Unlike traditional approaches, in agile methodologies, the team has the autonomy to create and change the responsibility for performing the tasks (Karhatsu et al., 2010; Chagas, 2015; PMI and Agile Alliance, 2017; Noll et al., 2017). Jia et al. (2016) argue that the decision-making behavior of each individual will influence the behaviors of other teammates and the project outcome. For example, each member makes a decision about effort estimation and gives user story points under these conditions; different individual decision-making behaviors will generate different results, which are pertinent to the success or failure of the project. (Jia et al., 2016).

Dutra and Santos (2020) investigated difficulties associated with organizational climate assessments. The authors identified pitfalls in (i) non-assessment of behaviors and factors specific to the development of an organizational climate in agile teams, and (ii) not explicitly considering agile roles and other organizational structure management functions. The authors argue that the items of assessment instruments should be detailed enough to allow respondents to think about the organizational culture and better characterize the agile behaviors depicted (Dutra and Santos, 2020).

2.2 Organizational climate in agile teams

There are several studies on organizational climate in software development teams (Soomro et al., 2016). However, many of these studies do not report characteristics of the software development process considered in the evaluated teams. In addition, the studies measured the climate using generic instruments used in different business domains, without considering values, principles, or specific practices of development teams. Our literature review identified three studies (Acuña et al., 2008; Grobelna and Stefan, 2019; Vishnubhotla et al., 2020) that investigated the organizational climate of agile teams by survey climate instruments.

Acuña et al. (2008) investigated whether the climate of software developers teams has any relationship with the quality of the software product. The authors used the TCI© (Team Climate Inventory) instrument (Anderson and West, 1998) to assess the climate. The experimental study was carried out with 105 students allocated in 35 teams. All teams used an adaptation of the eXtreme Programming method (XP) to develop the same software. The authors found that the climatic preferences of the team's vision and their perception of participatory security were significantly correlated to better software. According to the authors, it is important to track the organizational climate of teams as one of many indicators of the quality of the software to be delivered.

Grobelna and Stefan (2019) investigated how the organizational climate factors (e.g., Leadership Style, Autonomy, Rewarding, and Communication) in agile software development teams affected the regularity of work speed and the teams' efficiency. The authors prepared a questionnaire to measure the organizational climate, but the items created were not disclosed. The results confirmed that the desired organizational climate was based primarily on a positive relationship with the leader and other coworkers, commitment to work, and challenges at work. The authors argue that there are elements that point out that the more the team's organizational climate is characterized by the team's preferences, the greater the regularity of the work speed of this team is, and thus the team is more efficient (Grobelna and Stefan, 2019).

Vishnubhotla et al. (2020) investigated the association between personality traits and the climate in agile software development teams. The study was implemented with 43 members in eight agile teams. The authors used the TCI© instrument (Anderson and West, 1998) to assess the climate for each dimension (vision, participatory security, support for innovation, and task orientation). The study identified a statistically significant positive correlation between personality (considering the trait openness to experience) and the climate dimension (support for innovation). They concluded that the results of the regression analysis suggest that more data may be needed, and there are other human factors in addition to personality traits that should also be investigated in relation to the climate of agile teams.

In summary, the TCI© instrument is grounded in a theoretical model to measure vision, participatory security, support for innovation, and task orientation dimensions (Anderson and West, 1998). TCI© was used in Acuña et al. (2008) and Vishnubhotla et al. (2020) to measure factors that influence the capability of innovation of software development teams. The TCI© dimensions do not measure the dimensions proposed on TACT. The questionnaire items elaborated by Grobelna and Stefan (2019) were not published. Regarding the use of questionnaires or generic scales to assess the organizational climate in agile teams, Dutra and Santos (2020) claim that the use of assessment instruments that do not consider agile values, principles, practices, and roles in a proper context may create difficulties for the analysis of possible causes of problems and the execution of corrective actions within organizational climate management. Therefore, there is a need for specific instruments to measure the organizational climate of agile teams in the communication, collaboration, leadership, autonomy, decision-making, and client involvement dimensions.

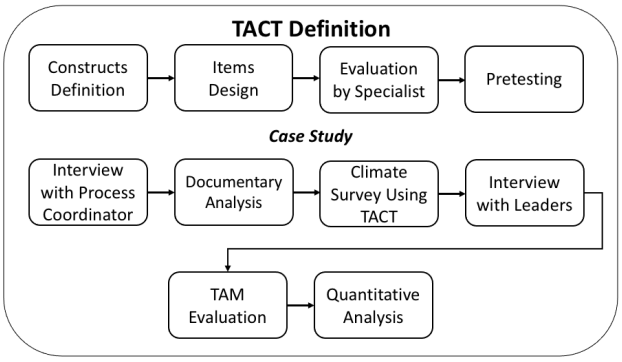

Figure 1. Main steps used to build TACT and to execute the case study

3 TACT Overview

In this section, we present the conception of the *insTrument to Assess the organizational ClimaTe of agile teams (TACT)*. Instruments for organizational climate assessments measure behaviors, attitudes, or preferences (Anderson and West, 1998; Patterson et al., 2005). As such, TACT conception and evaluation are based on psychometry concepts (Dima, 2018; Patterson et al., 2005; Graziotin et al., 2020). TACT design followed specific procedures suggested for elaborating and validating climate scales and other questionnaires in general (Graziotin et al., 2020; Anderson and West, 1998; Bandura, 2006; Dybå, 2000; González-Romá et al., 2009; Recker, 2013; Shull et al., 2008).

Figure 1 shows the steps followed to define TACT and to execute the case study used to evaluate it. The steps involving the definition of constructs, items design, evaluation by specialists, and pretesting are described in the next subsections. The activities used for data collection from the case study, such as the interview with the process coordinator, documentation analysis, a survey using TACT, leaders interview, and TAM evaluation, are in Section 4.3. The quantitative analysis from the case study is shown in Section 5.3.

3.1 Conceptual definition of the construct

The first step to define the construct is a literature review (Spector, 1992). The researchers should carefully read the literature about the construct, paying attention to specific details of exactly what the construct has been described (Spector, 1992). In the delineation of a construct, it is helpful to base the conceptual and scale development effort on work that already exists. For each TACT dimension, we identified (i) conceptual definitions to show a general description of the construct measured, and (ii) operational definitions to understand how the construct can be assessed (Delgado-Rico et al., 2012; Spector, 1992). An operational definition is a description of something in terms of the operations (procedures, actions, or processes) by which it could be observed and measured (VandenBos, 2017). The constructs are presented in Appendix A.1.

To start step 1, we identified systematic literature reviews and other relevant sources to provide (i) theoretical and operational definitions for the investigated constructs (i.e., com-

munication, collaboration, leadership, autonomy, decision-making, and client involvement), (ii) human factors and their influences on agile teams, and (iii) factors, models, scales, questionnaires, and items for assessing climate of software development teams. We have identified some systematic literature reviews about human factors that impact agile software development (Dybå and Dingsøyr, 2008; Franca et al., 2011; Chagas et al., 2015; Vishnubhotla et al., 2018; Dutra et al., 2021). Soomro et al. (2016) paper was considered for having identified studies, instruments, and factors used to assess the organizational climate of development teams. PMI and Agile Alliance (2017) and Miller (2020) were used to standardize names of roles, practices, and artifacts considered in agile development. We used the most influential human factors related to Agile Software Development teams (Chagas et al., 2015) to select the TACT dimensions investigated in this study. The Agile Manifesto (Beck et al., 2001) was also used in this step.

The identified literature was used (i) to make the conceptual and operational definition of constructs (Delgado-Rico et al., 2012; Spector, 1992) and (ii) to capture examples of behaviors, attitudes, climate instruments, and practices and their influences. For example, a) Dybå and Dingsøyr (2008) showed that *"the planning game activity was found to have a positive effect on collaboration within the company"*, b) Karhatsu et al. (2010) reported that *"communication and collaboration are at the heart of agile software development. As the Agile Manifesto states, individuals and interactions over processes and tools and customer collaboration over contract negotiation. One aspect in communication and collaboration is customer cooperation"*, and c) through Soomro et al. (2016), we identified some items (Açıkgöz et al., 2014) that could be adapted to measure the collaboration.

3.2 Design/adaptation/selection of items

Step 2 aims to propose items that will be used to assess each dimension, adapted to the population's culture. Thus, the constructs (Appendix A.1) identified in Step 1, the identified systematic reviews, and other relevant literature were considered.

Some items or questionnaires and examples of behaviors identified in the previous step must be adapted to agile roles, practices, or artifacts. PMI and Agile Alliance (2017) and Miller (2020) were considered a reference to identify the main roles and essential activities in agile software development projects. After reading the selected works, we started creating TACT. For each considered dimension, namely Communication, Collaboration, Leadership, Autonomy, Decision-making, and Client involvement, evaluation items were selected, adapted, or created.

Some items from scales without any copyright were selected and translated to Portuguese, e.g., *"IT13. Team members work together as a whole"* used in Açikgöz (2017) to assess collaboration between software development team members. In other cases, only the role of the person exercising the action was altered. For example, the original item *"My direct supervisor listened to my ideas and concerns"*, proposed in Sharma and Gupta (2012), was changed to item *"IT20. The team facilitator listens to my ideas and concerns"*.

