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An Instrument to Assess the Organizational Climate of Agile Software Development Teams

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ABSTRACT

Background: Agile methods are associated with values, principles, and practices that influence the organizational climate. Organizational climate assessments can provide concrete evidence of how the process, project activities, people, and culture work in practice. *Motivation:* Measuring the organizational climate of agile teams is a challenge for practitioners, mainly due to the scarcity of specific instruments for the agile context. Not assessing specific human factors that contribute to the formation of agile the teams' climate inhibits the capacity for an assertive diagnosis, entailing difficulties for analyzing possible causes of problems and the execution of corrective actions within climate management. *Objective:* We aim to investigate how to support the organizational climate assessment of agile teams considering the influence of human factors. *Method:* Design Science Research (DSR) was used to develop TACT ("insTrument to Assess the organizational ClimaTe of agile teams"). We performed a Qualitative Study, a Tertiary Study, and a Systematic Lite-rature Review (SLR) to establish, refine, and delimit the DSR project elements, e.g., problem, requirements, acceptance criteria, and knowledge base. Three case studies were performed to evaluate and identify improvement points in TACT. Finally, a survey was conducted to validate TACT's factor structure. *Result:* In the Tertiary Study, we identified 38 human factors that influence the Teams' Climate. From the SLR, the psychometric properties of 19 climate measures representing more than 80 dimensions involving a variety of constructs were investigated. TACT was grounded in the most critical human factors that influence agile development: Communication, Collaboration, Leadership, Autonomy, Decision-making, Client Involvement, Trust, Knowledge, Learning, and Motivation. Agile specialists have confirmed that TACT items are simple to understand and consistent with agility. The practitioners reported a future intention to use TACT. Based on the results, the most critical human factors influencing the climate team are (i) the collaboration among the team members to solve day-to-day problems highly affects the team's climate for learning, (ii) involvement among the Product Owner and team members in iteration planning greatly influences the team's climate toward colla-boration, and (iii) how quickly the team responds to the necessary changes and the autonomy in decision-making about the planning strongly influences the team's motivation. *Conclusion:* The results revealed that the TACT has good psychometric properties and provides professionals and researchers with a robust means to assess the ten critical dimensions for agility through

team members' perceptions of the process, the project, the typical roles in the agile context and the behaviors expected by the agile team members.

Keywords: Human Factor Influence, Organizational Climate, Agile Team Climate Assessment, Agile Software Development Teams.

RESUMO

Contexto: Métodos ágeis são associados a valores, princípios e práticas que influenciam o clima organizacional. Avaliações de clima organizacional podem fornecer evidências concretas de como o processo, as atividades do projeto, as pessoas e a cultura funcionam na prática. *Motivação:* Medir o clima organizacional de equipes ágeis é um desafio para os profissionais, principalmente pela escassez de instrumentos específicos para o contexto ágil. A não avaliação de fatores humanos específicos que contribuem para a formação do clima das equipes ágeis inibe a capacidade de um diagnóstico assertivo, acarretando dificuldades na análise das possíveis causas dos problemas e na execução de ações corretivas na gestão do clima. *Objetivo:* O objetivo central da tese é investigar como apoiar a avaliação do clima organizacional de equipes ágeis considerando a influência de fatores humanos. *Método:* Design Science Research (DSR) foi utilizado para desenvolver o TACT (do inglês *"insTrument to Assess the organizational ClimaTe of agile teams"*). De uma forma geral, executou-se um Estudo Qualitativo, um Estudo Terciário e uma Revisão Sistemática da Literatura (RSL) para estabelecer, refinar e delimitar os elementos do projeto DSR, por exemplo, problema, requisitos, critérios de aceitação e base de conhecimento. Três estudos de caso também foram realizados para avaliar e identificar pontos de melhorias no TACT. Por fim, foi realizada uma pesquisa de opinião para validar a estrutura fatorial do TACT. *Resultados:* No Estudo Terciário, identificou-se 38 fatores humanos que influenciam o clima das equipes. A partir da RSL, investigou-se as propriedades psicométricas de 19 medidas de clima que representam mais de 80 dimensões envolvendo uma variedade de construtos. O TACT foi fundamentado nos fatores humanos críticos para o desenvolvimento ágil: Comunicação, Colaboração, Liderança, Autonomia, Tomada de Decisão, Envolvimento do Cliente, Confiança, Conhecimento, Aprendizagem e Motivação. Especialistas em métodos ágeis confirmaram que os itens do TACT são simples de entender e consistentes com agilidade. Líderes e outros envolvidos na gestão do clima de equipes ágeis relataram uma intenção futura de usar o TACT. Com base nos resultados, os fatores humanos mais críticos que influenciam o clima das equipes são (i) a colaboração entre os membros da equipe para resolver os problemas do dia-a-dia afeta fortemente o clima de aprendizado da equipe, (ii) o envolvimento entre o Dono do Produto e os membros da equipe no planejamento da iteração influencia muito o clima da equipe para a colaboração e (iii) a rapidez com que a equipe responde às mudanças necessárias e a autonomia para tomada de decisões sobre o planejamento influenciam fortemente a motivação da equipe. *Conclusão:* Os resultados revelaram que o TACT tem boas propriedades psicométricas e fornece aos profissionais e pesquisadores um meio robusto para avaliar as dez dimensões críticas para a agilidade por meio das percepções dos membros da

equipe sobre o processo, o projeto, os papéis típicos do contexto ágil e os comportamentos esperados pelos membros das equipes ágeis.

Palavras-chave: Influência dos Fatores Humanos, Clima Organizacional, Avaliação do Clima em Equipes Ágeis, Times Ágeis de Desenvolvimento de Software.

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List of Acronyms

APA	American Psychological Association
ASD	Agile Software Development
BSE	Behavioral Software Engineering
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
CVI	Content Validity Index
DSR	Design Science Research
ECQ	Ethical Climate Questionnaire
EFA	Exploratory Factor Analysis
FA	Factorial Analyses
MIS	Management Information Systems
OCM	Organizational Climate Measure
OCQ	Organizational Commitment Questionnaire
P-CMM	People Capability Maturity Model
PO	Product Owner
QA	Quality Assurance
QC	Quality Criteria
PMI	Project Management Institute
RMSEA	Root Mean Square Error of Approximation
RQ	Research Questions
RUP	Rational Unified Process
SE	Software Engineering
SEM	Structural Equation Modeling
SLR	Systematic Literature Review
SMS	Systematic Mapping Study
SRMR	Standardized Root Mean Square Residual
TACT	The insTrument to Assess the organizational ClimaTe of agile teams
TAM	Technology Acceptance Model
TCI	Team Climate Inventory
TLS	Tucker-Lewis Index
TSI	Team Selection Inventory
UI	User Interface
ULS	Unweighted Least Squares (ULS)
UX	User Experience
XP	eXtreme Programming method

1. Introduction

As follows, we present the introduction, the motivation, objectives, research questions, the research method approach, and the text structure organization of this thesis.

1.1 Context

In order to contextualize all the investigations proposed in this thesis, we start presenting the formal definitions of the main terms that supported all the discussions: human factors, organizational climate, and agile teams.

- **Human factor** is a physical or cognitive characteristic, or social behavior of a person [5].
- **Organizational climate** is the meaning employees attach to the policies, practices, and procedures they experience and the behaviors they observe getting rewarded, supported, and expected [6].
- **Agile team** is an organization or team using agile development and approaches [7].

Although the APA (American Psychological Association) Dictionary of Psychology classifies the human factors study [8] as a branch of psychology, the vast, contemporary interest of the community in the Software Engineering (SE) area has been incontestable concerning the investigating on human factors and their effects in agile software development teams [9, 10, 11, 12, 13], and the organizational climate [14, 11, 15, 13, 16]. Curtis et al. [17] suggested in the People Capability Maturity Model (P-CMM) that companies could use organizational climate surveys to identify each person's opinion on their working conditions. To assess the different organizational climate constructs, researchers

have developed several measures. These measures are denominated as scale, inventory, psychological test, questionnaire, or instrument. The organizational climate instrument assesses some latent variables (those that are not directly observable [18]).

Since the 1960s, psychology, administration, and other areas have investigated factors that influence the formation of organizational climate in workgroups [6]. Therefore, many people might wonder what is new to investigate in the climate of the teams. For example, in the nursing area, new measures have been developed and validated to assess the organizational climate considering the specific activities of nurses [19]. Schneider [20] has argued that the organizational assessment, to be helpful, has to be strategically focused - a "climate for something." In the Software Engineering area, several empirical studies have been performed to understand the influences of organizational climate, including personality [21], industry-academia collaboration [15], software quality [22, 23], team performance [24, 25, 14], problem solving [26, 27], collaboration [28], creativity [29], software project risks [30], and even in relation to the impact of organizational climate on the regularity of work speed of agile software development teams [31].

Many software organizations define their software development processes based exclusively on agile methodologies or hybrid strategies, i.e., a combination of traditional and agile practices [32, 33]. However, "being agile" does not depend only on the agile methodologies or practices adopted but on a set of factors that involve the rapid change in planning and active involvement of the customer [34, 35, 36]. Moreover, many problems are often hidden in the management layers and the bureaucracy of organizations [36]. The rapid change in iterations planning requires a high degree of autonomy, communication, cooperation, and self-organization from the team members [37, 10]. Besides, planning must consider the collaboration with the customer, considering the business value and team capacity [37]. Support, trust, and flexibility are required at all levels of management in the organization so that the planning is effective. Therefore, the path to agility involves, in addition to adopting practices, changing the team members' behavior, active customer involvement, and support and trust of all management levels at the organization.

Nevertheless, the adoption and use of agile values, principles, and practices can be negatively impacted by some issues, such as [38, 39]: lack of skills/experience with agile methods, minimal collaboration and knowledge sharing, the existence of hybrid project standards, inconsistent processes and practices across teams, inadequate management support and sponsorship. To understand these issues, one should seek agile team members' opinions on their working conditions. Organizational climate surveys can help with this matter. Also, it is noticed that conducting agile climate assessments can positively impact agile transformation journeys [40].

Organizational climate surveys can provide concrete evidence of how the process, project activities, people, and culture work in practice [41]. Usually, an organizational climate survey is operated through an instrument. In addition, it must be evaluated whether the instrument can provide reflections on the culture of the target audience [42]. The organizational climate survey captures the development team's perception, satisfaction, or preferences regarding their working conditions. A negative organizational climate can cause adverse effects on software development team members with regard to aspects such as motivation, the ability to make good decisions and willingness to innovate while also affecting a project's success [26, 21, 43]. Considering agile teams, organizational climate assessments allow, for instance, to identify the ineffectiveness of leadership, measure the autonomy, collaboration or communication of the team, identify the lack of support from the various levels of management, notice inconsistencies in the use of ceremonies, and capture the teams' preferences among the various existing practices or tools etc. [31, 43, 21, 44].

Both the industry and the academia have shown interest in the organizational climate and its effects on teams and organizations for decades [6]. That interest encompasses not only business or human resource management perspectives but also a Software Engineering perspective [15, 11]. Therefore, the organizational climate should be measured. Besides, proper organizational climate management can help organizations to gain a competitive advantage [6].

An effective organizational climate assessment depends on theoretically established items that address specific management demands for a period [45]. Many organizational climate assessments use items proposed in the first half of the 20th century [45, 6], which can impact their use by agile teams. Therefore, both the assessment process and instrument items should enable critical reflections on the team activities, the behaviors of those involved, the organization processes, and the culture.

1.2 Motivation

There is a rich understanding of how psychological climate is formed, and their mediators and antecedents elements [46, 6]. However, there exists little empirical evidence on the climate formation within either the software teams or organizational behavior literature about how it is developed [21, 46]. Vishnubhotla et al. [16] point out the need for further studies to investigate the influence of human factors on the organizational climate of agile teams.

The first step in assessing the organizational climate is identifying the constructs for measuring. For example, what it is really important to measure once the organizational climate involves a wide variety of constructs [47, 21, 31, 48], for instance, participation safety [49], recognition [50], leadership [31, 44], autonomy [47], or senior management support for agile project [43]. After selecting the construct, the professional or researcher should select the appropriate organizational climate measure. Some organizations choose to create or adapt their instruments [42]. This task can be effortless when the assessment involves measuring the organizational construct, e.g., career progress opportunities or pay and benefits. However, when the construct involves latent variables, e.g., motivation, innovation, trust, or decision-making, it is vital to select an instrument with good evidence of psychometric quality (i.e., good indices of validity and reliability) [18].

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 challenging to select instruments due to copyright reasons. Hiring a specialized consulting company can aid this process. However, Dutra et al. [45] report that many consulting companies do not disclose details of how the instrument was designed, its reliability, or the statistical procedures adopted for its validation. Identifying and analyzing instruments with good quality evidence can be a challenge for professionals and researchers. Furthermore, the monetary value involving rights to use instruments with the copyright can inhibit small companies from conducting out their climate survey or motivate them to build their questionnaire wrongly. On the other hand, several climate instruments have permission for scientific use. However, these instruments do not measure the critical factors to agility. That has led several researchers to adopt measures and create their items, disregarding the investigated construct theory.

Graziotin et al. [18] reported the abuse and misuse of psychological questionnaires in software engineering research, i.e., the inappropriate use, misunderstanding about the theory of the human factor constructs, and indiscriminate change in the description of instrument items. Wagner et al. [51] argue that software engineering research should favor the use of validated psychometric instruments. Only through evidence of validity and reliability of an instrument is it possible to understand the factor structure behind the construct used and whether the instrument measures what it intends to. We investigated the organizational climate instruments, models, or measures that were explicitly developed to assess the software development teams' environment (see Chapters 2 and 6). However, some of the identified measures were developed considering the managers' opinions without being validated by software team members (e.g., [43] and [30]). In other studies, authors did not perform procedures to investigate the validity and reliability of the evidence of

measures (e.g., [52] and [53]). An instrument for assessing the agile organizational climate grounded in the critical factors to agility, with good validity and reliability evidence, would undoubtedly improve measurement capability, providing a more accurate diagnosis of the practices and the culture involved in agility.

1.3 Objectives and Research Questions

This thesis' central objective is: Supporting the organizational climate assessment of agile teams considering the influence of human factors.

The central objective is decomposed into two specific ones:

- Investigating how human factors and other project elements can affect the organizational climate of agile software development teams;
- Developing an instrument to measure the organizational climate of agile teams that supports team leaders and those responsible for climate management.

To achieve these objectives, the following three research questions (RQ) are considered:

- RQ1: How to assess the organizational climate in agile teams?
- RQ2: How can human factors affect the organizational climate of agile software development teams?
- RQ3. How to support continuous organizational climate assessment in agile software development teams?

1.4 Research Method in a Nutshell

To fulfill the proposed objectives and answer the research questions, we developed and validated [1] an *"insTrument to Assess the organizational ClimaTe of agile teams,"* nominated TACT. This artifact was designed to consider the influence of human factors in

[1] Psychometric validity is, therefore, a different (but related) concept compared to the one of study validity that software engineers used to deal one with. Validation in psychometric research is related to the interpretation of the test scores. For validating a test, we should gather relevant evidence for providing a sound scientific basis for the interpretation of the proposed scores [18].

the agile team climate. We used Design Science Research (DSR) [54] and other specific activities to develop and validate instruments that measure latent variables [18].

In DSR, the knowledge and understanding of a design problem and its solution are acquired in developing and applying an artifact [54]. According to Hevner [54], DSR has grounded in three research cycles for any research project: Relevance, Rigor, and Design cycles. The DSR cycles are often iterative, and the activities and the studies performed intertwine. Figure 1.1 depicts an overview of the DSR project performed in this thesis.

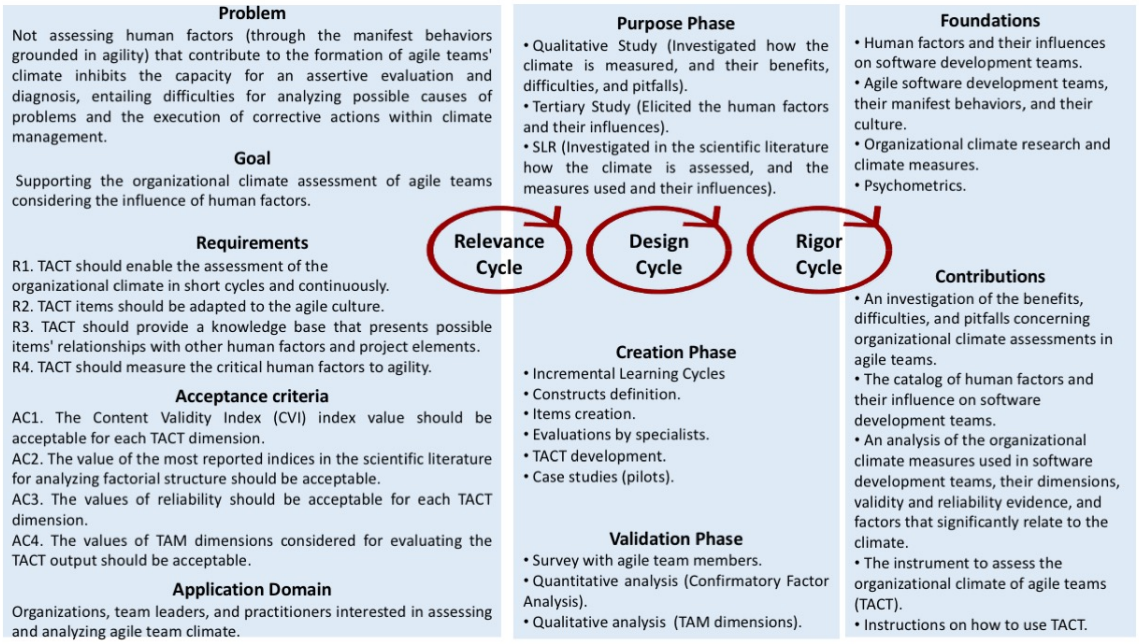


Figure 1.1: DSR project overview of this thesis

The DSR project scope is summarized through *Problem*, *Goal*, *Requirements*, *Acceptance Criteria*, and *Application Domain*. The *Problem* described is grounded in the literature and the difficulties and pitfalls of organizational climate assessment in agile teams identified in the *Qualitative Study* [42] (see Chapter 4). Concerning the *Goal* and *Application Domain*, we aimed to support the assessment of the climate of agile teams with an instrument that measures the critical human factors for agility. An ad-hoc literature review, the studies performed, and other studies identified pointed to the lacuna, problem, opportunity, delimitation, and the necessity of more evidence about the human factors influencing the agile team's climate. By using the proposed instrument, managers of the organizational climate would have a possible diagnosis of agile ceremonies, values, and principles (*Application Domain*). In addition, climate researchers could measure teams' environments with greater accuracy. The DSR project *Requirements* were initially proposed based on the literature. Later, the *Qualitative Study, Tertiary Study* [13], (see Chapter 5), and *Systematic Literature Review (SLR) Study* (see Chapter 6) provided a

better understanding, coverage, and refinement of requirements. All details about the *Requirements* and *Acceptance criteria* are addressed in Chapter 3. The *Acceptance criteria* represent several indicators used to evaluate the TACT items, validate the TACT´s factor structure, and assess the intended use of the artifact. The *Acceptance criteria* were used in the case studies [44, 55, 56] (see Chapters 7 and 8) and the *Validation Study* (see Chapter 9). The theoretical base (*Foundations*) that grounds this thesis is shown in Chapter 2. The DSR project details and its *Requirements, Acceptance criteria, Knowledge base,* and an overview of all studies performed in this research are shown in Chapter 3.

1.5 Thesis Outline

This thesis comprises ten chapters and six appendixes. Each chapter aims to achieve a specific objective. Table 1.1 displays the organization and highlights the contribution of each chapter.

Table 1.1: Thesis Organization

Chapter	Name: Objective	Published in
Chapter 1	Introduction: It features the background, objective, questions and purpose of the research.	
Chapter 2	Background: It features the background of organizational climate research, the main steps to develop and validate organizational climate measures, and the specific features concerning the organizational climate formation in agile teams.	
Chapter 3	Research Method: It features the research methodology adopted and the design of all activities grounded in DSR methodology.	[44, 55]
Chapter 4	Qualitative Study: It presents the planning, execution, and results derived from the Qualitative Study.	[42]
Chapter 5	Tertiary Study: It presents the planning, execution, and results derived from the Tertiary Study.	[13]
Chapter 6	Systematic Literature Review Study: It presents the planning, execution, and results derived from the Systematic Literature Review.	
Chapter 7	First and Second Case Studies: It presents the planning, execution, and results derived from the First and the Second Case Study.	[44, 55]
Chapter 8	Third Case Study: It presents the planning, execution, and results derived from the Third Case Study.	[56]
Chapter 9	Validation Study: It presents the planning, execution, and results derived from the Validation Study.	
Chapter 10	Conclusions: It presents the conclusion and draws an analysis of the main influences on the organizational climate formation of agile software development teams in addition to potential future research.	
Appendix A.1	TACT Final Version: It presents the TACT final Items.	
Appendix A.2	TACT Use: It presents practical orientations for TACT use.	
Appendix A.3	Conceptual and Operational Definition of the Constructs: It presents the conceptual and operational definition of the constructs used to define TACT items.	
Appendix A.4	Second Evaluation by Specialists: It presents the reports used in the Second Evaluation by Specialists.	[56]
Appendix A.5	TACT First Version: It presents the TACT items used in the First and Second case Study.	[55]
Appendix A.6	First Evaluation by Specialists: It presents the reports used in the first evaluation by specialists.	

2. Background

This chapter provides background on primary organizational climate concepts used in this thesis. The themes approached are climate definitions, climate research history, climate assessments activities, climate instrument development, agile teams, factors that influence the specific formation of the climate in agile teams, and related works.

2.1 Organizational Climate Definitions

There are many definitions of organizational climate [6, 11, 57]. Schneider and Barbera [6] defined organizational climate as *the meaning employees attach to the policies, practices, and procedures they experience and the behaviors they observe getting rewarded, supported, and expected.* Verbeke et al. [57] identified 32 different definitions of organizational climate in literature. After that, they identified categories and dimensions (i.e., clusters) commonly associated with the term (number of citations in parentheses): Organization (30), Members (26), Perceptions (21), Characteristics (15), Behaviors (15), Shared (11), Influence (9), and Practices (8). After applying statistical inference to the identified clusters (i.e., categories and dimensions), the authors defined organizational climate as *a reflection of the way people perceive and come to describe the characteristics of their environment* [57]. Lenberg et al. [11] proposed an update of the term Behavioral Software Engineering (BSE) to characterize concepts of human aspects of Software Engineering. The authors argue that there are knowledge gaps in the research area of BSE. That earlier research has focused on a few concepts (motivation, organizational change, cognitive style, job satisfaction, etc.), which have been applied to a limited number of software engineering areas. Among these concepts is organizational climate emerges, defined as *the recurring patterns of behaviors, attitudes, and feelings that characterize life in the organization* [11].

Yuan et al. [58] explain that team climate differs from organizational climate, as team climate focuses on the proximate work environment of individuals who relate to each other more closely. On the other hand, Anderson and West [49] recommend the use of the Team Climate Inventory instrument for use in settings such as organizational climate surveys. Based on [58] and [49], we understand that organizational climate is a general phenomenon that can be investigated at different levels of the institutions, through its divisions, directors, departments, teams, and down to the individual employee. Accordingly, team climate is the organizational climate measured at the team level.

2.2 Organizational Climate Research

Organizational climate has been investigated since earnest in the early 1960s and leadership was one of the first considered constructs [6]. Early organizational climate researchers believed that there was a limited number of constructs that characterized the climate [47, 6]. Over the years, many new constructs were developed, for example, autonomy, reward orientation, stress, harmony, job challenge, leadership facilitation, cooperation, friendliness, open-mindedness, risk orientation, or service quality [47, 6]. Schneider [20] has argued that the organizational assessment, to be useful, has to be strategically focused - "a climate for something." The organizational climate has been shown as a multifaceted theory in this context.

To assess the different organizational climate constructs, researchers have developed several measures. These measures are denominated as a scale, inventory, psychological test, questionnaire, or instrument. Organizational climate measures assess some latent variables (those that are not directly observable [18]). The organizational climate is measured through employees' manifested behaviors or perceived feelings. In general, organizational climate measures a) are self-reports; b) evaluate several dimensions (sometimes called factor or sub-scale) or only one dimension; c) have items that allow measuring an construct, and d) are built and validated using psychometric concepts.

Researchers have developed new measures for the different facets of the organizational climate. Some of these measures are generic and can be applied to several domains (e.g., [49, 47]). Other measures are specific to a domain, e.g., nursing professionals (see the results of study [19]) or software development [44, 43].

While some researchers aim to develop climate measures, others intend to investigate the relations among organizational climate constructs and other factors [21]. On the other hand, industry professionals want to assess the organizational climate of the teams or sec-

tors aiming at organizational development [42]. In both contexts, it is necessary to i) find an instrument that measures the construct, ii) check copyright issues for application, iii) analyze evidence of validity and reliability, and iv) verify if the cross-culture adaptation is necessary (i.e., adaptation of the items described for a specific language or group). Performing these analyses can be challenging for a new researcher or industry professional.

2.3 Organizational Climate Assessments

The organizational climate assessment is part of organizational development. It is commonly associated with diagnostic activities, development or selection of the approach to be used, data analysis, problem-solving action plans, and monitoring activities [59, 60, 61]. The diagnostic stage aims to identify indicators and dimensions associated with the organizational climate or issues that interfere with the organization's operation. Based on this, an approach to assess the organizational climate is developed. An assessment instrument is defined or selected considering the issues and indicators previously identified. The assessment instrument comprises items (i.e., questions) associated with a measurement scale. These items are usually analyzed in dimensions. Once the instrument is defined, data collection can be conducted. During analysis, workforce groups are formed to understand the collected data and mediate differences among those involved in its interpretation. Finally, actions to deal with the identified issues and stimulate organizational change are defined, executed, and monitored.

2.4 Organizational Climate Measures Development

Graziotin et al. [18] and Souza et al. [62] investigated the main phases, statistics procedures, and possible qualitative and quantitative evidence used to develop and validate a measure that assesses a latent variable (such as a measure of organizational climate). The branch of psychology and education which is devoted to the construction of valid and reliable psychological tests is denominated Psychometrics [18].

To develop an organizational climate measure, the researchers should investigate the theory about the considered construct and analyze other available instruments. At this point, the process of the items description starts. Subsequently, a series of studies seek to identify evidence of the validity and reliability of the proposed measure. Validity describes whether the data collected really measures what the researcher set out to measure [63].

Reliability describes the extent to which a variable or set of variables (items) is consistent in what is intended to measure [63].

Concerning validity, the central aspect addressed in this thesis is construct validity. Usually, the construct validity is performed through a statistics technique named Factorial Analyses (FA) or Structural Equation Modeling (SEM). Graziotin et al. [18] analyzed that FA is for understanding which instrument items "go together" to form factors (dimensions) in the data that should ideally correspond to the constructs that we are aiming to assess. Theoretically, the FA can have the exploratory or confirmatory goals through Exploratory Factor Analysis (EFA) or Confirmatory Factor Analysis (CFA) procedures. The EFA allows understanding as the items of a new construct are associated in a dimension. On the other hand, the CFA evaluates if the theoretical associations between items and dimensions are plausible. Another commonly used technique is SEM [62]. Souza et al. [62] explain that SEM is considered a mix of CFA with path analysis and aims to explain the relations between multiple variables. The factorial structure is considered adequate or with good psychometric properties when the following indices are acceptable. The primary reported indices in the scientific literature are [62]: the root mean square error of approximation (RMSEA ≤ 0.08), the goodness-of-fit (GFI > 0.9), Tucker-Lewis index (TLI > 0.9), Chi-square (χ^2)/Degrees of freedom (df) ($\chi^2/(\mathrm{df}) \leq 5$), the comparative fit index (CFI ≥ 0.9), and the normed fit index (NFI > 0.95) [64, 62].

Regarding reliability, the main index reported is α Cronbach coefficient (internal consistency) [62]. Souza et al. [62] analyzed that there is no consensus in the literature on the α Cronbach value. Even though some studies establish that values higher than 0.7 are ideal, some researchers consider values under 0.70 – but close to 0.60 – satisfactory. In this thesis, we considered ideal α Cronbach value more than 0.7.

2.5 Organizational Climate Formation in Agile Teams

In the Introduction, we used the ISO/IEC/IEEE 26515 [7] to define an "Agile Team" as "an organization or team using agile development and approaches." But organizations may have different definitions of what constitutes an agile team, depending on their software processes or software development contexts. Regardless of company size or industry sector, a majority of project teams and companies use customized processes that combine different development methods — based on agile methodologies or hybrid strategies, i.e., a combination of traditional and agile practices [65]. Therefore, identifying the roles and responsibilities in agile teams is challenging.

Miller [66] investigated the literature and performed a web-based survey to identify the responsibility for executing the tasks in agile methodologies, hybrid-agile methodologies, and hybrid-mixed methodologies (agile and non-agile methodologies). The author concluded that the tasks typically executed by a project manager are still practiced, although they are not (explicitly) addressed by agile methodologies. The team, product owner, and project sponsors assume the informal role in some project management tasks. According to the author, some other activities commonly performed by Scrum roles are: (i) the team is authorized to develop project plans, direct project work, and control project work, (ii) the PO is responsible for developing a project charter, define scope, and control scope, and (iii) the Scrum Master is responsible for collecting learned lessons and developing the project team [66].

Another relevant question about roles and responsibilities is who is really part of the agile team. To answer this question, Schwaber and Sutherland [67] comment that in Scrum, for example, there are no sub-teams or hierarchies. They wrote, "the fundamental unit of Scrum is a small team of people, a Scrum Team. The Scrum Team consists of one Scrum Master, one Product Owner, and Developers." Likewise, according to the Project Management Institute (PMI) and Agile Alliance [37], the typical roles in agile teams are Team members, Product Owner, and Team Facilitator. Conversely, based on their survey result, Collabnet and Version One [38] cite the roles of Architect, Developer, Quality Assurance (QA) role, Tester, User Interface (UI) or User Experience (UX) Designer in the Development Team Members.

Regardless of the roles involved, Agile software development comprises a set of iterative and incremental software engineering methods which are inspired by the "agile philosophy," as per the Agile Manifesto [68, 36, 37, 69], and operationalized through agile practices [36, 37]. The Agile Manifesto provides values and principles that represent behaviors that demand from the team ability for a quick assessment, feedback, and change [68]. How top management, coordinators, leaders, and the team utilize and believe in these values and principles influences the software development agile team's organizational climate [14, 43, 31, 68].

Within this context, the different dynamics in traditional and agile projects make it necessary for organizational climate assessments to be adapted to an agile context. We discuss some of those contexts below.

About management style, in traditional development, command and control are associated with the process, the manager, the coordinator, and top management. In contrast, agile development focuses on leadership and collaboration [70]. Control and command

relating to the development process and behavior are transferred to the agile team. As for management style, Schneider and Barbera [6] claim that leadership is central to climate development and maintenance. Thus, climate management must consider the role of a servant leader and the individual leadership of each member. The leader's role in an agile team is performed by an agile facilitator (in this thesis named Team Facilitator), a servant leader [37]. This role can be referred to as that of facilitator, coach, and team coordinator [37, 71]. The Team Facilitator helps the team to develop high performance. In Scrum, for instance, among other attributions, the Scrum Master promotes the team's adherence to Scrum practices (e.g., events, artifacts, roles, rules) [71].

In traditional projects, customer activities are often limited to providing and clarifying requirements. In agile development, in addition to providing, clarifying, and prioritizing requirements, the customer's responsibility also includes planning the iteration and negotiating deliveries with the team [37]. In Scrum, for example, this role is played by the Product Owner.

Another key difference related to the desired organizational structure. While in traditional development the organizational structure is mechanistic, i.e., bureaucratic with high formalization [72], in agile development it is organic, i.e., flexible and participative encouraging cooperative social action [72]. Wlodarkiewicz-Klimek [73] claims that companies that want to improve business agility must ensure there is a climate to make the organizational structure of management more flexible and adaptable to emerging changes. To accomplish this, the team reflects, at regular intervals, on how to become more effective, then tunes and adjusts its behavior accordingly [68].

In the *Tertiary Study* [13] (see Chapter 5), we found 29 systematic literature reviews (SLR) and systematic mapping studies (SMS) addressing the human perspective in SE teams. Of the 29 studies, two identified human factors that influence organizational climate, and eleven investigated the influence of the human factors in agile teams specifically.

Soomro et al. [14] reported that the development of an agile team's organizational climate includes factors that represent the involvement of the whole team, agile values (trust, openness, and respect during team interaction, for example), agile practices (feedback and negotiations), a culture favoring action and change (in terms of bringing progress and improvement to team activities), and collective thinking.

Navimipour and Charband [74] investigated the state-of-the-art mechanisms in knowledge sharing in project teams domains systematically. All selected papers mentioned the

importance of knowledge sharing and knowledge management. Also, the authors found that employees' motivation, climate, and organizational culture are essential to creating opportunities for knowledge sharing and creativity [74].

Chagas et al. [10] conducted an SLR to investigate which human factors impact agile projects and a survey in software companies to verify their perceptions. The authors concluded that Communication, Trust and Collaboration are essential factors in projects using agile methods. Still, others factors need to be more investigated due to the perception of its value to the industry.

Concerning the influence of the human factors, there are also differences between traditional and agile methods, such as decision-making and team motivation. Generally, in traditional methods, the project manager plans the project, the tasks, and the task estimates. On the other hand, in the agile methods, the teams should make decisions about the task planning, who will work on what, task estimates, and if user stories require more discovery work [75]. Melo et al. [76], in the study about motivation in the agile team, showed that lack of bureaucracy during the development process motivates agile teams. The unmotivated agile team member negatively influences the formation of the organizational climate in various dimensions. For instance, retention, project delivery time, productivity, budgets, and project success may be affected.

Regarding the influence of the human factors on the climate, Serrador et al. [43] investigated that "senior management support for agile" and "team support towards agile" influence "willingness to adapt." The authors suggested a set of practices and behaviors that sponsors and senior stakeholders can develop to contribute to a climate for project success. These include demonstrating support and being fully engaged with the project at critical times, such as charter signoff and scope change requests. They should also support the dedication of key team members to the project, rather than expecting success if core resources are actively engaged in multiple initiatives.

Figure 2.1 exemplifies the context of forming an organizational climate in agile development teams. Although there are many agile methods, the roles, activities and management structures considered in Figure 2.1 are the most commonly used elements [37].

Team members perceive workday events [77, 1]. These perceptions refer to team behavior, the leader, the Product Owner, the work, the organization and their actual activities. At this point, the mind begins to form and construct meanings. After the connection among these perceptions takes place, the mind starts to classify the organizational climate as, for example, positive, neutral or negative [1, 6]. This classification of the or-

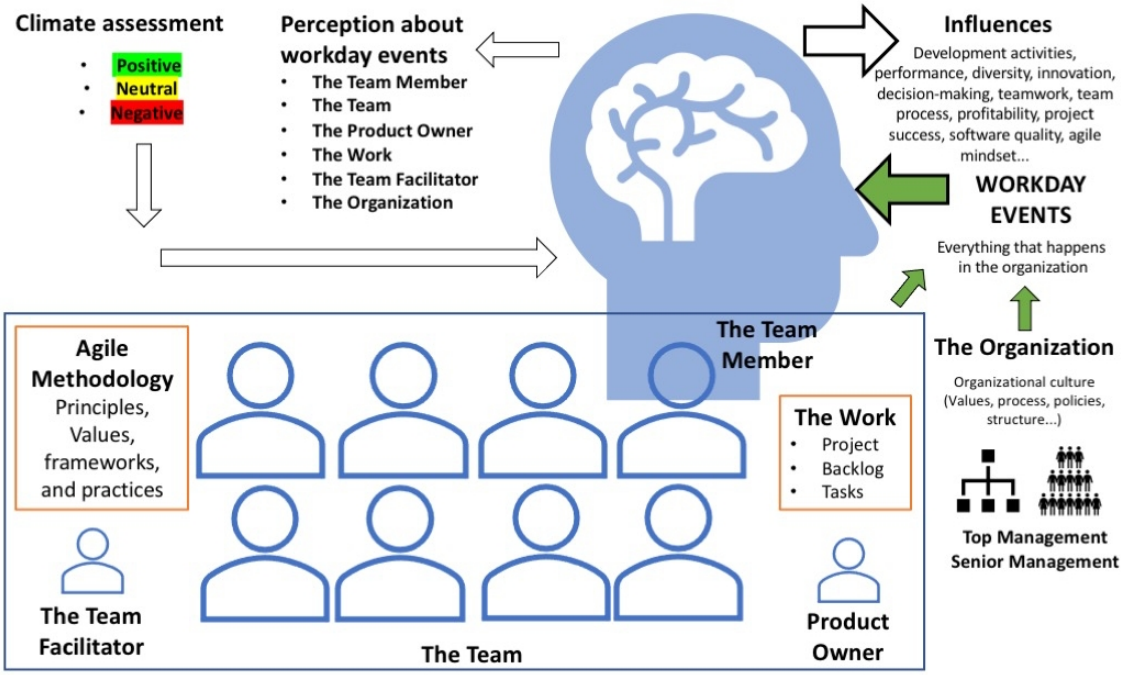


Figure 2.1: Organizational climate formation in agile team (inspired in [1])

ganizational climate influences motivation, teamwork, individual task development and the quality of the software developed, as well as the success of the development project [39, 6, 31, 30, 43, 14]. In agile software development, the team is expected to behave by agile values, principles, and practices [39, 36]. Not only the team but also other directly or indirectly involved positions such as top and middle management and the Project Manager. For example, the team should have the autonomy to define their tasks and estimate their activities, not a Project Manager.

2.6 Related Work

In general, the research in organizational climate has the objective of investigating the climate formation in a specific group and the influence of different factors in the climate. In addition, several researchers have developed and validated measures to assess a variety of facets of the organizational climate. Aiming to investigate the state of the art of organizational climate research in software development teams, we planned and executed the SLR Study (see Chapter 6). The main results are shown below.

2.6.1 Studies Investigating Organizational Climate in Agile Teams

Many studies investigate organizational climate in software development teams [14]. However, most of them consider the teams without mentioning the basis for the development process and utilize climate assessment models of a general nature. The studies we identified [23, 31, 16] investigated factors that influenced the development of an organizational climate in agile teams. The study [31] created a climate questionnaire based on the literature to investigate the influence of climate on the regularity of work speed of agile teams.

Acuña et al. [23] investigated whether the climate of software developer teams has any relation to the quality of the software product. The authors used the TCI© (Team Climate Inventory) instrument [49] to assess the climate. The experimental study was carried out with 105 students allocated into 35 teams. All teams adapted 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, tracking the teams' organizational climate is essential as it is one of many indicators of the quality of the software to be delivered.

Vishnubhotla et al. [16] 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 [49] 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 of openness to experience) and the climate dimension (support for innovation). They concluded that regression analysis results suggest that more data may be needed. Other human factors and personality traits should also be investigated concerning the climate of agile teams.

Grobelna and Trzcielinski [31] 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 prefer-

ences, the greater the regularity of the work speed of this team is; more efficient the team is [31].

The studies mentioned show the software engineering community's interest in measuring agile teams' organizational climate in the last decades. Acuña et al. [23] simulated an agile context to investigate the relation between team climate and software quality in an academic setting. Vishnubhotla et al. [16] investigated the relationship between personalities and the agile team climate of software professionals in a telecom company. Acuña et al. [23] and Vishnubhotla et al. [16] used the TCI instrument to measure the team climate to innovation. TCI instrument is grounded in the vision, participative safety, task orientation, and support for innovation. The TCI instrument is not specific to the agile team and measures latent factors not commonly investigated or known to the industry as critical. We did not identify the items used in Grobelna and Trzcielinski [31] which made it impossible for detailed analysis. Lastly, Vishnubhotla et al. [16] pointed out the necessity of more investigations involving human factors and climate.

2.6.2 Measures Developed for Assessing the Organizational Climate of Software Development Teams

We identified three specific measures developed [52, 30, 43] for evaluating the organizational climate of software development teams.

Bhatt et al. [52] proposed a Model for Outsourced Software to investigate the influence of different factors in outsourced software maintenance. The dimension denominated "Organizational Climate" consists of various factors involving tools, leadership, bonus, training, resources (such as PC and desktops), the difficulty of targets, and the level of under-staffing in the project. Examples of items include "Ease of availability of tele/video-conferencing facilities" and "Difficulty of targets set for the maintenance team." The authors did not report validity (factorial structure) or reliability procedures.

Sharma and Gupta [30] investigated the Organizational Climate for Success of the Software Project. The authors executed a comprehensive literature review and interviews with 300 software project managers to gauge the organizational climate factors that affected the success of their last executed project. Through Principal Component Analysis (PCA), the items were loaded into four dimensions: Effective Supervision, High Standards of Work Tasks, Intrinsic Fulfilment, and Role Clarity. An example of an item of dimension Intrinsic Fulfilment is "There were challenging tasks in my job role." The authors also presented 23 software project risks and their relations with the investigated climate dimensions.