New items were also proposed to assess the organizational climate specific to agile teams. For this purpose, critical factors and/or items were selected, and the descriptions were adapted to the roles and activities performed by agile teams. For example, to assess the Communication dimension, we defined the item *"The team and the product owner always reach consensus on the priority of the user stories by negotiating which bug to fix or functionality to add"*. This item was based on the team climate factor described in Nianfang Ji and Jie Wang (2012) *"Supervisors and staff communication and agreement their tasks, including what to do, to what degree, and how to do?"* and the description presented by Chagas (2015) for the communication factor *"Frequent communication can be used to prioritize features, set focus on bug-fixing or include more functionality"*.

On completion of Step 2, 49 items had been established, with 9 items to measure Communication, 8 items for Collaboration, 10 items for Leadership, 7 items for Autonomy, 8 items for Decision-Making, and 7 items for Client Involvement dimension. The items included in the TACT initial version are shown in Appendix A.2. TACT also comprises a dashboard, which is shown in Section 5.

3.3 Evaluation by specialists

At the beginning of Step 3, the TACT items were analyzed by two specialists in agile software development. For each item, two questions were considered *"Can it be inferred that the presented item represents a behavior related to agile software development teams?"* and *"Do you suggest any adaptation to the item description?"*. The first specialist has 10 years of experience in using such methods and 5 years as a consultant focused on the agile transformation of organizations and teams. The second specialist is a process coordinator at a huge company. She has 14 years of experience in software process improvement and 4 years as responsible for defining and monitoring changes in agile processes.

Every TACT item was considered related to agile software development teams. Two researchers, co-authors of this work, discussed all comments and suggestions made by the specialists. After that, some adaptations in item descriptions were made. For example, in IT08, the proposed description *"The team and the product owner always agree (...)"* was altered to *"The team and product owner always reach consensus (...)"*.

3.4 Pretesting

Google Sheets was used as a tool to develop TACT. It mostly contains the form for conducting the climate survey and a dashboard with the results of the frequency by item and dimension (Figure 2). The items proposed in Appendix A.2 are measured using a 5-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree). In TACT, the organizational climate of the team is classified as positive (values 5 and 4), neutral (value 3), or negative (values 2 and 1).

To begin Step 4, a pretesting was performed with 3 developers to identify possible problems of interpretation for

the TACT items and layout. In the end, the developers reported no difficulties in answering the survey. The authors implemented a layout suggestion presented in this step. To continue the preliminary assessment of TACT, a case study (Yin, 2013) was performed and is described in the next section.

4 Case Study Planning and Execution

Runeson and Höst (2009) claim that case studies in software engineering aim to investigate a contemporary phenomenon in a real context for understanding how and why software engineering activities should be carried out. They also argue that improving the software process and the resulting products with the acquired knowledge is possible. The authors also highlight the main characteristics of a case study, namely 1) their conclusions must reflect a clear chain of evidence, whether qualitative or quantitative, collected from various sources in a planned and consistent manner; and 2) they must add to the existing body of knowledge, based on established theory, if any, or build such theory. Thus, the case study described below is proposed as a method of evaluating both the case addressed and the TACT instrument (Yin, 2013).

4.1 Research questions

The study aims to evaluate TACT preliminarily. To achieve the aim, the research questions (RQ) are defined as follows:

- RQ1. How is the organizational climate in the examined agile teams?
  - RQ1.1. How did working from home affect the organizational climate of the teams for the analyzed dimensions?
- RQ2. How do leaders perceive TACT?
- RQ3. Which are the most influential items in each dimension for the analyzed case?

During the planning and execution of the study, teams allocated in the same physical environment were working from home due to the COVID-19 pandemic described in Davis et al. (2020). To investigate whether this fact could have impacted the organizational climate of the studied teams, we defined RQ1.1.

4.2 Description of the organization and teams

The organization analyzed in the study is a big Brazilian bank with millions of customers. It has dozens of development teams, composed of employees and outsourced collaborators. Each team defines the software development process and can choose traditional (structured and RUP) or agile (Scrum, Kanban, XP) methods, among others defined by the organization. Each team has the freedom to define the scenario and artifacts to be developed as long as it is officially stated to the process sector.

Regarding leadership, some teams use the role of Scrum Master, but in others, this role is played by the hierarchical leader of the team. When present, the role of coach facilitates the understanding and dissemination of good agile practices by the teams. During this time of working from home, the team's monitoring by the agile leader occurs through the ceremonies that continue to be performed, the monitoring of task execution, and meetings and interactions using Microsoft Teams and corporate Skype resources. Even with the change in the work routine, it was reported that tasks continue to be delivered within the established deadlines and with the required quality.

Three teams, named A, B, and C, were selected by convenience to participate in the case study. The teams have employees from the organization as well as outsourced members.

4.3 Data collection

For the data collection, we used interviews, document analysis, and the application of TACT. Data collection took place between January 2020 and March 2021.

The first data collection procedure was an interview with a process coordinator of the organization. The objective was to understand how the company assessed the organizational climate, which difficulties were faced with assessing the organizational climate of agile software development teams, how the development process was like, and how the composition of agile teams was like.

The second procedure was to analyze the executive reports with the last two organizational climate assessments results. It is noteworthy that the assessment performed by the organization is biennial and does not consider the team in which employees are allocated. Only employees and superintendence department. For this reason, it is not possible to understand the climate of individual teams.

The third procedure was the assessment of the organizational climate in the teams through TACT. All members of teams were invited to participate voluntarily and anonymously in the study. The organizational climate survey was applied in three cycles called pulses. Table 1 shows the dimensions applied to each team by pulse and the number of participants by each team in each pulse. Pulse 1 was executed in June 2020 for Team A and B. Pulse 2 was executed in February 2021 for Team C. Lastly, Pulse 3 was executed in March 2021, and all teams participated. The numbers in the columns Team A, Team B, and Team C represent the size of each team at the moment each pulse was executed. In the period between pulse 1 and pulse 2, some team members from Team A and B were allocated to other teams due to the conclusion of the product module.

Table 1. Measurement cycles

Pulse	Dimension	Date	Team A	Team B	Team C
1	Communication, Collaboration, Leadership	Jun20	13	10	-
2	Communication, Collaboration, Leadership	Feb21	-	-	4
3	Autonomy, Decision-making, Client Involvement	Mar21	9	5	4

In addition to the items present in Appendix A.2, three

open-ended questions were introduced: "*Regarding the examined dimensions (communication, collaboration, leadership, autonomy, decision-making, and client involvement), what are the main challenges for your team at this time working from home?"* and *"Do you have anything to add about your team's organizational climate?"*. In addition, at the beginning of the instrument, we included a description with the definition of the organizational climate and the objective of the assessment. Next, we presented a consent form to comply with ethical principles in which we informed that participation would be anonymous, voluntary and that the participant could abandon the assessment at any time without penalties.

The fourth procedure represents the execution of semi-structured interviews with the leaders of the respective teams. These interviews were designed to present the results of the climate assessment and capture the leader's perception of TACT and the team's organizational climate. To do this, they were asked some questions such as *"How do you evaluate the results, by dimension, of the organizational climate assessment carried out by the team? Do the results by dimension represent your perception of the team's daily life? In your opinion, was there any result that surprised you? Do you believe that the items used represent expected behaviors in agility (mindset, values, principles, and practices)? Otherwise, explain why the item does not represent expected behavior"*.

At the end of the interview, we sent a link to the leader to evaluate TACT through TAM (Technology Acceptance Model) (Venkatesh and Davis, 2000; Venkatesh and Bala, 2008). The dimensions of Intention to Use, Perceived Usefulness, and Output Quality were used (Venkatesh and Davis, 2000; Venkatesh and Bala, 2008). In the interviews, we used a consent form to present and assure ethical aspects.

5 Case Study Results

This section aims to present the results of the organizational climate assessment, thus answering the research questions.

5.1 How is the organizational climate in the examined agile teams? (RQ1)

Teams were allowed to answer the survey for 8 days on each pulse. We checked the data and calculations performed by TACT. In total, 22 team members participated in Pulse 1, 12 out of 13 (i.e., 92.31% of members) from Team A and 10 (100%) from Team B. In Pulse 2, 3 out of 4 (75%) members from Team C answered the survey. On the last pulse, 4 out of 9 (44%) members from Team A, 5 (100%) members from Team B, and 4 (100%) members from Team C participated in the study.

Table 2 shows the frequency for each investigated dimension. The "Dimension" column represents the description of the dimension. For each team, the relative frequencies (count for each value assigned by the members) and absolute frequencies (percentage in parentheses) were calculated according to the aforementioned Likert scale. In Table 2, we chose to count the values "strongly agree" and "agree" in the column "Positive", and "strongly disagree" and "disagree" in the column "Negative". Finally, we consider the frequency of "neutral" to categorize the organizational climate as neutral.

Figure 2 shows the TACT dashboard, which is used to present the results of the climate assessment. The climate is classified as positive, neutral, or negative to facilitate the analysis of results by team members, leaders, and others involved.

When analyzing the results in Table 2, higher frequencies can be observed in the "Positive" column for Team B and C in all dimensions. Considering that the 49 items represent good behavior expected by the main existing roles in an agile team, it is possible to classify the organizational climate of Teams B and C as positive or favorable for all dimensions. In team A, the organizational climate can be classified as i) positive for the Communication, Collaboration, and Leadership, and ii) negative for Autonomy, Decision-Making, and Client Involvement dimensions.

Table 2 shows that Team B and C presented a positive climate superior to that of Team A in all dimensions. For example, the frequency of the Communication dimension was 82 (91.1%) for Team B, 20 (74%) for Team C, and 62 (58%) for Team A.

Neutral and negative results represent points of attention for an analysis of possible causes and impacts on involved roles, elements of the process, the development project, or the team's culture in general.

5.1.1 Analysis of Organizational Climate from Team A

Among the assessed teams, Team A showed more items evaluated as negative and neutral (see Table 2). Thereby, the Organizational Climate can be considered negative for the Autonomy, Decision-making, and Customer Involvement dimensions. However, it is observed (i) positive evaluations in the items referring to the interaction between the team members, and (ii) negative and neutral evaluations in the interactions that involve the product owner and the leader. Some points of attention were clarified in open-ended questions and the interview with the leader.

In response to the question about the challenges for the Communication dimension at this time of working from home, a member of Team A said that *"virtual rooms, when poorly managed, end up providing a space for inopportune conversations"*. This statement was also corroborated by the leader of Team B *"they <the team> think they talk too much, lose focus a little bit"*, mentioning the feedback obtained from the team at the previous day's daily meeting. These comments can be associated with item "IT04. Team members frequently talk about club, entertainment, gym, parties, sports, and films". For item "IT07. In the current project, the daily meeting allows to know project problems and team difficulties", the leader of Team A admitted the negative result, *"the team decided not to hold the daily meeting during the period of working from home anymore, the difficulties are addressed by WhatsApp and the virtual room at Microsoft Teams"*. In addition, the leader of Team A agreed with the team, noting the negative result for item "IT02. The team keeps the list of impediments, risks, and control actions updated" *"many times I have to register the impediments myself,*

Table 2. Results of the organizational climate assessment for teams A, B and C

	Team A			Team B			Team C		
Dimension	**Negative**	**Neutral**	**Positive**	**Negative**	**Neutral**	**Positive**	**Negative**	**Neutral**	**Positive**
Communication	23 (21%)	23 (21%)	62 (58%)	6 (7%)	2 (2%)	82 (91%)	1 (4%)	6 (22%)	20 (74%)
Collaboration	10 (10%)	20 (20%)	66 (70%)	0 (0%)	2 (3%)	78 (97%)	0 (0%)	2 (7%)	22 (93%)
Leadership	27 (23%)	29 (24%)	64 (54%)	0 (0%)	13 (13%)	87 (87%)	0 (0%)	5 (17%)	25 (83%)
Autonomy	12 (43%)	9 (32%)	7 (25%)	2 (6%)	2 (6%)	31 (88%)	0 (0%)	2 (7%)	26 (93%)
Decision-making	9 (28%)	16 (50%)	7 (22%)	0 (0%)	4 (10%)	36 (90%)	0 (0%)	3 (9%)	29 (91%)
Client Involvement	6 (22%)	11 (39%)	11 (39%)	0 (0%)	2 (6%)	33 (94%)	(0%)	0 (0%)	28 (100%)

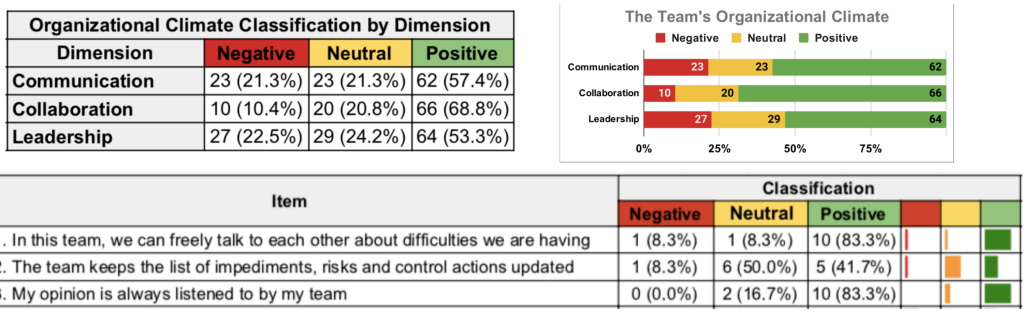

Figure 2. Part of TACT's Dashboard (Pulse 1: Team A Results)

they <the team> don't do it". In the Pulse 3, the item "IT39. My team has open and effective communication" had all neutral assessments (4 100%), reflecting a change in the team's climate for Communication dimension.

Team A showed a greater positive climate in relation to the collaboration between the members themselves, for example, in items "IT10. Team members consider sharing know-how with each other" and "IT12. My team works efficiently together when in the face of difficulties". However, when collaboration involves the product owner and the leader, points of attention in the item "IT17. In the current project, the team, the product owner, and the team facilitator work excellently together to plan the iteration" deserve to be stressed. With the analysis of the open question *"Do you have anything to add about your team's organizational climate?"*, it was possible to identify potentials causes for the negative assessment for item IT17. The members reported that *"after the coordination <hierarchical leader> change occurred, there was some distancing between the PO <Product Owner> and the team"* and *"the team leader does not play her role"*. This assessment of the negative climate was repeated in Pulse 3.

During the interview, in the analysis of IT17, the leader of Team A stated that *"the team often wants to impose on the PO what they think should be implemented in the product, they feel like they own the product"*. The leader also pointed out that *"the employee designated as PO cannot develop stories at team speed. Often, the product owner cannot approve a Sprint with the business customer, as customers have other priorities, which compromises the next Sprint planning"*.

Regarding the Autonomy and Decision-making dimension for iteration planning, the leader reported *"sometimes there are demands that override all planning. We lived this recently, every time an unplanned demand arrived that passed over all others demands. This hinders the planning team's autonomy"*. The leader also declared *"these past few months have been hard, a little stressful. Most of the demands were out for planning"*. The comments were said by the leader in the analysis of items "IT34. My team has the decision authority and responsibility to plan the iteration" and "IT35. My team has time to plan the changes without excessive stress or pressure".

The climate can be characterized as negative to Decision-making dimension, considering 9 (28%) items assessed as negative and 16 (50%) items as neutral. The item "IT41. The dependencies between the tasks do NOT hinder the fluidity of the project and do NOT cause major restrictions" obtained 75% of negative evaluations. About Decision-Making, a member of Team A reported: *"the decision-making process is still not very participatory"*. In the analysis of item IT41, the leader of Team A stated *"the dependencies between the tasks are getting in the way. Demands have a number of tasks that impact. If the PO does not approve the changes, this creates a configuration and change problem. In the company, if you put a demand into production and do not validate with the PO, the infrastructure team rollback the demand"*.

With respect to Client Involvement, a member from Team A described *"business representatives, <i.e., Product Owners> fail to fulfill their role during homologation, impacting the delivery in production not only that specific demand but also many others, as they depend on the implementation of the first demand"*.

5.1.2 Analysis of Organizational Climate from Team B

In Team B, more than 90% of the items were positively evaluated. However, some items were evaluated as negative and neutral, thus representing points of attention.

About the Communication dimension, a team member reported *"communication continues to flow very well, keeping productivity high and positive"*. Another report showed the good climate for Collaboration between team members *"when there is some difficulty to identifying an error in the tests, we share the screen, we make audio calls, we include other team members, whom we know have some more spe-*

cific experience at that point, in the conversations".

Team B leader did not obtain any negative evaluations, only 3 neutral in the item "IT25. The team facilitator gives the team helpful feedback on how to be more agile". Several praises for the performance of the agile leader during the period of working from home were registered in response to the open questions. These reports include *"... his work remained close and very positive", "... considering different points of view", "... moving together, even at a time of working from home"*.

Regarding the Autonomy dimension, the team leader said *"the team autonomy is very good. The members are participatory. In the team, there is no expression 'this is my task, or this is not my problem' "*. A member of Team B wrote, *"team members have always been autonomous about their tasks within each user story developed"*.

Concerning the Decision-making dimension, a member of Team B reported dissatisfaction *"the main challenges are when the team's decisions come up against approval from other areas"*. Analyzing the item "IT35. My team have time to plan the changes without excessive stress or pressure", the leader reported *"In the last few months, we had several PO <Product Owner> changes in the projects. Before, the PO was of IT <sector>, now by determination of the company the PO is of the business. The new PO does not 'walk' with the team. She <PO> does not feel part of the team. She <PO> did not want to be a PO. As the PO was not planning <the interaction>, the team had to plan it"*.

The previous problems reported by Team B leader may have influenced the two neutral evaluations (2 6%, see Table 2) recorded in the dimension Client Involvement. The items "IT44. In the current project, there are frequent meetings with business representatives and the team" and "IT47. The current project does NOT have frequent requirement changes due to bad user stories definition" had neutral evaluations. Analyzing items IT44 and IT47, the Team B leader reported *"many times the team had to prioritize and refine the user stories without the participation of the PO. After planning, she <PO> made several changes to the user stories and the acceptance criteria"*.