Serrador et al. [43] identified organizational climate factors which influence a project's success. Three dimensions (Top Management Support, Sufficient Resources and Willingness to Adapt) were identified and tested to measure their ability to predict different aspects of project success. Results of a data regression analysis from 449 projects showed that the Climate for Project Success was a significant and strong predictor of both Stakeholder Success and Budget/Time success. Top Management Support and Willingness to Adapt positively influenced Stakeholder Success; Top Management Support positively influenced Budget/Time Success. Interestingly, Budget Flexibility, an element within the Sufficient Resources dimension, was negatively related to Stakeholder and Budget/Time Success. Serrador et al. [43] claim that organizations that want to boost the success of their projects must focus on the climate development of (i) senior management support, (ii) engagement of interested parties, (iii) dedicated team, (iv) agile methods support, (v) frequent meetings with product owners, and (vi) a good team attitude to accept changes.

In a general analysis, the Bhatt et al. [52] model was primarily focused on outsourced software maintenance work. Serrador et al. [43] and Sharma and Gupta [30] investigated the factors that influence climate for the software project success with managers and top managers. Furthermore, the Bhatt et al. [52] model is old and may not reflect the contemporary critical factors and the three models mentioned are not adapted to the agile context. However, practitioners can use the models to ground, inspire, or develop a new measure to assess the agile team's climate. An instrument for evaluating the specific agile team' climate can improve measurement capability, providing a more accurate diagnosis of the practices and the culture involved in agility.

2.7 Final Considerations

This chapter showed an overview of the background theory that consolidates this thesis. The organizational climate has led to a multi-facet theory developed and investigated in several areas. In the software development teams, it has not been different. In a general way, our non-systematic literature and two literature reviews (see Chapters 4 and 5) provided the state-of-the-art knowledge inherent to climate research. This chapter has a brief view on organizational climate definitions, scientific research, and assessments. Furthermore, we identified the best practices and the most reported statistics indexes in Psychometrics to develop and validate the climate instrument. Finally, the identified studies showed how the researchers in the Software Engineering area had investigated the organizational climate in software development teams and agile teams specifically.

Concerning the models, theories, and instruments to measure the organizational climate, we analyzed that the model proposed by Bhatt et al. [52] only has specific items for outsourced software maintenance teams. It is not specific for agile teams. We did not identify validity and reliability evidence. The Climate for Project Success [43] model intended to construct a theory [43]. In the study, the authors did not define the instrument items. Thus, the results of the study [43] can be used to operationalize a new instrument. Organizational Climate for Success of the Software Project [30] showed good initial validity and reliability evidence. However, the four dimensions do not reflect the critical factors to agility. The questionnaire items elaborated by Grobelna and Trzcielinski [31] were not published. Also, we did not identify validity and reliability evidence for the proposed measure [31]. Acuña et al. [23] and Vishnubhotla et al. [16] measured the climate using the TCI instrument [49] to assess the climate. The TCI dimensions represent factors that influence the innovation capability of teams. TCI instrument is grounded in a theoretical model to measure vision, participatory security, support for innovation, and task orientation dimensions [49]. The TCI dimensions do not measure the critical human factors investigated in this thesis that influence the agile teams' climate.

Regarding the use of questionnaires or generic scales to assess the organizational climate in agile teams, we 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 [42]. Therefore, there is a need for specific instruments to measure the organizational climate of agile teams. We used Chagas et al. [10] results and our Tertiary Study results [13] to delimit the main human factors investigated in this thesis, such as communication, collaboration, leadership, autonomy, decision-making, client involvement, knowledge, learning, and motivation. To foster the use and applicability of the climate instrument proposed, we have decided to use the roles as generically as possible. Therefore, we explicitly consider only Team Facilitator, Product Owner, and Team Members as agile roles (which sums up all other potential agile team members roles) [37].

In the next chapter, Chapter 3, we present the approach used to develop TACT: *"an insTrument to Assess the organizational ClimaTe of agile teams."*

3. Research Method

This chapter details the methodological approach used in this thesis. We describe how the results of studies and other activities led to the development and validation of TACT ("insTrument to Assess the organizational ClimaTe of agile teams").

3.1 The Design Science Research Project

As described in Chapter 1, this thesis is grounded in Design Science Research (DSR) cycles. Hevner and Chatterjee [54] define DSR as a research paradigm in which a researcher answers questions relevant to human problems via the creation of innovative artifacts, thereby contributing new knowledge to the body of scientific evidence. The designed artifacts are valuable useful and fundamental in understanding that problem. We used the Relevance, Rigor, and Design cycles proposed by Hevner and Chatterjee [54] and *Incremental Learning Cycles* used by Trinkenreich, Santos, and Barcellos [78].

The *Relevance Cycle* initiates design science research with an application context that not only provides the requirements for the research as inputs but also defines acceptance criteria for the ultimate evaluation of the research results [54]. In the *Rigor Cycle*, the knowledge base available should be investigated. Hevner and Chatterjee [54] suggest two types of knowledge to be explored in this cycle 1) the experiences and expertise that define state-of-the-art in the application domain of the research and 2) the existing artifacts and processes found in the application domain. Lastly, the *Design Cycle* aims to propose iterative activities among the construction of an artifact, its evaluation, and subsequent feedback to refine the design further [54]. We also performed six *Learning Iterations* [78], in which we executed experimental studies to gain useful knowledge to create and evaluate TACT. Figure 3.1 and Table 3.1 details the DSR cycles, the phases considered in

this thesis, and the studies performed. The six Learning Iterations are identified in Figure 3.1 by L1, L2, L3, L4, L5 and L6.

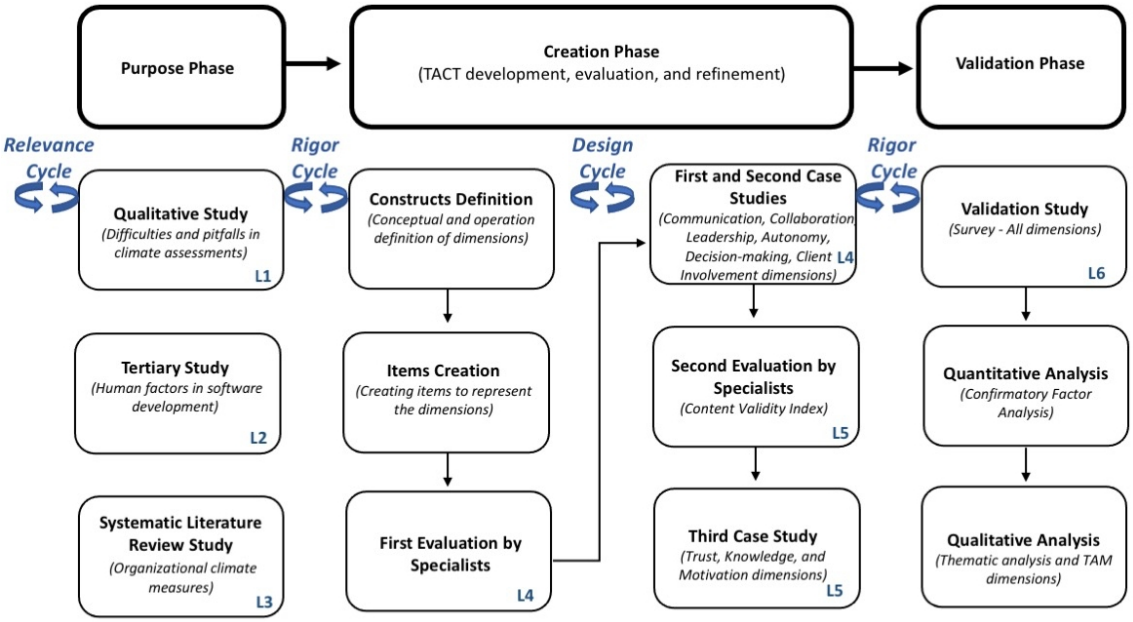


Figure 3.1: Studies and activities performed in this thesis

In the *Purpose Phase* (see Figure 3.1 and Table 3.1), we planned and performed the *Qualitative Study* [42] (see Chapter 4), the *Tertiary Study* [13] (see Chapter 5), and the *Systematic Literature Reviews (SLR) Study* (see Chapter 6). These studies comprise the first three Learning Iterations and aim to contemplate the Relevance and Rigor Cycles guidelines. In this phase, we (i) contextualized the problem, (ii) detailed the *Requirements* and *Acceptance Criteria*, (iii) created the *Knowledge Base* with the critical human factors and their influences and the climate organizational measures used in scientific research. The *Qualitative Study* aimed at understanding how organizations assess the organizational climate of agile teams and which are the benefits, the difficulties, and the pitfalls associated with this assessment. The *Qualitative Study* results were vital to contextualize the problem and identify and detail the requirements. The *Tertiary Study* also corroborated to specify the *Requirements* and create the *Knowledge Base* because the aim was to investigate the state-of-the-art on human factors in software development teams to elicit the human factors and their influence. Lastly, the *Systematic Literature Reviews (SLR) Study* had the purpose of identifying and analyzing the organizational climate measures used in software development teams, their dimensions, their validity and reliability evidence, and factors that significantly relate to the software development team's climate. The SLR results allowed the identification of the *Acceptance Criteria* and the measures for the *Knowledge Base*.

Table 3.1: Information about the conducted studies

Phase	Study [Ref.]	Objective	Results	Results used in
Purpose	Qualitative Study [42]	We investigated how organizations assess the organizational climate of agile teams and the associated benefits and difficulties.	We identified 16 benefits and 9 difficulties. Also, we defined 2 propositions representing 4 pitfalls;	Problem, Requirements, and Application Domain
	Tertiary Study [13]	We summarised the human factors that influence SE development teams and Agile Software Development (ASD) teams.	After analysing 29 secondary studies, we identified 101 human factors; 79 influences; 71 human factors and 60 influences on ASD;	Requirements; Knowledge Base; Constructs Definition; Items Creation
	SLR Study	We analyzed organizational climate measures, their validity and reliability evidence, and factors that significantly relate to the software development team's climate.	We identified 33 studies that present 19 organizational climate measures; 36 other measures; 52 factors that can affect the organizational climate.	Acceptance criteria; Construct Definition; Items Creation
Creation	First and Second Case Studies [44, 55]	We performed a preliminary evaluation of TACT considering Communication, Collaboration, Leadership, Autonomy, Decision-Making, and Client Involvement dimensions.	TACT captured the organizational climate of the teams adequately. The team leaders reported intention of future use. TACT dimensions presented high levels of reliability.	Items Creation and Evaluation by Specialists
	Third Case Study [56]	We performed a second preliminary evaluation of TACT considering Trust, Knowledge, Learning, and Motivation dimensions.	TACT captured the organizational climate of the teams adequately. The team leaders reported intention of future use. TACT dimensions presented high levels of reliability.	Items Creation and Evaluation by Specialists
Validation	Validation Study	The study aims to confirm the theoretical structure of TACT.	The results revealed that TACT has good psychometric properties and provides practitioners and researchers with a robust means for assessing ten critical dimensions to agility.	Validation Phase

In the *Creation Phase*, we performed the *Constructs Definition* (see Section 3.3.1 and Appendix A.3) of the TACT dimensions, the *Items Creation* (see Sections 3.3.2 and 3.3.5), two *Evaluations by Specialists* (see Sections 3.3.2 and 3.3.5), and three case studies [44, 55, 56] (see Sections 3.3.4 and 3.3.7). The *Constructs Definition* activity intentions to identify conceptual and operational definitions in the literature. The studies identified in the *Tertiary Study* and *SLR Study* facilitated this activity. The definitions goal is to support the *Items Creation* activities partially. In the *Items Creation*, a pool of items to assess each TACT dimension was developed. All items were evaluated by agile experts in the *Evaluations by Specialists*. Iteratively and intertwined with items creation and evaluations by specialists, we performed the *First and Second Case Study* and the *Third Case Study* as a pilot to identify improvements in TACT and provide initial evidence of validity and reliability. These two studies comprised two Learning Iterations.

Finally, the TACT artifact was developed after completing all the phases proposed in the DSR approach. Then, we validated it by executing a survey with practitioners, which comprised the final Learning Iteration so far. TACT final version is available in Appendix

A.1. Those involved in climate assessments can find some TACT use final orientations in Appendix A.2.

3.2 Purpose Phase

As mentioned before, in the *Purpose Phase*, we investigated and delimited the *Problem, Objective, Requirements,* and *Acceptance criteria* with more details. Furthermore, we investigated the scientific literature to form a *Knowledge Base* of the human factors and their influence, the organizational climate measures used, and factors that are related to climate. Three studies were performed in *Purpose Phase*: *Qualitative Study*, *Tertiary Study*, and *Systematic Literature Review (SLR)* Study.

We used the *Qualitative Study* results to establish the initial requirements of TACT. The *Tertiary Study* resulted in a vast knowledge base of papers investigating human factors and their influences. The *Systematic Literature Review (SLR) Study* identified the measures used to assess the organizational climate of software development teams and the *Acceptance criteria*. The DSR project *Requirements* and *Acceptance criteria* are outlined below.

3.2.1 Requirements and Acceptance Criteria

Table 3.2 shows the four established requirements based on the results of studies.

The requirement "R1. TACT should enable the assessment of the organizational climate in short cycles and continuously" is grounded in an identified difficulty in the *Qualitative Study*. We investigated that "Non-frequent assessments may lead to loss of information about the organizational climate" which could disturb the organizational climate assessment. To mitigate this difficulty, pulse surveys [79] can be applied. To support pulse surveys with TACT, the TACT dimensions should allow the measuring of a single dimension in each cycle if an organization desires. In order to attend "R2. TACT items should be adapted to the agile culture" requirement, we considered the agile manifesto [68], the papers identified in our systematic reviews, and other relevant literature. For instance, the results of the *Tertiary Study* pointed to examples of how human factors manifest themselves, and agile culture elements happened. We defined the "R3. TACT should provide a knowledge base that presents possible items' relationships with other human factors and project elements" requirement to provide more details about other human factors theoretically related to the item and possible project elements involved. For example,

Table 3.2: TACT requirement

Requirement	Based on study results
R1. TACT should enable the assessment of the organizational climate in short cycles and continuously	Qualitative Study (DF2. Difficulty to analyse data from organizational climate assessments containing many open- and closed-ended questions; DF6. Non-frequent assessments may lead to loss of information about the organizational climate; Pitfall 2.1: Not to carry out ongoing assessment, in small cycles and with few assessment items)
R2. TACT items should be adapted to the agile culture	Qualitative Study (DF3. Lack of adaptation of the assessment instrument to the organizational agile culture may lead to misunderstandings; DF4. Not understanding how to use organizational climate assessment results; DF7. Difficulty to identify possible control or mitigation actions; Pitfall 1.2: Not to explicitly consider agile roles and other organizational structure management functions; Pitfall 1.1: Non-assessment of behaviours (human factors) and factors specific to the development of an organizational climate in agile teams); Tertiary Study (Papers, human factors and their influences)
R3. TACT should provide a knowledge base that presents possible items' relationships with other human factors and project elements	Qualitative Study (DF7. Difficulty to identify possible control or mitigation actions); Tertiary Study (Papers, human factors and their influences); SLR (Papers, measures, and factors related)
R4. TACT should measure the critical human factors to agility	Qualitative Study (Pitfall 1.2: Not to explicitly consider agile roles and other organizational structure management functions; Pitfall 1.1: Non-assessment of behaviours (human factors) and factors specific to the development of an organizational climate in agile teams); Tertiary Study (The most investigated critical factors (Communication, Collaboration, Leadership, Autonomy, Decision-making, Client Involvement, Trust, Knowledge, Learning, and Motivation); SLR (Papers, measures, and factors related)

to measure motivation [80, 12, 81] the agile teams should have the autonomy to plan their task. Thereby, TACT should indicate this relation and possible project elements involved (e.g., Iteration Planning Meeting). In the *Tertiary Study*, we elicited human factors and their influence on agile software development teams. We identified the critical human factors that probably can impact the agility and the organizational climate. These human factors were used to delimit R4 (see Table 3.2). We used the secondary studies identified in the *Tertiary Study* and the primary studies identified in the secondary studies to determine details about the agile culture. All studies allowed understanding more details about the R2, R3, and R4 requirements. Next, Table 3.3 shows the four *Acceptance criteria* for TACT.

Acceptance criteria "AC1", "AC2", and "AC3" (see Table 3.3) were identified during the *SLR Study* execution. The main contribution of the *SLR Study* was to investigate the state of the art of organizational climate research in software development teams to analyze the measures used, their psychometric proprieties, and factors that significantly relate to the software development team's climate. The *SLR* results appointed 19 measures used to assess the organizational climate in software development teams. Besides, we identified the primarily reported indices in the scientific literature used to validate measures. The Content Validity Index (CVI) described in "AC1" provides evidence about the degree to which instrument items are relevant, and representative to the measured construct [83]. The CVI was used in the *Second Evaluation by Specialists* (see Section 3.3.6). The indexes

Table 3.3: TACT acceptance criteria

Criteria	Rationale
AC1. The Content Validity Index (CVI) index value should be acceptable for each TACT dimension.	CVI >= 0.7.
AC2. The value of the most reported indices in the scientific literature for analyzing factorial structure should be acceptable.	$\chi^2/(df) \leq 5$; CFI and TLI ≥ 0.9, RMSEA and SRMR ≤ 0.08. RMSEA confidence interval should be (upper limit ≤ 0.10) [64].
AC3. The values of the reliability should be acceptable for each TACT dimension.	The value of α Cronbach coefficient (reliability - internal consistency) should be more than 0.7[62, 82].
AC4. The values of TAM dimensions considered for evaluating the TACT output should be acceptable.	The values of the assessments considering TAM dimensions of Intention to Use, Perceived Usefulness, and Output Quality should have more items evaluated as positive than negative.

Content Validity Index (CVI), Technology Acceptance Model (TAM), Chi-square (χ^2), Degrees of freedom (df), Standardized Root Mean Square Residual (SRMR), Root Mean Square Error of Approximation (RMSEA), Tucker-Lewis Index (TLI), and Comparative Fit Index (CFI).

reported in "AC2" are addressed in the construct validity. Usually, the construct validity is performed through a statistics technique named Factorial Analyses (FA) [18]. The fit indexes evaluate if the proposed structure fits the data well. The indices were used in *Validation Study*. In regard to reliability (described in "AC3"), the index reported was α Cronbach coefficient (internal consistency). The value considered acceptable to the α Cronbach is more than 0.7 [62]. The α Cronbach was used in the case studies and the *Validation Phase*.

To conform to the last acceptance criteria, "AC4", we evaluated TACT through TAM (Technology Acceptance Model) [84, 85]. The dimensions of Intention to Use, Perceived Usefulness, and Output Quality were used [84, 85]. We used TAM dimensions in the interviews with the team leaders and mediators responsible for performing the organizational climate assessment in teams. TAM use was reported in Chapter 7, Chapter 8, and Chapter 9.

3.2.2 Knowledge Base

In DSR, the Rigor Cycle proposes that past knowledge be investigated before producing the artifact. It is contingent on the researchers to thoroughly investigate and reference the knowledge base to guarantee that the designs made are research contributions [54]. The Knowledge Base of this thesis was formed with the *Tertiary Study* and *SLR Study* results.

In the *Tertiary Study*, we selected 29 SLR/SMS to review and summarize information about human factors. As a result, we identified 101 human factors that influence software development activities from different perspectives. From them, 79 influences were

grouped based on their effects into Team Members, Teams, Projects, and Organizations. Furthermore, we identified 71 human factors and 60 influences in ASD. Table 3.4 shows part of results from *Tertiary Study*.

Table 3.4: A partial example of human factors and their influences identified in the Tertiary Study

Influence	Human Factor
Team Member Agile Mindset [86]	Collaboration, Communication, Motivation, Leadership, Creativity, Team working, Empowerment, Commitment, Trust, Responsibility, Knowledge, Integrity, Autonomy, Learning, Involvement, Experience, Innovation, Openness, Feedback, Honesty, Empathy
Team Motivation [80, 87, 88, 89, 12]	Collaboration, Communication, Motivation, Leadership, Ethics, Change/Adaptability, Commitment, Balance Work/life, Team working, Knowledge, Relevance, Autonomy, Learning, Involvement, Experience, Sense of Belonging, Recognition, Social Support, Ownership, Effectiveness, Coordination, Challenge, Feedback, Stress, Satisfaction, Interest, Fulfillment
Team Agile Capability [10, 90, 72, 87, 89]	Collaboration, Communication, Motivation, Leadership, Personality, Change/Adaptability, Balance Work/life, Empowerment, Trust, Responsibility, Knowledge, Cultural Aspects, Autonomy, Involvement, Respect, Competency, Conscious Sensitivity,
Team Climate [21, 74]	Collaboration, Communication, Motivation, Leadership, Creativity, Change/Adaptability, Balance Work/life, Team working, Commitment, Fulfillment, Trust, Responsibility, Knowledge, Relevance, Autonomy, Learning, Involvement, Vision, Cohesion, Recognition, Innovation, Conflicts Resolution, Decision-making, Social Support, Collective thinking, Moral, Orientation, Respect, Openness, Coordination, Competency, Challenge, Feedback, Satisfaction, Participative Safety, Enthusiasm, Sharing, Interaction
Organizational Agile Transition [91]	Involvement, Collaboration, Change/Adaptability, Decision-making, Communication, Team working
Sustainable Agile Use [72, 87]	Collaboration, Communication, Motivation, Leadership, Passion, Change/Adaptability, Empowerment, Trust, Responsibility, Knowledge, Cultural Aspects, Learning, Experience, Ethnicity, Recognition, Innovation, Decision-making, Social Support, Effectiveness, Competency, Education, Gender, Satisfaction, Honesty, Fulfillment

In the *SLR Study*, we selected 33 primary studies to review and summarize information about the organizational climate measures. As a result, we identified 19 measures used to assess the organizational climate in software development teams. The measures represent more than 70 dimensions (constructs) that confirm the multifaceted organizational climate theory. The notable measures used in the identified studies were Team Climate Inventory (TCI) [49], Team Selection Inventory (TSI) [92], Team Climate questionnaire [93], Ethical Climate Questionnaire (ECQ) [94] and Organizational Climate Measure (OCM) [47]. We extracted 52 factors that can exert some effect on team climate.

Design science research is grounded on existing ideas drawn from the domain knowledge base [54]. Accordingly, the papers, the human factors and their influences, the organizational climate measures, and the factors that can influence the climate were used to ground TACT creation.

3.3 Creation Phase

In the *Creation Phase*, we performed the Design Cycle. This cycle is the heart of any DSR project [54]. Thereby, we performed specific activities considered to develop

climate instruments such as (i) *Constructs Definition*, (ii) *Items Creation*, and (iii) *First and Second Evaluations by Specialists*. Furthermore, we performed the *First, Second, and Third Case Studies* as a pilot to investigate the TACT structure. To select the critical factors investigated in this thesis, we considered the most investigated factors in our *Tertiary Study* and those reported in Chagas et al. [10] to derive the ten TACT dimensions: Communication, Collaboration, Leadership, Autonomy, Decision-making, Client Involvement, Trust, Knowledge, Learning, and Motivation.

3.3.1 Constructs Definition

The first step to define the construct is a literature review [95]. We used the *Tertiary Study* [13] and *SLR Study* (see Chapter 6) results and other sources to identify (i) conceptual definitions to show a general description about the construct measured, and (ii) operational definitions to understand how the construct can be assessed [96, 95]. 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 [8]. The construct for the Trust dimension is presented below. Appendix A.3 presents all the identified constructs to each TACT dimension.

Construct Trust

- **Conceptual definition**
  - Reliance on or confidence in the dependability of someone or something. In interpersonal relationships, trust refers to the confidence that a person or group of people has in the reliability of another person or group; specifically, it is the degree to which each party feels that they can depend on the other party to do what they say they will do [8].
  - Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done [68].

- **Operational definition**
  - TRU.01. Lack of management confidence and support in agile methods can impact the enthusiasm and motivation of team members [87].
  - TRU.02. Team members trust the others to do their part [72].
  - TRU.03. Lack of client involvement can be due lack of trust [97].
  - TRU.04. Self-organizing and collaboration increase trust [97].

In the "Conceptual definition," we identified formal meanings that may span multiple groups and some other definitions specific to agile teams. The same idea was used in the "Operational definition" to identify elements that allow measuring the construct investigated.

3.3.2 Items Creation - First Cycle

We used the previously mentioned constructs in this activity and examined several other sources to ground the item descriptions. We used the *Tertiary Study* [13] (see Chapter 5) to identify studies that investigated the human factors and their influences. The *SLR Study* results (see Chapter 6) were considered for having identified studies and measures used to assess the organizational climate of development teams. We examined [37] looking for standardized names of roles, practices, and artifacts considered in agile development. The Agile Manifesto [68] was used because it showed the values and principles that grounded several agile methodologies. Lastly, the survey [98] appointed the primary agile practices used by the organizations.

We used generic nomenclatures for roles and practices in hybrid and agile processes to create every TACT item description. Scrum is the most used agile methodology [98]. However, we do not use the names of the roles or ceremonies from Scrum; e.g., we use Team Facilitator, Iteration, and Meeting Review instead of Scrum Master, Sprint, and Sprint Retrospective. By doing that, we expect to reach more teams using different process configurations. TACT was created considering the English and Portuguese versions. Other researchers participated in several sessions to improve item descriptions for Portuguese and English. The following describes how the item creation process took place.

Some items or questionnaires and examples of behaviors identified in the previous studies and activities must be adapted to agile roles, practices, or artifacts. 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., *"Team members work together as a whole"* used in [28] to assess collaboration among software development team members. Only the person's role in exercising the action was altered in other cases. For example, the original item *"My direct supervisor listened to my ideas and concerns"* proposed in [30], 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 [53] *"Supervisors and staff communication and agreement their tasks, including what to do, to what degree, and how to do?"* and the description presented in [97] for the communication factor *"Frequent communication can be used to prioritize features, set focus on bug-fixing or include more functionality."*

On completion of this activity, 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.5.

3.3.3 First Evaluation by Specialists

The procedures described in this section were used to evaluate the TACT items considered in the *First and Second Case Studies*. The main objective was to collect suggestions to improve the item description and verify if the items were related to agility. Two specialists in agile software development analyzed the TACT items. The items were available in both Portuguese and English languages. For each item, two questions were considered *"Question 1. Can it be inferred that the presented item represents a behavior related to agile software development teams?"* and *"Question 2. Do you suggest any adaptation to the item description?"*

The first specialist has 10 years of experience 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. The first specialist evaluated the Communication, Collaboration, and Leadership dimensions, and the second specialist evaluated Autonomy, Decision-making, and Client Involvement. The answers were attributed on a spreadsheet developed on Google Docs. All information used in the evaluation of the TACT items is available in Appendix A.6. The comments and suggestions made by the judges were written in Portuguese, the original language of specialists and researchers. Figure 3.2 shows a part of a mentioned spreadsheet with the evaluation from the first specialist. Figure 3.3 displays part of discussion by the researchers.

Dimension	Item			Audit			
Description	ID_Item	English	Portuguese	Question 1. Can it be inferred that the presented item represents a behavior related to agile software development teams?	Problem	Question 2. Do you suggest any adaptation to the item description?	Suggestion
Communication	[IT007]	In this team we can talk freely with each other about difficulties we are having and know that others will want to listen	Nesta equipe, podemos conversar livremente uns com os outros sobre as dificuldades que estamos tendo e saber que os outros querem ouvir	Yes		Yes	In this team we can talk freely with each other about difficulties we are having (and know that others will want to listen) (I see two points in this item: psychological safety and active listening. I suggest you have an item for each as they do not necessarily happen together)
Communication	[IT016]	The team keeps the list of impediments, risks and control actions updated	A equipe mantém atualizada a lista de impedimentos, riscos e ações de controle	Yes		Yes	I don't see it as a dimension of communication. I don't even know if I need to look at this. Maybe it's collaboration.
Communication	[IT062]	My opinion is always listened to by my team	Minha opinião é sempre ouvida pela minha equipe	Yes		No	Check out this active listening

Figure 3.2: Part of spreadsheet used to evaluate the TACT items - First Specialist

Only two items were not related to agile software development teams for the first specialist. He suggested changes in eight items. It is noteworthy that the decision-making to change or exclude items was not made considering only the empirical data. Both the thesis author and another researcher discussed all comments and suggestions made by the specialists (see Figure 3.3). After that, some adaptations in item descriptions were made. For example, whereas the item description originally proposed, "In this team, we can talk freely with each other about difficulties we are having and know that others will want to listen," the first specialist suggested splitting it into two items (see Figure 3.2). Two researchers analyzed the suggestion and opted to change the item description to "In this team, we can freely talk to each other about difficulties we are having." In another example, the proposed description *"The team and the product owner always agree on user story prioritized, focusing on bug-fixing or adding more functionality"* was altered to *"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."* We consider some suggestions proposed by the first specialist to make changes in the items of Communication, Collaboration, and Leadership dimensions.

Dimension	Item			Comments/Changes by Researchers		
Description	ID_Item	English	Portuguese	Author's Thesis	Action Taken	Researcher 2
Communication	[IT007]	In this team we can talk freely with each other about difficulties we are having and know that others will want to listen	Nesta equipe, podemos conversar livremente uns com os outros sobre as dificuldades que estamos tendo e saber que os outros querem ouvir	The original item is "On this team we can talk freely with each other about difficulties we are having and know that others will want to listen". However, as the instrument has item 062, the suggested adaptation will be accepted.	(Updated Item) In this team, we can freely talk to each other about difficulties we are having	Ok!
Communication	[IT016]	The team keeps the list of impediments, risks and control actions updated	A equipe mantém atualizada a lista de impedimentos, riscos e ações de controle	In this item, communication is formally manifested through the insertion of a record in the artifacts in question. If the lists of impediments and risks are not carried out or are out of date, the team has communication problems. The researcher chooses to keep the item in this dimension.		Ok! (To me it's communication really)
Communication	[IT062]	My opinion is always listened to by my team	Minha opinião é sempre ouvida pela minha equipe			

Figure 3.3: Part of spreadsheet used to evaluate the TACT items - Researchers Comments

The second specialist evaluated the TACT items of Autonomy, Decision-Making, and Client Involvement dimensions. We used the same questions considered in the first evaluation. Every TACT item related to agile software development teams and no changes were suggested.

3.3.4 First and Second Case Studies

The aim of the *First and Second Case Studies* (see Chapter 7) was to evaluate TACT preliminary for the Communication, Collaboration, Leadership, Autonomy, Decision-Making, and Client Involvement dimensions. TACT was used to measure the organizational climate in three agile teams of a prominent Brazilian bank. For the data collection, we used interviews, document analysis, and the application of TACT. Data collection took place between January 2020 and March 2021.

In the *First Case Study*, we used Communication, Collaboration, and Leadership dimensions of TACT to assess the organizational climate of two teams. In the *Second Case Study*, we extended the initial case study by adding the Client Involvement, Autonomy, and Decision-Making dimensions. A third team was also included.

3.3.4.1 Preliminary Evaluation of TACT

The literature recommends implementing a pilot study for the initial assessment of instruments that measure behaviors, attitudes, or feelings [70, 99, 18, 63]. The pilot must utilize a sample with the same characteristics as the target population [49, 70, 99, 47, 63, 18]. We decided to conduct 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 allowed us to infer that TACT can capture the context of the organizational climate experienced in the teams. Recker [63] reports that in DSR, the utility, quality, and efficacy of a design artifact must be rigorously demonstrated via well-executed evaluation methods. Thus, the case studies described below are proposed as a method of evaluating both the case addressed and the TACT instrument [100].

In the evaluation by specialists, two items (2 out of 27) were not considered related to agile software development teams by the first specialist, i.e., 92% items were positively evaluated. This percentage is already evidence of the content validity of TACT. However, after the researchers' discussion, we opted to keep the items in TACT (see researchers' discussions IT192 and IT128 in Appendix A.6).

The data collection procedures used in the case study showed that TACT correctly evaluated the organizational climate for the three teams. The quantitative analysis (see Chapter 7) indicated the most influential items by each dimension in the case study. TACT items showed high factor loading (> 6). TACT showed excellent psychometric indices, for example, high correlation inter items in the Spearman correlations (ρ) and high alfa Cronbach value (> 0.8). The correlation matrix 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. Considering quantitative analysis and the reports, we excluded IT04. We did not capture reports of misinterpretation on item IT32. The low correlation may be relative to the sample and not the construct. Thus, we opted to keep IT32 in TACT. Through the dimensions of TAM [84, 85], leaders rated TACT positively for Intention to Use, Perceived Usefulness, and Output Quality.

3.3.4.2 What We Learned

During the activities performed in the *Creation Phase*, we have identified several lessons that guided the next Design Cycle.

Concerning the *Items Creation* activity, we found we should pay attention when the items are from an instrument that has copyright. These items should only be used to inspire the creation of a new item. The *SLR Study* should identify the copyrighted instruments. TACT should have had more specific items for agile teams. We knew that the *Item Creation* activity should establish more items aiming possible exclusion of some of them during *First Evaluation by specialists* and the *First and Second Case Studies*. However, the case study participants reported being tired of answering the TACT items. For example, the Leadership dimension had ten items. As TACT was meant to have ten dimensions, we decided to reduce the items of each dimension. Later, we can use the value of the correlation matrix and the factor loading to reduce items.

Analyzing the activity of the *First Evaluation by Specialists*, we may conclude that the first specialist was effective and indicated many suggestions to improve TACT items. On the other hand, the second specialist did not indicate recommendations to enhance the items. To address this threat, we defined that in the *Second Evaluation by Specialists* (see Section 3.3.3), each TACT dimension should be evaluated by at least three professionals. Furthermore, during the execution of the *SLR Study*, we identified that the item evaluation should be more systematic and provide valid evidence in more detail. Thereby, we should (i) evaluate TACT items through the perspective of Simplicity, Cohesion, and Relevance/Representativeness [83, 101] and (ii) calculate the value of Content Validity Index for each TACT item and dimension.

Concerning the TACT language version, the teams considered had Portuguese as their native language. Thus, in the third case study, we should also consider teams that speak English. We should also include personal and team characteristics such as age, gender, time allocated together in a team, and team members' experience on agile methodologies to investigate the influence of other human factors on the organizational climate.

3.3.5 Items Creation - Second Cycle

It is essential to highlight that the definition of the items was iterative and incremental. For example, the case studies mentioned before also served to exclude, include and change the description of items. The thesis author defined all items. The activity involved other researchers in discussion sessions aiming to improve the items' descriptions. For the dimensions used in the *First and Second case Studies*, we decided to update and exclude some items. Table 3.5 exemplifies some changes.

Analyzing Table 3.5, the first line describes the change in the item description from "(...) we are having" to "(...) difficulties in the tasks." In the last line, we note the ex-

Table 3.5: Example of changes in TACT items

Dimension	Item used in the First and Second case studies	New proposed item description	Action
Communication	IT01. In this team, we can freely talk to each other about difficulties we are having	[IT1.1] In this team, we can freely talk to each other about our difficulties in the tasks	Description change
Communication	IT06. The team knows the skills and technical expertise of team members, and they use the skills and technical expertise appropriately and adequately	[IT8.3] The team knows the skills and technical expertise of the team members	Description change and allocation in other dimension
Leadership	IT21. The team facilitator discusses the problems of the team	-	Item excluded

clusion of "IT21". After finishing the changes in the items used in the *First and Second Case Studies*, the *Item Creation* activity continued to Trust, Knowledge, Learning, and Motivation dimensions.

We identified other human factors and possible project elements for each item created based on literature, item description, or researchers' inference. The requirement "R3. TACT should provide a knowledge base that presents possible items' relationships with other human factors and project elements" was implemented. Next, the process of item description and association to dimension, other human factors, and project elements are exemplified.

For example, to assess the Motivation dimension, we defined the item "IT63. The team has the autonomy to discuss how and when to deliver the project outcomes with the product owner." It is noticed that the item description explicitly involves (i) the human factors autonomy and communication (see the word "discuss") and (ii) team and product owner roles. Analyzing the excerpt "how and when to deliver the project outcomes," it is understood that that expression refers, for example, to the planning tasks of the project. Still considering the item description, we can also strongly infer the relation of the item with the human factor Coordination and implicitly the possible involvement with the agile ceremonies, such as Backlog Preparation and Refinement, Iteration Planning, Retrospective Meeting, and Estimate. We were also inspired by the autonomy dimension items of the Organizational Climate Measure (OCM) [47].

Continuing the analysis of "IT63", generally, the PO is responsible for defining the user stories priority. However, due to the team's technical analysis, other user stories can be more vital to the project. In this case, the team should have the autonomy to discuss this backlog item with the PO. Accordingly, the item was based on the autonomy (intrinsic) human factor described in the study [12, 76] as an element that motivates the agile software development team. We also considered the descriptions presented in (a) [102] for the

internal autonomy factor "lacking a good communication process with the Product Owner was probably one of the main reasons for the backlog missing important tasks, which reduced the quality of the team's common plan and reduced the internal autonomy," and (b) [103] for communication "frequent communication can be used to prioritize features, set focus on bug-fixing or include more functionality." Finally, we associated other human factors and project elements based on our empirical conviction because these associations would explore new investigations about TACT structure.

Once the process of *Items Creation* was finished, we invited several specialists in agile methods to evaluate the 75 TACT items (see Appendix A.4) and their associated elements.

3.3.6 Second Evaluation by Specialists

This activity aims to evaluate the TACT items. We invited several specialists in agile methods to evaluate as judges of the items through the perspective of Simplicity, Cohesion, and Relevance/Representativeness [83, 101]. Almanasreh et al. [83] explain that the Content Validity Index (CVI) provides evidence about the degree to which elements of an assessment instrument are relevant to and representative of the targeted construct for a particular assessment purpose. The evaluation was performed by professionals who are either experienced in agile methods or have scientific publications involving agile methods. Table 3.6 presents an overview of each judge's background, experience, and dimensions assessed.

Table 3.6: Judges Profile

ID	Academic education	Exp	Main roles	Pub	Assessed dimensions
J1	Bachelor of Computer Science and Ph.D. in Informatics	10	Professor, researcher, and team leader	15	Autonomy, Decision -Making, Customer Involvement, Trust, Knowledge, Learning, and Motivation
J2	Bachelor in Computer Science and Doctorate in Software Engineering	17	Mentor, consultant, coach, implementer, and leader appraisal of Software Process Improvement	5	Autonomy, Decision Making, Customer Involvement, and Motivation
J3	Bachelor of Computer Science and Master of Technology Development	4	Scrum Master	0	Communication, Collaboration, Leadership, Autonomy, Decision-Making, Customer Involvement, Trust, Knowledge, Learning, and Motivation
J4	Bachelor of Computer Science and Ph.D. in Informatics	10	PO, SC e Team Member	1	Communication, Collaboration, and Leadership
J5	Bachelor's and Master's Degree in Computer Science	10	Business Agility Strategist, Enterprise Agile Coach, and DevOps Consultant	1	Autonomy, Decision-Making, Customer Involvement, and Motivation
J6	Bachelor in Information Systems and Master in Informatics	9		2	Trust, Knowledge, and Learning
J7	Bachelor's Degree in Information Systems and Master's Degree in Electrical Engineering	13	Developer, Product Owner, Product Manager, Product Designer, Scrum Master, and Agile Coach	6	Communication, Collaboration, Leadership, Autonomy, Decision Making, Customer Involvement, Trust, Knowledge, and Learning

Exp = the experience on agile methods in years; Main roles = Mains roles exerted involved agile methods; Pub = Number of papers published in agile area

Analyzing Table 3.6, we observe that the judges are highly educated and have a wide experience in agile methods. Seven specialists in agile methods accepted to participate as judges in the evaluation process of the TACT items. Due to the number of items, we divided the evaluated dimensions among the judges. This criterion was adopted to avoid the judges' fatigue and consider the time available for each judge. At least three judges evaluated each item. For this, the judges used a Likert Scale of 5 points (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree). The answers were attributed on a spreadsheet developed on Google Docs. Each judge made their assessment independently without accessing another judge's assessment. The judges considered three type of criteria to assess each item: The item is simple to understand (Simplicity); The item allows measuring the associated dimension (Coherence); and The item is relevant/representative (Relevance/Representativeness). We also consider two open-ended questions to capture suggestions for changes to items "Do you suggest any adaptation to the item description?" and "In your opinion, are any items in the dimension redundant? Which one(s)?" All information used in the evaluation of the TACT items is available in the Appendix A.4. Figure 3.4 shows a part of a mentioned spreadsheet with the evaluation from the judge called J1.