5.1.3 Analysis of Organizational Climate from Team C

Regarding the Communication and Collaboration dimension, Team Leader C said *"The team is new. They <members> have only 3 months in this project. They <members> already knew each other. We have an excellent interaction. I do not know the team personally. What gets in the way are limitations of the tool (Microsoft Teams) because they <team> do not have full access. But the collaboration between them <team> is excellent"*. Regarding all neutral (3 100%) assessments in the item "IT05. During the retrospectives, the team finds the best way to do things", the leader reported *"We still have not managed to do the retrospective meetings formally, the team is new. The team started by resolving only incidents. We talked, but not formally at a ceremony"*.

Regarding the 3 neutral assessments involving iteration planning items "IT34. My team has decision authority and responsibility to plan the iteration" and "IT35. My team has time to plan the changes without excessive stress or pressure", the leader said *"They have autonomy. In the current project, they managed to negotiate changes in user stories. They had the autonomy to adjust the planning"*. About the pressure in Team C, the leader commented *"It should also be considered that the product under development has a fixed date (which cannot be changed) to be launched. The product impacts millions of bank customers"*.

Analyzing the Decision-making dimension, a member of Team C wrote *"decision-making is shared between the members outsourced, the members of the company, and the business representatives. We can all contribute with equal weight. Working from home facilitated the engagement and collaboration between these 3 roles"*. On Autonomy dimension, another member wrote *"the autonomy limits are agreed with the client"*.

Despite 100% positive evaluations of the Client Involvement dimension, one member reported that the Product Owner was not allocated in the same virtual environment. *"In some moments, communication with the management area <Product Owners> is not so synchronous, as we do not have access to the same communication tool (Microsoft Teams), but the continuous meetings in this same tool make it easier to exchange information and questions"*.

The 100% positive assessment of the team in the Client Involvement dimension did not surprise the leader. The leader declared *"The managers <the official PO, the substitute PO, and other stakeholders> praise the team a lot. In these last weeks, the managers have stayed together for up to 4 hours doing the backlog refining. I have never seen such engagement. In this project, there are many stakeholders involved. At this time of working from home, they <PO and stakeholders> are available to answer questions over the phone. Now, we are currently holding 1-hour refinement meetings. The report used at the demonstration meeting containing the evidence was highly praised by the PO. The PO said: 'I never got a homologation script with evidence that did not have errors' "*.

5.1.4 How did working from home affect the organizational climate of the teams for the analyzed dimensions? (RQ1.1)

Team members reported some challenges that could have impacted the organizational climate as they adapted to the period of working from home. The challenges mentioned were difficulty with communication tools; infrastructure problems; difficulties in reaching the support team; managing inopportune conversations in virtual rooms; absence of the facilitator at the ceremonies; customer contract hinders the action of the facilitator; and other challenges already present before the period of working from home.

Regarding the Communication dimension, members of Team A reported that *"working from home actually facilitated team communication"* and that there has been *"improved contact while working from home, we communicate more"*. In Team B, the statement *"our team is managing to maintain a good dialogue to clarify project issues"* stands out. The challenges identified for this dimension mention the network infrastructure and supporting software.

In relation to the Collaboration dimension, the challenges

captured in the open-ended questions point to Team B's collaboration difficulties with the external support team *"there have been challenges, some of which required the involvement of the support team"*. One member reported a preference for working in person with the team: *"... but I believe that being in the same physical space, help, and assistance would sometimes flow better". Another member stated that "the challenges are the same as they were before working from home"*.

Regarding the Leadership dimension, no issues were noticed in the performance of the leaders of Team B and C. On the other hand, members of Team A reported the absence of the team's leader in ceremonies and a certain distance from the team's activities.

In general, the members' responses did not indicate changes in organizational climate due to working from home for the dimensions investigated on TACT.

5.2 How do leaders perceive TACT? (RQ2)

During the interviews, for each analyzed dimension, the following question was asked to the leaders: *"Do you believe that the items used represent expected behaviors in agility (mindset, values, principles, and practices)? Otherwise, explain why the item does not represent expected behavior"*. Regarding this question, no item was assessed as not being consistent with agility.

In the final stage of the interview, the following questions were asked *"In your opinion, what are the benefits of using this instrument?"* and *"How can the organizational climate assessment tool be improved?"*. In relation to the first question, the leader of Team A answered *"I found it interesting, you can map out what needs attention... I can notice other things, interesting... It exposes, gives you a view of what is happening. Very practical, because we can focus on the point that needs attention"*. The Leader of Team B agreed, saying *"I was able to see the positive things and the neutral points in order to try to improve... The visual formatting (graphics) was very clear. I managed to understand the results effortlessly"*. The leaders did not report any suggestions to improve the instrument.

After the interview, TAM (Venkatesh and Davis, 2000; Venkatesh and Bala, 2008) was used, through the dimensions of TAM for the leaders to evaluate TACT. Some items taken into consideration in the assessment, for example, were *"Assuming I have access to the instrument, I intend to use it", "Using the instrument improves my performance in my job"*, and *"The quality of the output I get from the system is high"*. Considering a 7-point Likert scale, most leaders' responses were the options "Somewhat agree" and "Strongly agree" for all items of dimensions of Intention to Use, Perceived Usefulness, and Output Quality.

5.3 Which are the most influential items in each dimension for the analyzed case? (RQ3)

Due to the large number of items defined on TACT, it is relevant to identify the most important items for this case study, i.e., the most influential items in each dimension. For this purpose, we performed Factor Analysis (FA). FA is commonly used in Software Engineering to analyze items that use the Likert Scale (Sharma and Gupta, 2012; Klünder et al., 2020; Graziotin et al., 2020).

Graziotin et al. (2020) assert that FA allows to reduce the dimensionality of the problem space (i.e., reducing factors and/or associated items) and explaining the variance in the observed variables. In the case of analyses intended to assess a single construct, factor analysis helps identify those items that (best) represent the construct we are interested in, so that we can exclude the other items (Graziotin et al., 2020).

The quantitative results were processed using the R tool (v. 4.0.2) using primarily the *psych library* (Revelle, 2018). It should be stressed that these procedures have an initial exploratory purpose and are not conclusive, as the small sample size (N = 25 - Pulse 1 and 2; N = 13 - Pulse 3), non-randomness and data distribution can have interfered with the results (Dima, 2018; Kyriazos, 2018). The adopted procedures were i) analysis frequency of variation of the items and correlation matrix and ii) Factor Analysis.

In **step one**, the response frequencies for all items are checked to verify whether the items have enough variation to differentiate respondents. If an insufficient variation is identified (i.e., 95% of responses in a single category for an ordinal item), the item needs to be excluded from further analysis (Dima, 2018). In this case study, no items needed to be excluded.

To continue the analysis of step one, the item correlations (see Figure 3) were plotted for an initial visual diagnosis of the items and structure of the TACT dimensions (Dima, 2018). A higher degree of association between items of the same dimension may already be visible in the correlation matrix (Figure 2). Negative associations between items may indicate the need for reverse item coding, while items with weak associations consistent with other items may prove to be non-scalable in later stages (Dima, 2018).

Analyzing the Spearman correlations (ρ) for the test case (Figure 3), we can observe: i) absence of negative correlations; ii) IT04 and IT32 with insignificant positive correlation, thus IT04 and IT032 will be excluded from next analyzes; and iii) in general, high and moderate positive correlation between items in the dimensions. Critical values of ρ (0.9 to 1 - very high; 0.70 to 0.90 - high; 0.51 to 0.70 - moderate; 0.31 to 0.5 – low; and 0 to 0.3 - insignificant) (Hinkle et al., 2003).

To start the **second step**, we performed the test of calculating the Kaiser-Meyer-Olkin index (KMO). The KMO index is a statistical test that suggests the proportion of variance of the items that may be explained by a latent variable. The values KMO (see Table 3) were considered appropriate for the FA in each dimension. Value of KMO (< 0.5 - unacceptable; > 0.5 and < 0.7 - mediocre; > 0.7 < 0.8; good; 0,8 e 0,9 excellent) (Field et al., 2012).

As indicated by Field et al. (2012), the next analysis was conducted on the polychoric correlation matrix. We used the Parallel Analysis graph (Horn, 1965) to investigate the plausibility of the initial model proposed on TACT, i. e., the association of the items with their dimension. Figure 4 shows the Parallel Analysis graph (x-axis displays the "Factor Number"

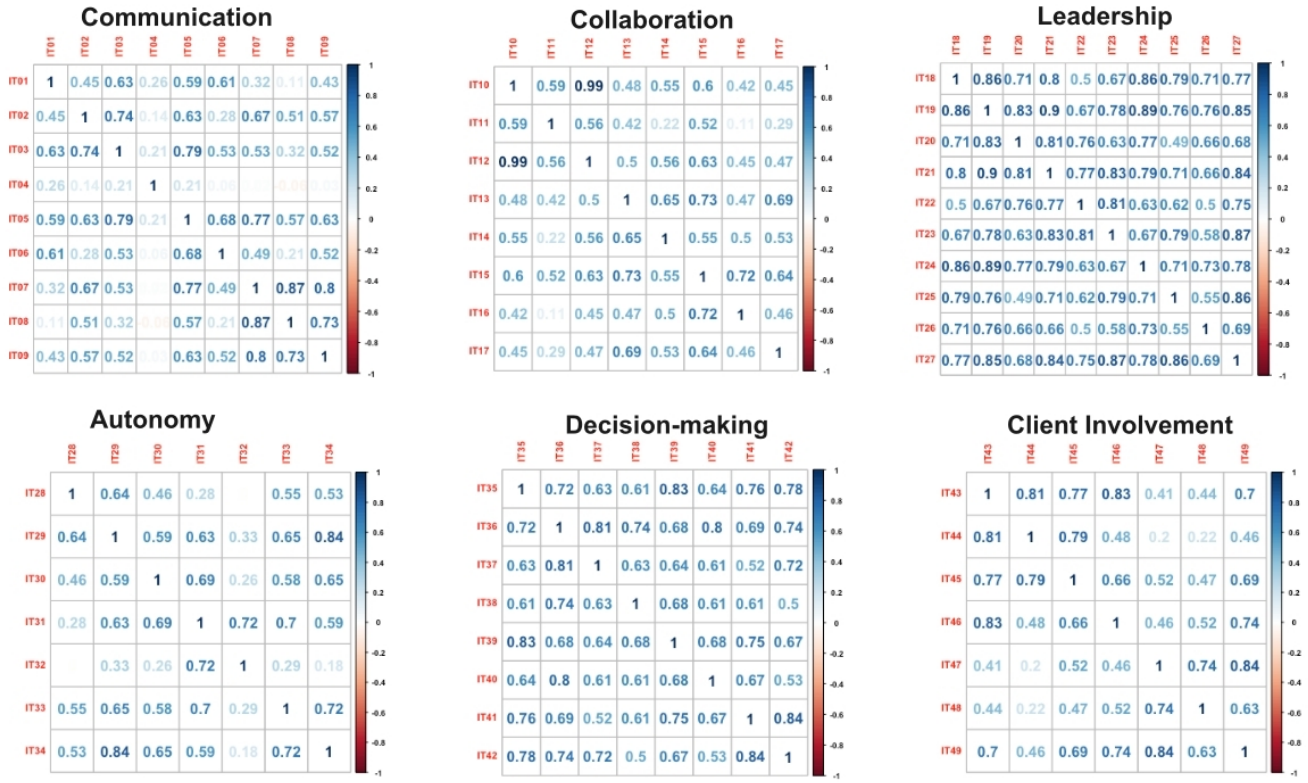

Figure 3. Correlation matrix of the dimensions

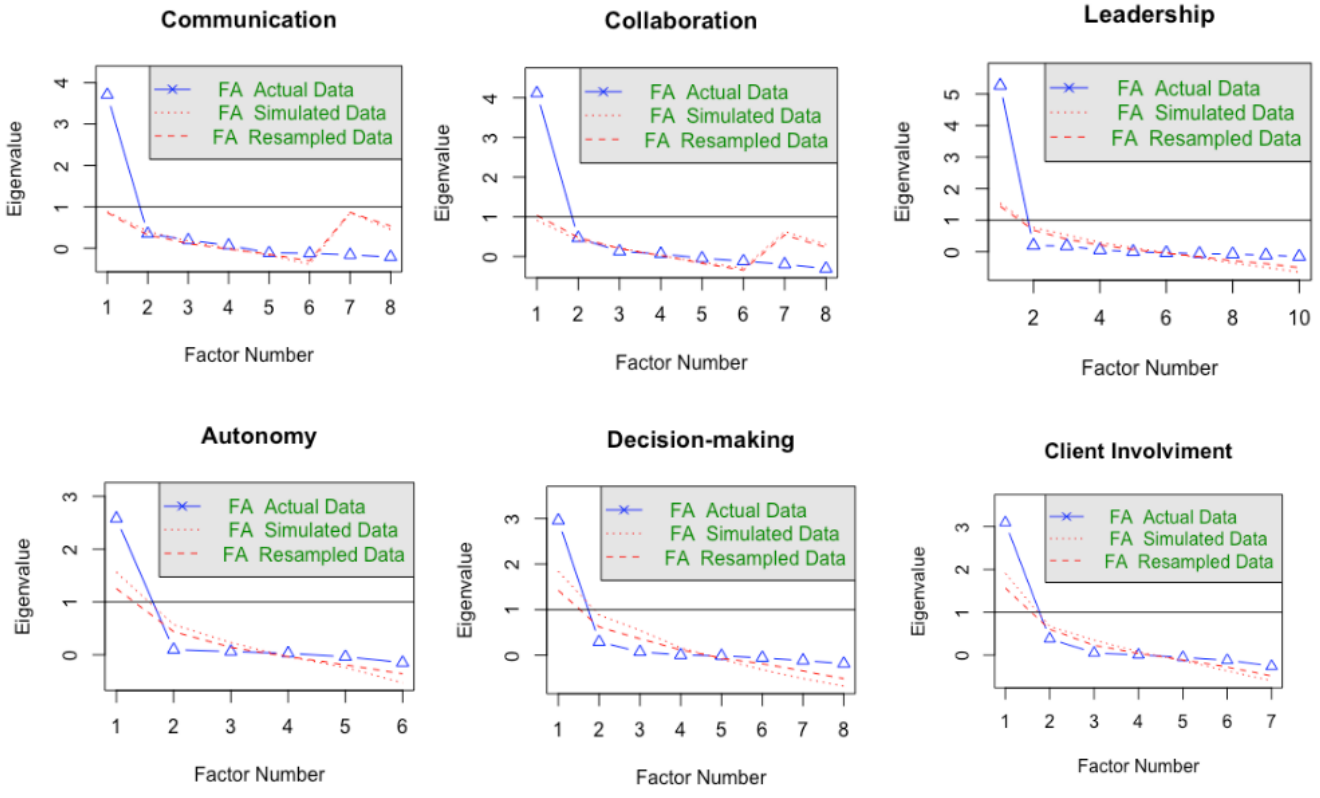

Figure 4. Parallel Analysis graphic

Table 3. Quantitative analysis results

Dimension	Item	λ
Communication	IT03	0.823
	IT05	0.760
	IT09	0.703
	IT01	0.686
	IT07	0.682
	IT08	0.606
KMO = 0.75	IT06	0.603
α = 0.9	IT02	0.543
Collaboration	IT12	0.883
	IT15	0.842
	IT10	0.800
	IT13	0.694
	IT11	0.632
	IT14	0.622
KMO = 0.67	IT17	0.618
α = 0.9	IT16	0.579
Leadership	IT21	0.858
	IT19	0.813
	IT20	0.745
	IT23	0.739
	IT27	0.728
	IT24	0.721
	IT22	0.698
	IT26	0.668
KMO = 0.85	IT18	0.665
α = 0.97	IT25	0.585
Autonomy	IT29	0.827
	IT28	0.702
	IT33	0.680
	IT30	0.610
KMO = 0.63	IT31	0.553
α = 0.95	IT34	0.514
Decision-making	IT39	0.827
	IT36	0.672
	IT42	0.651
	IT37	0.625
	IT40	0.563
	IT38	0.547
KMO = 0.7	IT41	0.491
α = 0.94	IT35	0.387
Client Involvement	IT45	0.792
	IT46	0.746
	IT43	0.731
	IT44	0.731
	IT49	0.720
KMO = 0.74	IT48	0.452
α = 0.94	IT47	0.337

and y-axis represents the "Eigenvalue"). As per the Kaiser criterion, only factors with eigenvalues greater than 1 can be retained (Kaiser, 1960). The data simulated by the Parallel Analysis confirmed the hypothesis of retaining one factor by dimension. As shown in Figure 4, all dimensions can be explained by a single factor.

The FA was performed separated for each dimension to verify the more significant items. Table 3 shows the quantitative results. Analyzing the column "Dimension" (Table 3) and the first line "Communication", it is possible to verify that the items are ordered by significance. The Factor loading (λ) (third column of Table 3) indicates the correlation of the item for the associated dimension. Regarding the small sample size, Field et al. (2012) argue that if a factor has four or more loadings greater than .6 then it is reliable regardless of sample size.

Analyzing the Communication dimension (Table 3), the items IT03 (λ = 0.823) and IT05 (λ = 0.760) have the highest factor load, and they can be considered the most significant ones. Therefore, for effective communication, the team should consider empathic listening (IT03) and ensure the necessary discussions on possible decision-making agreed during the retrospectives (IT05). For the Collaboration dimension, items IT12 (λ = 0.884) and IT15 (λ = 0.842) have the highest factor load, and they can be considered the most relevant. The IT12 represents that the team should work efficiently together to solve problems, and the IT12 the collaboration to innovation.