Dimension		Item			Content Validity			
ID_DI	Description	ID_Item	English	Portuguese	1. The item is simple to understand	2. The item allows measuring the associated dimension	3. The item is relevant/representative	Do you suggest any adaptation to the item description?
[DI04]	Autonomy	[IT4.1]	In the current project, I am free to choose the tasks I want to execute in the iteraction	No projeto atual, eu tenho liberdade para escolher as tarefas que quero executar na iteração	Strongly agree	Strongly agree	Strongly agree	
[DI04]	Autonomy	[IT4.2]	In the current project, the team facilitator protects the team autonomy from external interferences	No projeto atual, o facilitador da equipe protege a autonomia da equipe de interferências externas	Strongly agree	Strongly agree	Strongly agree	
[DI04]	Autonomy	[IT4.3]	In this organization, we have autonomy to suggest changes to the team's software process development	Nesta organização, temos autonomia para sugerir mudanças no processo de desenvolvimento de software da equipe	Strongly agree	Strongly agree	Strongly agree	I suggest using the "software development process".
[DI04]	Autonomy	[IT4.4]	In this team, we switch assignments in tasks to avoid specialization and individualism	Nesta equipe, trocamos atribuições em tarefas para evitar a especialização e o individualismo	Strongly agree	Disagree	Disagree	I'm not sure if task switching between team members would measure autonomy.
[DI04]	Autonomia	[IT4.5]	The team has autonomy to adopt technical solutions without consulting the product owner or the management	A equipe tem autonomia para adotar soluções técnicas sem precisar consultar o dono do produto ou a gerência	Strongly agree	Strongly agree	Strongly agree	In English, I would change "management" to "manager"
[DI04]	Autonomia	[IT4.6]	My team has autonomy to communicate with the product owner and other relevant stakeholders	Minha equipe tem autonomia para conversar com o dono do produto e outras partes interessadas	Strongly agree	Strongly agree	Strongly agree	

Figure 3.4: Part of evaluate made by Judge J1

Figure 3.4 shows the TACT items in the Portuguese and English versions, the dimension theoretically established by each item, and the criteria for analyses. The comments

and suggestions made by the judges were written in Portuguese, the original language of judges and researchers. The item "[IT4.3] In this organization, we have autonomy to suggest changes to the team's software process development" was allocated in the Autonomy dimension. Judge J1 attributed the option "Strongly agree" (5 on the Likert scale) to Simplicity, Coherence, and Relevance/Representativeness. Judge J1 also suggested a change in the item's description in English. She wrote, "I suggest using the 'software development process'." We grouped all comments made by the judges in the report presented in Appendix A.4. Figure 3.5 shows part of the report with the suggestions, and Figure 3.6 exemplifies a part of the report that questions the item redundancy.

Do you suggest any adaptation to the item description?	
Item	**(Judge) Suggestion**
[IT1.1]	
[IT1.2]	(J4) Should impediments be handled between team members only? Couldn't they be handled with the PO or Scrum Master? I do not know the clarity in regards to the PO or Scrum master being clear as part of the team members.
[IT1.3]	(J4) Define "the best way," I think it is pretty hard to know. Wouldn't it be convenient to change to "a better way"? (J7) For communication to be effective, there must be trust among members in the enviroment.

Figure 3.5: Part of the report indicating suggestions

In your opinion, are any items in the dimension redundant? Which one(s)?	
Dimension	**(Judge) - Suggestion**
Communication	(J3) No (J7) T.1 e T.2
Collaboration	(J3) No (J7) T2.1 e T2.2
Leadership	(J3) No (J7) IT3.4, IT3.5 e IT3.6
Autonomy	(J2) No. (J3) No (J5) No (J7) 4.3 e 4.4

Figure 3.6: Part of the report indicating possible redundancy between items

Analyzing Figure 3.6, in line 3, it shows that judge J3 did not identify redundancy items in the Communication dimension. On the other hand, judge J7 appointed a redundancy in items "T.1" and "T.2". Other judges did not manifest themselves. Figure 3.5 shows several comments for the items. These comments have been carefully analyzed to improve the descriptions of TACT items.

Having the seven judges finished the evaluation process, we calculated the Content Validity Index (CVI) to assess Simplicity (CVIs), Cohesion (CVIc), and Relevance or Representativeness (CVIr). The calculation was made for each item by dividing the total number of judges who attributed values (4 and 5) of the Likert scale by the total number of judges who evaluated the item [101]. The CVI was calculated for each item and each

theoretically established dimension. In this study, we considered the value of CVI $>= 0.7$ as an acceptable index [101].

We started changing and deleting items, analyzing each item's CVI value and the indications for changes suggested by the judges. It is noteworthy that the decision-making to change or exclude was not made considering only the empirical data (CVI < 0.7). For example, qualitative suggestions for exchanging expressions in items were accepted regardless of the CVI value. On the other hand, in some cases, the theoretical basis that supported the item's description was considered to measure the construct so as not to exclude or not carry out changes to the item. Three researchers discussed all comments and suggestions made by the specialists. After that, some adaptations in item descriptions were made. Figures 3.7 and 3.8 represent an example of the calculation of CVIs, CVIc, and CVIr for each item and the actions performed by the researchers about analyses of suggestions and the values of CVI.

The item is simple to understand										
	Simplicity					Total			%	CVI(s)
Item	SD	D	N	A	SA	D	N	A	A	
[IT1.1]	0	0	0	0	3	0	0	3	100,0	1,00
[IT1.2]	0	0	0	1	2	0	0	3	100,0	1,00
[IT1.3]	0	1	0	1	1	1	0	2	66,7	0,67
[IT1.4]	0	0	0	0	3	0	0	3	100,0	1,00
[IT1.5]	0	0	0	2	1	0	0	3	100,0	1,00

The item allows measuring the associated dimension										
	Coherence					Total			%	CVI(c)
Item	SD	D	N	A	SA	D	N	A	A	
[IT1.1]	0	0	0	0	3	0	0	3	100,0	1,00
[IT1.2]	0	0	0	1	2	0	0	3	100,0	1,00
[IT1.3]	0	0	2	1	0	0	2	1	33,3	0,33
[IT1.4]	0	0	0	0	3	0	0	3	100,0	1,00
[IT1.5]	0	0	0	2	1	0	0	3	100,0	1,00

Figure 3.7: Part of the report showed the CVI calculation for each item

The item is relevant/representative											Action Taken
	Relevance/Represent.					Total			%	CVI(r)	
Item	SD	D	N	A	SA	D	N	A	A		
[IT1.1]	0	0	0	0	3	0	0	3	100,0	1,00	Item deleted. Redundancy with item 1.2.
[IT1.2]	0	0	0	1	2	0	0	3	100,0	1,00	Updated item.
[IT1.3]	0	0	2	1	0	0	2	1	33,3	0,33	Updated item.
[IT1.4]	0	0	0	0	3	0	0	3	100,0	1,00	Description maintained.
[IT1.5]	1	0	0	2	0	1	0	2	66,7	0,67	Description maintained.

Figure 3.8: Part of the report showed the CVI calculation for each item (Cont.)

Figures 3.7 and 3.8, in line 1, represent the results of the evaluation of item "IT1.1 In this team, we can freely talk to each other about our difficulties in the tasks." CVI values were one for Simplicity (CVIs), Cohesion (CVIc), and (CVIr) Relevance/Representativeness. This value shows that the item can be excellent for measuring the team climate of agile teams. However, we opted to exclude item "IT1.1" due a suggestion by judge

J7 (see Figure 3.6). Judge J7 indicates a possibility of item redundancy of item "IT1.1" with "IT1.2. Team members always talk about impediments, problems, and risks, besides how to deal with them". In addition to deleting item "IT1.1", we changed item "IT1.2" description to "Team members always talk about impediments and how to address them."

The analysis of suggestions made by the judges and CVI values was executed iteratively for months and sometimes involved three researchers. The values of simplicity, coherence, cohesion, representativeness and adaptation to agile culture guided every discussion made by researchers. After this cycle of improvements by item, we observed the values of CVI by dimensions. Table 3.7 shows the CVI values by dimension.

Table 3.7: Content validity

Dimension	Content validity index (CVI)			Items number		
	CVIs	CVIc	CVIr	Initial	Update	Final
Communication	0.86	0.86	0.81	7	3	6
Collaboration	0.86	0.81	0.95	7	3	5
Leadership	0.89	1	0.94	6	1	6
Autonomy	0.94	0.86	0.94	7	5	7
Decision-Making	0.95	0.58	0.68	8	8	7
Client Involvement	0.97	0.86	0.89	7	5	6
Trust	0.96	0.75	0.86	7	2	7
knowledge	0.89	0.75	0.86	7	6	6
Learning	0.94	0.84	0.88	8	4	6
Motivation	0.91	0.82	0.93	11	7	8

CVIs = Content Validity Index for Simplicity; CVIc = Content Validity Index for Coherence; CVIr = Content Validity Index for Relevance/Representativeness.

Analyzing Table 3.7, we observe a value of CVI > 0.7 for all dimensions, except for the Decision-making dimension. The CVIs and CVIr of the decision-making dimensions were, respectively, 0.58 and 0.68. Therefore, considering the CVI value < 0.7, the judges' comments, and suggestions, we chose to rewrite and create some new items for the Decision-making dimension. The specialists who participated in the first stage were again invited to evaluate the new items in the decision-making dimension. Three judges agreed to participate in the new evaluation. Table 3.8 shows the new CVI values from the Decision-making dimension.

Table 3.8: New CVI to Decision-making dimension

Dimension	Content validity index (CVI)			Items number		
	CVI(s)	CVI(c)	CVI(r)	Initial	Update	Final
Decision-Making	0.95	0.9	1	7	3	7

CVI(s) = Content Validity Index for Simplicity; CVI(c) = Content Validity Index for Coherence; CVI(r) = Content Validity Index for Relevance/Representativeness.

Considering the new CVI values in the Decision-making dimension, there is an increase in its value (CVI > 0.9) for Simplicity, Coherence, and Relevance/Representativeness.

The judges unanimously (CVIr = 1) assessed the items relevant to decision-making in agile software development teams. Despite that, we decided to make some changes to the descriptions of the items indicated by the judges.

We showed the judges all TACT item associations with other human factors and project elements. The judges evaluated each relation by considering questions such as "Can it be inferred that the item allows the measurement of associated human factors? If not, inform the human factor code and the justification" and "Can it be inferred that the design elements associated with the item are pertinent? If not, inform the element code and justification" (see Figures 3.9 and 3.10). The thesis author and other researcher analyzed all judges' evaluations and comments, resulting in several changes. The researchers' actions were recorded in a spreadsheet and are available in the Appendix A.4.

ID_IT	Description	Human Factors	Can it be inferred that the item allows the measurement of associated human factors?	
			Yes	No
[IT1.1]	[IT1.1] In this team, we can freely talk to each other about our difficulties in the tasks	[HF002]Communication [HF015]Trust	5	0
[IT1.2]	[IT1.2] Team members always talk about impediments and how to address them	[HF002]Communication [HF065]Participative Safety [HF048]Coordination	5	0
[IT1.3]	[IT1.3] During the retrospectives, the team discusses the best way to improve the work	[HF002]Communication [HF022]Lerning [HF037]Decision-making [HF048]Coordination	5	0
[IT1.4]	[IT1.4] The daily meeting allows us to know the project problems and team difficulties	[HF002]Communication [HF017]Konwledge	4	1
[IT1.5]	[IT1.5] The team and the product owner always reach a consensus about the user stories priority by negotiating which bug to fix or functionality to add	[HF002]Communication [HF023] Client Involvement [HF001]Collaboration	5	0

Figure 3.9: Judges' evaluation concerning possible other human factors and project elements involved

Dimensão	ID_IT	If not, inform the human factor code and the justification.	Action Taken
Communication	[IT1.1]		Redundant item with 1.2 (Item excluded).
Communication	[IT1.2]	(J2) What is the difference between trust and safe participation? To me, they are the same. How about [HF037]Decision-making?	The Participative Safety HF removed and the Trust HF included.
Communication	[IT1.3]		
Communication	[IT1.4]	(J2) How about [HF048]Coordination? (J7) knowledge of the problems?	The Coordination HF included.
Communication	[IT1.5]	(J2) How about [HF037]Decision-making?	The Decision-Making HF included

Figure 3.10: Judges' comments concerning possible other human factors and project elements involved and researchers' actions (cont.)

Figure 3.9 shows the result of the evaluation of five items "[IT1.1], [IT1.2], [IT1.3], [IT1.4], and [IT1.5]" about the association relevance of the other human factors with the

item. For instance, in the item "[IT1.1] In this team, we can freely talk to each other about our difficulties in the tasks," five judges confirmed that the association among "[IT1.1]" with human factor "[HF001] Communication" and "[HF015] Trust". On the other hand, Figure 3.10 shows the judges' suggestions and the final actions performed by the thesis author after the discussion session with another researcher.

Upon completion of this activity, 64 items had been established with 6 items to measure Communication, 5 items for Collaboration, 6 items for Leadership, 7 items for Autonomy, 7 items for Decision-Making, and 6 items for Client Involvement, 7 items for Trust, 6 items for knowledge, 6 items for Learning, and 8 items for Motivation dimension. The items included in the TACT final version are shown in the Appendix A.1.

3.3.7 Third Case Study

As previously stated in the previous sections, for the *Third Case Study* (see Chapter 8), we decided to restructure the Communication, Collaboration, Leadership, Autonomy, Decision-making, and Client involvement dimensions. For this, we excluded, adapted and created new items. Several items were allocated in other dimensions. New items were established to Trust, Knowledge, Learning, and Motivation dimensions. All TACT items were again submitted to the evaluation of specialists in agile methods.

In the *Third Case Study*, we presented an evolution of TACT considering the Trust, Knowledge, Learning, and Motivation dimensions. We planned and executed a case study in a prominent Brazilian bank and a Canadian software house that maintains a financial system. We used qualitative and quantitative procedures to evaluate the results. TACT was used in the organizational climate survey with team members and team leader interviews, confirming the evaluation result.

3.3.7.1 Preliminary Evaluation of TACT

We execute a case study to preliminarily assess TACT and its dimensions of Trust, Knowledge, Learning, and Motivation in seven agile development teams. The case study was conducted in a Brazilian and a Canadian company developing Management Information Systems (MIS) in the financial domain.

In addition to the items established in TACT, open-ended questions were used to understand the context. In the end, we conducted interviews with the leaders to understand the possible causes or impacts of the items evaluated. TACT evaluated the organizational climate of the teams adequately. Therefore, we have initial evidence about the influence

of human factors such as trust, knowledge, learning, and motivation in forming an organizational climate in agile software development teams. This evidence is grounded in assessing climate using the TACT items, team reports, and leader interviews.

Concerning the quantitative analyses, we plotted the polychoric correlations matrices and Iclust Graphs of TACT dimensions to investigate how the items are interrelated and calculate the reliability of the dimensions. In general, there were high and moderate positive correlations between items in the dimensions. The reliability of the case study sample is high (α-Cronbach > 0.8).

Regarding the qualitative analyses, judges experienced in agile methods evaluated TACT items for Simplicity, Cohesion, and Relevance/Representativeness. The initial values of the Content Validity Index (CVI) were acceptable (>= 0.7) [96]. Analyzing the answers to the open-ended questions asked to the team members, together with the leader interviews, we have observed that it allows us to infer that the TACT could correctly capture the organizational climate of the investigated teams.

3.3.7.2 What We Learned

Recker [63] argued that the main case studies limitations are problems of controlled deduction (a lack of adequate evidence to support evidence beyond any doubt), issues of replicability due to the highly contextualized nature of the inquiry, and problems of control mechanisms to account for rival explanations or potentially confounding factors. Once aware of the limitations shown, we inferred that TACT captured the organizational climate for all teams adequately. For instance, hardly anything changed about the environment during the three evaluation cycles (between June 2020 and July 2021) carried out in the Brazilian B1 and B2 teams.

Team B2 had a favorable climate on all dimensions in every cycle. In the evaluated period, a new PO (without domain knowledge) was allocated to the projects of the B2 Team. TACT correctly captured the lack of knowledge. However, this negative element was offset by the dedication and attention that the PO had to the Team.

The B1 Team members reported dissatisfaction with the Leadership, Product Owner, and some employees during the three cycles. We realized friction between outsourced members with company employees. On the other hand, C2 Team Leader reported different types of employment relationships in the organization, more than in general. There are no differences among employees in Canada due to the kind of contract. Therefore, in future work, we suppose there might be some value in digging deeper into an investigating the

organizational climate of employees and outsourced team members. Furthermore, we realized that the factors and elements that influence the climate could be highly correlated.

Only two items (IT44 and IT61) had insignificant positive correlations with several variables in their dimensions regarding TACT items. The low correlation may represent (i) a characteristic of the sample, (ii) that the items represent behaviors that are little manifested in the considered teams in the assessment, or (iii) that the item does not allow measuring the dimension well. Anyway, more studies are needed to assess the structure of the dimensions. Therefore, we kept all TACT items for the final survey. The other human factors associated with the items TACT can be used to explore different structures in the *Validation Phase*.

3.4 Validation Phase

In the *Validation Phase*, we performed a survey (see Chapter 9) aiming to confirm the theoretical structure of TACT, i.e., whether the theoretical association of items with their dimension is plausible. For this, we used the TACT versions in Portuguese and English. Furthermore, we investigated the most critical human factors that influence the teams' climate. We captured the participant's suggestions to improve the organizational climate. Afterward, we grounded the suggestions in the literature to establish actions to improve to mitigate the critical human factors that influence teams' climate. Practitioners responsible for managing the climate of agile teams evaluated TACT through TAM (Technology Acceptance Model) [84, 85]. The dimensions of Intention to Use, Perceived Usefulness, and Output Quality were used [84, 85]

3.4.1 Evaluation of TACT

In total, 301 agile team members participated in the TACT *Validation Study*. We provided evidence of TACT factor structure based on Confirmatory Factor Analysis. The TACT dimensions showed high reliability (internal consistency). We also investigated the most critical factors and described several actions that can be considered by the climate management responsible for improving the team's climate. Finally, the ones responsible for climate management in the investigated teams confirmed the usefulness, quality, and future use intention.

3.5 Results Overview

The studies and activities performed in the DSR cycles described in this chapter allowed us to meet the *Requirements* and *Acceptance criteria* defined in DSR Project, the thesis objectives, and answer the research questions. All DSR project elements and research questions were derivatives of the objectives described in the Introduction and will be addressed next. In this section, we briefly discuss how the performed studies helped us to answer the research questions. A deeper discussion on the research questions will continue in Chapter 10 - Conclusions.

3.5.1 DSR Project

Table 3.9 and Table 3.10 reintroduce the *Requirements* and *Acceptance criteria* of the DSR project and show their found evidence.

Table 3.9: Main meet evidence by TACT each requirement

Requirement	**Source [Evidence of found requirement]**
R1. TACT should enable the assessment of the organizational climate in short cycles and continuously	Appendix A.1 [Each TACT dimension has less than 9 items and can be independently applied in a climate assessment.]; Validation Study [TACT structure showed excellent psychometric indices and high reliability for each dimension.]
R2. TACT items should be adapted to the agile culture	Appendix A.3: Construct Definition, Items Creation activity, and TACT Appendix A.1 [Studies and literature that founded the items] First Evaluation by Specialists Activity [Only 2 out of 49 items were negatively rated to agility.]; Second Evaluation by Specialists Activity [Relevance/Representativeness index (CVIr) was > 0.8 for all dimensions.]
R3. TACT should provide a knowledge base that presents possible items' relationships with other human factors and project elements	Items Creation activities [Studies and literature that grounded the items.] and Appendix A.1 [Other human factor and project elements reported.]; Second Evaluation by Specialists activity [Appendix A.4 shows the evaluation made by Judges concerning the relations of the other human factors and project elements, and discussions between researchers.]
R4. TACT should measure the critical human factors to agility	Tertiary Study [Human factors and their influences on agile software developments]; Items Creation activities [Studies and literature that grounded the items] Validation Study [Discussion];

Analyzing all evidence described in Table 3.9 and Table 3.10, we conclude that all studies and activities performed in this thesis indicate that TACT meets all *Requirements* and *Acceptance Criteria*.

3.5.2 How to assess the organizational climate in agile teams (RQ1)?

The investigations performed in the *Qualitative Study* and *SLR Study* support answering RQ1. Thereby, based on the studies results, we understand that the organizational climate assessment of agile teams might be enhanced considering the remarks described below:

Table 3.10: Main validity and reliability evidence by TACT acceptance criteria

Criteria	Rationale	Source [Evidence]
AC1. The Content Validity Index (CVI) index value should be acceptable for each TACT dimension.	CVI >= 0.7.	Second Evaluation by Specialists [The initial values of CVI for all TACT dimensions were > 0.8.]
AC2. The value of the most reported indices in the scientific literature for analyzing factorial structure should be acceptable.	$\chi^2/(df) \leq 5$; CFI and TLI ≥ 0.9, RMSEA and SRMR ≤ 0.08. RMSEA confidence interval should be (upper limit ≤ 0.10) [64].	Validation Study [$\chi^2/(df) = 1.17$, CFI = 0.997, TLI = 0.997, SRMR = 0.060, RMSEA = 0.024 (0.020 – 0.028)]
AC3. The values of the reliability should be acceptable for each TACT dimension.	α Cronbach coefficient > 0.7.	First and Second Case Studies, Third Case Study, and Validation Study [$\alpha > 0.8$ for all dimensions.]
AC4. The values of TAM dimensions considered for evaluating the TACT output should be acceptable.	Empirical evidence (positive percentage > negative percentage)	First and Second Case Studies, Third Case Study, and Validation Study [Agreement Percentage for all TAM dimensions > 88%.]

Content Validity Index (CVI), Technology Acceptance Model (TAM), Chi-square (χ^2), Degrees of freedom (df), Standardized Root Mean Square Residual (SRMR), Root Mean Square Error of Approximation (RMSEA), Tucker-Lewis Index (TLI), and Comparative Fit Index (CFI).

- Measure the critical factors to agility;
- Examine if instrument items fit agile teams' context (roles, values, practices) and national culture;
- Always check instrument copyright issues;
- The assessment should be performed through a few items in small cycles;
- Practitioners must choose an instrument with good validity and reliability evidence;
- Do not indiscriminately change the original item descriptions. Any change in the item description may alter the ability to measure the construct;
- Researchers must use the validation procedures available in psychometrics to propose items that access a given climate construct.

3.5.3 How can human factors affect the organizational climate of agile software development teams (RQ2)?

The *Tertiary Study* and *Validation Study* cooperated in providing inputs to answer RQ2.

In the *Tertiary Study*, we identified 71 human factors and 60 influences in agile teams. In addition, we identified more than 30 human factors that specifically influence team climate, e.g., Collaboration, Communication, Motivation, Leadership, Creativity, Change/Adaptability, Balance Work/life, Team working, Commitment, Fulfillment, and Trust. We identified in

Soomro et al. [21], for example, that the development of an agile team's organizational climate includes factors that represent the involvement of the whole team, agile values (trust, openness and respect during team interaction, for example), agile practices (feedback and negotiations), a culture favoring action and change (in terms of bringing progress and improvement to team activities) and collective thinking.

In the *Validation Study*, the Confirmatory Factorial Analysis (CFA) indicated the most critical human factors. In a general analysis, the critical human factors are (i) the [Autonomy] regarding [Decision-making] about the planning, (ii) meeting client expectations [Client involvement], (iii) quick responses to necessary changes [Motivation and Change / Adaptability], (iv) availability to help the team member in their difficulties [Learning], (v) the Product Owner works [Collaboratively] with the team to refine the user stories, (vi) Product Owner knows the real needs of users [Knowledge], (vii) the team facilitator assists the team in understanding the iteration objectives and resolving disagreements over user story priorities [Leadership], (viii) the Team facilitator should protect the team's autonomy [Leadership], and (ix) There is a safe environment where each one involved can discuss their doubts, uncertainties, and developments about the planning openly [Communication and Collaboration].

3.5.4 How to support continuous organizational climate assessment in agile software development teams (RQ3)?

To answer RQ3, we consider the discussions performed in the *Qualitative Study* and reports made by leaders and team members during the case studies. The findings described are empirical but cannot be generalized for all agile teams because they represent the reality of the context investigated. The recommendations are defined as follows.

- Use an instrument that (i) measures the critical factors for agility, (ii) provides the opportunity for evaluation in short cycles, and (iii) promotes reflections on the behavior of the prominent people involved in the team's activities;
- To know specific issues that influence the team climate and obtain suggestions of possible actions to be taken, the following questions can be considered: *"In your opinion, what most influences the organizational climate in your team?"* and *"How to improve your team's organizational climate?"*;
- Empower teams to analyze the climate assessment results and discuss and develop actions to improve the identified issues;

- Team members should know the benefits of climate assessment. This also involves understanding the actions taken to manage the organizational climate;
- Perform the organizational climate assessment of agile teams using TACT.

3.6 Final Considerations

In this chapter, we showed the methodological research procedures considered in this thesis. We used Design Science Research (DSR) cycles to develop and validate TACT, named after the expression *"insTrument to Assess the organizational ClimaTe of agile teams."* We used Relevance, Rigor, and Design cycles to plan and perform several studies and other activities to develop TACT. We also executed six Learning Iterations to support TACT creation and evaluation. In the following chapters, we present the studies executed. We start by describing the *Qualitative Study* in Chapter 4. We revisit the research questions in Chapter 10, answering them based on our accomplishments and findings from the studies.

4. Qualitative Study

We present a qualitative study aimed at understanding how organizations assess the organizational climate of agile teams, and which are the benefits and the difficulties associated with this assessment. We interviewed five personnel involved with organizational climate assessments. We used the interviews data to define two propositions based on the observed relationships and the interpretative understanding generated, as suggested in Recker [63]. The propositions describe pitfalls that hinder the organizational climate management. This study was published in Dutra et al. [42].

4.1 Methodology

We used a qualitative approach to collect and analyse the data [63, 104]. Qualitative methods are designed to assist researchers in understanding phenomena in context [63, 104]. Qualitative researchers typically gather a variety of data of different sorts, from interviews to documents to observations and so forth [63, 104]. Thereby, we considered using document analyses and interviews. Document analysis includes studying official publications, reports or other documents [104]. Patton [104] states that interviews allow to capture the opinion of participants, staff and other personnel involved in specific programs or processes of the organization. We used the interviews to descriptive and explanatory purposes. Descriptive interviews are used to provide a rich description of a phenomenon as perceived by individuals [63, 104]. Exploratory interviews are typically used to define questions, propose new theory constructs, and/or build new theories. Usually, propositions or hypotheses are generated based on the observed relationships or on the interpretive understanding generated [63].

4.1.1 Study Design

The objective of the study is to investigate how organizational climate assessments are carried out and deal with agile team contexts. Moreover, we want to identify pitfalls associated with these assessments and propose new research opportunities. To accomplish our goal, we interviewed key personnel involved with organizational climate assessments.

To accomplish the study goal, we defined the following research questions (RQ):

- RQ1. How do organizational climate assessments allow for the identification of behaviour corresponding with agile methodologies and the agile culture?
- RQ2. Which benefits and difficulties are associated with the performance of organizational climate assessments?
- RQ3. How do organizational climate assessments identify potential influences of software quality and agile team performance?

In order to answer the proposed RQ, we formulated the questions (Q) presented in Table 4.1.

Table 4.1: Research questions and questions considered in the interviews

Research Question	**Questions Considered**
Warm-up	Q1. How does your organization assess the organizational climate of agile software development teams? How is the process? What is the frequency? How is the instrument? What are the dimensions?
RQ1	Q2. Does the instrument cite any human factor? Which ones? Q3. Does the instrument consider the agile culture? How? Q4. Does the assessment instrument capture the perception of good and bad behaviours associated to the agile methodologies?
RQ2	Q5. Which benefits do organizational climate assessments provide to your organization? Q6. Which difficulties are faced to assess the organizational climate of agile software development teams in your organization?
RQ3	Verbatim

We defined warm-up questions to understand the organizations' context, the organizational climate assessment process, and the instrument used.

The objective of RQ1 is to understand how organizational climate assessments represent behaviours (evaluation items) compatible with agile culture. The term "behaviour" in

RQ1 was used because it is commonly used in definitions of organizational climate [57]. The term "human factor" in Q1 was used because it represents the physical or cognitive features, or social behaviour, of a person [5]. For that reason, the expression "human factor" was used to facilitate the identification of behaviours, feelings or attitudes assessed in the organizational climate survey. The use of the terms "behaviour" or "human factor" in the research questions does not exclude, for example, items or dimensions that evaluate processes or practices. Organizational climate assessments focus on employees' perceptions of different elements. Thereby, evaluation items are often described through behaviours, attitudes, feelings or preferences. For example, Açıkgöz and Günsel [29] used the item "The norms and procedures in my work team ... Help our team to function better" to assess the team's perception of the informal structure of the organizational process.

The objective of RQ2 is to investigate the benefits Q5 and difficulties Q6 associated to carrying out an organizational climate assessment. Through the answers given to Q5, proposals were established which represent pitfalls and new research opportunities.

To answer RQ3, we asked participants the research question verbatim. The objective of this question is to investigate how climate assessment results enable the identification of possible influences on the quality indicators of the software developed or the agile team performance. Product quality indicators and team performance are measured based on the analysis of the artefacts produced and the effort made in projects. It is important to notice that organizational climate assessments aim to capture the opinion or perception of employees about his/her own work, colleagues, or the organization itself. Thus, even if the team's estimates are considered correct as measured by project indicators, climate assessment could capture intentional deviations through developers' perception. For instance, a team member may think the productivity of his/her colleague is affected by long pauses or use of working hours to attend to personal issues.

4.1.2 Data collection and analysis

We sent e-mail invitations to Brazilian organizations that execute organizational climate assessment frequently and have software development teams using agile methodologies. The goals of the study and the definition of organizational climate were present in the invitation letter and reinforced verbally at the interview. All participants were involved in organizational climate management activities. Therefore, the participants had no doubts about the questions. In addition to the invitation letter, we also included a consent form to comply with ethical principles. The consent form showed the goals of the study, the participants' rights, and the privacy issues.

The participants work on organizations that perform organizational climate assessments frequently and have software development teams using agile methodologies. Each interview lasted an average of 30 minutes. For reasons of privacy, only two companies made the instrument and the last executive reports available in the assessment for us to analyse.

After the warm-up questions, we asked questions based on the research questions (see Table 4.1). We asked the interviewees to talk freely about the inquired topics. Thematic analysis [2, 3] was used for answer question RQ2. Figure 4.1 shows the thematic analysis process we used to code the data.

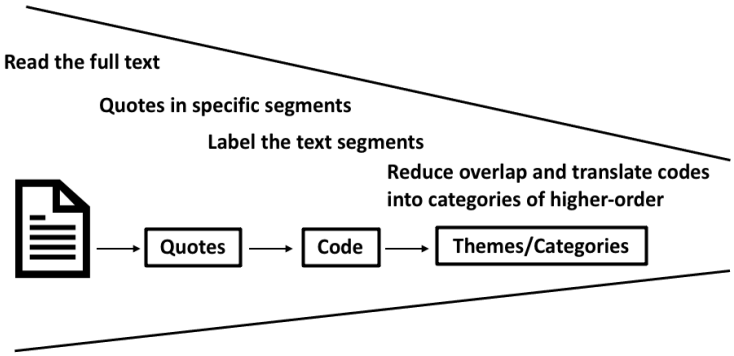


Figure 4.1: Thematic analysis process used (adapted from [2, 3])

The steps shown in Figure 1 were used for identifying, analysing, and reporting patterns within the data. Thus, we identified codes and categories relevant to the answers to the question RQ2. The thesis author performed the thematic analysis by examining interview transcripts and/or the raw audio recording. We used ATLAS.ti (https://atlasti.com/) as a supporting tool. The thesis author defined the codes associated with the text/audio (quotes). Later, he defined categories to group similar codes. All codes and categories were discussed and revised by another researcher. To verify the coherence of (i) the codes with the transcript, and (ii) the categories with the codes, the researcher used the following questions [3] "Are there clear, evident connections between the text and the codes?" and "Are categories internally coherent, consistent, and distinctive?" Necessary adjustments to the description of codes and categories were made by the thesis author. Examples of the coding process can be found in Section 4.2.3

4.2 Study Results

Next, we present findings related to the warm-up and research questions. We provide examples of quotes from participants that support our findings.

4.2.1 Characterization of the participating organizations

Understanding the context in which the data is collected is crucial to interpret data collected in any empirical study [63]. Some of the information describing the organizations was obtained through warm-up questions (Table 4.1). Companies' names are omitted for confidentiality. We considered both small and large organizations. Table 4.2 gives an overview of the participating organizations and interviewees. In Table 4.2, the numbers in the "Employees" column represent the total number of organization employees and (in parentheses) the number of employees in the IT department. The column "Climate Dimension" represents the grouping of items to measure the dimension described (see the last paragraph in Section 2.2). The "Climate Dimension" was extracted through the executive reports of organizations C and E. For organizations A, B, and D the dimensions were extracted in the analysis of open-ended questions.

Table 4.2: Participants and organizations involved

Participant	Role	Organization Type / Software Focus	Employees (IT Specific)	Software Processes Used	Climate Survey Frequency	Climate Dimension
P1	Agile team coordinator	(A) Startup; Banking	+20 (4)	Scrum	Undetermined frequency	Leadership; Culture; Owner Sentiment; Initiative; Career Progress Opportunities
P2	Agile team coordinator	(B) Insurance	+10,000 (N/A)	Waterfall; RUP; Agile	Yearly	Engagement (identification); Leadership; Team Recognition; Career Progress Opportunities; Pay; Clarity of Objectives
P3	Agile team coordinator	(C) E-commerce	+10,000 (+1,000)	Scrum; Kanban	Weekly	Engagement (identification); Wellbeing; Career; Professional Development; Feedback; Recognition; Leadership; Diversity
P4	Human resources manager	(D) Software house; Accounting; Real estate	+1,500 (+650)	Scrum	Yearly	Satisfaction; Process; Benefits; Leadership; Pay
P5	Agile team coordinator	(E) Bank	+50,000 (+2,000)	Waterfall; UP; Agile; XP	Every Three Years	Identification; Pay and Benefits; Autonomy; Innovation; Performance, Diversity; Material Support; Leadership, Justice and Transparency

Organization A resulted from a startup company and has over 20 collaborators, 4 of which are currently allocated to the development team. Their ERP provides billing, sales and invoicing services. Their software development process is based on Scrum. The organizational climate assessment instrument for Organization A was developed with the support of a consultancy firm and contains open- and closed-ended questions. The objective of the organizational climate assessment survey is to assess the collaborator's view

of the company, with a focus on leadership evaluation. The collaborator interviewed, identified as P1, acts as a software development project coordinator.

Organization B is an insurance company with a variety of products, over 10,000 collaborators and clients in the millions. Their organizational climate assessment is carried out annually. The survey is of an anonymous nature, but boards of directors and board of directors are identified, development teams are not. The organization has different types of development processes, including agile methods. The satisfaction rate, measured in the climate survey, influences the calculation of result participation. It uses an instrument developed with the support of a consultancy firm. The instrument encompasses the assessment by immediate superiors, collaborator recognition, collaborator relationship with other departments, pay/wages, clarity of company objectives; clarity of objectives presented by management. After conducting the climate identification survey, the organization holds management meetings to discuss and analyse the raised problems. The interviewed collaborator, identified as P2, is an agile team development coordinator.

Organization C operates in the field of e-commerce, and supports its operations through e-commerce, logistics, customer services and marketplace platforms. The company is listed on the Stock Exchange, with over 10,000 employees, and around 1,000 collaborators in the IT sector, as well as various teams using Scrum, Unified Process and Kanban. The Organization uses an online tool developed and run by a company specializing in organizational climate assessment. Organizational climate survey invitations requesting collaborators' participation are sent out every Monday. Different dimensions are measured, considering assessment objectives. Coordinators meet up twice a month to identify and analyse steps to improve the climate in specific dimensions. The tool presents choices of action plans for critical dimensions. The interviewed collaborator, identified as P3, coordinates a Scrum development team.

Organization D is a software house with many accounting and real estate management products. They have over 30,000 clients, with a total of around 1500 collaborators, with 250 in software development and 400 in support. The organizational climate survey is developed without consultancy support and is performed annually. Top management keep track of results and analyse and implement suggestions for improvement made by collaborators. They recently adopted agile practices and Scrum in their development process through suggestions identified in open-ended questions in the organizational climate survey. The interviewed collaborator, identified as P4, manages the institution's human resources (HR) department.

Organization E is a bank with millions of clients. The organization has three large development units. The unit considered in the interview has around 400 collaborators. This unit has many teams that use processes based on Waterfall, Scrum, Unified Process (UP) and XP. Among the dimensions measured through the instrument are innovation, material support, relationships, wages/pay and diversity. The climate survey is carried out every three years. The collaborator interviewed, identified as P5, coordinates many agile teams.

4.2.2 How do organizational climate assessments allow for the identification of behaviour corresponding with agile methodologies and the agile culture? (RQ1)

To answer RQ1, we asked questions "Q2. Does the instrument cite any human factor? Which ones?," "Q3. Does the instrument consider the agile culture? How?", and "Q4. Does the assessment instrument capture the perception of good and bad behaviours associated to the agile methodologies?" We also analysed the instruments and reports provided by organizations C and E. Participants said that the organizational climate is assessed in many dimensions aiming to capture how employees measure their satisfaction in different aspects. The human factors identified were: Autonomy, Collaboration, Commitment, Communication, Culture, Diversity, Engagement, Feedback, Initiative, Innovation, Leadership, Motivation, Recognition, Respect, Satisfaction, Sense of Ownership, Team Spirit, Trust, Vision, and Wellbeing.

Most of the human factors identified impact teams that develop new products together. Although some of the human factors identified are present in agile culture - Collaboration and Motivation [68] for example - according to the interviewees, no instrument in use considered agile values or principles contextually. Chagas et al. [10] investigated the most critical human factors in agile software development projects. The critical factors identified in [10] and also identified in our study were: Autonomy, Communication, Trust, Leadership, and Collaboration. On the other hand, the critical human factors Knowledge and Client Involvement, investigated in [10] were not present in the instruments of the organizations interviewed in our study. Human factors influence agile teams and their activities in different ways [10]. It was noticed that some organizations evaluated only the hierarchical leadership, ignoring the role of agile leadership. Furthermore, no organization evaluated the team's perception in terms of active customer involvement, stakeholder engagement, and support from senior management which are critical factors in the formation of the organizational climate of the agile team.

Participant P2 said "my assessment instrument only had generic questions about alignment to organization directives." Participant P5 said that "the instrument was not developed with this objective, but it comes up with questions to verify empowerment and trust among team members, such as 'Do collaborators trust each other?'"

According to Participant P1, Organization A's instrument has open-ended questions that enable to assess behaviour deviations considering organizational culture, opportunities for professional growth and Sense of Ownership. Participant P2 said that Organization B's instrument does not allow the identification of perceptions of behaviour in the right context. However, "the instrument has closed-ended questions on how the interaction occurs among team members and how good the relationship between an employee and his/her colleagues is." Participant P4 said Organization D's instrument considered human factors "only through very shallow open-ended questions," not considering whether they represent good or bad behaviours. Participant P3 said that when answers were grouped by dimension it was possible to see the number of employees "who evaluated a specific item negatively."

4.2.3 Which benefits and difficulties are associated with the performance of organizational climate assessments? (RQ2)

To answer this research question, we asked questions Q5 and Q6 to all participants. Table 4.3 presents the 16 benefits we identified.

Table 4.3: Identified benefits of organizational climate assessments

Category	Benefits
CBN1. Software Development Project Improvements	BN01. Fosters improvement of team performance BN02. Allows for the analysis of influences between software product quality and organizational climate BN03. Promotes increase in innovation
CBN2. Human Factors Development	BN04. Promotes increase in collaboration BN05. Recognizes the need to improve communication BN06. Identifies behaviour deviations BN07. Promotes greater commitment BN08. Allows to assess team motivation BN09. Promotes increase in recognition BN10. Allows for the assessment of team feeling
CBN3. Software Process Improvements	BN11. Allows for the identification of software process improvements BN12. Captures common practices performed in the industry BN13. Allows for the identification of new software tools
CBN4. Workforce Needs Understanding	BN14. Allows for the identification of workforce needs BN15. Promotes the proposal of actions to address workforce needs BN16. Allows monitoring of measured dimensions through time

The codes and categories presented in Table 4.3 and Table 4.4 were identified using the thematic analysis procedures described in Section 4.1.2. The codes presented in the first line in Table 4.3, for example, CBN1 and BN01, represent only indexes to facilitate

reference to the category and code in the text. The categories identified in Table 4.3 represent benefits concerning agile projects CBN1, development of human factors CBN2, proposals to the improvements of the process CBN3, and the understanding of the needs of the teams CBN4. It is noteworthy that most of the specifics benefits to agile teams (for example BN12 and BN13) were captured mainly through open-ended questions present in the instruments. For example, "what can be done to improve the organizational climate?" Only on questions like that, the agile teams could discuss specific problems concerning the team, other roles, the project, the process, and the agility.

The results presented in Table 4.3 suggest that the climate survey provides the opportunity to gain knowledge about the needs and feelings of the agile team. Participant P3 corroborates the following statement: "when we don't carry out a climate survey we become 'blinded', it isn't possible to sense the team's general feeling or if we're doing well." This quote was coded under benefit "BN10. Allows for the assessment of team feeling" and associated to "CBN2. Human Factors Development."

When Participant P2 said "a motivated collaborator is more careful. He produces better software and makes fewer mistakes," we associated it with benefits "BN08. Allows to assess team motivation," and "BN01. Fosters improvement of team performance." These benefits are associated with categories "CBN2. Human Factors Development" and "CBN1. Software Development Project Improvements," respectively. When Participant P2 said the organizational climate assessments allow to "get an idea of what [i.e., software development practices] other organizations are doing, which software tool is available, where they [i.e., competitors] are headed, where we are headed," we derived benefits "BN12. Captures common practices performed in the industry," and "BN13. Allows the identification of new software tools." To Participant P4, a climate assessment "improves the productivity of our projects [which relates to BN01], makes our projects more pleasant to execute" and "captured the opportunity to adopt agile practices in our software development process [which relates to BN12]." Benefits BN01 and BN12 are associated with category CBN1 and CBN3, respectively. When Participant P4 mentioned that one of the benefits of organizational climate assessment allows for "understanding the needs of the employees," we associated it to benefit "BN14. Allows the identification of workforce needs."

Participant P1's quote "in viewing the assessment results, I identified that we needed more frequent communication" was grouped with similar answers form other participants to originate benefit "BN05. Recognizes the need to improve communication." Similar benefits were later associated to category "CBN2. Human Factor Development."

Note that results (Table 4.3) indicate that organizational climate assessments enable the development of human factors such as Collaboration, Communication, Commitment, and Motivation. Nonetheless, the assessments themselves are not enough to develop Human Factors (nor are they sufficient to promote process improvements or improve software development project results). The development of human factors must be considered after analysis of the assessment results and the taking of specific improvement actions being established.

We identified 9 difficulties, presented Table 4.4. We grouped them into 3 categories, which address the assessment design, its execution, and subsequent actions.

Table 4.4: Difficulties of organizational climate assessment identified

Category	**Difficulty**
CD1. Design and Application of the Instrument	DF1. Agile team is not aware of the purpose and practical benefits of organizational climate assessments DF2. Difficulty to analyse data from organizational climate assessments containing many open- and closed-ended questions DF3. Lack of adaptation of the assessment instrument to the organizational agile culture may lead to misunderstandings
CD2. Analysis of Measuring	DF4. Not understanding how to use organizational climate assessment results DF5. Difficulty to understand dissatisfaction reported by team members DF6. Non-frequent assessments may lead to loss of information about the organizational climate
CD3. Action Planning and Problem Solving	DF7. Difficulty to identify possible control or mitigation actions DF8. Difficulty to address behaviour deviations DF9. Agile leaders do not promote analysis nor discussions of organizational climate survey results with the agile team

As per Table 4.4, category CD1 reveals difficulties in terms of development and application of the survey, CD2 reveals difficulties on understanding the results and periodicity of the assessment, and CD3 reveals difficulties in understanding and solving problems reported by the teams.

Participant P5 reported “low respondent adherence, because team members do not understand the objective of the climate survey DF1. They end up answering whatever comes to mind. It is not unusual for the team to remark ‘it’s that survey again. There are a lot of questions DF2. What’s the purpose of this?’ DF1. The team does not recognize the practical benefits of the research DF1.” Participant P5 also informs that “there are leaders who do not talk with the team formally, there is no formal dialogue ritual to discuss climate survey results with the team, there is no assessment of what we can improve DF9.”

Participant P1 reported difficulties analysing data captured by the assessment instrument due to too many open and closed-ended questions DF2. Participant P4 corroborates this by saying ”it is necessary to assess whether the [developer’s] answer makes sense

[open-ended questions]. Some issue contexts are hard to figure out." This excerpt was associated with "DF5. Difficulty in understanding dissatisfaction reported by team members."

Other difficulties were the basis for the definition of the propositions and pitfalls described in the Discussion Section.

4.2.4 How do organizational climate assessments identify potential influences of software quality and agile team performance? (RQ3)

During the interview, we asked participants the research question verbatim.

Participants P1, P3, P4 and P5 consider that climate assessment helps to analyse possible causes and influences of problems or to understand other indicators. This analysis is taken into account observing actions undertaken in the past accompanied by real software quality and development staff performance indicators. Participant P4 said "the climate assessment led the software development unit to make a number of changes. We had a leadership change. He was quite a good technical leader, a programmer. But the assessment results pointed out that there was dissatisfaction with his leadership. The final delivered product was not good, it had many problems. We could not meet the deadlines. After the new leader took over, the product was delivered with fewer defects. Also, the work environment improved." Only Participant P3 declared that "the instrument used to support the assessment analysis indicates possible action plans when the climate indicators are negative, but no suggested action has been effective, nor has it provided useful insights." When questioned why, Participant P3 said that "the instrument [in use] is too generic." According to Participant P2, the assessment instrument does not enable the identification of the influence of the organizational climate on the quality of the software produced or team performance. He highlighted the need for interpretative subjectivity in order to carry out such an analysis.

4.3 Discussion

In this section, we discuss the findings of the study in light of the existing literature. As stated earlier, exploratory interviews can be used to build new propositions based on the observed relationships or the interpretive understanding generated [63].

We aim to investigate how organizations considered assessing the organizational climate of agile teams, and which are the benefits and the difficulties associated with this

assessment. Based on the results, we formulated two propositions that describe pitfalls. The identified pitfalls that can be used by practitioners during the design and execution of organizational climate assessments of agile teams. The propositions can be used to define new research proposals to improve the instruments and the organizational climate assessment process of agile teams.

4.3.1 Instruments and the organizational climate assessment process

With regard to instruments, results indicate that all organizations use a single model to assess organizational climate for all sectors. Organizations A, B, C and E use models developed by consultancy firms. Only Organization D used their own model, developed by the HR sector. Dutra et al. [45] state that private consultancy firms do not usually disclose details of their design methods for theoretical assessment items, or their data collection and analysis procedures. Discussion of categories is uncommon in HR literature and in organizational practice [45]. For this reason, we have identified the main dimensions measured in the instruments (see Table 2). We only obtained access to the models in companies C and E.

Dutra et al. [45] carried out a survey with 123,445 respondents from 491 organizations in various regions of Brazil with an aim to propose a categorization of the dimensions geared towards corporate reality in Brazil. Our results are consistent with the dimensions identified [45]. The 4 main dimensions detected were: identity (how employees relate to or identify with the company), satisfaction and motivation, learning, development and leadership [45] . All dimensions mentioned were identified in our study.

With regard to specific factors aimed at developing the organizational climate of agile teams identified in the literature review (Section 2), our results show that the 5 organizations considered did not explicitly assess the following dimensions: agile values and practices; mindset for action and change; collective thinking; servant leadership; support for agile methods; frequent meetings with product owners, active customer involvement, and a favourable team attitude towards accepting change.

Organizations A, B and D capture opinions or complaints about specific agile team issues through open-ended questions. In these questions, collaborators were able to complain or give suggestions on any issue (BN11 and BN12). For example, Organization D started to use agile practices through suggestions made by developers, and also carried out a leadership change after continuous complaints were made. Organization B considers proposals for the adoption of instruments by way of suggestions from agile team members (BN12). However, the acquisition of suggestions or complaints through open-ended ques-

tions created comprehension difficulties (DF2 and DF8) as well as problems to establish actions (DF7).

Moreover, only organizations A, with just one team, and C identified the agile teams among the collaborators responding to the survey. Participant P4 said that "since the survey is treated in confidence it is difficult to deal with certain problems, including those involving leadership issues, because we were not able to identify the leaders" (DF5).

With reference to the organizational climate assessment process, team members were no more than just respondents. Coordinators and middle management established and prioritized control actions. In the opposite direction, Wlodarkiewicz-Klimek [73] proposes that the following organizational climate factors influence the development of organizational agility: (i) conscious increase in employee independence and responsibility and (ii) openness and reactivity to a changing environment. We present the propositions and pitfalls established with the respective discussions in literature as follows.

4.3.2 Propositions and Pitfalls

- ***Proposition 1:*** *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 an organizational climate management.*

We identified (see discussion of RQ1) that most assessment instruments did not enable a detailed and contextualized analysis of team behaviour. One of the difficulties reported (DF3) is associated to employees feeling confused while answering assessment items that are too generic and not well adapted to the organizational culture (DF3). This assumption is corroborated by the following quote from Participant P3: "some questions lack alignment [with the culture of Organization C]. For instance: 'is your supervisor someone who is close to you?' We don't use the term 'supervisor', our processes don't use this term/role, nor is it a role in our organizational structure. Each respondent understands 'supervisor' differently. Some respondents think it means a department coordinator, others a team leader [i.e., a scrum master]." The interviewees said that most issues related to behaviour deviations were captured through open-ended questions (see DF2), which made it difficult to properly understand the issues and take corrective action (see DF4 and DF7).

Agile culture is associated with values, principles, practices, and roles that differ from other project management standards [68, 37, 72]. A worldwide survey [38] reports on some issues and challenges that have a negative effect on the adoption of agile methods,

including inconsistent processes and practices across teams and pervasiveness of traditional development methods. Ostroff et al. [105] argue that if the adopted practices do not reflect the culture, or if practices are poorly implemented, climate perceptions may develop which are contrary to the underlying cultural values and assumptions. Observing the definitions of organizational climate shown previously, we believe that instruments must enable the assessment of collaborators' perception of their own behaviours, which must be represented by detailed examples of conduct that team members should have to perform their activities. Therefore, items of assessment instruments should be detailed enough to allow respondents to think about the organizational culture and better characterize the agile behaviours depicted. Besides, the organizational climate assessment instruments used by agile teams must be adapted to mention elements associated with the agile culture and how agile teams behave in the organization. Failure to do so may lead to a misunderstanding by both respondents and those in charge of analysing climate assessment results.

Within the context of Proposition 1, we identified two pitfalls.

Pitfall 1.1: *Non-assessment of behaviours (human factors) and factors specific to the development of an organizational climate in agile teams*

The benefits identified (Table 4.3) indicate that organizational climate assessment enables "CBN1. Software Development Project Improvements", "CBN2. Human Factor Development" and "CBN3. Software Process Improvements." In some cases, however, definition and understanding of these improvements have been undermined. Companies did not understand how to use the organizational climate assessment results (DF4). For that reason, Pitfall 1.1 is based on DF3 (Lack of adaptation to agile culture).

The use of assessment items that represent human factors and specific factors in forming agile team organizational climates allows for an understanding that is coherent with "Agile Philosophy" [2]. Açıkgöza and Günsel [106], for example, investigated the effects of organizational climate over team innovativeness. The scale used to measure innovation contains 4 items. "The team started using new procedures and methods" is an example [35]. In addition to measuring innovation in the team, the item presented enables the assessment of agile team members' perception of the process, action culture and change [21], motivation [76] as well as agile principles (i) "Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done" and (ii) "the team reflects on how to become more effective, then aligns itself and adjusts its behaviour accordingly" [68]. Melo et al. [76] point out that the lack of bureaucracy in the development process is a specific motivator for agile teams.

Pitfall 1.2: *Not to explicitly consider agile roles and other organizational structure management functions*

Companies B, D and E only recorded the sectors of collaborators who responded. In company E, agile team members applied to participate in teams whose sectors' climate had been better assessed in the organizational climate survey. Schneider and Barbera [6] revealed that leadership is essential for organizational climate development and maintenance. Thus, organizational climate assessment must take into account the organizational structure of the company and the role of servant leader. For that purpose, a climate survey must identify the respondent's agile team and include an assessment dimension of the servant leader (Scrum Master, for example), of the client (Product Owner) and other organizational structure coordinators, supervisors and managers in a manner that is clear and coherent with their positions and responsibilities. Wlodarkiewicz-Klimek [73] state that organizations should have a coherent perspective (management and employees) of viewing the organization and understanding its activities. Lucas et al. [107] also reported interpretation problems with regard to the terms "manager/supervisor" and "Scrum Master/agile coach." This ambiguity probably affected the responses since some of the individuals evidently have both a manager and a Scrum Master [107].

Serrador et al. [43] state that Senior Management Support has positive influence over the success of the project. The authors suggest that organizations that wish to create a successful climate in their projects must (i) ensure senior management support, and (ii) consider top management support of agile methodologies [43] .

Within this context, Holtzhausen and Klerk [71] used a specific scale to assess the servant leader. The authors suggest that dimensions such as Empowerment, Standing back, Accountability and Humility, for example, can be used to assess the position of servant leader [25]. Some examples of items measured and adapted to the agile context are "My Scrum Master keeps himself/herself in the background and gives credit to others" and "My Scrum Master encourages his/her staff to come up with new ideas" [71].

In addition to considering agile roles, the organizational structure for coordination, middle management and senior management must be considered. According to Sherman et al. [15] the main focus of climate measures is typically on two overall dimensions: "Do employees perceive that management's commitment is high, based on its actions (practices, procedures, and policies enacted by management)?; Is the importance of the facet (topic) communicated to the employees by managers?" [15]. Serrador et al. [43] used the item "How supportive is senior management of the use of agile methodologies in general?" to assess senior management support for agile teams, for instance.

- ***Proposition 2:*** *Not involving the agile team in continuous organizational climate management may cause a poor understanding of the influences that exceed the perception about performance and quality indicators.*

We identified difficulty "DF1. Agile team is not aware of the purpose and practical benefits of organizational climate assessments". A failure to fully understand the practical benefits of a climate survey reduces respondent participation. Organizations B and C only hold meetings between the coordinators to discuss and analyse problems identified in the climate survey. In Organization E, agile team coordinators do not discuss or analyse the results with the agile teams. In Organization D, only middle management and coordinators discuss action plans. P4 reports that top management at Organization D follows survey results and action plan progress.

In all the organizations surveyed, agile team members responded only to climate survey questions. Team members did not take part in other stages of the organizational climate management process. Moving in the opposite direction, Kotter [108] proposes that the process of change should empower the base. In our study, participants consider that climate assessment helps to analyse possible causes and influences of problems or to understand other indicators. For this reason, we defend member participation in organizational climate management issues. Developers are aware of reported details concerning problems and their likely influences which allow to exceed climate, project and performance indicator analysis. Besides, team members can point out possible relations between climate dimension and other factors.

Organizational climate research dimensions have been usually treated as independent, ignoring the notion that certain combinations of cultural values or other dimensions may better capture the holistic nature of the context [105]. Corroborating this assumption, some studies show the correlation of influences between climate dimensions, e.g. [26]. Acikgoz and Ilhan [26] showed that the innovation orientation and goal orientation dimensions of team climate are directly and positively related to the problem-solving capability of software development teams. Therefore, the assessment instrument must allow the identification of elements that influence the organizational climate through correlations suggested in the literature.

In the context of Proposition 2, we pointed out two pitfalls.

Pitfall 2.1: *Not to carry out ongoing assessment, in small cycles and with few assessment items*

We identified difficulty "DF6. Non-frequent assessments may lead to loss of information about the organizational climate" after Participant P4 feedback, who said that "holding climate assessments once a year results in facts being forgotten." Participant P5 said that "it is possible that at the time of the survey being carried out, the climate had a certain feature. However, soon afterwards everything can change, due to a change in the process, for example." Organization E conducts climate assessments every three years. DF6 was also corroborated by Participants P1 and P4. Moreover, participants informed us they took action based on negative feedback obtained from organizational climate assessments. For example, Organizations A and B changed team leaders as a way to improve project indicators due to the perception of problems reported during climate assessment, not due to project data and indicator analysis.

DF2 presented the problem of there being too many questions in the survey. To overcome this problem, Pulse surveys [79] can be applied. Pulse surveys [79] are brief assessments held quickly in a short-term period.

Pitfall 2.2: *Not involving the agile team in organizational climate management activities*

Participant P2 reported that during problem analysis meetings, agile coordinators were silent when faced with reports regarding their own conduct or that of their teams (DF7 and DF8). In all organizations agile team members only participate as respondents to the climate survey. They are not required or expected to participate in other activities related to organizational climate management. In Organization E, agile team coordinators do not discuss climate survey results with the team (DF9), despite the final report of the climate survey stating that "managers and teams should reflect on the results and define, as a group, projects and actions for Climate improvement in their Unit. A diagnosis without action does not revert into improvements." Organization C holds fortnightly meetings with coordinators only, to analyse the problems.

The benefits identified in the interviews (Table 3) indicate that the organizational climate assessments enable the identification of improvements in the development process (CBN3), the software project (CBN2) and also human factor development (CBN2). Thus, climate assessment can bring about cultural and technical change in many ways. Senapathi and Srinivasan [87] report that team empowerment is a key factor for the sustainable use of agile methods. In this respect, in addition to gathering opinions on organizational climate, agile teams must be involved in result analysis and discussion, and furthermore, propose actions for adjustment and improvement. Review meetings can be used towards

this objective. In addition, agile teams should be represented in climate assessment working groups.

Guaranteeing agile team member participation in the climate management process provides team empowerment. Shahzad et al. [99] report that team empowerment influences the innovation process. One example of an assessment item that is adapted to the agile context and that can be used to assess team empowerment is: "The agile teams in our organization are part of both short- and long-term planning processes" [99].

Assessments carried out by Organization C can be considered climate pulse surveys [79]. They allow the identification of changes in the organizational climate in real time. To design them, agile coordinators, team members and human resources managers must select appropriate metrics and predictive assessment dimensions. Thus, the resulting analysis can be done fast enough and corrective actions can be taken in a short period of time to avoid recurrence of the reported issues.

4.4 Threats to Validity and Limitations

Despite the small number of participants, we endeavoured to consider different types of organizations such as startups (Organization A), others with more bureaucratic processes, i.e. banks and insurance companies (Organizations E and B) and, in addition, a software house (Organization D). Our findings on the items measured in these organizations are compatible with Brazilian organizations [45]. It is worth mentioning that it is not possible to indicate that our findings do not represent other cultures or locations, since some of the scales used to measure organizational climate are used in many countries.

Every study presents threats to the validity of its results [63]. Recker [63] considers four guidelines to assess the validity of qualitative studies. Dependability: We have presented evidence that our interpretations were based on interviews. We showed direct quotes to substantiate some of our results. Credibility: The survey questionnaire was tested prior to the first interview. During the interviews, questions were explained to participants and additional information was given when needed. We triangulated our results, the propositions and pitfalls with other studies. Confirmability: The thesis author defined properties associated with either the transcribed text or original audio from the interviews. The quotations were grouped into codes and categories. All quotations, codes and categories were revised by the another researcher. Transferability: We present a general view of the interviewees' perception. We do not propose a generalization of the findings nor

a theory based on the collected data. The propositions and pitfalls are still exploratory, were not validated and do not constitute a theory.

Although the results can be valid in other contexts and organizations, they must be taken as subjective interpretations and as initial evidence.

4.5 Final Considerations

We presented a qualitative study in order to investigate how organizations carry out organizational climate assessments of agile teams. We interviewed five professionals involved with such assessments in five Brazilian organizations. In summary, (i) the process has a long interlude between assessments, (ii) agile team members do not participate in discussions about results or to the define action plans, (iii) the instruments considered have many open- and closed-ended questions, and (iv) the instruments applied are equal to all departments of the organization.

Based on interviews, we identified 16 benefits and 9 difficulties. The 16 benefits identified were grouped into 4 categories. They indicate that organizational climate assessment in agile teams allows "Workforce Needs Understanding," thus enabling "Software Process Improvements," "Software Development Project Improvements," and "Human Factor Development." The 9 difficulties identified were grouped into 3 categories and reflect precautions that those involved in climate assessment must bear in mind with regard to "Design and Application of the Instrument," "Analysis of Measuring," and "Action Planning and Problem Solving" activities.

We formulated two propositions which describe pitfalls that may be taken into account during the design and performance of organizational climate assessments: "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 an organizational climate management" and "not involving the agile team in continuous organizational climate management may cause a poor understanding of the influences that exceed the perception about performance and quality indicators." These propositions represent specific pitfalls for agile team organizational climate management.

In the next chapter, Chapter 5, we present the *Tertiary Study*.

5. Tertiary Study

This study aims to elicit human factors and their influence on Software Engineering development teams and in Agile Software Development (ASD) teams in particular. To achieve this goal, we executed a tertiary study. The main contribution of this study is offering a comprehensive overview of the human factors and their influence on SE. We expect the results to sensibilize managers, leaders, and academics to propose actions that corroborate the establishment of more healthy social interactions. This study was published in Dutra et al. [13].

5.1 Method

This tertiary study uses the same methodology of SLR and SMS, following the guidelines proposed by [109, 110]. We devised the protocol based on both guidelines and an exemplary tertiary study [111].

5.2 Research questions, inclusion/exclusion criteria, and the search string

To achieve the objective described in the introduction, the *research questions (RQ)* were defined as follows:

- *RQ1. Which human factors are investigated?*
- *RQ2. How do human factors influence software development?*
- *RQ3. How do human factors influence Agile Software Development?*

A broad *inclusion criterion* was defined in the scope of the tertiary study: SLR/SMS must investigate human factors that affect software development teams. We also defined 8 *exclusion criteria* to ensure the quality of the findings, which are: Written in a language other than English; Duplicates; Outside Computer Science area; Not peer-reviewed; Not accessible; Research Proposal; SLR/SMS that present results from another SLR/SMS identified in this tertiary study and do not report new human factor or influence; and SLR/SMS that do not meet the inclusion criteria. To capture the largest number of studies, an initial period was not defined in the exclusion criteria.

Before executing the tertiary study, we searched Scopus and Compendex for other studies with similar goals. Through this non-systematic literature review, we identified the two control studies (i.e., [10, 9]) and several synonyms to the terms used in the search string (e.g., [10, 9, 33]). Based on the study goal, we derived the first version of the search string containing the terms human factor, systematic literature review, Software Engineering, and teams. After several tests, the canonical *search expression* was defined as:

((”human factor” OR ”human aspect*” OR ”social factor*” OR ”behavior*” OR ”skill*” OR ”soft factor*” OR ”non-technical factor” OR ”personality” OR ”attitude*”)* ***AND*** *(”systematic review” OR ”systematic literature review” OR ”systematic map” OR ”systematic mapping” OR ”mapping study”)* ***AND*** *((”software engineering” OR ”software development” OR ”software system*” OR ”software life cycle” OR ”software process” OR ”software maintenance” OR ”software project*”) OR (”software developer*” OR ”software professional*” OR ”software engineer*”) OR (”software team*” OR ”SE team*” OR ”IS team*” OR ”programming team*” OR ”team project*” OR ”project team*”)))*

5.2.1 The search process and study selection

After the approval of the protocol, we performed the search on selected search engines. For each search engine, the string was adapted and executed. The results were recorded and analyzed in a Google Sheets spreadsheet. The spreadsheet with the full protocol and all the steps and extractions performed can be found at `https://doi.org/10.6084/m9.figshare.14572365.v1`.

The *selection of papers* was executed using two filters. In the first filter, the title, abstracts, and keywords were read. For each study, the considered exclusion or inclusion criteria were indicated. Each study was evaluated by both the thesis author and another researcher independently. Comments were recorded and analyzed in case of divergence of

the criteria used by each researcher. In the second filter, the thesis author read the papers' full-text. Studies were included if they met one of the inclusion criteria, or excluded if they met specific exclusion criteria. This study was planned and executed from October 2018 to March 2021. We searched the online databases in Nov/2018, May/2020, and Jan/2021. We performed snowballing in Mar/2021. The results cover publications until the year 2020. The search and analysis of results were executed in two phases, as depicted in Fig. 5.1.

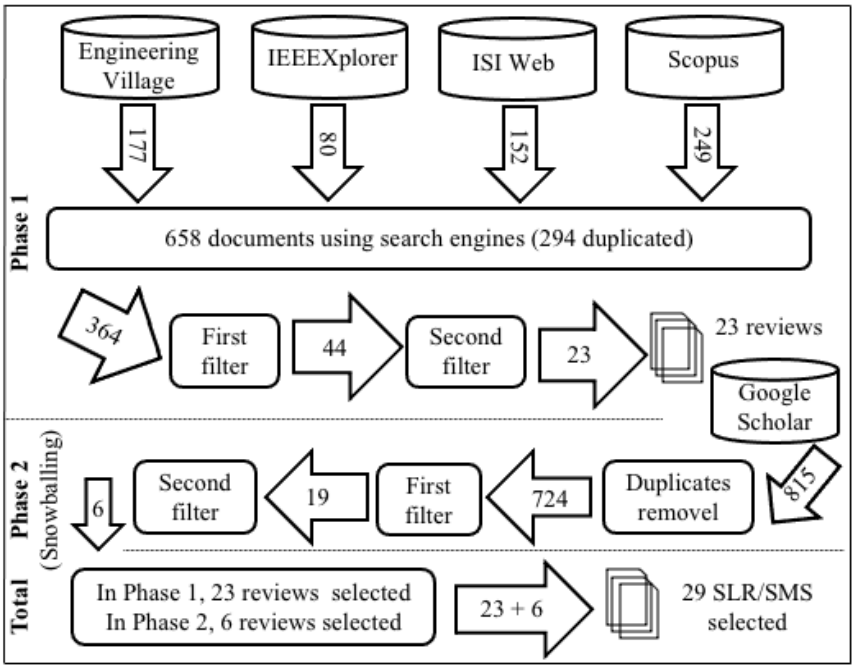


Figure 5.1: Phases to SLR/SMS selection

- **Phase 1:** We run the search expression in the most used online databases for software engineering, i.e., IEEEXplore, Scopus, Engineering Village, and ISI Web of Science [33]. In the first filter, 364 documents were analyzed, and 320 studies were rejected. To apply the second filter, 44 full-text studies were read. In the end, we identified 23 SLR/SMS.

- **Phase 2:** In this phase, we performed a forward snowballing using as seeds the 23 SLR/SMS identified in Phase 1 using Google Scholar. We limited the results to the first 100 studies referencing each SLR/SMS. In total, other 724 documents were scrutinized by applying the inclusion and exclusion criteria in the two filters. In the end, we identified 6 new relevant SLR/SMS.

5.3 Extraction and analysis

We used the spreadsheet mentioned above to collect the information needed to address the quality criteria and research information (references, search string, and research in human and ES topic).

According to Kitchenham and Brereton [109], quality assessment is important to classify the papers for review studies. Table 5.1 presents the considered questions and quality criteria. The first four were based on [111]. The quality score was only informative. No SLR/SMS were excluded.

Table 5.1: Questions and quality criteria

Question	Criteria Quality (Points)
Are the inclusion (IC) and exclusion criteria (EC) described and appropriate?	IC and EC are explicit (1); IC and EC are implicit (0.5); IC and EC are not defined and cannot be readily inferred (0)
Is the literature search likely to have covered all relevant studies?	The search covered more than 4 bases plus an additional search strategy (1); The search covered 3 to 4 bases (0.5); The search covered 2 bases or a restricted set of journals (0)
Did the research questions involve quality issues that are addressed by the study?	The use of quality criteria is reported (1); The research questions mention quality aspects (0.5); No (0);
Were the base studies adequately described?	Relevant data from each selected paper is presented (1); Human factors are grouped for analysis (0.5); Primary studies are not detailed (0)
Were the results analyzed critically?	The results were compared with other studies (1); Few results were discussed (0.5); No (0)

Thematic analysis was used to identify the human factors and their influences [3]. We used ATLAS.ti as a supporting tool. The thesis author identified the codes associated with the origin text. To analyze the human factors influences, the thesis author defined categories to group similar codes. The other researcher discussed, revised, and audited all codes and categories.

5.4 Results

Table 5.2 summarizes the 29 selected SLR/SMS, including their quality score and the SE topics investigated. The most investigated "Human Topic" in the selected studies were Personality and Motivation. Each topic is the subject of five studies. Seven studies approach dozens of human factors in the perspective of "Individual Factors" and "Human Aspects." The other "Human Topics" are examined from different perspectives for effective use in ASD, such as Capability [90], Sustainability [87], Diversity [112], Human Challenges [113], Human Factor [10], and Mindset [86].

Motivation [80, 122, 123, 89, 12] and Personality [124, 125, 126, 21, 9] were the main research topic in ten studies. Beecham et al. [123] analyze that Motivation is difficult

Table 5.2: Summary of the identified SLR/SMS

Study	Human Topic	Software Engineering Topic	Quality Score
[90]	Capability	ASD	5
[114]	Communication	SE; GSD	5
[72]	Critical Factors	ASD	5
[115]	Decision-making	Software Project	3.5
[116]	Diversity	SE	2.5
[112]	Diversity	ASD	3.5
[117]	Emotional	SE	5
[118]	Human Aspects	SE; Productivity	3
[91]	Human Aspects	ASD	2.5
[113]	Human Challenges	ASD; GSD	5
[10]	Human Factor	ASD	5
[88]	Human Factor	SE; Code Review	3.5
[119]	Human Factor	SE; Productivity	3.5
[120]	Human Factor	Software Quality	3
[121]	Individual Factor	Modern Code Review	4,5
[74]	Knowledge sharing	SE	3.5
[86]	Mindset	ASD	3
[80]	Motivation	ASD; Productivity	3.5
[122]	Motivation	SE	5
[123]	Motivation	SE	5
[89]	Motivation	ASD	4
[12]	Motivation	ASD	4
[124]	Personality	SE	5
[125]	Personality	SE	4.5
[126]	Personality	Requirement Engineering	3
[21]	Personality	Performance	5
[9]	Personality	SE	5
[127]	Sentiment	Software Practice; Artifacts	2.5
[87]	Sustainability	ASD	4.5

to measure. Besides, learning, exploring new techniques, and problem-solving seem to be motivating aspects in SE [123]. Cruz et al. [9] state that Personality is generally seen through the person's behaviors, thoughts, and feelings. In general, the studies aim to assess the Personality type preferences for team roles or in software development activities. The Myers–Briggs Type Indicator (MBTI), a questionnaire that indicates different traits of personality, was the most used test [9].

In recent years, the academy's interest in deepening studies on the influence of Emotion [127, 117] and Diversity [116, 112] in the development team has been observed. Sánchez-Gordón and Colomo-Palacios [117] identified 40 emotions investigated in team members, e.g., anger, fear, disgust, sadness, joy, love, and happiness. Diversity in the SE presents multiple dimensions regarding ethnicity, age, gender, and disabilities [116].

Table 5.2 shows that 11 studies are specific for Agile Software Development (ASD), and 9 studies have a specific perspective in SE. Moreover, some studies also investigated other types of factors, e.g., organizational [119] or task characteristics [115]. Productivity and Performance were studied in four studies. Two recent reviews address the Global Software Development (GSD) [114, 113] and the Modern Code Review Process [88, 121]. Regarding the "Quality Score", 11 studies had an excellent evaluation with a score of 5

(see the fourth column in Table 5.2). Approximately 76% of the studies (22) got a score bigger or equal to 3.5. Hence, most of the studies achieved good quality [33].

The following sections show the 101 human factors identified (Table 5.3) associated with the 79 influences (Tables 5.4, 5.5, 5.6, 5.7), thus answering the research questions. The character "*" (Tables 5.3, 5.4, 5.5, 5.6, 5.7) denotes human factors and their influences on ASD. The large number of human factors and influences prevents us from analyzing all data due to the lack of space in this article.

5.4.1 Which human factors are investigated? (RQ1)

To answer RQ1, we coded the human factor investigated in each study (see Table 5.3). The number in parentheses refers to the number of SLR/SMS in which the human factor was discussed. We group only human factors with the same semantic radical, for example, motivation and (de)motivation were grouped in *Motivation*. Personality traits were grouped in *Personality*. We decided not to categorize the human factors due to the differences in the theoretical constructs they can represent. The most common human factor were *Communication (21), Collaboration (17), Knowledge (17), Motivation (15), Trust (14), Personality (13), Involvement (13), Experience (12), Leadership (11), Team working (11), Autonomy (11),* and *Learning (11)*. The less investigated human factor in the studies, with one citation each, involved mainly emotions, e.g., *Emotionally Resilient, Conscious Sensitivity, Contentment, Disgust, Friendship,* and *Pride*.

Notice that in Table 5.3, some human factors represent individual aspects, such as physical and cognitive characteristics, feelings, or behaviors. Behaviors represent employee interactions manifest with the other developer, team, work, or organization.

Individual characteristics can be represented by *Age, Gender, Personality, Disability, Ethnicity,* or *Race*. Two studies [116, 112] investigated "Diversity" factors in the team composition and task assignment. Cognitive characteristics correspond to the way the software developer reasons. In this sense, human factors can be represented by *Learning, Decision-Making,* or *Intelligence*.

Some human factors represent behaviors related to the team member's interaction with the team or the work. Usually, activities inherent to software development are performed as a team. In this sense, we identified human factors to represent the necessary behaviors to ensure interaction between members, e.g., *Collaboration, Communication, Coordination,* or *Collective thinking*.

Table 5.3: Human Factors influencing software development

Age* (3) [116, 21, 112]	Empowerment* (5) [115, 123, 87, 122, 86]	Motivation* (15) [80, 10, 90, 72, 123, 87, 122, 88, 119, 113, 89, 12, 118, 86, 120]
Anger (3) [117, 88, 127]	Enjoy (2) [122, 117]	Need for Stability (3) [123, 122, 21]
Anticipation (1) [117]	Enterprising* (2) [90, 122]	Openness* (3) [90, 21, 86]
Autonomy* (11) [80, 10, 115, 90, 72, 123, 122, 119, 89, 12, 86]	Enthusiasm* (2) [90, 21]	Orientation (2) [122, 21]
Balance Work/life* (9) [80, 115, 90, 72, 123, 122, 21, 89, 12]	Equity* (3) [80, 115, 12]	Ownership* (4) [72, 122, 89, 120]
Boredom (2) [123, 122]	Ethics* (3) [90, 112, 89]	Participative Safety* (5) [115, 122, 21, 88, 12]
Calm/relaxation* (2) [72, 117]	Ethnicity* (3) [116, 21, 112]	Passion* (2) [72, 87]
Challenge* (5) [80, 123, 122, 21, 12]	Excited (1) [117]	Perseverance* (1) [90]
Change/Adaptability* (9) [80, 90, 72, 123, 87, 122, 21, 12, 91]	Experience* (12) [80, 90, 72, 126, 88, 119, 89, 12, 118, 121, 86, 120]	Persistence* (1) [12]
Cohesion* (5) [9, 90, 21, 119, 118]	Fairness (1) [119]	Personality* (13) [9, 124, 90, 125, 72, 126, 123, 116, 122, 21, 119, 112, 120]
Collaboration* (17) [80, 10, 115, 124, 90, 72, 123, 87, 122, 21, 113, 12, 118, 91, 121, 86, 120]	Fatigue (1) [120]	Politeness (1) [127]
Collective Thinking (1) [21]	Fear (2) [122, 117]	Pressure* (3) [80, 72, 120]
Commitment* (9) [115, 90, 72, 21, 119, 113, 89, 12, 86]	Feedback* (9) [80, 115, 72, 123, 122, 114, 89, 12, 86]	Pride (1) [120]
Communication* (21) [9, 80, 10, 115, 90, 72, 126, 123, 122, 21, 88, 114, 119, 113, 89, 12, 118, 121, 74, 86, 120]	Flexibility* (3) [90, 123, 21]	Proactivity* (3) [90, 122, 120]
Competency* (9) [90, 72, 126, 123, 87, 122, 21, 88, 120]	Friendship (1) [88]	Race* (2) [87, 112]
Competition* (1) [90]	Frustration (2) [117, 88]	Recognition* (6) [80, 115, 123, 87, 21, 89]
Concentration* (2) [90, 72]	Fulfillment* (3) [80, 87, 21]	Relevance* (3) [80, 123, 21]
Conflicts Resolution* (3) [9, 90, 21]	Gender* (6) [125, 116, 87, 21, 112, 120]	Respect* (4) [115, 72, 21, 119]
Conscious Sensitivity* (1) [90]	Happiness (3) [117, 127, 120]	Responsibility* (8) [90, 72, 87, 122, 21, 113, 12, 86]
Consistency (1) [88]	Honesty* (4) [90, 87, 12, 86]	Rigidity (1) [88]
Contentment (1) [117]	Initiative* (1) [90]	Rudeness (1) [127]
Conviction* (1) [90]	Innovation* (4) [87, 122, 21, 86]	Sadness (2) [117, 127]
Coordination* (7) [80, 72, 123, 122, 21, 114, 12]	Integrity* (2) [90, 86]	Satisfaction* (8) [80, 115, 124, 72, 122, 119, 12, 121]
Creativity* (8) [115, 124, 90, 123, 122, 74, 86, 120]	Intelligence (2) [88, 119]	Sense of Belonging* (3) [80, 115, 123]
Cultural Aspects* (7) [10, 72, 87, 88, 114, 74, 120]	Interaction (2) [88, 114]	Sharing* (8) [72, 21, 88, 113, 12, 121, 74, 120]
Decision-making* (8) [9, 115, 123, 87, 21, 12, 91, 120]	Interest* (2) [117, 89]	Social Support* (2) [87, 21]
Depression (1) [117]	Involvement* (13) [80, 10, 90, 72, 123, 116, 122, 21, 114, 113, 12, 86, 120]	Stress* (6) [80, 115, 72, 123, 122, 117]
Disability* (2) [116, 112]	Joy (3) [122, 117, 127]	Surprise (1) [117]
Disgust (1) [117]	Knowledge* (17) [80, 10, 115, 90, 72, 126, 123, 87, 88, 114, 119, 89, 12, 118, 121, 74, 120]	Team working* (11) [80, 115, 90, 123, 122, 21, 119, 89, 12, 86, 120]
Education* (5) [90, 72, 126, 87, 120]	Language (2) [114, 74]	Trust* (14) [10, 115, 72, 123, 87, 21, 117, 88, 114, 119, 12, 74, 86, 120]
Effectiveness* (5) [90, 123, 87, 119, 120]	Leadership* (11) [80, 10, 124, 90, 72, 123, 87, 122, 21, 119, 86]	Vision* (3) [90, 21, 120]
Efficiency* (2) [90, 21]	Learning* (11) [80, 10, 90, 72, 126, 87, 122, 12, 121, 86, 120]	Wellness* (2) [10, 123]
Emotionally Resilient (1) [122]	Love (2) [117, 127]	Willingness* (2) [90, 74]
Empathy* (3) [88, 119, 86]	Moral* (2) [90, 21]	

Dyba and Dingsøyr [72] reported that in ASD is necessary to establish negotiation to explore and agree on the progress of the tasks. The negotiation involves *Communi-*

cation and *Collaboration* between the members of the agile team and the product owner for the planning of iterations and the execution of tasks. Vishnubhotla et al. [90] classified *Collaboration* as an individual attribute of developers and an attribute that allows understanding the integrated perspectives to innovation.

Other human factors represent behaviors of development team members regarding the organization's culture. Organizations define their processes, rules, and practices through their mission, vision, and values. Thus, the way the organization operates generates feelings or behavioral reactions in their employees. Melo et al. [80] and Beecham et al. [123] state that reward and incentive policies contribute to feelings and behaviors of *Recognition*. The way the organization operates, presents its objectives, or expresses possibilities of articulation, is internalized and then externalized through behaviors that show work *Relevance, Participative Safety, Openness,* and *Coordination* as part of the development team member.

5.4.2 How do human factors influence software development? (RQ2)

To answer RQ2, we analyzed the research structure of each study and the discussions to relate human factors and their influences. After coding the human factors, we associated the 79 identified influences into four categories: Team Member (Table 5.4), Team (Table 5.5), Project (Table 5.6), and Organization (Table 5.7).

The influences on *Team Member Attributes* (Table 5.4) and *Team Attributes* (Table 5.5) group the human factors authors did not associate with specific SE activities. Vishnubhotla et al. [90] elicited the i) individual engineer attributes and ii) attributes for the team in the category denominated professional. The authors classified, for instance, *Enthusiasm* as affective (Table 5.4) and active *Learning* and improvement as growth (Table 5.5). The authors also identified factors that impacted *Innovation* from the perspective of professionals (see *Team Member Innovation* influence in Table 5.4) and the team (see *Team Innovation* influence in Table 5.5). Influences in different perspectives (e.g., team member and team) also occurred in the other factors (e.g., *Motivation*).

We identified 5 studies that investigated *Motivation* in the *Team Member* (Table 5.4) and *Team* (Table 5.5). França et al. [122], in an update of the review performed by Beecham et al. [123], investigated external signs and aspects that (de)motivate software engineers. *Learning* opportunities, experimentation to gain *Knowledge, Autonomy,* and effective *Communication* (Table 5.4) are human factors that (de)motivate software engineers to be more or less productive [122]. Melo et al. [80] identified factors that influence

Team Member Motivation (Table 5.4) and *Team Motivation* (Team 5.5) on ASD. *Autonomy* and *Feedback* were factors that motivate the team member [80].