In the Leadership dimension, item IT21 is highlighted. The item IT21 (λ = 0.858) measures the activities of the team leader in discussing the problems and impediments of the team. The facilitator's behavior in protecting the team autonomy from external interference IT29 (λ = 0.827) has a high correlation to other items to the Autonomy dimension. For effective Decision-making, the teams should have open and effective communication IT39 (λ = 0.827). Lastly, for dimension Client Involvement, the item IT45 (λ = 0.792) represents the opportunity of stakeholders to suggest changes or improvements to the software.

We calculated the reliability (see Table 3) of TACT dimensions using the α-Cronbach coefficient (Landis and Koch, 1977). The α-Cronbach indexes for each dimension are $\alpha >$ 0.8, which implies the reliability of TACT for this case study is high (Landis and Koch, 1977).

6 Discussion

6.1 Case Study

We execute a case study to assess TACT preliminarily. TACT has 49 items to assess the climatic dimensions of Communication, Collaboration, Leadership, Autonomy, Decision-Making, and Client Involvement in agile development teams. The case study was carried out with three teams working at a bank. The climate assessment took place during a period in which teams that were previously physically allocated together were instead conditioned to work from home. In addition to the items established in TACT, open-ended questions were used to understand the challenges faced by members working from home. In the end, we conducted interviews with the leaders to understand the possible causes or impacts of the items evaluated.

Analyzing the frequency of responses attributed to the items by the members, the answers to the open questions and the data from the interviews, there are signs of a positive organizational climate in Teams B and C. On the other hand, there are signs of a negative organizational climate in Team A. Thereby, negative and neutral frequencies were observed

in some items, which can represent points of attention.

Communication, collaboration, autonomy, and decision-making are critical human factors in agile software development teams because members use them to plan and execute iterations, besides periodically adjusting the process or the team's behavior (Chagas et al., 2015; PMI and Agile Alliance, 2017). Regarding the Communication, Collaboration, Autonomy, and Decision-making dimensions, there were positive frequencies for the relationship between the members of each team (e.g., IT03, IT11, IT12, IT28, IT31, and IT38). However, negative and neutral frequencies point to possible difficulties in Team A when collaboration, communication, autonomy, and decision-making involve the roles of the product owner (IT33 and IT49) and the facilitator (IT09, IT17, and IT29) and, also, agile ceremonies (IT08 and IT34) and artifacts (IT02 and IT08).

Team A abandoned or mischaracterized some agile practices while working from home, for instance, the daily meeting (IT07). Regarding the artifacts, the team was not communicating some impediments to the leader (IT02) and both the product owner and the team were not adapting the requirements for the user story format (IT08 and IT16), due to the contract with the software factory, which established the requirement in another format for payment estimates. Another critical factor identified in Team A was the inability of the product owner to establish requirements according to the team's speed and capacity (IT17). Thus, although the collaboration between team members was classified as positive in Team A, the relationship with the product owner and the team facilitator reflected points of attention, which can be observed in the statement from one member: *"the agile methodology is being abolished in our team"*.

As previously stated, leadership is one of the central elements for forming the organizational climate (Schneider et al., 2014). The main activities of the servant leader can be summarized in (i) remove team impediments and (ii) facilitate, disseminate, and ensure the use of agile values, practices, and rules (Noll et al., 2017; PMI and Agile Alliance, 2017). Concerning leadership, during the interview, the leader of Team A clarified the negative assessment for item IT19, "*I follow it closely when I am called, when I am needed"*. In Team B, TACT captured a closer relationship between the leader and the team. However, when the leader of Team B analyzed the neutral points of IT19, she made the following statement: *"I have not been able to dedicate myself, to be the Scrum Master that I was [before working from home]. The agility factor has been the greatest challenge, solving impediments faster. I need to do things that I still have not managed to"*.

The challenges captured in several reports did not point out new insights about working from home for the dimensions investigated. Concerning the challenges, the team members reported *"The challenges are the same as those that existed before working from home", "There are no new problems in working from home. They [the challenges] existed before"*, and *"the current moment of working from home has not brought any new challenges so far(...)"*. It is worth noting that, according to the report by the process coordinator, the quality and performance indicators are the same as before working from home began. Supporting the report of the process coordinator, Serrador et al. (2018) claim that it is often argued that teams allocated in the same physical space have a better performance, a greater success in the project. However, the authors also did not identify a significant difference between local and remote teams in the study on the climate for the success of development projects (Serrador et al., 2018).

6.2 Preliminary evaluation of TACT

The literature recommends implementing a pilot study for the initial assessment of instruments that measure behaviors, attitudes, or feelings (Dybå, 2000; Patterson et al., 2005; Shahzad et al., 2017; Recker, 2013). The pilot must utilize a sample with the same characteristics as the target population (Anderson and West, 1998; Dybå, 2000; Shahzad et al., 2017; Patterson et al., 2005; Recker, 2013). On TACT, we decided to carry out the preliminary assessment through a case study because we wanted to capture the perception of the teams' climate in different data sources. The results and analysis presented in the previous sections established a chain of evidence that allows us to infer that TACT can capture the context of organizational climate experienced in the teams.

In the evaluation by specialists (see Section 3.3), every TACT item related to agile software development teams was considered. This assessment is already evidence of the content validity of TACT.

In a qualitative analysis (see Section 5.2), the leaders confirmed that the items represent agile values, principles, and practices. Through the dimensions of TAM (Venkatesh and Davis, 2000; Venkatesh and Bala, 2008), leaders rated TACT positively for Intention to Use, Perceived Usefulness, and Output Quality.

In quantitative analysis, the correlation matrix (Figure 3) revealed a high and moderate positive correlation between most of the items of each dimension. Only the items IT04 and IT32 showed an insignificant correlation with the other dimension items. Thus, we excluded IT04 and IT032 from the Factor Analysis. Development teams that talk about the subject of IT04 reported a positive emotion, contributing to the group's optimism (Licorish and MacDonell, 2014). However, Team A members understood that talking about these issues would be a negative behavior when Team A analyzed the results. This misinterpretation may have been caused by the description of the item "IT04. Team members FREQUENTLY talk about club (...)". Regarding IT04, leader Team C said, *"perhaps the word 'frequently' caused the misunderstanding"*. Considering quantitative analysis and the reports, we excluded IT04 of TACT. We have not captured reports of misinterpretation on item IT32. The low correlation may be relative to the sample and not to the construct. Thus, we opted to keep IT32 in TACT.

Factor Analysis allowed, based on the response patterns, to verify the proposed structure of TACT, i.e., the associated items in each dimension. The Parallel Analysis graph (Figure 4) indicated that a single factor could explain all dimensions. Furthermore, most TACT items have high (> 6) factor loadings (see Table 3). Therefore, there is initial empirical evidence that the structure proposed in TACT is acceptable.

Quantitative analysis revealed high reliability of the TACT dimensions (see Table 3). The α-Cronbach indexes for each

dimension are $\alpha > 0.8$, which implies the reliability of TACT for this case study is high (Landis and Koch, 1977).

6.3 TACT use recommendations

Wagner et al. (2020) recommend that Software engineering research should either adopt or develop psychometrically validated questionnaires. We extend that recommendation to the companies that realize organizational climate assessment. Validating a climate instrument without selling intent is challenging because it is necessary to find companies or persons willing to invest their time answering a questionnaire without a counterpart. We highlight that all evidence of validity and reliability are conditioned to the date this research was conducted, i.e., the more investigations are executed using TACT, the more evidence of validity and reliability there will be. Thereby, TACT items can be used by researchers who want to measure proposed constructs or investigate other possible factor structures.

The organizational climate is measured through manifested behaviors or perceived feelings by the employees. Climate instruments are self-reports. Only the team member knows how he is feeling. Although many factors can skew team member's views, when several individuals point in the same direction, a point of investigation is revealed. For example, if an item with too many negative ratings might indicate a lack of practice, a specific problem, or a misunderstanding about the agile mindset. Therefore, climate instruments only allow for a pre-diagnosis of what must be investigated and dealt with in the later stages of the Organizational Climate Management process.

Organizational climate instruments measure some latent variables (those that are not directly observable). TACT items represent examples of good behaviors or practices widely used in agile software development teams. Therefore, team leaders, managers, or the responsible for preparing and conducting organizational climate assessments can use the TACT items for a more accurate diagnosis. If a specific item has many neutral or negative evaluations, an investigation point is revealed. For example, the assessment of item "IT35. My team has time to plan the changes without excessive stress or pressure" shows how the team member feels (stressed/pressured) and suggests what project activities or situations (such as interaction planning, task estimation, abusive or unrealistic deadlines given by PO or manager) might be the cause of that feeling. Notice that terms in the item description (for example, *plan, stress*, and *pressure* in IT35) allows team members to reflect on how they are feeling about the day-to-day events.

To create every TACT items description, we used generic nomenclatures for roles and practices used in hybrid and agile processes. Scrum is the most used agile methodology (Digital.ai, 2020). However, we do not use the names of the roles or ceremonies from Scrum, e.g., we use Team Facilitator, Iteraction, and Meeting Review instead of Scrum Master, Sprint, and Sprint Retrospective. By doing that, we expect to reach more teams using different process configurations. Thereby, if TACT is used by a team where the software development process has other names to roles or ceremonies or still does not have a specific role, the team members can misunderstand the items. To address this limitation and threat, at the beginning of the climate survey, we show the vocabulary of terms used in TACT compared with Scrum terms.

Regarding the number of items and time interval of the application of TACT, based on a previous study (Dutra and Santos, 2020), we claim that using many items and having a long time interval in the organizational climate survey in agile teams can hinder the assessment, diagnosis, and establishment of actions to climate management. Having too many items in climate surveys and the lack of control activities can also demotivate the team member's participation in new climate surveys. In that regard, we recommend that practitioners adopt one or two dimensions by cycle, performing several cycles per year. However, more critical than measuring the organizational climate is involving the team in discussions of possible actions that allow a climate change. A simple open-ended question that can help team engagement in climate management is "How to improve your team's organizational climate?".

7 Limitations and Threats to Validity

The research procedures used in this study are adequate to build an organizational climate instrument, but we faced some limitations. The main one concerns the small sample size. As mentioned in Section 5.3, the quantitative procedures have an initial exploratory purpose. Due to the small sample size, the use of Factor Analysis (FA) is not possible without segregating the data. Due to that, we conducted FA by each TACT dimension. In future studies (see Section 8.1), we will perform Exploratory and Confirmatory FA. In Pulse 3, only 4 out of 9 Team A members answered the survey. The number of participants can hinder Team A's organizational climate assessment because the four respondents may have the same perspective of the team organizational climate while the other members of Team A that did not participate in Pulse 3 would have another perspective. The Team leader A interview helped us confirm the results and deal with this limitation.

Recker (2013) proposes some principles for evaluating qualitative and quantitative studies.

Concerning *reliability*, a contextual description of the organization was presented as well as direct quotes from team members and leaders which were considered to support the analysis. Thus, it is possible to guarantee that individuals other than the researchers, when considering the same observations or data, will reach the same or similar conclusions (Recker, 2013). From a quantitative point of view, an investigation was carried out to assess the study's reliability, using descriptive statistics, correlations, and Cronbach's α coefficient. Thus, the reliability of TACT dimensions for the case study sample is high.

To address possible threats to *internal validity*, we decided to use multiple sources of evidence. The team members assessed the organizational climate through the TACT items and open-ended questions. In addition, the leaders' perceptions were captured through interviews. In this way, a chain of evidence was established, and the review of the evaluation results was assured (which also relates to measurement

validity). Regarding TACT, two auditors experienced in agile methods and the leaders in the study assessed whether the item descriptions represented elements of agile values, principles, and practices.

External validity concerns how much and when the results of a study can be generalized to other cases or domains (Recker, 2013). To mitigate this threat, we provide detailed descriptions of the study context. However, Schneider et al. (2014) claim that everything that happens in the organization changes its climate. Thus, it is not possible to guarantee similar results in another cycle in the same examined teams or even in other teams of the same organization.

8 Final Considerations

We presented the initial version of TACT (*insTrument to Assess the organizational ClimaTe of agile teams*), designed to measure the dimensions of Communication, Collaboration, Leadership, Autonomy, Decision Making, and Client Involvement. We also presented a case study to evaluate TACT and measure the organizational climate of three agile teams from the same organization. Data collection included TACT results, interviews with team leaders, and answers to open-ended questions by the participants.

The sample data revealed a positive organizational climate for all dimensions in teams B and C and negative for Autonomy, Decision Making, and Client Involvement dimensions for team A. Thereby, some items assessed as negative or neutral indicated points of attention. Through open-ended questions and interviews with leaders, the evaluation carried out through TACT was confirmed and the points of attention were better explored. We identified the abandonment of some agile ceremonies, difficulties in planning the iteration, the inability of the product owner to keep up with the speed and capacity of the team, and even the absence of leadership. Based on the statistical analysis of the data from assessing the organizational climate, there is an initial evidence that the validity and reliability of TACT dimensions are high.

8.1 Future works

Besides the TACT dimensions proposed in the present study, we are investigating new constructs: Motivation, Trust, Learning, and Knowledge. Other case studies are being executed to assess the climate of the same three teams mentioned in this study and other four teams of another organization.

After finishing the case studies cycle, we will execute a survey to investigate and validate the factorial structure of all TACT dimensions. We will use Exploratory and Confirmatory Factor Analysis to investigate and confirm the measured dimensions. As a result, TACT dimensions and items will likely be reduced. After conducting the survey, we will have the means to create guidelines for using TACT and interpret the results.

We also intend to investigate the influence of gender, team size, and team members' experience on agile methodologies in the organizational climate. Moreover, in the future, there might be some value in digging deeper into an investigation on whether the organizational climate of employees and outsourced team members differs.

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A Appendix

A.1 Constructs

Construct Communication

- **Conceptual definition**
  - Frequent communication between project stakeholders is core to agile software development (Chagas et al., 2015; Chagas, 2015).
  - "The perception of participatory safety could encourage team members to be open in communicating their ideas with the team, which could otherwise be risky" (Ganesh, 2013).
  - Vishnubhotla et al. (2018) reported "the 'insider' voices of Scrum practitioners about the soft skills they consider most valued to have by product owner and scrum master. Communication skills and teamwork were most valued for both roles. Besides them, customer orientation was expressed as important for program managers, whereas commitment, responsibility, interpersonal and planning skills were considered valuable for scrum masters".
  - "Gap in communication between developer and customer can guarantee the success of the project while in contrast lack of communication skill causes project problems" (Askarinejadamiri, 2016).

- **Operational definition**
  - Communication is a capability for the team member (Vishnubhotla et al., 2018).
  - Communication is an attribute for team (Vishnubhotla et al., 2018).
  - The team has formal and informal communication (Dybå and Dingsøyr, 2008).
  - The team discusses the project and impediments (Moe and Dingsøyr, 2008; PMI and Agile Alliance, 2017).
  - The team discusses how to improve the process and the project (Moe and Dingsøyr, 2008; PMI and Agile Alliance, 2017).

Construct Collaboration

- **Conceptual definition**
  - "Team collaboration is a set of functions and activities carried out before, during, and after teamwork to achieve team objectives" (Açikgöz, 2017).
  - "Customer collaboration over contract negotiation" (Beck et al., 2001).
  - "Communication and collaboration (C&C) are at the heart of agile software development. As the Agile Manifesto states, 'individuals and interactions over processes and tools' and 'customer collaboration over contract negotiation. One aspect in C&C is customer cooperation" (Karhatsu et al., 2010).

- **Operational definition**
  - Team collaboration involves communication and coordination (Karhatsu et al., 2010).
  - Collaboration involves work as a team with i) the client (or their representative), ii) the team, and iii) others stakeholders (Açıkgöz et al., 2014; Chagas et al., 2015; Vishnubhotla et al., 2018).

Construct Leadership

- **Conceptual definition**
  - The leadership (in agile projects) is based on the role of the servant leader (PMI and Agile Alliance, 2017).
  - "Team leadership plays a significant role in improving interpersonal and group processes within the team. Team leaders who play the role of 'communication integrators' are very crucial for the success of the team. The team leader should also ensure periodically whether the members are clear with the team objectives and understand their level of agreement with those objectives" (Ganesh and Gupta, 2006).
  - "Agile software engineering adopts a leadership style that empowers the people involved in the development process" (Chagas, 2015).

- **Operational definition**
  - Leadership is played by a formal role (PMI and Agile Alliance, 2017; Noll et al., 2017).
  - The leader facilitates ceremonies, removes impediments, and shields the team from outside interference (PMI and Agile Alliance, 2017; Noll et al., 2017).
  - The leader is a "communication integrator" (Ganesh and Gupta, 2006).

Construct Autonomy

- **Conceptual definition**
  - "The autonomy of a team is defined as the ability to continue to operate in its own way without external interference. The role of formal authority is redesigned, so that governance and coordination appear to be the outcome of actions of networks, operating without any formal sanction" (Annosi et al., 2020).

  - "Autonomy refers to the authority and responsibility that a team has in their work. It is a significant factor for team effectiveness. A team must have a real possibility to influence relevant matters; otherwise self-organization is more symbolic than real. On the other hand, a team should not be left completely alone. Instead, while management should give a team substantial freedom, it should maintain subtle control and have regular checkpoints. Three levels of autonomy are external, internal, and individual. The external refers to the degree that the people outside of a team influence the team's decisions. Moreover, it sets the decision-making boundaries for the team. Meanwhile, internal autonomy defines how the work is organized inside the team. The team may have substantial power to make decisions while some individuals have none. Great care should be taken to make sure that there really is internal autonomy instead of, for example, team leader autonomy. Finally, individual autonomy, on its part, tells how much an individual has freedom to decide about his or her own work processes" (Karhatsu et al., 2010).

- **Operational definition**
  - Individual, internal, and external autonomy (Karhatsu et al., 2010).
  - The team planning the tasks (Karhatsu et al., 2010).
  - The leader protects the team (Noll et al., 2017; PMI and Agile Alliance, 2017).
  - The team has good communication with the client (Moe et al., 2008).