Table 5.4: Influence on Team Member

Influence	Human Factor
Team Member Attributes* [115, 124, 90, 125, 72, 126, 123, 87, 122]	Collaboration, Communication, Motivation, Leadership, Ethics, Creativity, Personality, Balance Work/life, Team working, Empowerment, Commitment, Trust, Responsibility, Knowledge, Integrity, Autonomy, Learning, Involvement, Experience, Conflicts Resolution, Decision-making, Flexibility, Concentration, Competency, Need for Stability, Challenge, Willingness, Stress, Conviction, Education, Perseverance, Proactivity, Gender, Satisfaction, Participative Safety, Enthusiasm, Equity, Enjoy
Team Member Motivation* [80, 123, 122, 89, 12]	Collaboration, Communication, Motivation, Leadership, Creativity, Personality, Change/Adaptability, Balance Work/life, Team working, Empowerment, Trust, Responsibility, Knowledge, Relevance, Autonomy, Learning, Involvement, Wellness, Experience, Sense of Belonging, Recognition, Innovation, Decision-making, Ownership, Effectiveness, Coordination, Competency, Need for Stability, Challenge, Feedback, Stress, Satisfaction, Participative Safety, Honesty, Sharing, Joy, Boredom, Enjoy, Fulfillment
Team Member Satisfaction [9, 124, 122, 21]	Motivation, Personality, Satisfaction, Enthusiasm
Team Member Decision-making* [9, 10, 115, 126]	Collaboration, Communication, Leadership, Creativity, Personality, Balance Work/life, Team working, Empowerment, Commitment, Trust, Responsibility, Knowledge, Autonomy, Learning, Sense of Belonging, Recognition, Respect, Competency, Feedback, Satisfaction, Participative Safety, Equity
Team Member Emotion* [80, 90, 72, 122]	Communication, Motivation, Leadership, Ethics, Passion, Team working, Competency, Initiative, Willingness, Stress, Enthusiasm, Boredom
Team Member Education* [9, 72]	Collaboration, Communication, Personality, Commitment, Competency
Team Member Problem Solving* [80, 122]	Motivation
Team Member Work Ethics* [90]	Motivation, Ethics, Commitment, Responsibility, Integrity, Flexibility, Honesty
Team Member Interpersonal Attributes* [90]	Collaboration, Team working, Involvement, Conflicts Resolution, Proactivity
Team Member Innovation* [90]	Collaboration, Creativity, Enterprising, Change/Adaptability, Vision, Disability, Innovation, Openness, Efficiency
Team Member Agile Attitudes* [87]	Collaboration, Passion, Responsibility, Learning, Honesty
Team Member Agile Mindset* [86]	Collaboration, Communication, Motivation, Leadership, Creativity, Team working, Empowerment, Commitment, Trust, Responsibility, Knowledge, Integrity, Autonomy, Learning, Involvement, Experience, Innovation, Openness, Feedback, Honesty, Empathy

The *Team Member Decision-making* influence (Table 5.4) represents the behaviors of each individual that will influence the behavior of other team members and the project results [115]. Jia et al. [115] identified environmental factors influencing individual *Decision-Making* behavior in software projects. The authors show team characteristics, e.g., *Communication, Trust, Respect,* and *Feedback*, influence *Team Member Decision-making* (Table 5.4) [115].

The *Team Climate* influence (Table 5.5) represents factors that can be defined as a combination of its team members' interactions to share their perceptions of the team's work procedures and practices [21]. Soomro et al. [21] investigated several factors that influence the *Team Climate*. The authors reported that *Collaboration, Cooperation, Coor-*

Table 5.5: Influence on Team

Influence	Human Factor
Team Attributes* [10, 115, 90]	Collaboration, Communication, Motivation, Leadership, Creativity, Personality, Enterprising, Change/Adaptability, Balance Work/life, Team working, Empowerment, Trust, Responsibility, Knowledge, Relevance, Cultural Aspects, Autonomy, Learning, Involvement, Experience, Cohesion, Recognition, Decision-making, Social Support, Moral, Orientation, Effectiveness, Respect, Competency, Need for Stability, Challenge, Feedback, Efficiency, Proactivity, Fear, Satisfaction, Emotionally Resilient, Competition, Conscious Sensitivity
Team Motivation* [80, 87, 88, 89, 12]	Collaboration, Communication, Motivation, Leadership, Ethics, Change/Adaptability, Commitment, Balance Work/life, Team working, Knowledge, Relevance, Autonomy, Learning, Involvement, Experience, Sense of Belonging, Recognition, Social Support, Ownership, Effectiveness, Coordination, Challenge, Feedback, Stress, Satisfaction, Interest, Fulfillment
Team Agile Capability* [10, 90, 72, 87, 89]	Collaboration, Communication, Motivation, Leadership, Personality, Change/Adaptability, Balance Work/life, Empowerment, Trust, Responsibility, Knowledge, Cultural Aspects, Autonomy, Involvement, Respect, Competency, Conscious Sensitivity,
Team Performance [9, 124, 126, 21, 74]	Collaboration, Communication, Motivation, Personality, Team working, Commitment, Trust, Knowledge, Relevance, Cultural Aspects, Learning, Ethnicity, Recognition, Disability, Decision-making, Collective thinking, Respect, Openness, Coordination, Age, Gender, Satisfaction, Participative Safety
Team Training and Learning* [80, 90, 87, 89, 12]	Motivation, Knowledge, Learning, Feedback, Education, Sharing
Team Leadership* [10, 90, 72]	Collaboration, Communication, Leadership, Team working, Commitment, Competency, Feedback
Teamwork* [80, 124, 116, 21]	Motivation, Personality, Disability, Age, Gender, Enthusiasm
Team Diversity* [123, 116, 112]	Motivation, Ethics, Personality, Ethnicity, Race, Disability, Age, Gender
Team Collaboration* [10, 72, 127]	Collaboration, Communication, Involvement, Politeness
Team Composition* [9, 90, 87]	Personality, Knowledge, Cultural Aspects, Ethnicity, Race, Decision-making, Competency, Efficiency, Gender
Team Climate* [21, 74]	Collaboration, Communication, Motivation, Leadership, Creativity, Change/Adaptability, Balance Work/life, Team working, Commitment, Fulfillment, Trust, Responsibility, Knowledge, Relevance, Autonomy, Learning, Involvement, Vision, Cohesion, Recognition, Innovation, Conflicts Resolution, Decision-making, Social Support, Collective thinking, Moral, Orientation, Respect, Openness, Coordination, Competency, Challenge, Feedback, Satisfaction, Participative Safety, Enthusiasm, Sharing, Interaction
Team Knowledge Sharing* [121, 74]	Communication, Creativity, Trust, Knowledge, Cultural Aspects, Learning, Language, Willingness
Self-organized Team* [10, 72, 86]	Knowledge, Cultural Aspects, Autonomy, Experience, Empowerment, Decision-making, Ownership, Coordination, Calm/relaxation
Team Innovation* [90, 21]	Collaboration, Motivation, Creativity, Vision, Innovation, Orientation, Participative Safety
Team Business Excellence* [90]	Effectiveness, Openness
Team Commitment* [89]	Motivation, Commitment
Team Emotion [117]	Trust, Stress, Fear, Anger, Anticipation, Contentment, Depression, Calm/relaxation, Disgust, Excited, Happiness, Frustration, Interest, Joy, Love, Sadness, Surprise, Enjoy
Team Experience* [90]	Knowledge, Experience
Team Social Attributes* [90]	Collaboration, Communication, Motivation, Cohesion, Competition
Team Ownership* [89]	Motivation, Ownership
Team Operational Excellence* [90]	Competency, Efficiency

dination, Collective Thinking, and *Cohesion* can potentially influence the Organizational Climate of the team.

In their comprehensive SLR, Sanchez-Gordon and Colomo-Palacios [117] identified 7172 articles related to *Team Emotions* (Table 5.5) on SE. The authors reported 40 dis-

Table 5.6: Influence on Project

Influence	Human Factor
Agile Project* [9, 80, 10, 90, 72, 87, 112, 113, 89, 12]	Collaboration, Communication, Motivation, Leadership, Ethics, Creativity, Personality, Enterprising, Passion, Change/Adaptability, Balance Work/life, Team working, Empowerment, Commitment, Trust, Responsibility, Knowledge, Integrity, Cultural Aspects, Autonomy, Learning, Involvement, Wellness, Experience, Vision, Ethnicity, Cohesion, Sense of Belonging, Recognition, Innovation, Conflicts Resolution, Decision-making, Social Support, Flexibility, Concentration, Collective thinking, Moral, Ownership, Orientation, Effectiveness, Respect, Openness, Coordination, Competency, Challenge, Feedback, Efficiency, Initiative, Willingness, Stress, Conviction, Education, Perseverance, Proactivity, Gender, Satisfaction, Participative Safety, Competition, Honesty, Enthusiasm, Conscious Sensitivity, Sharing, Calm/relaxation, Interest, Equity, Boredom, Fulfillment
Maintenance Project* [9, 80, 116, 12]	Motivation, Personality, Gender
GSD Project* [113]	Collaboration, Communication, Motivation, Commitment, Responsibility, Involvement, Sharing
Software Quality* [80, 124, 126, 122, 21, 88, 89, 12, 120]	Collaboration, Communication, Motivation, Creativity, Personality, Balance Work/life, Team working, Empowerment, Trust, Knowledge, Cultural Aspects, Autonomy, Learning, Involvement, Experience, Vision, Decision-making, Ownership, Effectiveness, Respect, Competency, Feedback, Education, Proactivity, Gender, Enthusiasm, Sharing, Pressure, Happiness, Fatigue, Pride
Project Success* [9, 80, 10, 90, 72, 126, 123, 122]	Collaboration, Communication, Motivation, Personality, Cultural Aspects, Knowledge, Leadership, Involvement, Experience, Satisfaction
Project Success* [80, 10, 90, 72]	Communication, Motivation, Leadership, Knowledge, Cultural Aspects, Involvement, Satisfaction
Engineering Practices* [80, 10, 72, 116, 87, 89]	Collaboration, Communication, Motivation, Leadership, Creativity, Personality, Knowledge, Involvement, Experience, Ethnicity, Disability, Age, Gender, Satisfaction, Fulfillment
Agile Practices* [80, 10, 72, 87, 89]	Collaboration, Communication, Motivation, Knowledge, Cultural Aspects, Autonomy, Learning, Involvement, Experience, Concentration, Ownership, Effectiveness, Coordination, Feedback, Satisfaction, Sharing
Customer Involvement* [10, 72, 114, 113, 12]	Collaboration, Communication, Motivation, Team working, Commitment, Cultural Aspects, Involvement, Respect, Competency, Stress, Satisfaction
Productivity [126, 123, 119, 118, 127]	Collaboration, Communication, Motivation, Leadership, Personality, Team working, Commitment, Trust, Knowledge, Autonomy, Experience, Cohesion, Fairness, Effectiveness, Respect, Education, Satisfaction, Happiness, Empathy, Intelligence
Allocation Process* [9, 90, 116, 118]	Personality, Knowledge, Cultural Aspects, Ethnicity, Cohesion, Disability, Decision-making, Gender
Budget* [72, 123, 21, 89, 12]	Motivation, Efficiency
Project Management* [80, 90, 123, 89]	Collaboration, Communication, Motivation, Personality, Commitment, Recognition, Need for Stability, Satisfaction, Participative Safety
Project Construction* [9, 80, 10, 116, 127]	Communication, Motivation, Leadership, Personality, Knowledge, Involvement, Gender, Anger, Joy, Love, Sadness, Rudeness, Politeness
Code Review Process [9, 88, 121]	Collaboration, Communication, Motivation, Personality, Trust, Knowledge, Cultural Aspects, Learning, Experience, Competency, Participative Safety, Sharing, Anger, Frustration, Interaction, Empathy, Intelligence, Rigidity, Consistency, Friendship
Project Testing [9, 80, 124, 116, 12]	Motivation, Personality, Gender
Project Requirements Engineering* [90, 72, 89]	Collaboration, Communication, Motivation, Personality, Change/Adaptability, Team working, Commitment, Knowledge, Cultural Aspects, Involvement, Experience, Respect, Competency, Stress, Gender, Satisfaction, Sharing
Project Software Process* [80, 89]	Motivation
Project Models and Methods* [116]	Disability
Sustainable Agile Use* [72, 87]	Collaboration, Communication, Motivation, Leadership, Passion, Change/Adaptability, Empowerment, Trust, Responsibility, Knowledge, Cultural Aspects, Learning, Experience, Ethnicity, Recognition, Innovation, Decision-making, Social Support, Effectiveness, Competency, Education, Gender, Satisfaction, Honesty, Fulfillment
Communication in GSD Project [114]	Communication, Trust, Knowledge, Cultural Aspects, Involvement, Language, Coordination, Feedback, Interaction
Decision Time* [12]	Communication, Motivation, Decision-making, Satisfaction
Delivery Time [123]	Motivation
Project Diversity* [112]	Ethics, Personality, Ethnicity, Race, Disability, Age, Gender
Documentation* [89]	Motivation
Resources* [89]	Motivation
Risk Management* [89]	Motivation
Project Sponsorship* [89]	Motivation
Project Team Size* [12]	Communication, Motivation, Coordination
Project Tracking* [89]	Motivation
Technically Challenging Tasks* [80]	Motivation, Relevance, Challenge
Reduced Rework Repetition* [89]	Motivation
Changes Prioritization* [89]	Motivation
Project Profitability* [122, 112]	Motivation, Ethnicity, Gender
Project Team Distribution* [12]	Communication, Motivation
Agile Logistic* [89]	Motivation

crete emotions, the most frequent being *Anger, Fear, Disgust, Sadness, Joy, Love,* and *Happiness*. As per the authors, the study of emotions has received growing attention from

Table 5.7: Influence on Organization

Influence	Human Factor
Organization Management* [80, 10, 115, 90, 72, 123, 87, 122, 113]	Collaboration, Communication, Motivation, Leadership, Personality, Team working, Commitment, Trust, Knowledge, Recognition, Innovation, Decision-making, Coordination, Competency
Organization Rewards and Incentives* [80, 123, 122, 89]	Motivation, Recognition
Organizational Culture* [115, 72, 12]	Collaboration, Motivation, Change/Adaptability, Cultural Aspects, Autonomy,Decision-making, Ownership, Coordination, Feedback
Organization's Job retention [9, 123, 122]	Motivation, Personality
Organization Structure* [80, 72, 89]	Collaboration, Motivation, Cultural Aspects, Autonomy, Ownership, Equity
Organizational Absenteeism* [123, 122, 89]	Motivation
Organizational Agile Transition* [91]	Involvement, Collaboration, Change/Adaptability, Decision-making, Communication, Team working
Organization's Methodology Champion* [87]	Leadership, Learning
Organizational Development [126]	Education
Organizational Commitment [115, 122]	Motivation, Commitment, Decision-making
Organizational Environment [115, 116]	Ethnicity, Disability, Decision-making, Age, Gender

the research community in recent years, but the management of emotions has always been challenging in practice [117].

Analyzing Table 5.6 (Influence on Project), it is possible to observe that the most frequent factors are *Communication* and *Collaboration*. Ammad et al. [114] state that, in recent years, many software organizations are doing their development practices in the GSD environment. The SLR results showed that *Communication* is one of the critical issues in GSD and is becoming more complicated over time. Askarinejadamiri [126] claimed the requirement gatherer training in *Communication* skills is fundamental to increase *Software Quality* (Table 5.6). Barroso et al. [124] identified a study that showed the Influence of *Personality* on *Software Quality*. Guveyi et al. [120] identified that individual factors are the most important category of human factors affecting people and will directly affect software quality. The most researched factors were *Communication, Collaboration, Experience,* and *Education* [120]. The authors concluded that investing in people will affect the success and quality of the project positively [120].

Project Requirements Engineering and *Project Construction* (Table 5.6) are two of the most performed activities in software development. *Communication* is the most influential human factor in that activities. However, we identified other human factors less investigated, e.g., diversity [116, 112]. Menezes and Prikladnicki [116] reported that "although the project was a success in the delivery phase, a *transgender* developer was not comfortable in technical visits in loco. Due to physical limitations, some members with *Disabilities* avoid moving to the customer because there is no adaptation in the workplace

environment." For that reason, the human factors *Gender* and *Disability* were associated with the *Project Requirements Engineering, Project Construction,* and *Allocation Process* influence [116].

Fatima et al. [88] identified the individual, social, and personal factors influencing the *Code Review Process* (Table 5.6). They classified the factors, for instance, by individual characteristics (*Communication, Trust,* and *Competence*), emotion (*Anger, Frustration,* and *Empathy*), and social factors (*Trust, Interaction,* and *Friendship*) [88].

Table 5.7 presents the HF influences in the Organization category. The *Organization Management* influence is most frequent in the studies. When the organization presents a beneficial environment, through effective *Organization Management*, team members tend to increase *Motivation* and *Commitment* [12, 115]. *Motivation* is the most frequent HF in (Table 5.7). França et al. [122] reported that *Motivation* is the level of employee involvement with the company, as evidenced by the *Organizational Commitment*. *Motivation* also impacts *Organization's Job retention, Organizational Absenteeism,* and *Organization Rewards and Incentives* influence [123, 122].

5.4.3 How do human factors influence Agile Software (RQ3)

We identified 70 human factors and 69 influences concerning ASD. These human factors are listed with "*" in Table (5.3, 5.4, 5.5, 5.6, 5.7). The high number of influences is explained by 11 of the selected studies concerned ASD specifically. *Motivation, Communication, Collaboration,* and *Trust* are the most cited factors when describing human factors in ASD [10, 12, 89]. ASD differs from traditional methodologies through principles, values, frameworks, or practices that contribute to forming an autonomous and self-organized team [72, 86, 68].

Many human factors investigated are based on the Agile Manifesto [10, 86, 68]. We identified that *Autonomy, Empowerment, Change, Communication, Collaboration, Learning, Feedback, customer Involvement, Motivation,* and *Trust* are explicitly supported by the Agile Manifesto [10, 86] and influence the team member, team, project, or organization in different aspects. E.g., Chagas et al. [10] argue that the value of interaction between people is made explicit in the sixth agile manifesto principle: "The most efficient and effective method of conveying information to and within a development team is face-to-face conversation." Therefore, *Communication* influence on *Customer Involvement* and *Agile Practices* (Table 5.6) [10].

Ozkan and Gok [86] reported that effective agile individuals, teams, and organizations require a particular attitude, way of thinking, and behavior, so-called as agile mindset. Regarding the *Team Member Agile Mindset* influence (Table 5.4), the authors [86] argued that *Autonomy, Empowerment,* and self-organizing (Table 5.5), along with *Teamwork*, enable teams to respond to varying cases of complexity. *Teamwork* with powerful *Commitment*, dedicated focus on and oriented to a shared goal, and creating value to the customer with high quality are the main drivers for success.

Many human factors impact the *Team Member Motivation* (Table 5.4) and *Team Motivation* (Table 5.5). Melo et al. [80] showed that a lack of bureaucracy during the development process *Motivates* agile teams. Moreover, constant *Learning* and *Knowledge Sharing* are necessary to the adoption of agile practices. The *Sense of Belonging* and *Recognition* are other main factors influencing *Motivation* on ASD teams [12, 89]. In the other direction, the human factor *Motivation* impacted other factors such as *Organization Rewards and Incentives* [80, 123, 122, 89] and *Organizational Absenteeism* [123, 122, 89].

Senapathi and Srinivasan [87] identified factors that impact sustained agile use. Some HF were extracted through the discussions or reports proposed by the authors. For instance, the authors reported "teams with mixed attitudes, (where some were very passionate about agile practices and others who were not very keen on agile resulted in an attitude of 'us vs. agilists')." Based on that, we coded that *Passion* influences *Sustainable Agile Use* (Table 5.6).

Pinton and Torres [91] investigated the human aspects of agile transition (see *Organizational Agile Transition* influence in Table 5.7). The HF identified were client *Involvement, Collaboration, Change/Adaptability,* and *Decision-making*. The authors argued that the project manager should act only as a facilitator and be part of the final decision along with the team, no longer maintaining the planning and controlling roles of the traditional model. *Teamwork* is the key, so *Collaboration* is of paramount relevance. The entire team is responsible for work completion, so both project ownership and benefits are shared among all members. When the team fails to embrace this mindset, the transition becomes much more arduous. Customers should be dedicated to the project and have the same *Collaborative* and *Communicative* roles as any other team members. It is also worth mentioning that the development team requests customers' *Feedback Collaboratively* to adjust the process towards its optimization continually [91].

5.5 Discussion

The 29 selected SLR/SMS provided us a helpful insight into the state of the art of human factor research in Software Engineering (SE). In general, most of the studies have a good quality score. We identified 101 human factors and 79 influences on SE. We grouped the influences into 4 categories. We identified 70 human factors and 69 influences on ASD. These factors and influences possibly represent the most significant ones to be considered by software organizations and SE researchers.

A quick search for "human factors" on online databases shows that the number of studies on human factors increases each year. In many studies, researchers consistently report the need for further studies (e.g., see [10, 9]). However, Capretz [128] reported that "others might think that there's no place for the discussion of soft skills in an area that's so driven by logic and based on a mathematical foundation. These misconceptions discourage educators and researchers willing to work in this interdisciplinary area." The researcher also states that "from the management's perspective and for the majority of software practitioners, human factors are still considered marginal and treated as common sense [128]." Based on this statement [128], we decided to discuss possible uses of human factors and their influence identified from a perspective for the management, researchers, and academics.

Our results might help those in charge of management activities to identify suitable human factors for specific activities. Managers and team leaders can use the human factors list and their influences as input to manage project risks and the team. For instance, to reduce *Organizational Absenteeism* or increase *Organization's Job Retention* (Table 5.7), the management must guarantee a *Motivated Team* (Table 5.5). Team leaders can identify and execute actions limiting or impairing the *Self-organized Team or Team Agile Capability* (Table 5.5). For this, the enhancement of human factors (e.g., *Coordination, Empowerment,* and *Autonomy*) must be considered. Also, a human resource professional can use our results as input to define processes such as those related to People Involvement and Competency Acquisition (as described in ISO 10018 [5]) or to Human Resource Recruitment by, for instance, ensuring *Team Diversity* (*age, gender, disability,* or *Ethnicity*) due to its positive influence to *Team Member Innovation*.

Our results might interest researchers studying behaviors, emotions, or personal characteristics in SE. Whereas the outcomes are a catalog of papers, human factors, and their influence on how human factors are being discussed in SE. For instance, researchers with interest in *Motivation* can find i) 5 SLR in which *Motivation* is the main topic (Table 5.2),

ii) other 15 studies that discuss *Motivation* (Table 3), and iii) more than 50 influences *Motivation* has on other human factors and SE activities. Researchers can also use human factors to create specific instruments to measure a psychological construct (e.g., *Team Member Decision-making*, see Table 5.4) or technical activities (e.g., *Code Review Process*, see Table 5.5). Machuca-Villegas et al. [129] used the results of Canedo and Santos [118] to create an instrument for measuring perception about social and human factors that influence software development productivity.

Concerning the academic perspective, Oguz and Oguz [130] reported that academia needs to balance hard and soft skills with realistic projects to decrease the gap between the software industry and software engineering education. In line with that, Dyba and Dingsøyr [72] reported the student perceptions about participating in the empirical study at an university. The students' found that working in agile teams helped them develop professional skills such as *Communication, Commitment, Collaboration,* and *Change/Adaptability* [72]. We believe that the lecturer is responsible for developing educational activities involving human factors, e.g., *Collaboration, Communication,* resolutions of conflict, and *Motivation* of the future software engineer. Thereby, it is necessary to propose activities in realistic projects, involving phases of requirements, analysis, design, coding, and tests. These activities should simulate the roles and tasks of real software development teams.

5.6 Limitation and Threats to Validity

It is essential to notice that we do not foresee to indicate the influence of the human factors using statistical concepts, such as correlations (positive/negative) or causalities. Moreover, several primary studies identified by the selected SLR/SMS are case studies, had small or regional samples, and did not use psychometrically validated instruments to measure the psychological constructs investigated (e.g., *Motivation*). Thus, it is difficult to generalize the influence of the construct. Thereby, a reader has to access the original SLR/SMS and, often, the cited primary studies to understand (i) whether the human factor or their influence represents a positive or negative feature and (ii) possible generalizations.

Petersen et al. [110] proposed 4 threat types to assess the *validity* of SMS. For each identified threat, we planned and executed control actions as follows.

Regarding the *descriptive validity*, two researchers carried out the definition of questions, extraction fields, and assembly of the search expression. Some adjustments were made during the execution of the research. However, the extraction and coding into categories were performed only by the thesis author with supervision and correction by another

author. To minimize this threat, a report was generated (using a feature of Atlas.ti) indicating the categories and the associated original text, so the researchers expressed and resolved interpretative doubts.

To treat threats related to *theoretical validity* and potential bias, two researchers participated in this study selection process. The researchers performed the two filters observing the inclusion and exclusion criteria. Interpretive divergences in applying the inclusion or exclusion criteria were inserted in a collaborative spreadsheet, which allowed the researchers to review the findings. A possible common limitation to SLR/Systematic Mapping Studies (SMS) is related to the possibility of not finding relevant articles [111]. To address this limitation, (i) the construction of the search expression was performed iteratively and incrementally considering the terms and synonyms used in other SLR [10, 9, 33], and (ii) we opted to use four online databases and complement the search results performing forward snowballing. For instance, Mourão et al. [131] investigated that using Scopus and iterative forward snowballing may be an appropriate alternative to execute reviews in SE although, providing a lower level of recall than combining database search and iterative backward and forward snowballing.

Interpretive validity is achieved when the conclusions are reasonable given the data, and hence maps to conclusion validity [110]. A threat in interpreting the data is researcher bias. To reduce this threat, we first extracted the human factors from studies that presented them categorized on lists or tables. By doing that, the thematic analysis process was made easier since a new category was created only when a human factor could not be associated with an existing one. Besides that, the researchers that collaborated with this work have experience in SLR/SMS and thematic analysis.

Regarding the *repeatability* of this research, the entire review protocol is described in detail. All documents/studies resulting from the automatic search in the online datases are availble in the spreeedsheet. The inclusion/exclusion criteria pointed bu each researcher are available and auditable.

5.7 Final considerations

Our primary motivation was to investigate the state of the art on human factors in ES teams to elicit the human factors and their influence. We believe this study is the first, by means of a tertiary study, to systematize the influence of human factors through categories, regardless of the subject or specific practices in SE. We selected 29 SLR/SMS to review and summarize information about human factors. As a result, we identified 101 human

factors that influence software development activities from different perspectives. The 79 influences were grouped based on their effects into Team Members, Teams, Projects, and Organizations. Furthermore, we identified 71 human factors and 60 influences in ASD.

In the next chapter, Chapter 6, we present the *Systematic Literature Review Study*.

6. Systematic Literature Review Study

This study aims to identify and analyze the organizational climate measures used in software development teams, their dimensions, their validity and reliability evidence, and factors that significantly relate to the software development team's climate. To achieve these goals, we executed an SLR. The main contribution of this study is to offer a comprehensive overview of measures to assess organizational climate, show other measures used to investigate relations with climate constructs and analyze factors that can affect the organizational climate.

6.1 Research method

The Systematic Literature Review (SLR) was planned and executed to evaluate and synthesize existing research evidence. We devised the protocol following the guidelines proposed by Kitchenham and Brereton [109] and Petersen et al. [110].

6.1.1 Study planning

The goal of this SLR, stated according to GQM paradigm [132], is ***analyze*** studies about the organizational climate ***with the purpose of*** characterizing ***with respect to*** organizational climate measures, their evidence of validity and reliability, and factors that significantly relate to the software development team's climate ***from the point of view*** of researchers ***in the context of*** the software development teams.

To achieve the objective, three research questions (RQ) were defined as follows:

- RQ1. Which are the organizational climate measures considered in the studies?

- RQ2. Which are the measures used to investigate possible relations with organizational climate?
- RQ3. Which factors have a significant relationship with teams' climate?

A broad inclusion criterion was defined in the scope of the review: Studies that use constructs to assess the organizational climate in software development teams.

We also defined 8 exclusion criteria to ensure the quality of the findings, which are: Written in a language other than English; Duplicates; Not accessible; Not peer-reviewed; Research proposal; SLR that do not meet the inclusion criteria; Non-measured proposed construct; Study already identified in SLR (for Snowballing). To capture the largest number of studies, an initial period was not defined in the exclusion criteria.

Based on the study goal, we derived the first version of the search string containing the terms "organizational climate" and "software development team". We used the studies of Soomoro et al. [21] and Chagas et al. [10] to identified synonymous terms to organizational climate and software development team, respectively. The pilot phase was performed using the Engineering Village database. After several tests, we reduce the synonymous to the "software development team" to two words without changing the search results. In the end, the canonical *search expression* was defined as:

("team climate" OR "group climate" OR "work climate" OR "organizational climate" OR "corporate climate" OR "management climate") ***AND*** *("agile" OR "software")*

6.1.2 Studies selection

We considered the main search engines used in SE, which allowed the export of complete information about the studies. The databases searched engines considered were IEEE Xplore, Scopus, Engineering Village, and ISI Web of Science. We also used Google Scholar in the snowballing phase. Mourão et al. [131] investigated that using Scopus and iterative forward snowballing may be an appropriate alternative to execute reviews in SE although, providing a lower level of recall than combining database search and iterative backward and forward snowballing. For each search engine, the string was adapted and executed. The results were recorded and analyzed in a Google Sheets spreadsheet. The spreadsheet with the full protocol and all the steps and extractions performed can be found at https://figshare.com/s/05e5ea036650ca08a193.

The *selection of papers* was executed using two filters. In the first filter, title, abstracts, and keywords were read. For each study, we applied the established exclusion or inclusion

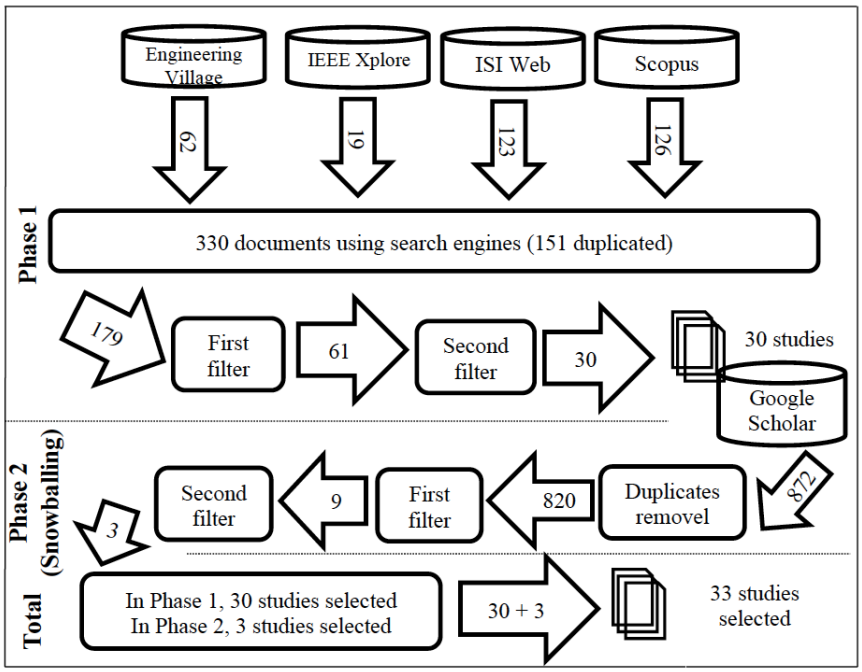


Figure 6.1: Phases to SLR selection

criteria. Each study was evaluated independently by both the thesis author and another researcher. Comments were recorded and analyzed in case of divergence of the criteria used by each researcher. In the second filter, the thesis author read the study's full-text and extracted the results. Once they met the inclusion criterion, studies were included or excluded if they met specific exclusion criteria. The results cover publications until the year 2020. The other researcher audited all procedures performed in the second filter. All researchers discussed the results and how to present them.

The search was executed in two phases. Figure 6.1 shows the two phases executed in this review and the results of selection.

Phase 1: We run the search expression in the mentioned online databases, i.e., IEEE Xplore, Scopus, Engineering Village, and ISI Web of Science. In the first filter, 330 documents were analyzed, and 151 documents were rejected. To apply the second filter, 61 full-text studies were read. In the end, we identified 30 studies.

Phase 2: In this phase, we performed forward snowballing using as seeds the 30 studies identified in Phase 1 using Google Scholar. We limited the results to the first 100 studies referencing each study. In total, we scrutinized other 820 documents by applying the inclusion and exclusion criteria in the two filters. In the end, we identified 3 new studies.

6.1.3 Data extraction

We used Atlas.TI tool to manage the information extracted to each field shown in Table 6.1. The form extraction' fields aim to help the researchers understand the primary study identified in this SLR, their planning, execution, and analysis, thus allowing, answering the research questions. Sometimes, to extract the measure proprieties (e.g., Validity and Reality Evidence) it was necessary to access the source study indicated in the primary study. Figure 6.2 exemplifies the data extracted from Ganesh and Gupta [4].

Table 6.1: Extraction Form

Field	Description	RQ
ID	Study internal code	
Reference	Full study reference	
CQ	Criteria Quality (see Table 6.2)	
Abstract	Summary for this SLR (in Portuguese)	
EXT01	Organizational climate perspective investigated	
EXT02	Hypothesis, aims, models, or relationships analyzed	RQ3
EXT03	Software development models used	
EXT04	Sample country	
EXT05	Sample size	
MEA01	Organizational climate measure name	RQ1; RQ3
MEA02	Dimensions/constructs (number of items)	RQ1; RQ3
MEA03	Measure Author	RQ1
MEA04	Validity Evidence	RQ1
MEA05	Reliability Evidence	RQ1
MEA06	Measure Limitations	RQ1
MEA07	Other measures investigated	RQ2; RQ3

Analyzing Figure 6.2 and Table 6.1, we can observed that one of the authors' objectives was to investigate the relationship between climate and team commitment [4]. *EXT2* represents the hypothesis investigated. *MEA01* shows that Team Climate Inventory [49] was used to asses the Participative Safety dimension (*ME02*). Lastly, *MEA07* represents the other measure investigated in the hypothesis, denominated Organizational Commitment Questionnarie (OCQ) [4]. Other elements on Figure 6.2, e. g., *[FC02]* and *P6_H2*, are described in the next section.

6.1.4 Data analysis

The data extraction fields are enough to answer RQ1 and RQ2. However, to answer RQ3 is necessary to understand (i) the measures (dimensions and items) and (ii) the degree of statistic analyses performed by the study's author. That is because some studies' authors change the original name of the measures or dimensions. Furthermore, the relation analysis between the variables could be in the measure, dimension, or item level. Therefore, it is essential to extract factors to represent the measure, dimensions, or items. Thereby,

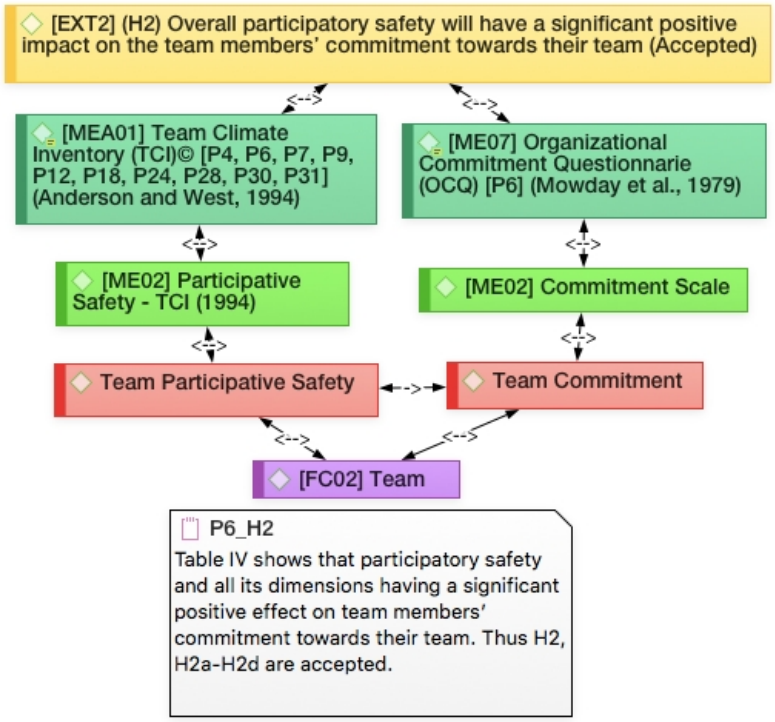


Figure 6.2: Example of fields extracted and thematic analysis in Ganesh and Gupta [4]

thematic analysis [3] was used to identify and categorize factors that have a relationship with organizational climate.

Only the measure, dimensions and items with relation statistical significance or validated by the authors were extracted in factors and grouped into categories. Figure 6.2 exemplifies the codification process. Ganesh and Gupta [4] identified a significant positive impact of participatory safety dimension on team commitment. For this, *Team Partipative Safety* is positively correlated with *Team Commitment* factor. The factors were grouped in the *[FC02] Team* category for the measure items that represent aspects from the team. The first author defined factors to group similar dimensions or items. All factors and categories were discussed, revised, and audited by the third author. The note *P6_H2* represents the part of the text that the study author analyzes the statistical results.

6.1.5 Quality assessment

According to Kitchenham and Brereton [109], quality assessment is important to classify the papers for review studies. Table 6.2 presents the questions and quality criteria (QC) considered. QC were based on [21]. The score quality was only informative. No paper was excluded because we want to analyse all articles that come into scope, including, for example, studies that did not clearly define their measurements (see QC3 in Table

6.2). We used the aforementioned spreadsheet to collect the information needed to address the quality criteria.

Table 6.2: Quality Criteria

Question
QC1. Are the aims clearly stated?
QC2. Are the variables used in the study adequately measured?
QC3. Are the measures used in the study fully defined?
QC4. Are the data collection methods adequately described?
QC5. Are the study participants or observational units adequately described?
QC6. Are all study questions answered?

6.2 Results

A total of 33 studies were included in this review. We used the Extraction Form data (see Table 6.1) and the research questions to analyzing organizational climate measures, their psychometric properties, and the factors that can affect the climate.

6.2.1 Studies overview

Table 6.3 presents an overview of the selected studies. The first column shows the authors and the year of publication. The most relevant authors were Açikgöz [29, 139, 106, 26, 27, 28] (6 publications), Acuña and Gómez [142, 138, 23, 22] (4 publications), and Ganesh [135, 4, 137] (3 publications). Figure 6.3 shows the year in which the studies were published. Of the 33 studies identified, 11 (33%) studies were published between the years 2016 and 2020. The most relevant sources were the journals Information and Software Technology (5 studies), International Journal of Recent Technology and Engineering (3 studies), and Empirical Software Engineering (2 studies). Considering the amount of publication in recent years and the primary sources, it is noted that research on organizational climate is still current and relevant to the SE community.