Construct Decision-Making

- **Conceptual definition**
  - "Responding to change over following a plan" (Beck et al., 2001).
  - "At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly" (Beck et al., 2001).
  - "Software development involves interdependent individuals working together to achieve favorable outcomes, so the decision-making behavior of each individual will influence behaviors of other teammates and the project outcome. Individuals have many chances to make a decision in a development process. For example, individuals may choose a resolution to deal with a conflict. In agile development, each one makes a decision about effort estimation and gives user story points. Individuals may often independently make 'work' or 'shirk' choices in teamwork. Under these conditions, different individual decision-making behaviors will generate different results, which are pertinent to the success or failure of the project" (Jia et al., 2016).
  - "Product development teams quite often experience problems, barriers and setbacks during the new product development project, which require an immediate and effective decision process to generate sufficient courses of action. Decision processes refer to team members' collective efforts to process knowledge about key task-related components, emerging issues and problems. Individual creativity represents a possible contribution to the teams to deal with these difficulties. Moreover, creativity-based decision processes likely allow the teams to become more proactive when dealing with emerging issues. Indeed, product development teams have to think outside the box when making decisions, as well as offer practical solutions for problems that can be implemented beyond organizational constraints. Such a process is characterized by the ability to understand complexity, to break through prevailing cognitive patterns, and to try new paths when old sets do not work" (Açıkgöz and Gunsel, 2016).

- **Operational definition**
  - Task identity and significance (Jia et al., 2016).
  - The member perceives recognition of management and leadership (Jia et al., 2016).
  - The team has fast and effective communication (Chagas, 2015; Chagas et al., 2015).
  - The team plains the project without stress or pression (Jia et al., 2016).
  - The team shares decision-making (Chagas, 2015; Chagas et al., 2015).
  - The team autonomy influences decision-making (Chagas, 2015; Chagas et al., 2015).

Construct Client Involvement

- **Conceptual definition**
  - Having a client focus is one of the main aims of an agile team (Karhatsu et al., 2010).
  - "Customer collaboration over contract negotiation" (Beck et al., 2001).
  - "Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely" (Beck et al., 2001).
  - "Lack of client involvement is 'the biggest problem' because Agile [requires] fairly strong client involvement" (Karhatsu et al., 2010).
  - "Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage" (Beck et al., 2001).

- **Operational definition**
  - Client satisfaction, collaboration, and commitment are features of client involvement. (Jia et al., 2016).
  - A good relationship with users/clients is a motivating aspect for the team (Franca et al., 2011).
  - The client (or their representative) provides and elucidates requirements (Dybå and Dingsøyr, 2008).

– The client (or their representative) validates the software (Dybå and Dingsøyr, 2008).

A.2 The items of TACT by dimension

Table 4. Items used to measure the Communication dimension

Items	Source
IT01. In this team, we can freely talk to each other about difficulties we are having	Stewart and Gosain (2006)
IT02. The team keeps the list of impediments, risks and control actions updated #	Anderson and West (1998); Miller (2020); PMI and Agile Alliance (2017)
IT03. My opinion is always listened to by my team	Anderson and West (1998)
IT04. Team members frequently talk about club, entertainment, gym, parties, sports, and films # *	Anderson and West (1998); Licorish and MacDonell (2014); Shahzad et al. (2017)
IT05. During the retrospectives, the team finds the best way to do things #	Chagas et al. (2015); Chagas (2015); González-Romá et al. (2009)
IT06. The team knows the skills and technical expertise of team members, and they use the skills and technical expertise appropriately and adequately #	Nianfang Ji and Jie Wang (2012)
IT07. In the current project, the daily meeting allows to know project problems and team difficulties #	Chagas et al. (2015); Dybå and Dingsøyr (2008)
IT08. The team and the product owner always reach consensus on the priority of the user stories by negotiating which bug to fix or functionality to add #	Chagas (2015); Nianfang Ji and Jie Wang (2012)
IT09. In the current project, the team and the product owner always solve the disagreements about the iteration scope #	Miller (2020); Noll et al. (2017)

Represents original items

Table 5. Items used to measure the Collaboration dimension

Items	Source
IT10. Team members consider sharing know-how with each other	Lee (2001)
IT11. Team members always help each other when there is a need	Shahzad et al. (2017)
IT12. My team works efficiently together when in the face of difficulties	Açikgöz (2017); Shahzad et al. (2017)
IT13. Team members work together as a whole	Anderson and West (1998)
IT14. All project-related decisions are applied consistently across to affected team members	Anderson and West (1998)
IT15. The team collaborates to look for new ways to analyze the problems #	Patterson et al. (2005); Vishnubhotla et al. (2018)
IT16. The team has excellent ability to design the software based on user stories #	Açıkgöz et al. (2014); PMI and Agile Alliance (2017)
IT17. In the current project, the team, the product owner, and team facilitator work excellently together to plan the iteration #	Dybå and Dingsøyr (2008); Noll et al. (2017)

Represents original items

Table 6. Items used to measure the Leadership dimension

Items	Source
IT18. The team facilitator gives me helpful feedback on how to be more effective	Sharma and Gupta (2012)
IT19. The team facilitator eliminates barriers, encourages, and facilitates the use of agile methods #	Noll et al. (2017); Senapathi and Srinivasan (2013)
IT20. The team facilitator listens to my ideas and concerns	Sharma and Gupta (2012)
IT21. The team facilitator discusses the problems of the team	Açıkgöz and Ö. İlhan (2015)
IT22. The team facilitator protects the team from outside interference	Ancona and Caldwell (1992)
IT23. The team facilitator helps my team to acknowledge and solve our disagreements	Stone and Bailey (2007)
IT24. The team facilitator assists to understand whether the iteration objectives are clear and whether the team agrees with these objectives #	Ganesh and Gupta (2006); PMI and Agile Alliance (2017)
IT25. The team facilitator gives the team helpful feedback on how to be more agile #	PMI and Agile Alliance (2017); Sharma and Gupta (2012)
IT26. The team facilitator is always free to support the team when business requirements conflict with the technical reality #	Noll et al. (2017); PMI and Agile Alliance (2017)
IT27. The team facilitator investigates and helps the team to be more effective, taking into account the team velocity and the team capacity #	Chagas et al. (2015); Miller (2020); Noll et al. (2017)

Represents original items

Table 7. Items used to measure the Autonomy dimension

Items	Source
IT28. In the current project, I am free to choose the tasks I want to execute in the iteraction #	Karhatsu et al. (2010)
IT29. In the current project, the team facilitator protects the team autonomy from external interferences #	Karhatsu et al. (2010); Moe and Dingsøyr (2008)
IT30. In this organization, we have the autonomy to suggest change the team's software process development #	Patterson et al. (2005)
IT31. In this team, we switch assignments in tasks to avoid specialization and individualism #	Moe and Dingsøyr (2008); Chagas (2015)
IT32. The team has autonomy to adopt technical solutions without consulting the product owner or the management #	Patterson et al. (2005)
IT33. My team has autonomy to communicate with the product owner and other relevant stakeholders #	Moe and Dingsøyr (2008); Chagas (2015)
IT34. My team has decision authority and responsibility to plan the iteration #	Karhatsu et al. (2010); PMI and Agile Alliance (2017)

Represents original items

Table 8. Items used to measure the Decision-Making dimension

Items	Source
IT35. My team has time to plan the changes without excessive stress or pressure #	Jia et al. (2016); Kettunen (2014)
IT36. In my team, members must NOT need to think equally #	Chagas (2015); McAvoy and Butler (2007)
IT37. In the iteration planning, the team analyzes the technical alternatives and chooses the most appropriate one #	Chagas (2015); Moe et al. (2009); PMI and Agile Alliance (2017)
IT38. In the retrospective, the team identifies, analyzes and selects improvement items #	Jia et al. (2016); PMI and Agile Alliance (2017)
IT39. My team has open and effective communication #	Misra et al. (2009)
IT40. This organization allows the team to make their own technical decisions about the best way to develop the project #	Patterson et al. (2005); Chagas (2015)
IT41. The dependencies between the tasks do NOT hinder the fluidity of the project and do NOT cause major restrictions #	Jia et al. (2016); PMI and Agile Alliance (2017)
IT42. In the current project, my work is recognized by management #	Jia et al. (2016)

Represents original items

Table 9. Items used to measure the Client Involvement dimension

Items	Source
IT43. During the demo review, the team shows and validates the new functionalities with the right people #	Ancona and Caldwell (1992); PMI and Agile Alliance (2017)
IT44. In the current project, there are frequent meetings with business representatives and the team	Serrador et al. (2018); Zaineb et al. (2012)
IT45. Stakeholders always have the opportunity to suggest changes or improvements to the software #	PMI and Agile Alliance (2017)
IT46. In the demo review, project problems and improvements are identified with stakeholders participation #	Serrador et al. (2018); PMI and Agile Alliance (2017)
IT47. The current project does NOT have frequent requirement changes due to bad user stories definition #	Sharma and Gupta (2012); Ahmed et al. (2017)
IT48. The current project has met or exceeded the client expectations #	Misra et al. (2009); Ahmed et al. (2017)
IT49. The product owner is always available to explain the user stories' details #	Hoda et al. (2010); PMI and Agile Alliance (2017)

Represents original items