The second column (Table 6.3) shows that organizational climate has been named in various ways. The nomenclature *Organizational Climate* was only considered in 4 studies [145, 144, 99, 52]. Sometimes, the expression "Climate" was used (i) to recognize different facets, e.g., *Procedural Justice Climate* (2 studies) [23, 28], *Climate for Success* (2 studies) [43, 30], and *Ethical work climate* (1 study) [140], and (ii) to partially refer to the measure name used in the investigations, e.g., *Work Climate* [136] and *Psychological climate* [46]. Finally, *Team Climate* expression (20 studies) was used to delimit the assessment coverage. *Team Climate* was investigated with other constructs, representing

Table 6.3: Identified studies overview

Authors (Year)	Investigated relationships involving climate measures	Sample Size	Sample Country	Software Process	Quality Score
Tan et al. (2003) [133]	Team climate with predisposition to report bad news in an individualistic/collectivistic culture	354	USA; Singapore	NI	6
Acuña et al. (2006) [22]	Team climate with software quality	103	Spain	Agile (XP)	6
Bhatt et al. (2006) [52]	Organizational climate with maintenance team capability, software baseline, maintenance effort, and customer attitude	392	NI	NI	6
Stewart and Gosain (2006) [134]	Team climate (trust and ideology) with project development stages, task completion, team size, and perceived effectiveness	67	NI	NI	6
Ganesh and Gupta (2006) [135]	Team climate with virtualness and task interdependence	125	NI	NI	6
Acuña et al. (2008) [23]	Team climate with software quality	105	Spain	Agile (XP)	6
Schilhavy and King (2010) [136]	Work climate with professionalism and Machiavellianism	63	NI	NI	6
Tsai and Cheng (2010) [41]	Team climate with self-efficacy and knowledge sharing outcome expectancies	225	Taiwan	NI	6
Açıkgöz and Günsel (2011) [106]	Innovative climate with team innovativeness and environmental uncertainty	86	Turkey	NI	6
Ji e Wang (2012) [53]	Propose a simulation model based on team climate factors	NI	NI	Agile, Waterfall, Prototype, and Code-test model	5
Sharma and Gupta (2012) [30]	Organizational climate for success with software project risks	300	India	NI	6
Ganesh (2013) [137]	Organisational climate with task interdependence and procedural justice	192	India	NI	6
Antino et al. (2014) [24]	Team climate with team performance and team satisfaction	484	Mexico	NI	6
Gómez and Acuña (2014) [138]	Team climate with team satisfaction and software quality	105	Spain	Agile (XP)	6
Acikgoz et al. (2014) [139]	Team climate with team cognition and team intuition	139	Turkey	NI	6
Sojer et al. (2014) [140]	Ethical work climate with firm rules affects developers' level of subjective norms supporting unethical reuse	869	NI	NI	6
Soomro et al. (2015) [14]	Team climate with team performance and personality	36	Malaysia; China; India	NI	6
Zhang et al. (2015) [141]	Team climate with the co-workers' production deviance, individual production deviance, and Confucian work ethic	322	China	NI	5
Ganesh and Gupta (2015) [4]	Team climate with the team members' commitment, organizational justice and task routineness	177	India	NI	6
Acuña et al. (2015) [142]	Team climate with software quality and team satisfaction	307	Spain	Agile (XP); UP	6
Acıkgoz and Ilhan (2015) [26]	Team climate with team problem solving	139	Turkey	NI	6
Acikgoz et al. (2015) [27]	Team climate with team problem solving and team learning	139	Turkey	NI	6
Acıkgoz and Günsel (2016) [29]	Team climate with team decision process and individual creativity	139	Turkey	NI	6
Shahzad et al. (2017) [99]	Organizational climate with organizational innovation performance	215	Pakistan	NI	6
Acikgoz (2017) [28]	Procedural justice climate with team collaboration	133	Turkey	NI	6
Serrador et al. (2018) [43]	Climate for the project's success with quality, stakeholder, and budget	226	NI	NI	6
Purvis et al. (2018) [46]	Psychological climate with advice-receiving, expertise, trust, task performnance and friendship	64	USA	NI	6
Viswanathan et al. (2019) [25]	Team climate with team trust and team performance	NI	India	Self Managed Team	5
Viswanathan and Lakshmi (2019) [143]	Team climate with innovative work behavior	NI	India	Self Managed Team	4,5
Viswanathan et al. (2019) [144]	Organizational climate with employee engagement	NI	India	Self Managed Team	3
Dutra et al. (2020) [44]	Proposal of an orgnaizational climate instrument (leadership, communication, and collaboration climate)	22	Brazil	Agile	6
Vishnubhotla et al. (2020) [16]	Team climate whith personality traits	43	Sweden; India; Ukraine; others	Agile	6
Gutu (2020) [145]	Organizational climate for innovation with leadership style	4286	Romania	NI	4

Not Identified (NI); Unified Process (UP)

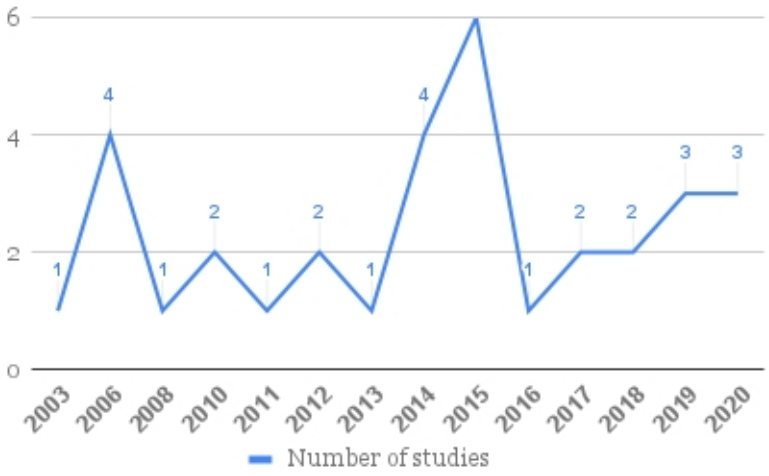


Figure 6.3: Distribution of publication year

the perspective of the individual, the team, the project, and the organization. For instance, i) Acikgoz and Günsel [29] investigated the relation between *Team Climate* with *Individual Creativity*, ii) Gomez and Acuna [138] investigated the influences between *Team Climate* with *Team Satisfaction* and *Software Quality*, and iii) Shahzad et al. [99] investigated the *Team Climate* with *Team Members' Commitment*, *Organizational Justice* and *Task Routineness*.

Regarding the characteristics of the samples (columns "Sample Size" and "Sample Country" in Table 6.3), most studies have a small and regional sample (e.g., [138, 44]). On the other hand, some studies (e.g., [145, 24, 140, 52]) have a suitable sample size for programmers considering Wagner et al. [51] claim that for most intents and purposes, a sample size of more than 400 programmers makes possible strong generalizability given the population is representative. Tan et al. [133] investigated cultural differences between the USA and Singapore. Few studies notified details about the "Software Process" used by the teams. The main software process approaches reported were *Agile* (6 studies) and *Self Managed Teams* (3 studies).

Regarding the "Quality Score" (see Table 6.3, last column), approximately 90% of studies (30) got a score ≥ 5. Hence, most of the studies achieved very good quality [21]. Some studies did not totally define their measures or did not show the full statistical results (e.g., [144, 145]). The values attributed to each Quality Criteria for the studies are available in the online spreadsheet.

Finally, the 33 studies identified show the interest of the academia in investigating the organizational climate and its effects on team members, team, organization actions, and Software Engineering activities.

6.2.2 Which are the organizational climate measures considered in the studies? (RQ1)

In total, we identified 19 measures (instruments, models, inventories, questionnaires, factors, or scales) used to assess organizational climate (see Table 6.4). For each measure identified, we extracted the official name or the construct name indicated by the authors, the dimensions (i. e., sub-scales, factors or constructs) when available. We analyzed the measures' items and their validity and reliability evidence notified by instrument authors or studies identified in this present SLR. In general, the measures identified are self-report questionnaires with many sources of evidence validity. The main evidence identified were content validity, reliability of the dimensions, and factor structure of dimensions (based on Exploratory Factor Analysis, Confirmatory Factor Analysis, Principal Component Analysis, or Modelling Equation Structures).

Together the measures have more than 70 dimensions that represent different perspectives about the team, the management, the project, and the organization. This diversity of dimensions confirms the multifaceted theory of organizational climate. The four most used measures in the identified studies were *Team Climate Inventory (TCI)* [49] (13 studies), *Team Selection Inventory (TSI)* [92] (4 studies), *Team Climate questionnaire* [93] (4 studies), and *Ethical Climate Questionnaire (ECQ)* [94] (2 studies). *TCI, TSI, Team Climate questionnaire,* and *ECQ* showed good and acceptable validity and reliability evidence. We found copyright for five instruments [49, 92, 93, 94, 110], but all instruments permit scientific research usage.

Team Climate Inventory (TCI) [49] and *Team Selection Inventory (TSI) [92]* have been used in the teams of different business domain and in scientific research. The dimensions measured by TCI and TSI represent factors that influence the capability of innovation of software development teams. While the TCI is a team-level measure of the actual climate of the team, the TSI is an individual-level measure of a person's preferred team-working climate [92]. The original theoretical model had four main dimensions [49]. Vision is an idea of a valued outcome which represents a higher order goal and a motivating force at work. The construct of participative safety hence relates to active involvement in group interactions wherein the predominant interpersonal atmosphere is one of non-threatening trust and support. Task orientation describes a general commitment to excellence in task performance coupled with a climate which supports the adoption of improvements to established policies, procedures, and methods. Support for innovation is the expectation, approval and practical support of attempts to introduce new and improved ways of doing things in the work environment [49]. The TCI and TSI were cross-adapted and validated

to many languages, applied in several teams from several domain, and had many validity evidence published [24].

Team Climate Questionnaire [93] was used in four studies [29, 139, 26, 27] and their four dimensions allow measure (i) the extent to which team members believe the team is supported by the organization and their managers (Support from the organization), (ii) the extent to which new ideas about work are implemented in the team (Innovation), (iii) the extent to which team members invest effort in the achievement of team goals (i.e., Goal achievement), and (iv) the extent to which team norms and procedures are designed to enable team members to master their tasks and improve team functioning (i.e, Enabling formalization) [93]. According to the authors, *Team Climate Questionnaire*'s main limitation was the sample of teams used in the original study composed of only one type of domain. However, *Team Climate Questionnaire* had demonstrated robust psychometric properties in the studies identified in this SLR.

Ethical Climate Questionnaire (ECQ) [94] was developed based on organizational and economic theory. Schilhavy et al. [136] report that ECQ was extended and used by other researchers. We identified good evidence of validity and reliability for ECQ. Example ECQ items are: "Everyone is expected to stick by company rules" and "At [company name], the first consideration is whether a decision violates any law."

Organizational Climate Measure (OCM), developed by Patterson et al. [47] and used in Tsai and Cheng [41], consists of 17 dimensions (82 items) divided into four quadrants: human relations, internal process, open systems, and rational goal. The OCM was developed from a theoretical basis, the competing values model itself reflecting considerable prior theoretical development [47]. OCM was validated with a big sample of 6869 employees across 55 manufacturing organizations. The authors suggest that is important that OCM were applied across a variety of organizational types and in a variety of national contexts. OCM is the measure with the greatest number of dimensions (17).

Three instruments measured an unique construct using the term "Climate". Thereby, it was necessary to understand how the "Climate" term was defined in the study or, sometimes what the item descriptions represent.

The four items to measure *Organizational Climate* in [99] were adapted from [147, 148] and they measured the factors climate about "Communication" between team members. Two examples of items are: "We regularly talk about things that concern us" and "We take the time to listen to each other." The reliability of dimension was < 0.7, and according to some authors, it may be considered inadequate [62]. We found another mention

Table 6.4: Measures used to assess the organizational climate

Measure [Author]	Dimensions (Amount Items)	Used in	Validity Method	Reliability
Team Climate Inventory (TCI) © [49]	Vision (11), Participative Safety (8), Support for Innovation (8), Task Orientation (7), Interaction Frequency (4)	[14, 4, 142, 24, 138, 137, 106, 23, 22, 135, 16, 25, 143]	EFA and CFA: Four/five-factor solution was identified	α for all dimensions was between 0.84 and 0.94
Team Selection Inventory (TSI) © [92]	Participative Safety (11), Support for Innovation (8), Team Vision (11), Task Orientation (11), Social Desirability (16)	[142, 138, 23, 22]	FA: Six factors solution was identified (representing the four climate scales and two social desirability scales)	$\alpha > 0.7$ for all dimensions
Team Climate © [93]	Support from the organization (4), Innovation Orientation (4), Goal Achievement (4), Enabling formalization (4)	[29, 139, 26, 27]	CFA: Four-factor solution was identified	$\alpha > 0.77$ for all dimensions
Ethical Climate Questionnaire (ECQ) © [94]	Rules (4), Law and Codes (4), Caring (7), Independence (4), Instrumental (7)	[140, 136]	FA: The items describing the nine theoretical ethical climate types were factor analyzed (PCA)	$\alpha > 0.7$ for all dimensions
Climate for Project Success [43]	Top Management Support (3), Sufficient Resources (3), Willingness to Adapt (3)	[43]	Regression analysis	NI
Organizational Climate for Success of the Software Project [30]	Effective Supervision (4), High Standards of Work Tasks (6), Intrinsic Fulfilment (4), Role Clarity (3)	[30]	FA: PCA was used for extracting organisational climate factors	$\alpha > 0.9$ for all dimensions
Perceived Organizational Climate [146]	Organizational Climate: Reluctance to Report Bad News (3), Perceived Organizational Climate (4)	[133]	SEM: The measure demonstrated good psychometric properties	$\alpha > 0.82$ for all dimensions
Model to Outsourced Software [52]	Organizational Climate (10), System Baseline (11), Maintenance Team (9), Customer Attitude (10)	[52]	Correlation analysis to the model proposed	NI
Organizational Climate [147, 148]	Organizational Climate (Communication) (3)	[99]	RA: The regression coefficient is showed the significant positive results	$\alpha = 0.67$
Organizational Climate Measure (OCM) © [47]	Autonomy (5), Integration (5), Involvement (6), Supervisory Support (5), Training (4), Welfare (4), Formalization (5), Tradition (4), Innovation and Flexibility (6), Outward Focus (5), Reflexivity (5), Clarity of Organizational Goals (5), Efficiency (4), Effort (5), Performance Feedback (5), Pressure to Produce (5), Quality (4)	[41]	EFA and CFA: The model presented stable psychometric indices	Autonomy (α = 0.67); For other dimensions $\alpha > 0.73$
Team Climate [141]	Team Climate (Productivity deviance) (4)	[141]	SEM: The measure demonstrated good psychometric properties.	$\alpha > 0.7$
Team Climate Factors [53]	Recognition or praise, play advantages and abilities, job importance, clear work requirements, teamwork and support, and commit to doing high-quality work. Details about the items have not been published.	[53]	Monte Carlo; Project managers assessed the simulated model.	-
Behavioral Response and Interpersonal Trust Measures [149]	Affect-based trust (5), Cognition-based trust (6)	[134]	EFA and CFA: The model presented stable psychometric indices; Expert evaluations	Affect-based trust (α = 0.89); Cognition-based trust (α = 0.91)
Procedural Justice Climate (PJC) [150]	Procedural Justice Climate (Leader decision-making) (6)	[28]	CFA: A model with several construct was validated	$\alpha = 0.87$
Instrument to Assess the Organizational Climate of Agile Teams (TACT) [44]	Communication (9), Collaboration (8), Leadership (10)	[44]	Content validity by agile experts; Pilot study.	α (Communication = 0.9128; Collaboration = 0.8937; Leadership = 0.9721)
Situational Outlook Questionnaire (SOQ) [NI]	Autonomy, Fairness, Cohesion, Innovation, Pressure, Recognition, Trust	[145]	NI	$\alpha = 0.98$
Psychological Climate [50]	Supportive Management (5), Role Clarity (3), Contribution (4), Recognition (3), Self-expression (4), Challenge (2)	[46]	CFA: The Single-factor, second-order (6 dimensions) CFA for general Psychological Climate was used.	$\alpha > 0.69$ for all dimensions
Organizational Climate [NI]	Organizational Climate (NI)	[144]	NI	NI
Shared Ideology [134]	Shared Ideology (2)	[134]	CFA: Two items loaded into the dimension	Composite reliability = 0.930

Cronbach coefficient (α); Confirmatory Factor Analysis (CFA); Exploratory Factor Analysis (EFA); Factor Analysis (FA); Not Identified (NI); Principal Component Analysis (PCA); Regression Analysis (RA); Structural Equation Modeling (SEM)

to *Organizational Climate* in [144], but the authors did not identify the source. Therefore, we cannot assure [99], and [144] refer to the same measure. Observing the similarity of the studies [25, 143, 144], we guessed that the instrument used in [144] could be TCI [49].

Zhang et al. [141] used four items to measure the construct denominated *Team Climate*. Items evaluated the informal norms ("Productivity deviance") adopted by individuals (e.g., "All employees here intentionally worked slower than they could have worked" and "All employees here left their work for someone else to finish"). The items used in [141] were translated from English into Chinese by using a standard translation-back-translation procedure to ensure language equivalence.

Açikgöz [28] adapted six items from Baker et al. [150] to measure the *Procedural Justice Climate (PJC)*. The items measure the extent to which project-related decisions and leaders' decision-making are applied for all individuals consistently. E.g., "Project-related decisions are made by our team leader in an unbiased manner", and "Our team leader makes sure that all team members' concerns are heard before project-related decisions are made".

Some researchers built the measure items based on many sources to operationalize specific constructs to assess the organizational climate in software development teams.

Bhatt et al. [52] proposed a *Model to Outsourced Software* to investigate the influence of different factors in outsourced software maintenance. The dimension denominated "Organizational Climate" consists of different factors involving tools, leadership, bonus, training, resources (such as PC and desks), the difficulty of targets, and the level of under-staffing in the project. Examples of items include "Ease of availability of tele/video-conferencing facilities" and "Difficulty of targets set for the maintenance team." The authors did not report procedures about the validity (factorial structure) or reliability.

Stewart and Gosain [134] measured the construct *Team Climate: Trust and Ideology*. To measure *Team Climate: Trust*, the authors [134] adapted any items proposed in *Behavioral Response and Interpersonal Trust* instrument [149]. Although [134] used the instrument proposed in McAllister [149] to assess the *Team Climate: Trust*, we did not identify citations with the expression "climate" in the McAllister [149]. The authors [134] created three items to measure the *Team Climate: Ideology* (see *Shared Ideology measure* in Table 6.4). However, one item was dropped. The final items to evaluate the Shared Ideology dimension were "Members of this group have shared values (omitted)" and "Members of this group have shared customs and hold similar views (omitted)."

Tan et al. [133] adapted Keil et al. [146] instrument to assess the reluctance of people to report bad news. Keil et al. [146] instrument shows and employs a role-playing scenario, in which the subject was asked to play the role of a software project leader in a fictitious company.

Sharma and Gupta [30] investigated the *Organizational Climate for Success of the Software Project*. The authors executed a comprehensive literature review and interviews with 300 software project managers to gauge the organizational climate factors that affected the success of their last executed project. In the end, through Principal Component Analysis (PCA), the items were loaded into four dimensions Effective Supervision, High Standards of Work Tasks, Intrinsic Fulfilment, and Role Clarity. An example of an item of dimension Intrinsic Fulfilment is "There were challenging tasks in my job role." The authors also presented 23 software project risks and their relationships with the investigated climate dimensions.

Nianfang and Wang [53] identified six *Team Climate* factors that impacted the software project duration the most. Team climate factor identification methods included literature study, questionnaire, or reference to the existing models, such as the TCI. The questionnaire includes 11 questions in total. All survey items were not divulged. One item example is "I always play advantages and abilities at work." We did not identify information about factor structure and reliability in the study.

Serrador et al. [43] investigated the *Climate for Project Success*. The questions proposed by the authors measure the degree of stakeholders engagement (*Top Management Support* dimension), flexible budget and team fully dedicated (*Sufficient Resources* dimension), and team and senior management support for agile (*Willingness to Adapt* dimension). Examples of items are "How often does the business representative [product/business sponsor] meet with the project team?" and "How supportive is the project team of the adoption of agile methodologies?"

Dutra et al. [44] proposed a measure specific for agile teams called *Instrument to Assess the Organizational Climate of Agile Teams (TACT)*. TACT has three dimensions (Communication, Collaboration, and Leadership) and original items, e.g., "The team facilitator investigates and helps the team to be more effective, taking into account the team velocity and the team capacity" and "In the current project, the team and the product owner always solve the disagreements about the iteration scope." Due to the small sample size, the authors state that further studies are needed to validate the theoretical construct.

Table 6.5: Measures used to investigate relationships with organizational climate factors

Perspective	Measure Name [Used in]
Team Member	IPIP-NEO Personality Test [14, 16]
	Individual Creativity [29]
	Predicting Dishonest Actions (Scenario) [140]
	Knowledge Sharing Self-efficacy [41]
	Confucian Work Ethic [141]
	Predisposition to Report Bad News [133]
	Professionalism Scale [136]
	Individualism–Collectivism [133]
	Short Form Mach IV (Machiavellianism) [136]
	Innovative Work Behaviour [143]
	Employee Engagement [144]
Team	Team Innovativeness [106]
	Team Performance [24, 25]
	Team Performance [14]
	Team Problem Solving [26, 27]
	Team Collaboration [28]
	Gladstein's Questionnaire [142, 24, 138]
	Production Deviance [141]
	Multi-dimensional Team Learning [29, 139]
	Learning [27]
	Extrarole-Behavior Scale [137, 135]
	Team Trust [25]
	Social Network Measures [46]
	Leadership Questionnaire (MLQ 5X) [145]
	Team Intuition [139]
	Innovative Work Behaviour [143]
Project	Outcome Expectancy [41]
	Software Risk Dimensions [30]
	Task Routineness Scale [4]
	Perceived Effectiveness [134]
	New Product Success [28]
	Project Performance [46]
Organization	Environmental Uncertainty Scale [106]
	Organizational Commitment Questionnarie (OCQ) [4]
	Organizational Justice [4, 137]
	Organizational Innovation Performance (OIP) [99]

Lastly, *Psychological Climate instrument* was developed by Brown and Leigh [50] and used in [46]. The authors argued that an organizational environment that is perceived as psychologically safe and meaningful is related directly to job involvement and indirectly to effort and work performance [50]. Items examples are "My boss is flexible about how I (omitted due to copyright) (Supportive Management)" and "I feel very useful (omitted) (Contribution)." *Situational Outlook Questionnaire (SOQ)* used in [145] can refer to a stable measure older than 50 years. However, we did not identify the measure's authors in the section of "References" in the study [145].

We discuss the main implications for academia and industry for selecting and using organizational climate measures identified in Section 6.3.

6.2.3 Which are the measures used to investigate possible relations with organizational climate? (RQ2)

We identified 36 measures used to investigate several relationships with the organizational climate factors. The measures represent many constructs that reflect the perspectives of team members, team, project, and organization. Table 6.5 shows the instruments. We only described measures investigated in two or more studies. Other measures are described in response to RQ3.

The *IPIP-NEO Personality test* is grounded in the Five-Factor Model (FFM) personality traits (openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism) to distinguish personal characteristics and preferences [14].

Gladstein's Questionnaire [151] was used in [142, 24, 138] to measure team satisfaction. Antino et al. [24] explain that *Gladstein's Questionnaire* assesses the degree to which subjects display satisfaction with their colleagues, the manner of the team working, and with the team as a whole.

Team performance was assessed by Antino et al. [24] and Viswanathan et al. [25] through Ancona et al. [152] scale. Antino et al. [24] considered five items related to team efficiency, technical innovations quality, adherence to schedules, and ability to resolve conflicts. On the other hand, Viswanathan et al. [25] assess three dimensions, namely efficiency, effectiveness, and time awareness team performance based in Ancona et al. [152] and other measure not identified. Soomro et al. [14] measured performance based on project tasks completion, team organization, communication and management, processes, presentation and demonstration, and plan.

Team Problem Solving was developed by Aladwani [153] and adapted in studies [26, 27]. *Problem-solving* is related to the team members' ability to discuss problems collectively to provide solutions throughout the development of a product [26]. Examples of items are "The project team was effective at generating alternative solutions" and "The project team was effective in identifying problems."

Açıkgöz et al. [139] and Açıkgöz and Gunsel [29] adapted items from *Multi-dimensional Team Learning* measure developed by [154] to assess team cognition [139] and team decision processes [29]. The original measure proposed by [154] has 10 dimension and has the objective of classify new product development team learning in a framework of socially shared cognitive process. The original dimension denominated "Intelligence" [154] was renamed to "Team decision processes" [29].

6.2.4 Which factors have a significant relationship with teams' climate? (RQ3)

To answer RQ3, we analyzed the study's goals, hypotheses, models, measures, and statistical results. Moreover, we only extracted the factors if the results were statistically significant or validated. We use thematic analysis [3] to identify, name, and categorize other investigated factors according to the level of statistical analysis described in each study. For example, personality traits present in IPIP-NEO Personality Test were grouped in *Personality* and categorized into *Team Member*, and *Customer Responsiveness*, which is related to the time to respond to a question related to objectives, was associated to *Project* category [52]. We identified 52 factors that can exert some effect on the organizational climate of software development teams. Table 6.6 shows the factors grouped into Team member, Team, Project, and Organization. As follows, we describe the factors investigated in two or more studies.

Table 6.6: Factors that influence team climate

Category	Factor
Team Member	Creativity [29], Engagement [144], Ethic [141], National Culture [133], Outcome Expectancy [41], Personality [14, 16], Productivity Deviance [141] Professionalism [136], Report Bad News [133], Innovation [143], Supporting Unethical Code Reuse [140]
Team	Change [52], Cognition [139], Collaboration [28], Commitment [4], Decision Processes [29], Efficacy [41], Friendship [46], Innovativeness [106], Interaction [52], Knowledge [52], Knowledge-sharing [52], Learning [27], Motivation [52], Performance [24], Problem Solving [26, 27], Productivity Deviance [141] Satisfaction [24, 142, 138], Stability [52], Trust [46], Virtualness [135]
Project	Budget [43], Complexity [52], Customer knowledge [52], Customer Responsiveness [52], Customer Training [52], Defects [52], Effort [52], Performance [46], Project Effectiveness [134], Risk [30], Software Development Stages [134], Software Quality [142, 138, 23, 22], Stakeholder [43], Success [28], Task Characteristics [134, 137, 135, 4], Team Size [134], Time Success [43]
Organization	Commitment [52], External Orientation [106], Innovation Performance [99], Procedural Justice [137, 4],

The studies [14, 16, 142] investigated the relationship between the (*Personality*) traits with the team climate. The IPIP-NEO Personality Test and Team Climate Inventory (TCI) were used to measure the constructs (see Tables 6.4 and 6.5). Soomro et al. [14] identified that the extraversion trait (*Personality*) has the strongest significant positive relationship with the team climate [21]. The authors show that extroverted personalities have a good progressive impact on team performance and its work climate. Vishnubhotla et al. [16] observed a statistically significant positive correlation between openness to experience and support for innovation. Additionally, agreeableness was observed to be positively correlated with the overall team climate. The authors suggest software organizations maintain a personality and team climate repository of their employees and vividly incorporate both personality and team climate factors in their decision-making process.

In the category Team (see Table 6.6), we analyze the relation between climate with *Problem-solving* and *Satisfaction* factors.

Problem solving is related to the team members' ability to discuss problems collectively to provide solutions throughout the development of a product [26]. The hypothesis investigated was that team climate is positively related to team problem-solving [26, 27] and team problem solving will mediate the relationship between team climate and team learning [27]. The Team Climate [93] (see Table 6.4) and Team Problem Solving (see Table 6.5) measures were used to assess the constructs. Structural equation modeling was employed as a statistical analysis tool to investigate the hypotheses. The two hypotheses were partially supported. The findings showed that (i) team climate (innovation orientation and goal orientation dimensions) was positively related to team problem solving, and (ii) the relationships between team climate and team learning were partially mediated by team problem-solving. The authors argue that (i) as team members discuss new ideas, the team becomes more successful in dealing with more complicated problems; and (ii) a positive climate in the team can potentialize supportive and trusting relationships, which in turn increase social interaction and knowledge exchange, triggering higher levels of learning [26, 27].

Team *Satisfaction* (Table 6.6) was assessed using Gladstein's Questionnaire (Table 6.5). The studies [24, 142, 138] used TCI (Table 6.4) to measure the actual climate of the team while the study [138] used TSI to measure the preferred team-working climate [92]. The study of Antino et al. [24] had the objective of developing and validating the Spanish version of the TCI. In addition to investigating the relationship between climate and satisfaction, Gómez and Acuña [138] and Acuña et al. [142] also examined the relationship between climate and software quality. In order to measure *Software Quality*, Gómez and Acuña [138] selected a set of standard software engineering criteria, primarily taken from SWEBOK, such as decomposition and modularization, testability, and functionality. Gómez and Acuña [138] and Acuña et al. [142] identified significant correlations and heterogeneity relationship of team climate with satisfaction and software quality. It is essential to highlight that the studies [138] and [142] were carried out in an academic environment with software development teams composed of students.

In addition to *Satisfaction*, the outstanding factor in the project category is *Task Characteristics* (Table 6.6). Ganesh and Gupta [135] and Ganesh [137] investigated the relation between climate and task interdependence. Ganesh [137] explained that task interdependence is the extent to which a task requires coordination among different members for its accomplishment. TCI was used to measure the climate and Extrarole-Behavior Scale (Table 6.5) to measure task interdependence. The hypothesis that task interdependence

positively affects the team climate was supported. The authors discuss that task interdependence requires team members to interact, cooperate, coordinate and share information. This cooperation in planning and in executing the task, over some time, may create a positive team climate [135, 137].

In the category Organization (Table 6.6), we described the relation between climate and *Procedural Justice* factor. Ganesh and Gupta [4] and Ganesh [137] measured Organization *Procedural Justice* using the scale design by Colquitt [155] and team climate dimensions using TCI [49]. Ganesh [137] explained that procedural justice is the extent to which members feel that the organization's decision-making procedures are fair. Results showed a significant positive impact of *Procedural Justice* on team participative safety [4, 137] and team support for innovation [137]. Ganesh [137] analyzed that the presence of fair procedures may lead to trust among members, which, in turn, can encourage risk-taking among members. Thus, increased trust due to perception of fair procedures would have increased team members' perceptions of participative safety [4, 137] and team support for innovation [137].

6.3 Discussion

This is the first systematic review that analyses the organizational climate measures and factors that significantly relate to the software development team's climate. We identified 33 studies that investigated the organizational climate. We identified and analyzed the psychometric properties of 19 climate measures (see Table 6.4). Other 36 measures were used to investigate relationships with climate measures. For each study identified, all statistically significant relationships were analyzed. In total, 52 factors that significantly relate to the software development team's climate were extracted and categorized.

Wagner et al. [51] argue that the community of Software Engineering (SE) should adopt and develop psychometrically validated instruments. Concerning the measures adopted, we extend these recommendations to companies, human resource managers, leaders, and other practitioners involved in organizational climate assessment. However, we acknowledge it is not trivial to identify and analyze the measures and their validity and reliability evidence. In the published papers, information on validity and reliability is commonly described. Concerning the development of new measures, the researcher can use the steps proposed in [51] to define and validate the instruments. In the following sections, we discuss the results from the perspective of climate assessment practitioners and SE researchers.

6.3.1 Organizational climate measures used in SE research

In a general way, all measures we identified with copyright have strong reliability and validity evidence published. Those measures are TCI [49], TSI [92], Team Climate [93], ECQ [94], and OCM [47]. We did not identify the author's reference to the Situational Outlook Questionnaire (SOQ) measure in the primary study [145]. Still, even after searching the web, we are not sure whether SOQ is copyrighted. Some instruments have permission for use in scientific research, for instance, TCI instrument [49].

We identified four specific measures [53, 30, 43, 44] for evaluating the organizational climate of software development teams.

The measures Team Climate Factors [53] and Climate for Project Success [43] intended to construct a theory [43] and a simulation model [53]. In the studies, the authors did not define the instrument items. Thus, the results of both studies [43, 53] can be used to operationalize a new instrument.

The dimension Organizational Climate present in the Model to Outsourced Software [52] only has specific items to outsourced software maintenance teams. The theoretical basis used to build the model reflects the critical factors at that time for outsourced software maintenance. For the use, it is necessary to evaluate if the items are still representative for the current moment. We did not identify validity and reliability evidence for the measure.

TACT [44] instrument only describe initial validity and reliability evidence. Although the study presents the execution of a content validity process by specialist judges, the sample was small. Therefore, the instrument can be used to explore or confirm its factorial structure.

Organizational Climate for Success of the Software Project [30] showed good initial validity and reliability evidence. Sharma and Gupta [30] recommend their measure to the practitioner's community who are struggling to ensure project success by developing novel approaches for mitigating risks in software projects.

In general terms, the measures used to assess organizational climate from software development teams in the SE research have the following main characteristics: (i) 6 out of 19 measures (31%) have copyright; (ii) 4 out of 19 (21%) measures are specific to software developments teams, but only two (10%) have initial validity and reliability evidence and were designed to operationalize a climate survey with the teams, (iii) 5 out of 19 (25%) measures adapted previous items or changed the original construct name.

6.3.2 Factors relationship with the team's climate

We identified 52 factors that significantly relate to the software development team's climate. The factors were grouped (see Table 6.6) in Team Member, Team, Project, and Organization. The factors show a holistic view of the several elements that can influence the team climate. Our results corroborate the statements of [6, 16]. Schneider and Barbera [6] argued that everything that happens in organizations is due to organizational climate and culture, and everything that happens affects organizational climate and culture. Vishnubhotla et al. [16] suggest there are other human factors in addition to personality traits, which should also be investigated with regard to their relationship with team climate. The team leaders and managers should consider these factors in organizational climate management or new climate surveys.

For a researcher, it is essential to know the construct, theory, other existing measures, and factors related to the investigated measure. The 52 extracted factors can be used in new investigations, using, for example, a different measure that assesses the same construct. Furthermore, the researchers can use the factors to propose a new measure or an organizational climate theory. However, the list of factors (see Table 6.6) should be analyzed with care since some studies samples are small and local.

6.3.3 Guidance for practitioners and researchers

Changes in measure items threaten the validity of the construct: In the measure selection process, researchers and practitioners should analyze (i) the theory that grounded the measure, (ii) the instrument manual (i.e., the test documentation) when available, and (iii) the items description. Furthermore, practitioners should verify if the organizational climate measure is effective to software development teams' context (roles, values, practices), language, and national culture. For instance, the role "boss" shown in the item "My boss is flexible about how I accomplish (omitted)" presented in *Psychological Climate instrument* [50] may not reflect the roles of the contemporary organizations' structure. In this SLR, we identified some studies that changed the constructs' official name indicated by the measure author (e.g., [139, 29, 134]) or grouped several items of different measures for assessing a given construct [99]. In these cases, the practitioners should investigate the measure construct minutely, aiming to ground the changes theoretically. Furthermore, new procedures to research should be conducted to analyze the impact of these changes. It is essential to notice that any change in the original items can change their psychometric properties. Thereby, the threats to validity must be investigated and addressed. Depending on the changes made to the measures, a new process for evaluating the measure should

be conducted. The procedures described in Graziotin et al. [18] should be used to validate a new or adapted measure. The procedures described in Zhang et al. [141] and Antino et al. [24] can help in the translation and trans-cultural adaption.

Analyze evidence of validity and reliability of measure: This evidence is available in the scientific literature or the measure manual (which is expected when the measure has copyright). The commonly reported procedures and indices available to evaluate the psychometric properties quality of measures were addressed in Section 2.4. During the statistical analyses, researchers should perform Exploratory or confirmatory factor analysis to investigate the factor structure of the measure [18]. Only after checking the factor structure, should reliability be calculated. We highlight that all evidence of validity and reliability are conditioned to the date the research was executed, i.e., the more investigations executed using the measure, the more evidence of validity and reliability there will be. Thereby, a measure with little or no evidence can be used to the explore new evidence.

Use open science practices: Researchers should adopt open science practices [156]. Therefore, we recommend the publication of the measure items (without copyright), the database, and the source code used in statistical analyses. For example, new relations between personality traits and team climate could be investigated should the databases of identified studies using TCI [49] found in this review were available.

6.4 Limitations and Threats to Validity

A limitation of this study is the answer to RQ3. It is essential to notice that we do not foresee indicating the type of statistic association and their characteristics performed between the measures, e.g., correlation, the strength of the relationship, or direction of variables. Moreover, several primary studies had small or regional samples and used adapted measures. Some measures reflect specific concepts to particular cultures. For example, Zhang et al. [141] examine the impact of the Confucian work ethic on deviant behavior in Chinese companies. We report that factors shown in Table 6.6 may exert influence on organizational climate. Thereby, a reader must access the primary studies to understand more details about the measure, the type and strength of the association between the measures, and possible generalizations.

The SLR results might have been affected by some threats to validity such as in the study selection process, and the extraction and data analysis. Petersen et al. [110] proposed four threat types to assess the *validity* of systematic mapping studies. For each identified threat, we planned and executed control actions as follows.

To reduce *descriptive validity*, a spreadsheet has been designed to support the data collection process. Every decision about the study selection process and date extraction are recorded in the available spreadsheet. We also used Atlas.ti to support the data analyses.

To treat threats related to *theoretical validity* and potential bias, two researchers participated in this study selection process. The first and third authors applied the first filter to all studies independently. Discrepancies were discussed until a consensus were reached. The second filter was executed by the first author and audited by the third author. A possible common limitation to systematic reviews is related to the possibility of not finding relevant studies [111]. To address this limitation, (i) the construction of the search expression was performed iteratively and incrementally considering the terms and synonyms used in other SLR (namely [21, 10]), and (ii) we opted to use four online databases and complement the search results performing forward snowballing.

Interpretive validity is achieved when the conclusions are reasonable given the data, and hence maps to the validity of conclusion [110]. A threat in interpreting the data is researcher bias. To respond RQ3, we use thematic analysis [3] to identify and group the factors. To reduce a possible threat of interpretation, the first author made the extraction and analysis process, and the third author audited the results. For this, the auditor used the representation graphs containing the extraction fields (see Fig. 6.2). Hence, the researchers expressed and resolved interpretative doubts. Besides that, the authors have experience in SLR/SMS and thematic analysis.

Regarding the *repeatability* of this SLR, the entire review protocol is described in detail. All documents/studies references resulting from the automatic search in the online databases are available in the support spreadsheet. Thus, the inclusion/exclusion criteria pointed by each researcher are open and auditable.

6.4.1 Final Considerations

Our primary motivation was to investigate the state of the art of organizational climate research in software development teams to analyze the measures used, their psychometric proprieties, and factors that significantly relate to the software development team's climate. To accomplish this objective, we planned and executed a systematic literature review. We selected 33 primary studies to review and summarize information about organizational climate measure.

As a result, we identified 19 measures used to assess organizational climate in software development teams. Together the measures represent more than 70 dimensions (con-

structs) which confirm the multifaceted theory of organizational climate. The notable measures used in the identified studies were Team Climate Inventory (TCI) [49], Team Selection Inventory (TSI) [92], Team Climate questionnaire [93], Ethical Climate Questionnaire (ECQ) [94] and Organizational Climate Measure (OCM) [47]. These measures show strong evidence of validity and reliability.

Some organizational climate measures identified are old and may not reflect the culture of current software development teams. Furthermore, other measures do not have or have weak validity and reliability evidence. These measures should only be used after thoroughly investigating the items description and the theoretical construct that supports them. Using those measures in empirical investigations should consider an exploratory purpose as a learning opportunity, addressing and treating possible threats to validity. We highlight that all evidence of validity and reliability are conditioned to the research data, i.e., the more investigations are executed using a specific measure, the more evidence of validity and reliability there will be available.

We also analyzed the relationships investigated by the study authors between different constructs. We extracted 52 factors that can exert some effect on team climate. The most investigated factors were personality, problem-solving, satisfaction, software quality, and task characteristics.

The practitioners and researchers can use the results to help analyze and choose organizational climate measures, including other measures. Our results can be helpful to researchers interested in investigating organizational climate, their influences, or proposing new theories or measures. In the next chapter, Chapter 7, we present the *First and Second Case Studies*.

7. First and Second Case Studies

In this chapter, we present the preliminary evaluation of TACT. Its initial version comprises the Communication, Collaboration, Leadership, Autonomy, Decision-Making, and Client Involvement dimensions. 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. 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. TACT captured the organizational climate of the teams adequately. The team leaders reported intention of future use. The case studies were published in Dutra et al. [44] and Dutra et al. [55].

7.1 Case Study Planning and Execution

Runeson and Höst [157] 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 [100].

7.1.1 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 [158]. To investigate whether this fact could have impacted the organizational climate of the studied teams, we defined RQ1.1.

7.1.2 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.

7.1.3 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 (See Appendix A.5). 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 7.1 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 7.1: 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 TACT, 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) [84, 85]. The dimensions of Intention to Use, Perceived Usefulness, and Output Quality were used [84, 85]. In the interviews, we used a consent form to present and assure ethical aspects.

7.2 Case Study Results

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

7.2.1 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 7.2 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 Likert scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree). In Table 7.2, 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 7.1 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.

Table 7.2: 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%)

When analyzing the results in Table 7.2, 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 7.2 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.

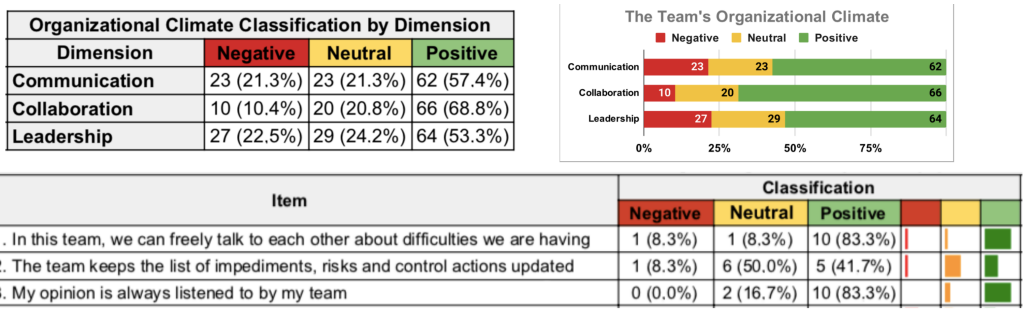


Figure 7.1: Part of TACT’s Dashboard (Pulse 1: Team A Results)

7.2.1.1 Analysis of Organizational Climate from Team A

Among the assessed teams, Team A showed more items evaluated as negative and neutral (see Table 7.2). 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, 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"*.

7.2.1.2 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 specific 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 7.2) 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"*.

7.2.1.3 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' ".

7.2.2 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.

7.2.3 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 [84, 85] 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.

7.2.4 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 [30, 159, 18].

Graziotin et al. [18] 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 [18].

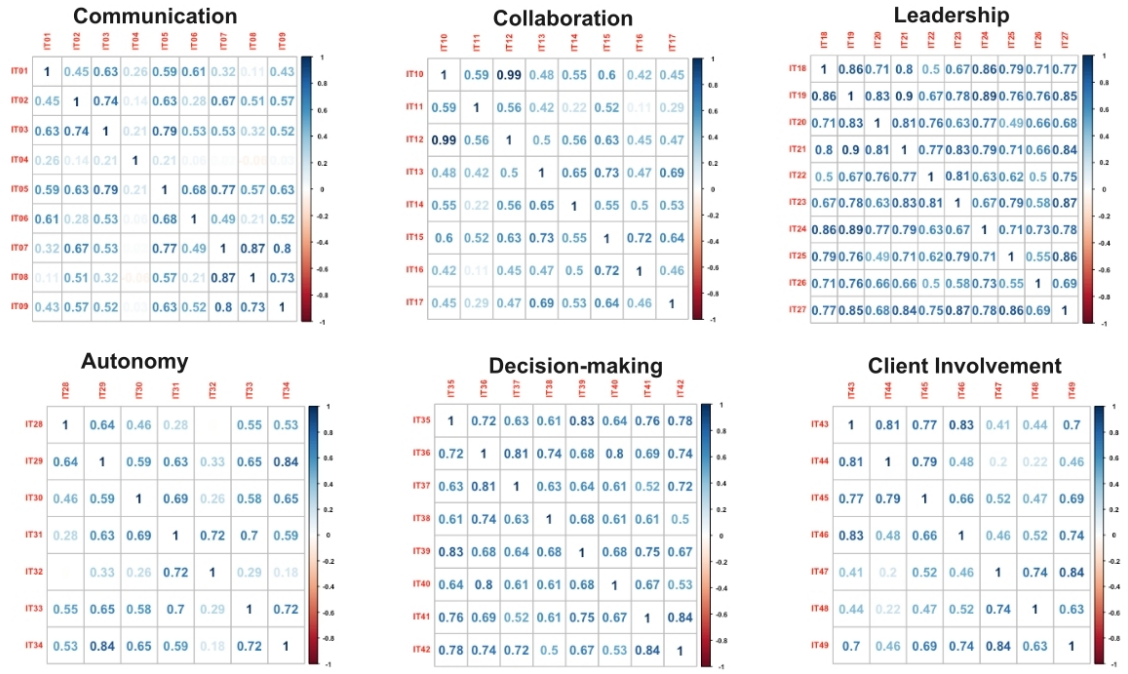


Figure 7.2: Correlation matrix of the dimensions

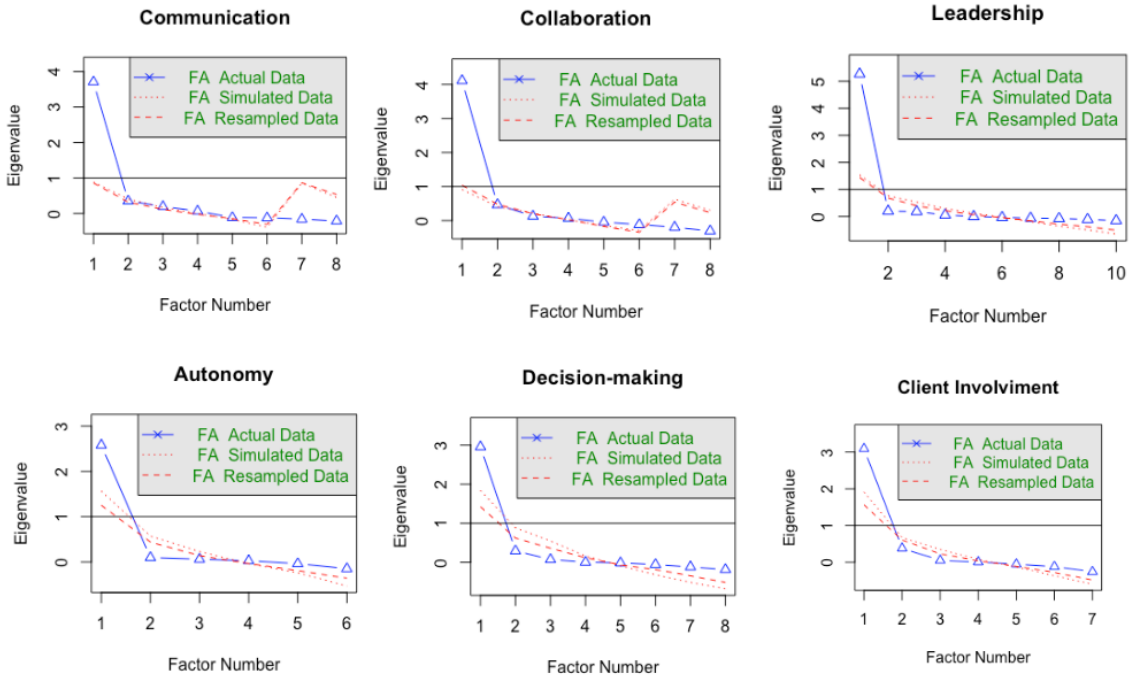


Figure 7.3: Parallel Analysis graphic

The quantitative results were processed using the R tool (v. 4.0.2) using primarily the *psych library* [160]. 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 may have interfered with the results [161, 162]. 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 [161]. In this case study, no items needed to be excluded.

To continue the analysis of step one, the item correlations (see Figure 7.2) were plotted for an initial visual diagnosis of the items and structure of the TACT dimensions [161]. A higher degree of association between items of the same dimension may already be visible in the correlation matrix (see Figure 7.2). 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 [161].

Analyzing the Spearman correlations (ρ) for the test case (Figure 7.2), 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) [163].

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 7.3) 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) [164].

As indicated by [164], the next analysis was conducted on the polychoric correlation matrix. We used the Parallel Analysis graph [165] to investigate the plausibility of the initial model proposed on TACT, i. e., the association of the items with their dimension. Figure 7.3 shows the Parallel Analysis graph (x-axis displays the “Factor Number” and y-axis represents the “Eigenvalue”). As per the Kaiser criterion, only factors with eigenvalues greater than 1 can be retained [166]. The data simulated by the Parallel Analysis

Table 7.3: 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

confirmed the hypothesis of retaining one factor by dimension. As shown in Figure 7.3, all dimensions can be explained by a single factor.

The FA was performed separated for each dimension to verify the more significant items. Table 7.3 shows the quantitative results. Analyzing the column "Dimension" (Table 7.3) 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 7.3) indicates the correlation of the item for the associated dimension. Regarding the small sample size, [164] 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 7.3), the items IT03 ($\lambda = 0.823$) and IT05 ($\lambda = 0.760$) 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 ($\lambda = 0.884$) and IT15 ($\lambda = 0.842$) 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 ($\lambda = 0.858$) 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 ($\lambda = 0.827$) has a high correlation to other items to the Autonomy dimension. For effective Decision-making, the teams should have open and effective communication IT39 ($\lambda = 0.827$). Lastly, for dimension Client Involvement, the item IT45 ($\lambda = 0.792$) represents the opportunity of stakeholders to suggest changes or improvements to the software.

We calculated the reliability (see Table 7.3) of TACT dimensions using the α-Cronbach coefficient [82]. The α-Cronbach indexes for each dimension are $\alpha > 0.8$, which implies the reliability of TACT for this case study is high [82].

7.3 Discussion

7.3.1 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 [10, 37]. 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 [6]. 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 [167, 37]. 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, [43] 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 [43].

7.3.2 Preliminary evaluation of TACT

The literature recommends implementing a pilot study for the initial assessment of instruments that measure behaviors, attitudes, or feelings [70, 47, 99, 63]. The pilot must utilize a sample with the same characteristics as the target population [49, 70, 99, 47, 63]. 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, two items (2 out of 27) were not considered related to agile software development teams by the first specialist, i.e., 92% items were positively evaluated. This perceptual is already evidence of the content validity of TACT. However, after the researchers' discussion, we opted to keep the items in TACT (see researchers' discussions IT192 and IT128 in Appendix A.6).

In a qualitative analysis (see Section 7.2.3), the leaders confirmed that the items represent agile values, principles, and practices. Through the dimensions of TAM [84, 85], leaders rated TACT positively for Intention to Use, Perceived Usefulness, and Output Quality.

In quantitative analysis, the correlation matrix (Figure 7.2) 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 [168]. 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 7.3) indicated that a single factor could explain all dimensions. Furthermore, most TACT items have high (> 6) factor loadings (see Table 7.3). 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 7.3). The α-Cronbach indexes for each dimension are $\alpha > 0.8$, which implies the reliability of TACT for this case study is high [82].

7.3.3 TACT use recommendations

The TACT use final recommendations is available in Appendix A.2.

Wagner et al. [169] 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 [98]. However, we do not use the names of the roles or ceremonies from Scrum, e.g., we use Team Facilitator, Iteration, 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 et al. [42], 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?"

7.4 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 7.2.4, 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, 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 [63] 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 [63]. 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 [63]. To mitigate this threat, we provide detailed descriptions of the study context. However, [6] 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.

7.5 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.

In the next chapter, Chapter 8, we present the *Third Case Study*.

8. Third Case Study

Previous preliminary versions [44, 55] of TACT, an instrument to assess the organizational climate of agile teams, comprise the Communication, Collaboration, Leadership, Autonomy, Decision-making, and Client Involvement dimensions. This study presents TACT's evolution considering the Trust, Knowledge, Learning, and Motivation dimensions. We executed a case study in a prominent Brazilian bank and a Canadian software house that maintain a financial Management Information Systems (MIS). We used qualitative and quantitative procedures to evaluate the results. Interviews with the involved agile team members and team leaders interviews confirmed TACT's ability to measure the agile organizational climate. The case study was published in Dutra et al. [56].

8.1 Case Study Planning

The case study described below evaluated the considered the teams' climate and TACT.

Our *research questions* (RQ) are defined as follows: RQ1. How is the organizational climate in the examined agile teams? RQ2. How was TACT's performance in the climate assessment?

The *participants* are software engineers from two organizations, named B and C for confidentiality purposes. Each organization's mediators indicated teams by convenience to participate in the case study. Organization B teams were nominated B1, B2, B3, and B4 Teams and Organization C teams were C1, C2, and C3 Teams. We used a consent form to guarantee data confidentiality and to present and assure ethical aspects.

Organization B is a prominent Brazilian bank with millions of customers. It has dozens of development teams composed of employees and outsourced collaborators. Regarding

leadership, some teams have a Scrum Master, but in others, this role is played by the hierarchical leader of the team. Business experts perform the function of PO. Each team defines the software development process and can choose traditional (structured and RUP) or agile (Scrum, Kanban, XP) methods, among others.

Organization C is a Canadian technology company with more than 20 years of existence. It develops a wealth management (WM) system. Its software process is based on Scrum and, in a lesser degree, SAFE. The software development teams have one technical lead, one Scrum Master (shared with another team), one PO, from 2 to 4 developers, and one quality champion (i.e., a developer also accountable for the quality assurance activities).

For the *data collection*, we used TACT and interviews. For Organization B, we used both instruments in Portuguese. For Organization C, we used English versions of the instruments. The thesis author and another researcher conducted the interviews with Organization B. A third researcher conducted the interviews with Organization C. Data collection took place between May and July 2021.

The first procedure was the assessment of the organizational climate in the teams. All team members were invited to participate voluntarily and anonymously in the study. In addition to the items present in TACT (see Appendix A.1), we also asked each team member's characteristics. Two additional open-ended questions were introduced ("*In your opinion, what most influences the [trust, knowledge, learning, and motivation] dimension in your team?"* and *"How to improve your team's organizational climate?"*).

The second procedure involved semi-structured interviews with the leaders of the respective teams. These interviews were designed to present the climate assessment results 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/item, of the organizational climate assessment carried out by the team? Do the results by dimension/item represent your perception of the team's daily life?"*. We were only able to conduct interviews with B1, B2, B3, B4, and C2 teams leaders. At the end of the interview, we sent a link to the leaders to evaluate TACT through TAM (Technology Acceptance Model) [85].

For the *data analysis*, we used analysis of frequencies, polychoric correlations matrices [83], Iclust Graphs [160], and α-Cronbach value for quantitative analyses. In the qualitative analysis, we considered evaluation using TAM and reports made by the par-

ticipants. The thesis author analysed the data. The results were discussed and revised by other researchers.

8.2 Case Study Results

Table 8.1 shows the team profiles. In total, 30 team members participated in the study. The team members are aged around 42 years, all members have an under-graduation degree, and 10 (33%) have a master's or doctorate, 14 (47%) participants have more than five years of experience in agile methods, 11 (37%) of the respondents were female. In a general way, in the sample, there is gender diversity. The respondents are highly educated, have experience in agile methods, and have worked together for over a year.

Table 8.1: Teams profile

Team					Gender		Experience			Time		
ID	Country	Size	Part.	Age (σ)	M	F	3 to <5	5 to 10	>= 10	<= 12	12 to 24	>=24
B1	BRA	9	7	41(8)	4	3	6	1	0	0	1	6
B2	BRA	5	4	53(8)	4	0	3	1	0	1	1	2
B3	BRA	4	3	46(8)	1	2	2	0	1	1	2	0
B4	BRA	4	4	42(6)	2	2	4	0	0	4	0	0
C1	CA	5	3	38(5)	2	1	1	2	0	0	2	1
C2	CA	5	5	40(11)	3	2	0	4	1	0	2	3
C3	CA	5	4	37(4)	3	1	0	3	1	2	2	0
Total		37	30	42(9)	19	11	16	11	3	8	10	12

Experience = in agile (year); Time = allocated together (month); Part. = Participants; (σ) = Standard deviation; BRA = Brazil; CA = Canada

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

In Table 8.2 we show the frequencies value for each dimension assessed. 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. 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. Higher frequencies in the "Positive" column can be considered a favorable organizational climate to each dimension. Higher frequencies in the "Negative" can be considered an adverse climate.

When analyzing the results in Table 8.2, higher frequencies can be observed in the "Positive" column in several dimensions for the majority of the teams, except for the B1 Team since a negative organizational climate can be observed in every dimension. Together, neutral and negative results represent points of attention for analyzing possible causes and impacts on active roles, elements of the process, the development project, or

Table 8.2: Results of the organizational climate assessment for the teams

Team	Trust (%)			Knowledge (%)			Learning (%)			Motivation (%)		
Name	Neg.	Neu.	Pos.	Neg.	Neu.	Pos.	Neg.	Neu.	Pos.	Neg.	Neu.	Pos.
B1	22 (45%)	7 (14%)	20 (41%)	18 (43%)	8 (19%)	16 (38%)	15 (35%)	17 (40%)	10 (24%)	18 (32%)	17 (30%)	21 (37%)
B2	2 (7%)	3 (11%)	23 (82%)	2 (8%)	0 (0%)	22 (92%)	0 (0%)	0 (0%)	24 (100%)	3 (9%)	1 (3%)	28 (87%)
B3	1 (5%)	1 (5%)	19 (90%)	6 (33%)	3 (17%)	9 (50%)	1 (6%)	4 (22%)	13 (72%)	9 (37%)	2 (8%)	13 (54%)
B4	0 (0%)	1 (4%)	27 (96%)	2 (8%)	1 (4%)	21 (87%)	2 (8%)	3 (12%)	19 (79%)	2 (6%)	0 (0%)	30 (94%)
C1	1 (5%)	4 (19%)	16 (76%)	4 (22%)	5 (28%)	9 (50%)	0 (0%)	7 (39%)	11 (61%)	2 (8%)	2 (8%)	20 (83%)
C2	3 (9%)	7 (20%)	25 (71%)	13 (43%)	4 (13%)	13 (43%)	3 (10%)	4 (13%)	23 (77%)	7 (17%)	7 (17%)	26 (65%)
C3	0 (0%)	5 (18%)	23 (82%)	2 (8%)	11 (46%)	11 (46%)	0 (0%)	8 (33%)	16 (67%)	1 (3%)	5 (16%)	26 (81%)

Neg. = Negative; Neu. = Neural; Pos. = Positive

the team's culture in general. For example, the non-positive evaluations for the knowledge dimension are above 45% (considering negative plus neutral) for B3, C2, and C3 Teams. Analyzing the aggregate results of negative and neutral elements can be a good strategy for climate management.

Analysis from Trust Dimension: Analyzing the Trust dimension (see Table 8.2), we might observe a positive climate for almost all teams except for the B1 team. The negative highlight in B1 and B2 teams was the item IT43 that assesses trust between the team and the PO.

The B1 Team had the worst performance for the Trust dimension (45% of the items assessed negatively). Questioned about the factors that most influence the trust in the team, the members said "the outsourced developers are upstanding and committed, the others have no idea what they're doing," "there is a lack of commitment among some members," "there is no consistency at work. Priorities constantly change, especially when it comes from the PO's work."

Regarding the Trust dimensions, the B1 Team Leader said, " the results are positive when related to the team or team members <IT38>. However, at the time of the survey, there was an apparent lack of trust concerning the PO <IT43> as there was no clear alignment between the several POs envolved, generating the lack of confidence. Another point is (the perception of) agility <IT39>, concerning knowledge and management support on agile values, principles, and practices as the team performs a hybrid methodology. Agility is starting, and we are using only some (agile) practices. From this, the team may understand that the management does not have as much knowledge to provide the necessary support."

The B2 team members (82% positive) highlighted "Teamwork and commitment," "Transparency" and "The entire team's commitment to delivering an excellent product."

The B2 Team leader confirmed these statements. She declared, “regarding trust in the team and the individual components of the team <IT39, IT41, and IT42>, the percentage is very positive. Trust and knowledge among the team are very high. Everyone is on the same curve. Only the PO <IT43> was out of line with the whole. We had a problem with the PO; he did not know the product, so the team did not trust him.”

Analyzing the results of the B3 Team, the leader said, “the team is united. They <members> work well as a team, help each other, and have complementary profiles. The team perceives the commitment and availability of the PO.” Corroborating the leader’s statement, one member wrote, “the team is cohesive. They have been working together for some time, and knowledge complements each other.”

The C1 and C2 Teams members have confirmed the environment of trust. They reported, “everyone wants the best as a team,” “we have the willingness to admit mistakes and ask for help when required,” and “the team has coordination and open communication.”

The C2 Team leader commented on the neutral evaluation in items IT39 (support for agile) and IT43 (trust in the PO). She said, “there was some perception that management was not supporting proper agile practices. The PO was hired without proper business knowledge and could not provide clear information to the team.” The C2 Team leader declaration was confirmed by a team member, who wrote, “the PO does not have business knowledge, so sometimes the team misses proper requirements.”

Analysis from Knowledge Dimension: Table 8.2 shows that only the B2 and B4 Teams presented a positive climate superior to 85% in the Knowledge dimension.

A B2 Team member confirmed the excellent environment. He wrote, “the experience and daily interaction together with the exchange of knowledge and experience that end up happening when there is any doubt or need to deepen a certain item.” Another member of the B Team pointed out that the biggest challenge facing the team’s work is the “difficulty of prioritizing” for the knowledge dimension. Regarding the Knowledge dimension, the B2 Team Leader said, “the tracking of functionalities, the backlog and the kanban are well organized. Everything is documented, so inputs are easily located even if there is an exit/entry of team members.”

The B4 Team had 87% positive values to the Knowledge dimension. Team members did not comment. However, the team leader said, “the PO is very present and available (...) despite being a new team, some members had already worked together, so this ends up strengthening and uniting the group.”

Considering all the results of the knowledge dimension, the worst consequences were those from the B1 and C2 (43% negative) teams.

We identified an unfavorable and troubled climate by analyzing the comments of the B1 Team members. They declared, "part of the team knows a lot, and the other does not care to learn," "many people do not seek the knowledge they need (PO, for example). Therefore, we always need extensive meetings with managers <PO and stakeholders>, which, if they happened frequently, would not need to be extensive. Some people are centralizers. Other people do not seek transparency for fear of influencing productivity," "the team is not as committed as it should be and needs to look for more technology and business knowledge." Analyzing the negative result for items IT45 (loss of knowledge with the exchange of members) and IT47 (loss of knowledge between client and team), the B1 Team Leader comments, "Concerning IT45, it is related to the software factory. The <OMITTED Company> team is very dependent on the (software) factory. If all the factory members go out to service, we do not have the <OMITTED Company> internal technical capacity to continue the system. There is no internal developer, what makes it very difficult. There is no transfer of knowledge. It exists on paper, but it does not happen."

In the C2 Team, a member wrote, "there is little or no training on the business. Our PO does not know the business (he relies on other people). The team depends on people who know the legacy code because lack of documentation." In the analyses of possible causes of negative assessment in Knowledge dimension, the C2 Team Leader said, "the team had to understand the legacy code to migrate it to the new tech. The legacy code was poorly written/designed and it is hard to understand, and there was almost no documentation to assist that. Therefore, there was a high dependency on people with some knowledge of business rules."

Analysis from Learning Dimension: The B2 Team was unique to show 100% of the items evaluated as positive, the B1 Team obtained the worst result (35% as negative), and the other teams had positive climate between 60% and 80% (see Table 8.2).

B2 team members highlight that the team supports knowledge sharing, positively influencing the team climate. Corroborating that, the leader said, "the retrospective ceremony is used to 'lay the cards on the table,' everyone speaks, and actions are recorded so that they can be put into practice."

The B1 team evaluated 15 out of 42 items (7 members multiplied by 6 items) as negative (36%) and 17 out of 42 items (40%) as neutral. Item "IT54 The team aims to contin-

uously improve existing agile practices and incorporate new Software Engineering practices" was the most negatively rated item (4 as negative, 2 as neutral, and 1 as positive). Regarding IT54, the B1 team leader said, "the team is still not running fully agile, despite using some practices. The PO is also not interested in using the practices that agility offers." Somewhat, team members reported a lack of team interest and a lack of incentive by the management to improve learning. They wrote, "I perceive that the team does not search for learning opportunities," "there is no incentive or interest for most people to learn something new," and "...support (it's no use for the team to be willing, but hierarchically to be 'hindered."' About item "IT56. The team discusses new emerging technologies," the B1 team leader declared, "there is no discussion of emerging technologies. There is rarely anything that uses API, BUS, but the transaction is carried out daily in a batch way."

In the C2 Team, the item "IT52. In this organization, people are promoting the effective use of agile methodologies" obtained only one evaluation as positive. The C2 Team Leader said about this assessment, "there was some perception that management was not supporting proper agile practices. Therefore, the team felt uncomfortably pressured." The team members show positive points. They wrote, "the collaboration level of the team helps us all learn from each other," and "the team itself is the highlight."

Considering all teams, item "IT55. The team teaches me how to handle my difficulties in the tasks" deserves to be highlighted for its positive evaluation. Twenty-three members, i.e., 77% of the sample, confirmed the perception of self-help among team members.

Analysis from Motivation Dimension: In this dimension, autonomy was the most discussed theme. The B1 Team member wrote, "we don't have autonomy." In the B3 Team, members analyzed "the lack of autonomy to define the deadlines for carrying out tasks negatively influences the team's motivation" and "the lack of autonomy directly influences the team's motivation. The team runs into the Company's internal bureaucracy that does not provide tools and grant access to the customer's environment quickly." In the C2 Team, a developer reported, "...unfeasible deadlines deliver stress and hurt the team autonomy in planning its tasks."

The statements of the B3 and C3 Team leaders corroborate the analysis of the team members. The B3 team leader said, "the Motivation dimension has the most negative responses. The current project is critical, with short delivery times, pressure and stress. The first iterations were planned according to the delivery deadline, and there was no or little autonomy of the team regarding the deliverables or adopted architecture." In the same direction, the C3 Team revealed, "the team was being asked to finish a project in an

unrealistic deadline and not being heard about the risks, which resulted in a lot of stress. Even their bonuses were mentioned as a possible impact of that project's success."

The lack of the teams' autonomy manifested through the product delivery fixed deadlines and the lack of planning considering the speed and capacity of the team, probably generating a lack of motivation and stress in developers. In the sample, the items with the most negative ratings were IT61 (feel stressed and pressured to execute the tasks), with 16 assessments as negative and 5 as neutral, and IT62 (the team organizes its tasks'), which has 7 negative reviews and 7 as neutral.

The satisfaction of seeing the product delivered and being helpful to the client motivates the team. The B1 Team members wrote: "product delivery impacts our <team>," corroborating the statement that the C3 team member wrote "product delivery influences motivation positively." The B2 Team member reported satisfaction and recognition as motivation factors. He wrote, "our motivation driven by pride and satisfaction in seeing the product delivered and useful to the customer."

8.2.2 How was TACT's performance in the climate assessment (RQ2)?

Analyzing the answers to the open-ended questions asked to the team members, together with the leader interviews, we have observed that it allows us to infer that the TACT could correctly capture the organizational climate of the investigated teams. We also found that the TACT questions allowed team members to reflect on their activities and feelings by answering open-ended questions. The members said, "we need a space for the factory <outsourced company> to feel free to talk about what bothers us. Like this form <TACT>" and "if there is more dialogue and exchange among team members and other teams, I'm sure we will change many aspects of the key points discussed by this form <TACT>."

To continue the assessment of the performance of TACT, we invited team leaders to evaluate TACT considering TAM dimensions of Intention to Use, Perceived Usefulness, and Output Quality [85]. Some items that considered the assessment 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 Likert scale, most of the leaders' responses were the options "Somewhat agree" and "Strongly agree" for all items of dimensions of Intention to Use, Perceived Usefulness, and Output Quality.

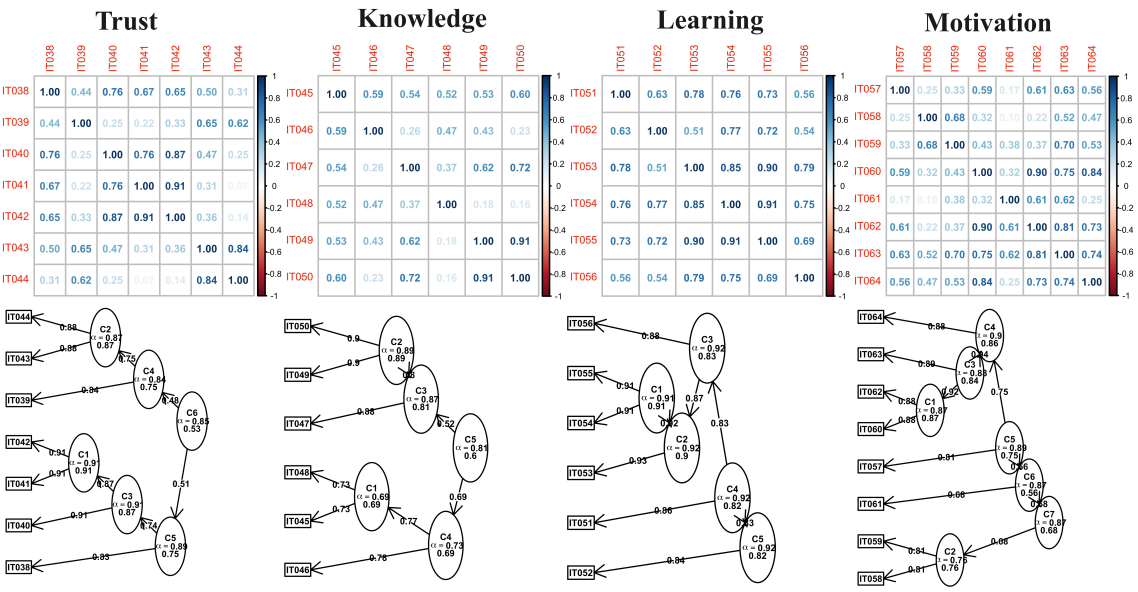


Figure 8.1: Correlation matrix and Iclust graph of the dimensions

The quantitative results were processed using the R tool (v. 4.0.2) using primarily the *psych library* [160]. To investigate the initial structure of the TACT dimensions, their reliability, and how the items are interrelated, we plotted the polychoric correlations matrices and Iclust Graphs of TACT dimensions (Fig. 8.1).

Polychoric correlations are the best option to analyze latent constructs, which are measures using a Likert scale (ordinal date) [83]. A correlation with other variables of the same dimension in latent variables is expected [164]. If several correlation values are below 0.3 in the dimension, it is possible to exclude the items. Conversely, correlations with values above 0.8 can be considered multicollinearity (i.e., very correlated variables) and singularity (perfectly correlated variables). In this case, it may also be viewed as excluding variables. Field et al. [164] argue that the process of excluding items is an empirical one.

We analyze the reliability using clusters, also considering the β coefficient (see Figure 8.1, the second value into the cluster), a more conservative estimate of reliability [160]. The purpose of cluster analysis is to reduce the complexity of the data and try to identify homogeneous subgroups.

Analyzing the polychoric correlations matrices (Figure 8.1), we can observe: i) absence of negative correlations; ii) IT44 and IT61 with insignificant positive correlations with several variables, iii) few variables of the same dimension with very high values (e.g., IT41 and IT42) and iv) in general, high and moderate positive correlation among items in the dimensions. Critical values of correlations (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) [163].

Considering the Iclust graphics and matrices of polychoric correlations (see Figure 8.1), we can observe in the Trust dimension that the items IT41 and IT42 have a high and moderate correlation with other items. The C1 cluster shows the best values (0.91) for α and β. Together with the C3 cluster (IT40) the best solution was identified ($\alpha = 0.91$ and $\beta = 0.87$). Concerning the Motivation dimension, more clusters (7) are observed among all dimensions and lower β values in the final clusters (e.g., $\beta = 0.56$ in the C6 cluster). This segregation of clusters may indicate different types of motivation in the dimension or a specific composition for the sample. Anyway, more studies are needed to assess the structure of the dimensions. The C4 cluster demonstrates value for Motivation dimension ($\alpha = 0.91$ and $\beta = 0.86$). Thus, IT62, IT60, IT63, and IT64 may be considered more influential and used in item reductions. Cronbach's alphas of all of the dimensions were over 0.8 (acceptable) [164].

8.3 Discussion

It is worth remembering that the TACT instrument measures latent variables (e.g., manifest behavior, feelings, or those that can be directly measurable). Accordingly to Boehm and Turner [170], the main differences between traditional process and agile approaches lie in the people issues. The authors reported that the customer, developers, and organizational culture have a significant influence on the success of agile projects. Several years have passed since the initial discussions proposed by Boehn and Turner [170]. However, the challenges are still latent, including for banking companies [171].

PO, the customer representative: The PO was responsible for managing the product backlog in the investigated companies. Boehm and Turner [170] explained that the customer should be Collaborative, Representative, Authorized, Committed, and Knowledgeable (CRACK). An unfavorable organizational climate was manifested in teams in which the PO had no knowledge of the business domain or experience.

In the C2 Team, we observed that the negative assessment captured by TACT in the members' reports and the leader's interview were not about a person's dissatisfaction but exclusively the lack of knowledge of the PO. The C2 team members evaluated the PO commitment "IT43" as positive, but all items about PO Knowledge "IT50" as negative. On the other hand, in the B3 and C3 Teams, all TACT items that describe the PO activities were evaluated as positive. Corroborating the quantitative data, a C3 Team member wrote, "the PO does an excellent job analyzing business requirements." The leader said about the B3 Team PO, "sometimes the PO has difficulties specifying business/product rules

and reflecting some changes during functionality development. But the team perceives his commitment and availability."

Team Members: Critical factors for success in agile methods include trust, knowledge, and learning [13, 10]. Boehm and Turner [170] argued that agile methods tend to need a richer mix of higher-skilled-talented people. We believe that a favorable climate can influence several other factors. In comparison, an adverse environment can negatively affect the project's success.

All B1 Team evidence indicates an adverse or deliverable climate for all dimensions. There is friction between outsourced members with company employees. A Team member reported, "part of the team knows a lot, the rest doesn't care to learn." Another member wrote, "the PO is often rude, even humiliating (rarely) the team, making it seem like we are in their shoes <The project has three PO>. He does not master the knowledge about his own business. Many of the development team's ideas do not even get heard because managers <PO> feel like we are taking their authority away."

Agile Culture: Boehm and Turner [170] reported that in agile culture, team members feel comfortable and empowered when there are many degrees of freedom available for them to define and work problems. Team members reported a lack of autonomy to define deadlines and tasks. A C2 Team member wrote, "unfeasible deadlines deliver stress and hurt the team autonomy in planning its tasks." A C1 Team member analyzed factors that influence the Motivation dimension, then wrote, "previous commitments with unrealistic deadlines, and the unwillingness of management/engineering/process do not have their agenda and are not willing to negotiate priorities." The C1 Team member reported dissatisfaction with the partial implementation of agile methods "if organization claimed use of Agile methodology, then all layers have to commit and follow it not only on paper but in reality."

How to improve Teams' Climate: We considered the discussions of Boehm and Turner [170], team members' suggestions, and the leaders' reports in the interviews to propose four actions to improve team climate. Those responsible for managing the organizational climate should consider these guidelines to foster a favorable organizational climate in the agile software development teams.

Listen to the team members: An open communication between all team members and stakeholders is essential for the success of any project. However, sometimes it is necessary to collect information anonymously. Conducting the organizational climate assessment is an effective way to capture the feeling of giving a voice to employees. Using an orga-

nizational climate instrument (like TACT), which allows specific reflections on the agile culture, allows a more detailed understanding of the team's reality. Regarding this matter, a member reported, "if there is more dialogue and exchange among team members and other teams, I'm sure we will change many aspects of the key points discussed by this form <TACT>." Also, the B4 Team leader reported, "the TACT items enabled to identify items that may have a problem or need improvement."

Promote actions to disseminate knowledge and learning: Developing complex information systems in a legacy environment that is highly regulated as the systems from Organization B and C is a challenge for the teams. In addition, a high turnover of team members is typical in Brazil and Canada. The team has difficulties understanding the context, rules, and laws in this environment. A member reported, "there is little or no training on the business. Our PO does not know the business (he relies on other people). The team depends on people who know the legacy code because of documentation." The team members suggested several kinds of actions to disseminate knowledge and learning. Among their suggestions are "(having) training sessions," "trying out new technologies," and "formal and informal knowledge transfer sessions among team members."

Empower the team: Beck et al. [68] call out "build projects around motivated individuals. Give them the environment and support they need and trust them to get the job done." The organization that claims the implementation of agile methods should ensure autonomy to decision-making concerning task planning, deadlines, and timeboxing. Fixed-term deadlines for delivery not taking into account speed and the teams' capability possibly corroborates to an unfavorable climate resulting in lack of motivation in the team members. Concerning how to improve team climate, the C1 Team members wrote, "I would say not to assign deadlines to projects that are not the way how agile works. (...) We feel some of the uncertainties are not considered."

Have a PO CRACK: Boehm and Turner [170] explained that the customer should be a CRACK. This might seem obvious, but we believe that the PO should i) be experienced in identifying and analyzing requirements, b) know the system domain, c) show availability and open communication to discuss and clarify user stories with the team, and d) be simply the owner of the product. Concerning PO activities, a B2 Team leader said, "the PO was not someone from the product. He had a managerial role. He was connecting the true PO (who was in other bank functions) and the team. When the team questioned something, he never got the answer right away, and when he tried to answer right away, he usually got it wrong. The team had to rework."

8.4 Limitations and Threats to Validity

The main limitation of this study is the sample size (n = 30). We performed a case study as pilot to identify improvements and initial evidence sources. Recker [63] discusses some guidelines for evaluating qualitative and quantitative studies.

Concerning *reliability*, we showed a contextual description of organizations and the teams, as well as direct quotes from team members and leaders, which were considered to support the analysis. We plotted the polychoric correlations matrices and Iclust Graphs of TACT dimensions to investigate how the items are interrelated and calculate the reliability of the dimensions. The reliability for the case study sample is high (α-Cronbach > 0.8).

To address possible threats to *internal validity*, we decided to use multiple sources of evidence. We triangulated the climate assessment quantitative results with the team member opinion (open-ended questions) and leader reports (interviews). Thereby, the review of the evaluation results was assured (which also relates to measurement validity). Regarding TACT, judges experienced in agile methods evaluated TACT items for Simplicity, Cohesion, and Relevance/Representativeness. The initial values of the Content Validity Index (CVI) were acceptable (>= 0.7) [96].

External validity concerns how much and when the results of a study can be generalized to other cases or domains [63]. It is impossible to guarantee similar outcomes in another cycle in the same examined teams or even in different groups of the same organization. Therefore, generalizations not can be realized. However, we detailed the organizations and teams' contexts to assess how the environment characteristics match other research fields.

8.5 Final Considerations

We presented a case study to evaluate the partial version of TACT designed to measure the dimensions of Trust, Knowledge, Learning, and Motivation. The organizational climate assessment was performed in seven agile teams from a Brazilian and a Canadian company. TACT items, interviews, and open-ended questions were used to collect the data. Analyzing all evidence in the data collected, we inferred that TACT captured the organizational climate of the teams correctly. Also, TACT presented high levels of reliability.

We found that the PO's experience and knowledge about the system's domain directly influence the teams' perception of the Trust and Knowledge dimension. Knowledge-sharing among team members positively impacted the Learning dimension. In the opposite direction, the lack of people promoting agile methodology and the unwillingness to improve agile practices negatively influenced Learning among teams. The lack of team autonomy in delivery planning has harmed the motivational dimension. Contrarily, recognition for the work done and satisfaction in seeing the product is helpful to the customer were motivating factors.

In the next chapter, Chapter 9, we proceed with the TACT validation process. We executed a survey to investigate and validate the factorial structure of all TACT dimensions.

9. Validation Study

This study aims to investigate TACT ("insTrument to Assess the organizational ClimaTe of agile teams") structure for the collected data. Thereby, we purpose to: (i) confirm the theoretical structure of TACT, (ii) investigate the most critical factors that influence the agile teams' climate, (iii) investigate how to improve the agile teams' climate, and (iv) capture practitioners perception involved in the climate management concerning TACT.

9.1 Methodology

The methodological approach used in this study is based on a survey. Recker [63] describes a survey as a means of gathering information about the characteristics, actions, perceptions, attitudes, or opinions of a large group of units of observations (such as individuals, groups, or organizations). Surveys are commonly used to validate the instruments that measure latent variables [18].

9.1.1 Measures, demographic variables, and open-ended questions

We used all TACT dimensions (i. e., Communication, Collaboration, Leadership, Autonomy, Decision-making, Client Involvement, Trust, Knowledge, Learning, and Motivation) to measure the organizational climate (see Appendix A.1). We also captured the personal characteristics such as country, gender, age, education, time allocated in the team, and time experience on agile methodologies. TACT items are measured using a 5-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree). In addition to TACT items, two open-ended questions were added: *"In your opinion, what most influences the organizational climate in your team?"* and *"How to improve your team's organizational climate?"*

To evaluate TACT qualitatively, we used the Intention to Use, Perceived Usefulness, and Output Quality dimensions of TAM (Technology Acceptance Model) [84, 85]. TAM items are measured using a 7-point Likert scale (1 = strongly disagree, 2 = moderately disagree, 3 = somewhat disagree, 4 = neutral -neither disagree nor agree-, 5 = somewhat agree, 6 = moderately agree, and 7 = strongly agree).

9.1.2 Data Collection

The procedure for administering TACT to agile teams' members was a web-based survey. Two strategies were adopted to collect data: (i) agile teams from Brazilian organizations and (ii) individual participants from Brazil and other countries. We sent e-mail invitations to Brazilian organizations with software development teams using agile methodologies. We also invited members of agile teams to participate in the survey through various dissemination channels. Data was collected from Brazilian organizations and through e-mails, groups on LinkedIn/Facebook related to programming and agile, and universities, researchers, and professionals lists. The groups' members are thousands. However, we could not determine the number of views and calculate the response rate. Data collection took place between August 2021 and February 2022. We performed the communication in English and Portuguese, the TACT languages. The subjects selection in this study is considered non-probability [172].

Google Sheets was used as a tool to operationalize the survey. At the beginning of the survey, we included a description with the definition of the organizational climate, the objective of the assessment, and the vocabulary of terms used in TACT compared with Scrum terms. Next, we presented a consent form to comply with ethical principles. We informed that participation would be anonymous and voluntary and that the participant could abandon the assessment at any time without penalties. Only if the participant checked the option *"I currently play a role in an agile software development team, and I AGREE to participate in the survey"* the TACT items were shown. Finally, we performed a pretesting to identify issues and improvements.

Wohlin et al. [172] explain that to maintain long-term relationships and trust with the subjects of a study, feedback of results and analysis are essential. If feasible, from a confidentiality point of view, data from individuals' performance may be reported back together with the overall analysis. Thereby, as a counterpart, we committed to sending the report (issued by TACT) with the result of the organizational climate of the teams and all teams aggregated to the companies that accepted to participate in this study. For this, interviews were designed to present the climate assessment results and capture the

participants' perception of TACT and the team's organizational climate. To do this, they were asked questions such as *"How do you evaluate the results, by dimension/item, of the organizational climate assessment carried out by the team? Do the results by dimension/item represent your perception of the team's daily life?"* We invited the responsible for climate management in the Brazilian companies considering this survey to present the results. At the end of the interview, we sent a link to the representatives to evaluate TACT through TAM (Technology Acceptance Model) [84, 85]. The data collected in the case studies were not suitable for this study because they used only a few TACT dimensions each. Therefore, no data collected from the case studies were considered in this study.

9.1.3 Data Analysis

The dataset was initially checked for errors, e.g., (i) outliers or non-compatible information in the age, time allocated in the team, time experience on agile methodologies, and (ii) other data typed in gender or role fields.

For quantitative analysis, we used descriptive statistics [161], Spearman correlation matrices [164], Confirmatory Factor Analysis [18, 161], and reliability indexes [160, 161]. The dataset has been analyzed by Google Sheets (the tool used to support TACT use) and the R tool. The quantitative results were processed using the R tool (version 4.0.2) through the *psych* and *lavaan* libraries [173, 160]. The package with the R script, the dataset, and the forms used in this research are available at the link (See this link).

For qualitative analysis, we used thematic analysis [2, 3]. The thesis author analysed the data and identified codes, factors, and categories relevant to the answers to the questions (*"What most influences the organizational climate in your team?"* and *"How to improve your team's organizational climate?"*). ATLAS.ti (https://atlasti.com/) was used as a supporting tool. All codes, factors, and categories and their associations were discussed and revised by another researcher. An example of the coding process is shown as follows. Team members answering question *"In your opinion, what most influences the organizational climate in your team?"* wrote, "the freedom that members have to express their opinion on the company, project, and technical issues of the members," "the freedom to propose and discuss ideas without any fear of having their competence judged," "the freedom to talk about any topic with teammates. The team is mature enough to embrace criticism and suggestions, making it an excellent workplace." These sentences were coded in "Open and constant communication among members" and associated with the "Communication" factor. The "Communication" factor was associated with the "Human Factor" category. Other examples of the coding process can be found in Section 9.2.3.

Still aiming to evaluate the TACT qualitatively, we analyzed (i) the answer frequencies to TAM dimensions evaluated by the representatives of the Brazilian organizations and (ii) reports made in the interviews.

9.2 Results

This section analyzes the collected data from six Brazilian organizations and other individual participants from Brazil and other countries.

9.2.1 Demographic Analysis

In total, 301 participants responded to the survey. From six Brazilian companies that participated in this study, 161 individuals evaluated their teams' climate. Individually, 96 participants from Brazil and 44 from other countries accepted our invitation and responded to the survey. Table 9.1 shows the organizations profile and Table 9.2 describes the respondents profile.

Table 9.1: Organization profile and their participants

Id.	Organization Type	Software Focus	Teams	Respondents
ORG1	Public university	Academic system; Human resource systems	2	19
ORG2	Software house	Accounting; Real estate systems	16	60
ORG3	Software house	Academic systems; Health systems	5	25
ORG4	Software house	Public safety systems	4	22
ORG5	Fintech	Payment systems	1	9
ORG6	Research and innovation	Ecosystem development	6	26
		Total	**34**	**161**

Organizations' names are omitted for confidentiality (see Table 9.1). We considered both small and large organizations. For instance, Organization 2 (ORG2) is a software house with many accounting and real estate management products. Organization (ORG2) has over 30,000 clients, around 1500 collaborators, more than 250 in software development, and 400 in support teams. On the other hand, ORG5 has 18 collaborators and one development team with 9 team members. Thus, we endeavored to consider different types of organizations, such as fintech (ORG5), one with more defined and institutionalized processes (ORG2), and the software development sector from a Brazilian public university (ORG1).

Analyzing the Table 9.2, we note that 257 (85%) participants live in Brazil. The majority of team members are aged less than 40 years (232, 78%), 181 (60%) have an undergraduate degree, and 168 (56%) participants have more than two years of experience in agile methods. In a general way, the sample is gender diverse, and respondents are highly edu-

Table 9.2: Personal profile of the respondents (n = 301)

Variable	Frequency (%)
Age	
<= 20	7 (2%)
> 20 to <=30	127 (42%)
> 30 to <=40	105 (36%)
> 40	62 (20%)
Gender	
Masculine	217 (72%)
Feminine	83 (27.5%)
Other	1 (0.3%)
Country	
Brazil	257 (85%)
India	19 (6%)
USA	7 (2.4%)
United Kingdom	5 (1.7%)
Malaysia	2 (0.7%)
Argentina, Czech Republic, Canada, Ecuador, Germany, Ireland, Italy, Peru, Poland, South Africa, and Zambia	11 (4%)
Education	
High School	52 (17%)
Undergraduate	181 (60%)
Master's Degree	60 (20%)
Doctoral Degree	8 (3%)
Months working in the Team	
< = 12	185 (62%)
> 12 to <= 24	64 (21%)
> 24	52 (17%)
Years of Experience in Agile	
<= 2	133 (44%)
> 2 to <= 4	64 (21%)
> 4 to <= 6	41 (14%)
> 6	63 (21%)
Role	
Developer	175 (58%)
Quality Analyst	53 (18%)
Tester	12 (4%)
Systems Analyst	8 (2.6%)
User Experience (UX) Designer	4 (1.3%)
Agile Leader	22 (7%)
Product Owner	13 (4%)
Coordinator and Project Manager (PM)	3 (1%)
Several roles	11 (4%)

cated, have more than two years of experience in agile methods, and have been working in the current team for less than a year. The roles listed in Table 9.2 highlight the variety of roles assumed in the agile teams. For example, seven participants who performed specific roles as UX Designer, Coordinator, and PM considered themselves members of an agile team.

9.2.2 Validating TACT Theoretical Structure

Wohlin et al. [172] describe some relevant statistics for ordinal scales such as frequency, mode, median, and Spearman correlation. These analyzes foster an initial understanding of the sample behavior and the distributions and relationships of the items. Afterward, we show the Confirmatory Factor Analysis (CFA) results performed to validate the theoretical structure of the TACT.

9.2.2.1 Descriptive Statistics

Descriptive analysis of TACT items is illustrated in Table 9.3. The relative frequencies (count for each value assigned by the members) and absolute frequencies (percentage in parentheses) were calculated using the aforementioned Likert scale. High-frequency values are present in agree (4) and strongly agree (5) options. Therefore, considering frequency, median, and mode values, we can observe that most participants chose agree or strongly agree as options. In a general way, considering that all items represent good behaviors expected by the leading roles in an agile team, we can infer that the majority of participants considered the organizational climate of their teams as positive or favorable. Figure 9.1 exhibits a graph with the six items that had high frequencies, the three items evaluated most positively (IT01, IT09, and IT53), and the three items evaluated most negatively (IT25, IT45, and IT05).

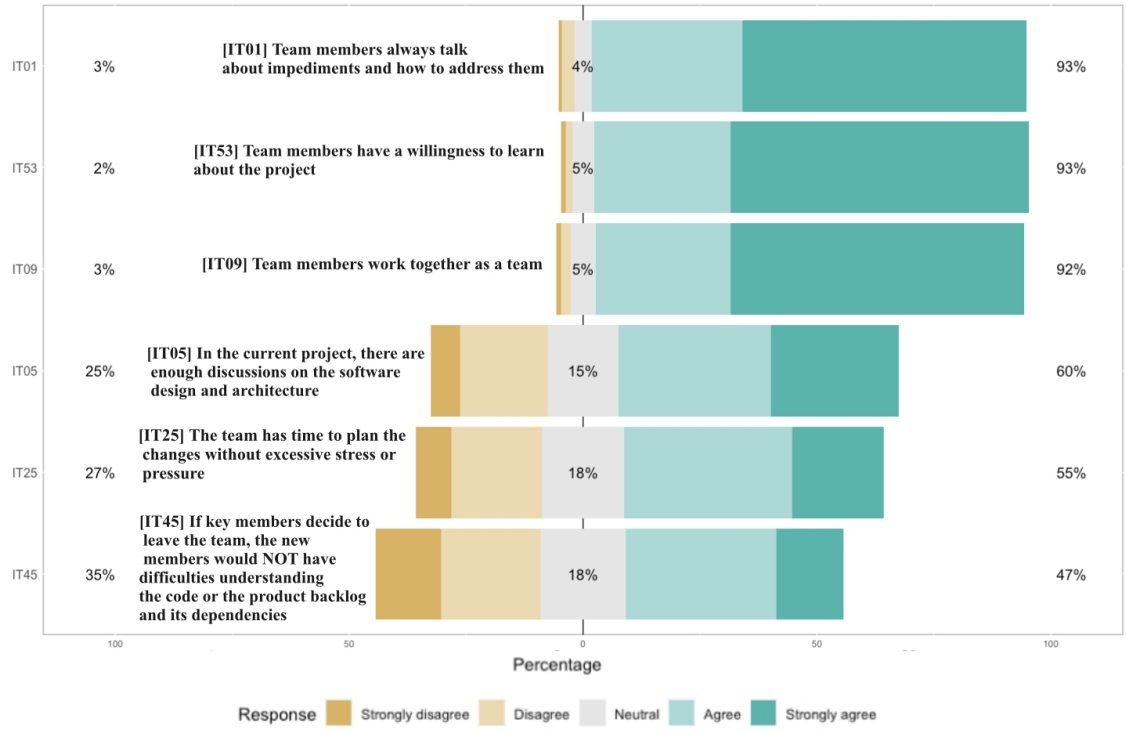


Figure 9.1: The three items best rated negatively and positively

The items IT01 (from the Communication dimension), IT09 (from the Collaboration dimension), and IT53 (from the Learning dimension) obtained more than 90% of positive evaluations. The value obtained can be considered an excellent indicator of an ideal team climate for communication, collaboration, and learning. On the other hand, The items IT05 (from the Communication dimension), IT25 (from the Decision-making dimension), and IT45 (Knowledge dimension) had more than 25% of negative evaluations and more than 15% as neutral. A good strategy for managing the organizational climate

Table 9.3: Descriptive statistics

Item	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Median	Mode
IT01	2 (0.7%)	8 (2.7%)	11 (3.7%)	97 (32.2%)	183 (60.8%)	5	5
IT02	5 (1.7%)	20 (6.6%)	15 (5.0%)	108 (35.9%)	153 (50.8%)	5	5
IT03	3 (1.0%)	7 (2.3%)	31 (10.3%)	89 (29.6%)	171 (56.8%)	5	5
IT04	6 (2.0%)	29 (9.6%)	32 (10.6%)	106 (35.2%)	128 (42.5%)	4	5
IT05	19 (6.3%)	56 (18.6%)	46 (15.3%)	98 (32.6%)	82 (27.2%)	4	4
IT06	9 (3.0%)	16 (5.3%)	39 (13.0%)	104 (34.6%)	133 (44.2%)	4	5
IT07	1 (0.3%)	9 (3.0%)	22 (7.3%)	108 (35.9%)	161 (53.5%)	5	5
IT08	3 (1.0%)	14 (4.7%)	36 (12.0%)	112 (37.2%)	136 (45.2%)	4	5
IT09	3 (1.0%)	6 (2.0%)	16 (5.3%)	87 (28.9%)	189 (62.8%)	5	5
IT10	3 (1.0%)	12 (4.0%)	25 (8.3%)	103 (34.2%)	158 (52.5%)	5	5
IT11	7 (2.3%)	19 (6.3%)	40 (13.3%)	97 (32.2%)	138 (45.8%)	4	5
IT12	7 (2.3%)	13 (4.3%)	33 (11.0%)	107 (35.5%)	141 (46.8%)	4	5
IT13	4 (1.3%)	8 (2.7%)	31 (10.3%)	78 (25.9%)	180 (59.8%)	5	5
IT14	11 (3.7%)	26 (8.6%)	42 (14.0%)	88 (29.2%)	134 (44.5%)	4	5
IT15	8 (2.7%)	20 (6.6%)	26 (8.6%)	88 (29.2%)	159 (52.8%)	5	5
IT16	15 (5.0%)	21 (7.0%)	47 (15.6%)	101 (33.6%)	117 (38.9%)	4	5
IT17	12 (4.0%)	24 (8.0%)	42 (14.0%)	89 (29.6%)	134 (44.5%)	4	5
IT18	10 (3.3%)	38 (12.6%)	36 (12.0%)	109 (36.2%)	108 (35.9%)	4	4
IT19	12 (4.0%)	21 (7.0%)	48 (15.9%)	104 (34.6%)	116 (38.5%)	4	5
IT20	11 (3.7%)	12 (4.0%)	30 (10.0%)	104 (34.6%)	144 (47.8%)	4	5
IT21	23 (7.6%)	38 (12.6%)	58 (19.3%)	94 (31.2%)	88 (29.2%)	4	4
IT22	16 (5.3%)	31 (10.3%)	49 (16.3%)	102 (33.9%)	103 (34.2%)	4	5
IT23	8 (2.7%)	12 (4.0%)	25 (8.3%)	85 (28.2%)	171 (56.8%)	5	5
IT24	18 (6.0%)	10 (3.3%)	49 (16.3%)	111 (36.9%)	113 (37.5%)	4	5
IT25	23 (7.6%)	58 (19.3%)	53 (17.6%)	108 (35.9%)	59 (19.6%)	4	4
IT26	9 (3.0%)	10 (3.3%)	23 (7.6%)	96 (31.9%)	163 (54.2%)	5	5
IT27	4 (1.3%)	21 (7.0%)	34 (11.3%)	105 (34.9%)	137 (45.5%)	4	5
IT28	9 (3.0%)	17 (5.6%)	36 (12.0%)	114 (37.9%)	125 (41.5%)	4	5
IT29	3 (1.0%)	16 (5.3%)	22 (7.3%)	74 (24.6%)	186 (61.8%)	5	5
IT30	2 (0.7%)	14 (4.7%)	25 (8.3%)	115 (38.2%)	145 (48.2%)	4	5
IT31	14 (4.7%)	40 (13.3%)	43 (14.3%)	96 (31.9%)	108 (35.9%)	4	5
IT32	13 (4.3%)	15 (5.0%)	50 (16.6%)	91 (30.2%)	132 (43.9%)	4	5
IT33	14 (4.7%)	40 (13.3%)	52 (17.3%)	87 (28.9%)	108 (35.9%)	4	5
IT34	1 (0.3%)	10 (3.3%)	35 (11.6%)	95 (31.6%)	160 (53.2%)	5	5
IT35	14 (4.7%)	26 (8.6%)	42 (14.0%)	92 (30.6%)	127 (42.2%)	4	5
IT36	2 (0.7%)	17 (5.6%)	67 (22.3%)	115 (38.2%)	100 (33.2%)	4	4
IT37	12 (4.0%)	25 (8.3%)	35 (11.6%)	91 (30.2%)	138 (45.8%)	4	5
IT38	3 (1.0%)	17 (5.6%)	28 (9.3%)	90 (29.9%)	163 (54.2%)	5	5
IT39	4 (1.3%)	22 (7.3%)	36 (12.0%)	90 (29.9%)	149 (49.5%)	4	5
IT40	7 (2.3%)	9 (3.0%)	23 (7.6%)	117 (38.9%)	145 (48.2%)	4	5
IT41	10 (3.3%)	25 (8.3%)	57 (18.9%)	93 (30.9%)	116 (38.5%)	4	5
IT42	7 (2.3%)	14 (4.7%)	29 (9.6%)	83 (27.6%)	168 (55.8%)	5	5
IT43	9 (3.0%)	20 (6.6%)	28 (9.3%)	76 (25.2%)	168 (55.8%)	5	5
IT44	11 (3.7%)	28 (9.3%)	64 (21.3%)	99 (32.9%)	99 (32.9%)	4	4
IT45	42 (14.0%)	64 (21.3%)	55 (18.3%)	97 (32.2%)	43 (14.3%)	3	4
IT46	5 (1.7%)	23 (7.6%)	35 (11.6%)	119 (39.5%)	119 (39.5%)	4	4
IT47	15 (5.0%)	36 (12.0%)	73 (24.3%)	119 (39.5%)	58 (19.3%)	4	4
IT48	7 (2.3%)	19 (6.3%)	38 (12.6%)	134 (44.5%)	103 (34.2%)	4	4
IT49	17 (5.6%)	20 (6.6%)	48 (15.9%)	97 (32.2%)	119 (39.5%)	4	5
IT50	10 (3.3%)	15 (5.0%)	39 (13.0%)	107 (35.5%)	130 (43.2%)	4	5
IT51	4 (1.3%)	9 (3.0%)	30 (10.0%)	115 (38.2%)	143 (47.5%)	4	5
IT52	6 (2.0%)	20 (6.6%)	45 (15.0%)	99 (32.9%)	131 (43.5%)	4	5
IT53	3 (1.0%)	4 (1.3%)	14 (4.7%)	88 (29.2%)	192 (63.8%)	5	5
IT54	7 (2.3%)	16 (5.3%)	30 (10.0%)	122 (40.5%)	126 (41.9%)	4	5
IT55	9 (3.0%)	18 (6.0%)	25 (8.3%)	94 (31.2%)	155 (51.5%)	5	5
IT56	20 (6.6%)	23 (7.6%)	41 (13.6%)	104 (34.6%)	113 (37.5%)	4	5
IT57	11 (3.7%)	33 (11.0%)	44 (14.6%)	91 (30.2%)	122 (40.5%)	4	5
IT58	5 (1.7%)	15 (5.0%)	26 (8.6%)	102 (33.9%)	153 (50.8%)	5	5
IT59	11 (3.7%)	18 (6.0%)	40 (13.3%)	88 (29.2%)	144 (47.8%)	4	5
IT60	5 (1.7%)	12 (4.0%)	24 (8.0%)	96 (31.9%)	164 (54.5%)	5	5
IT61	26 (8.6%)	32 (10.6%)	50 (16.6%)	99 (32.9%)	94 (31.2%)	4	4
IT62	5 (1.7%)	26 (8.6%)	42 (14.0%)	116 (38.5%)	112 (37.2%)	4	4
IT63	11 (3.7%)	20 (6.6%)	46 (15.3%)	95 (31.6%)	129 (42.9%)	4	5
IT64	5 (1.7%)	6 (2.0%)	26 (8.6%)	98 (32.6%)	166 (55.1%)	5	5

is considering the amount of negative and neutral assessments. Analyzing the most negatively rated items, we can infer that a part of the team members was (i) stressed (IT25) maybe because of lack of autonomy for planning or fixed time to delivery, (ii) considered the documentation and code complex (IT45) to understand by a new member, and (iii) indicated the lack of discussions about software architecture (IT05).

Regarding the frequency analysis, all items must be checked to verify whether the items have enough variation to differentiate respondents [161]. 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 [161]. In this study, no items needed to be excluded.

9.2.2.2 Correlation Analysis

The item correlations (see Figure 9.2) were plotted for an initial visual diagnosis of the items and structure of the TACT dimensions [161]. Field et al. [164] explain that the correlation with other variables (items) of the same dimension in latent variables is expected (because they measure the same thing). Dima [161] describes that a negative association between items might indicate the need for reverse item coding. If several correlation values are below 0.3 in the dimension, it is possible to exclude the items [164]. Conversely, correlations with values above 0.8 can be considered multicollinearity (i.e., very correlated variables) and singularity (perfectly correlated variables). In this case, excluding variables is also possible. Field et al. [164] argue that the process of excluding items is an empirical one.

Analyzing the Spearman correlations (ρ) for the data collected (Figure 9.2), we can observe: (i) absence of negative correlations; (ii) IT22 and IT23 have insignificant positive correlation with several variables; (iii) communication dimension items with low values, and (iv) in general, moderate positive correlation between items in the dimensions. The critical values of ρ are 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 [163].

Autonomy dimension (see Figure 9.3) has a total of seven items. The items IT22 and IT23 had insignificant values ($\rho < 0.3$) with several items. For example, IT22 had ρ values < 0.3 with four items (IT18, IT19, IT20, and IT21) and IT23 with three (IT18, IT19, and IT21). As the correlation value of item IT22 with IT20 and IT21 is close to the limit (e.g., 0.29 with IT20), we chose not to exclude it. Regarding item IT23, it correlates (> 0.3) with three items of the dimension. Therefore, we also decided to keep IT23 for Confirmatory Factorial Analysis. The low values for items IT22 and IT23 also hide an inappropriate description or something more difficult to happen in agile teams.

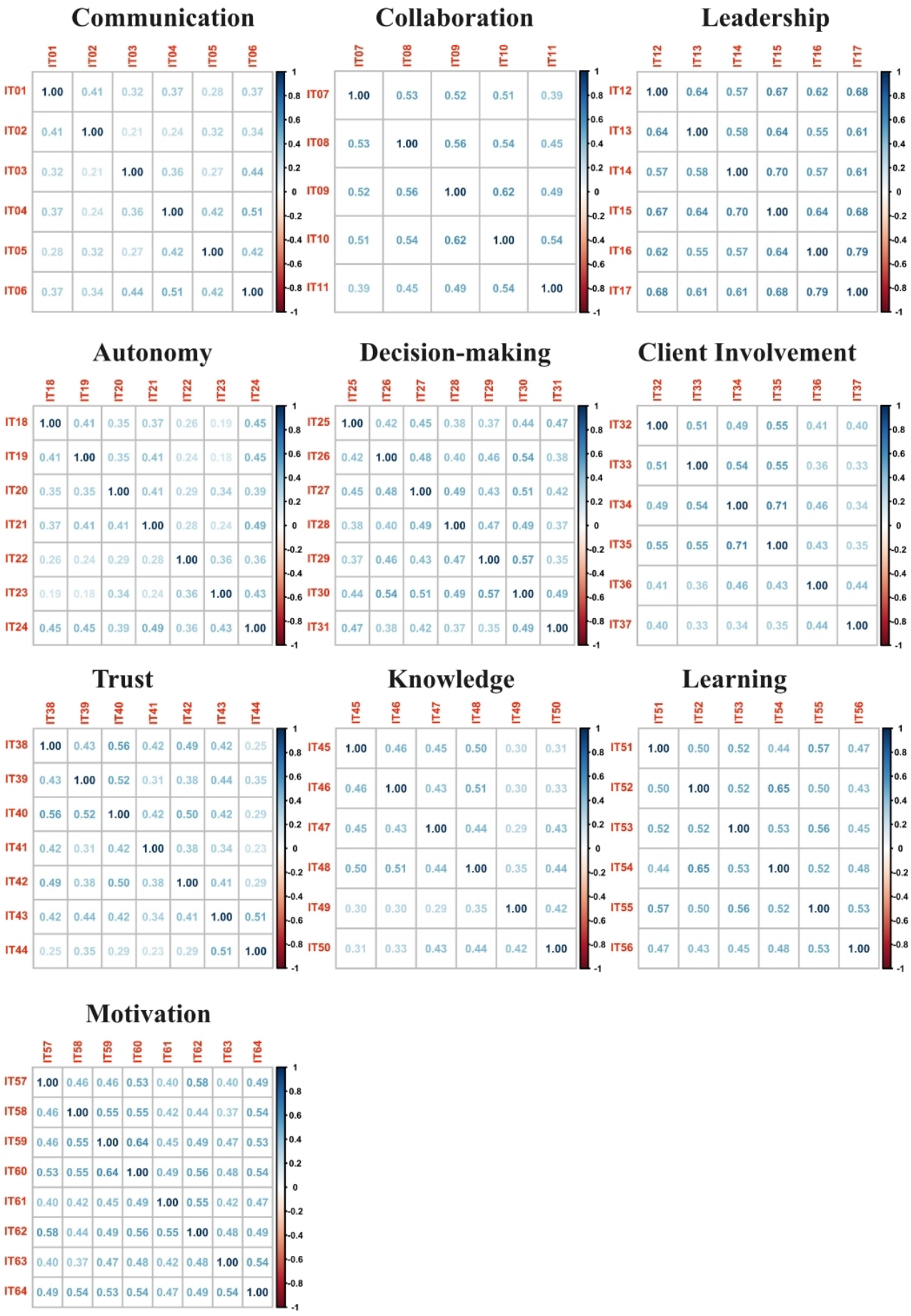


Figure 9.2: Correlation matrices

9.2.2.3 Confirmatory Factor Analysis

A Confirmatory Factor Analysis (CFA) was performed in order to assess the plausibility of the theoretical association between the items and their respective dimension. As mentioned before, the quantitative results were processed using the R tool using primarily the *lavaan* library [173].

The analysis was implemented using the Unweighted Least Squares (ULS) estimation method, suitable for ordinal data [174, 175]. The fit indexes used were: chi-square/degrees of freedom (df), Standardized Root Mean Square Residual (SRMR), Root Mean Square Error of Approximation (RMSEA), Tucker-Lewis Index (TLI), and Comparative Fit Index (CFI) [62, 64]. The $\chi^2/(df)$ value should be ≤ 5 or, preferably, ≤ 3. The CFI and TLI values should be ≥ 0.9 and preferably above 0.95. The values of RMSEA and SRMR should be ≤ 0.08. The RMSEA confidence interval should be (upper limit ≤ 0.10) [64]. Table 9.4 shows the fit indexes values.

Table 9.4: TACT theoretical model fit indexes

$\chi^2(df)$	$\chi^2/(df)$	CFI	TLI	SRMR	RMSEA (90% IC)
2241.344(1907)	1.17	0.997	0.997	0.060	0.024 (0.020 – 0.028)

The values in Table 9.4 show that the structure proposed in TACT fits the data well. All fit indices supported the theoretical structure. Hence, the TACT structure is adequate or acceptable. Table 9.5 shows the TACT factor loadings. The first column shows the items grouped by dimension and then ordered alphabetically by id. The factor loading (λ) (second column of Table 7.3) indicates the correlation of the item for the associated dimension. The λ values can be between -1 and 1. The closer to 1, the stronger and more meaningful the item is to the dimension. Thus, items with a higher value of the λ in the same dimension can be considered more influential. Field et al. [164] point out that the values of λ might be observed considering the sample size. For example, in a sample with 301 participants, the λ value of 0.364 can be used as an indicator to exclude an item. Regarding the sample size, Field et al. [164] argue that if a factor (dimensions) has four or more loadings greater than 0.6, then it is reliable regardless of sample size.

Considering the factor loadings (λ) for the sample (see Table 9.5), we can observe: (i) no dimension had less than 4 items with factor loadings > 0.6 and (ii) no item has a factor loading lower than 0.364 or 0.4 [162]. In the general way, each TACT dimension is represented strongly by their items (more than 4 items with factor loading (λ) value > 0.6) [162].

Table 9.5: TACT factor loadings

Item	Factor loading (λ)
Communication	
IT01	0.694
IT02	0.603
IT03	0.543
IT04	0.728
IT05	0.567
IT06	0.769
Collaboration	
IT07	0.689
IT08	0.720
IT09	0.825
IT10	0.852
IT11	0.892
Leadership	
IT12	0.877
IT13	0.865
IT14	0.814
IT15	0.892
IT16	0.831
IT17	0.939
Autonomy	
IT18	0.549
IT19	0.811
IT20	0.621
IT21	0.709
IT22	0.500
IT23	0.519
IT24	0.755
Decision-Making	
IT25	0.685
IT26	0.673
IT27	0.729
IT28	0.717
IT29	0.733
IT30	0.822
IT31	0.725
Client Involvement	
IT32	0.764
IT33	0.605
IT34	0.752
IT35	0.746
IT36	0.773
IT37	0.729
Trust	
IT38	0.790
IT39	0.736
IT40	0.795
IT41	0.594
IT42	0.730
IT43	0.728
IT44	0.577
Knowledge	
IT45	0.627
IT46	0.753
IT47	0.644
IT48	0.725
IT49	0.557
IT50	0.767
Learning	
IT51	0.828
IT52	0.759
IT53	0.785
IT54	0.746
IT55	0.873
IT56	0.703
Motivation	
IT57	0.795
IT58	0.690
IT59	0.744
IT60	0.845
IT61	0.681
IT62	0.808
IT63	0.684
IT64	0.802

9.2.2.4 Reliability Analysis

The psych library [160] offers several methods to analyze the structure of the items and the dimensions, which allows the creation of several reliability estimates that can be used, for example, to reduce the number of items in a dimension or group items to represent a phenomenon [160]. We calculated reliability for the indexes Cronbach's α, Revelle's β, and McDonald's ω [176, 161]. The value of reliability above 0.70 is generally acceptable, and > 0.8 desirable [62, 176, 177, 82, 161].

We investigated the reliability analysis using clusters, also considering the β coefficient (see Figure 8.1, the second value in the cluster), a more conservative estimate of reliability [160, 178]. The purpose of cluster analysis is to reduce the complexity of the data and try to identify homogeneous subgroups. The item cluster analysis (iclust algorithm [160]) examines similarities between items. It generates solutions by grouping items to maximize the value of Cronbach's α on the resulting scale, considering the coefficient β [160, 178]. Polychoric correlation matrices were considered in the iclust simulation [178] and in the calculation from other indexes [161, 83]. Figure 9.3 shows the simulation result of the iclust algorithm proposed in the graphs.

Considering the Iclust graphics (Figure 9.3), the α-Cronbach index value for all dimensions is > 0.8, which implies that the reliability of TACT is high [82, 177, 161]. Concerning the β-Revelle index values, all dimensions has values acceptable (considering the Autonomy dimensions nearly > 0.7) [161]. Continuing the analysis, we can observe: (i) some items are segregated in their dimension (e.g., items IT07, IT08, and IT11 in the Collaboration dimension), (ii) similar values for α and β in the final clusters, which could justify the exclusion of items without affecting the reliability of the dimension (e.g., in the Trust dimension, if we consider the items IT38, IT39, IT40, and IT42 from the C4 cluster, similar reliability would be defined without the items from the C5 and C6 clusters), and (iii) some clusters with low α and β indices (e.g., C2 Cluster in the Autonomy Dimension).

Anunciação [179] reports that Cronbach's alpha is the most commonly used index to measure the internal consistency but has its limitations: its values are dependent on the number of items in the scale, assumes tau-equivalence and is not robust against missing data, and treats the items as continuous and normally distributed data. We estimated McDonald's ω index as an alternative to Cronbach's alpha. Finally, Table 9.6 shows the final values for the reliability (internal consistency) to TACT dimensions, considering the Cronbach's α, Revelle's β, and McDonald's ω indexes. We emphasize that all reliability values were acceptable.

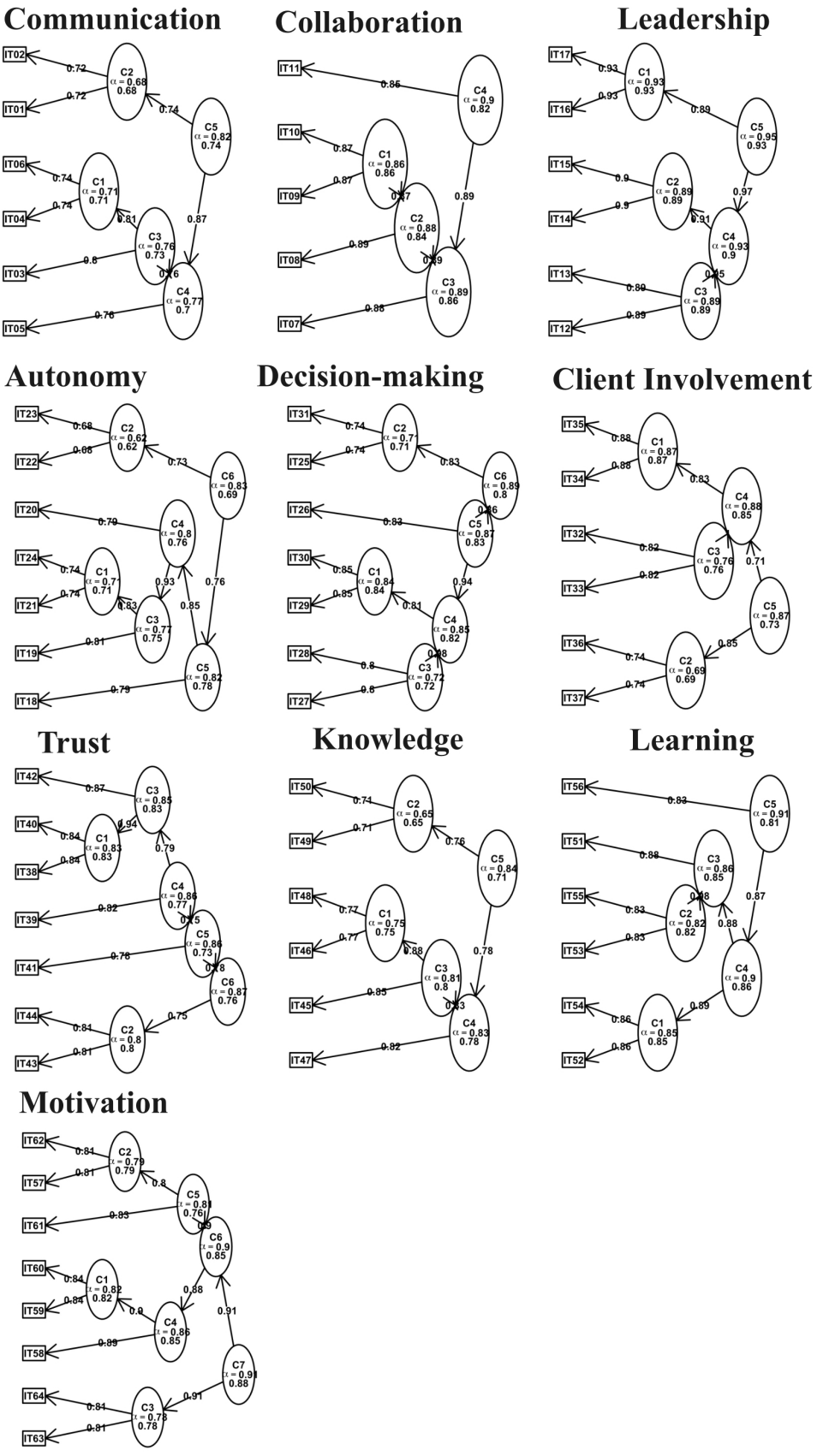


Figure 9.3: Iclust graphs

Table 9.6: TACT dimensions reliability

Dimension	α	β	ω
Communication	0.82	0.74	0.78
Collaboration	0.90	0.82	0.85
Leadership	0.95	0.93	0.94
Autonomy	0.83	0.69	0.81
Decision-making	0.89	0.80	0.85
Client Involvement	0.87	0.73	0.85
Trust	0.87	0.76	0.85
Knowledge	0.84	0.71	0.81
Learning	0.91	0.81	0.87
Motivation	0.91	0.88	0.89

9.2.3 Critical Factors that Most Influence the Agile Team's Climate

Dozens of human factors influence the team members, the team, the project, and the software development activities from agile teams [13, 90, 89]. Knowing the critical factors can help organizations and researchers delimit their efforts to investigate, treat, or potentiate manifest behaviors that most influence the agile team's favorable or unfavorable climate. In order to identify the most critical factors, we (i) considered the TACT items with the highest factor loadings (see Table 7.3) by dimension, (ii) simulated another CFA considering just one dimension, and (iii) applied coding procedures based on thematic analysis to identify response patterns to question *"In your opinion, what most influences the organizational climate in your team?"* Table 9.7 shows the items that most influence each TACT dimension, and Table 9.8 describes the items with more impact considering the simulation with one dimension. Based on the thematic analysis procedures, we grouped the critical factors indicated by the participants into categories Human factor (Table 9.9), Project (Table 9.10), and Organization (Table 9.11).

Table 9.7: The most critical items by TACT dimension

Dimension	**ID Item**	λ
Communication	IT06. The team facilitator assists in understanding whether the iteration objectives are clear and whether the team agrees with these objectives	0.769
Collaboration	IT11. In the current project, the team, the product owner, and the team facilitator work very well together to plan the iteration	0.892
Leadership	IT17. The team facilitator investigates and helps the team to be more effective, taking into account the team velocity and capacity	0.939
Autonomy	IT19. The team facilitator protects the team autonomy from external interferences	0.811
Decision-Making	IT30. When the dependencies between tasks hinder the project execution, the team makes decisions to resolve or mitigate possible impacts	0.822
Client Involvement	IT36. The current project has met or exceeded the client expectations	0.773
Trust	IT40. In the current project, team members develop tasks with high quality and good performance	0.795
	IT38. In the current project, there is a feeling of trust among team members	0.790
Knowledge	IT50. The product owner has sufficient knowledge about the users' actual needs	0.767
	IT46. The team knows the skills and technical expertise of the team members	0.753
Learning	IT55. The team teaches me how to handle my difficulties in the tasks	0.873
Motivation	IT60. The team responds quickly to changes that need to be done	0.845

By analyzing the description of the most critical items presented in Table 9.7, a strong influence can be observed when team members need to interact with each other and with

others. In many agile teams, the PO interacts with stakeholders to identify user stories. Thus, to some extent, the PO should know the business domain and the real need of users (the Knowledge dimensions, item IT50). During iteration planning (the Collaboration dimension, item IT11) or refinement meetings, the prioritization of user stories or the lack of understanding of user stories can lead to disagreements. In these cases, the way the PO communicates with the team and his current knowledge about the user's needs influence the climate regarding dimensions of collaboration (IT11) and knowledge (IT50). When exercised through a team facilitator role, agile leadership requires much more than simply addressing impediments or teaching agile practices [37]. It is critical that the agile facilitator knows the speed and capacity of the team (item IT17, the Leadership dimension) and acts to mediate possible priority divergences in the iteration planning (IT11 and IT17). Leadership performance strongly influences good communication, collaboration, and leadership climate (IT06, IT11, and IT17). We also emphasize that the way the leader acts in protecting the team from external threats affects the team's autonomy (TI19). Team members should work together to plan the iteration (IT11), define and estimate tasks, or reschedule tasks when changes occur (IT30). A feeling of trust, collaboration, learning, and motivation is positively revealed when members share their difficulties and know that members will help (IT55), that they develop high-quality work (IT40), and that they can make decisions to change the plan (IT30) meeting the speed required by the current market (IT60).

Every TATC item is grounded in good behavior, practices, and agile values that influence the climate. Graziotin et al. [18] reported that performing factor analysis with one dimension allows identifying those items that (best) represent the construct. Thereby, we performed another CFA putting all items in just one dimension to identify the most critical TACT items. The results were acceptable [64]: χ^2 = 3179.493; (df) = 1952; $\chi^2/(df)$ = 1.62; CFI = 0.99; TLI = 0.98; RMSEA = 0.046 (0.043 - 0.049); SRMR = 0.07. Table 9.8 shows the TACT factor loadings.

As per in Table 9.8, the five most critical items IT55, IT60, IT11, IT17, and IT30 are also present in Table 9.7. The first four items have very close factor loadings (0.79 to 0.80), allowing us to classify items IT55, IT60, IT11, and IT17 as the most critical factors influencing the agile teams' climate. A meticulous analysis of the theoretical framework that underlies each item (see Appendix A.1) was conducted. Thus, we identified that "IT55. The team teaches me how to handle my difficulties in the tasks (Learning)" and "IT11. In the current project, the team, the product owner, and the team facilitator work very well together to plan the iteration (Collaboration)" are related to collaboration. The item "IT55" refers to the collaborative environment among the team members to solve day-

Table 9.8: The most critical items by TACT dimension (Simulation with one factor)

Ranking	Item ID	λ	Dimensions
1	IT55. The team teaches me how to handle my difficulties in the tasks	0.806	Learning
2	IT60. The team responds quickly to changes that need to be done	0.796	Motivation
3	IT11. In the current project, the team, the product owner, and the team facilitator work very well together to plan the iteration	0.791	Collaboration
4	IT17. The team facilitator investigates and helps the team to be more effective, taking into account the team velocity and capacity	0.789	Leadership
5	IT30. When the dependencies between tasks hinder the project execution, the team makes decisions to resolve or mitigate possible impacts	0.765	Decision-making
6	IT51. In each iteration, the team improves its ability to handle the most significant problems	0.765	Learning
7	IT62. The team organizes and plans its tasks clearly	0.762	Motivation
8	IT64. The team can use new ideas to improve the performance in the tasks and the deliverables	0.755	Motivation
9	IT10. The team collaborates to look for new ways to analyze and solve the problems	0.752	Collaboration
10	IT40. In the current project, team members develop tasks with high quality and good performance	0.752	Trust

of-day problems, influencing team learning. The item "IT11" refers to the collaboration between the main agile roles involved in the iteration planning. In the same direction, the necessary changes in the planning (IT60 and IT30) require changing adaptability (IT60), decision-making (IT30), and autonomy (IT30), influencing team motivation (IT60) directly.

Table 9.9 describes several influences reported by the participants that can be considered critical to the teams' climate formation. We highlight that we did not critically analyze the relevance or coherence of the participants' influence on the open-ended question. This section cites all influences but only explores the most-cited ones.

The number between parenthesis (see Table 9.9) indicates the citation frequency for the influence and human factor. Communication (29) and Collaboration (27) factors were the most cited. The influence of "Open and constant communication among members" is highlighted with 12 citations in the Communication factor. An ORG3 team member wrote, "...team members enough discuss to resolve any outstanding issues." A team member from ORG6 company reported, "we <team members> have excellent communication established both before the pandemic and during working from home." Communication is an essential factor in the construction of collaboration. When the communication is safe and open, the team members perceive the relation of communication with other elements. For instance, an ORG2 team member registered, "the team is communicative, participatory and collaborative, which creates a good sense of teamwork among the members and a feeling of belonging." This citation was coded as "Collaboration among team members" in the "Collaboration" factor. Other participants' opinions reported the dependent relationship among the human factors, the communication and the collaboration. One participant

wrote, “ethics, respect for the opinions of each member, and everyone are willing to help out. In this way, the environment becomes favorable to express their ideas/opinions and to receive help to clarify something or solve problems.” Another participant reported, “the openness that team members have to express their opinions and question in case of doubts influence the environment. For me, that is fundamental for the team’s trust and, consequently, to guarantee a climate of partnership in the team.” These two citations were coded as “Open and constant communication among members (Communication)” and “Openness to clarify any problem or doubt (Collaboration).”

When analyzing the critical factor in the Project category (see Table 9.10), higher frequencies can be observed in the “Iteration Planning (30)” and “Team in general (23)” factors. Several activities can be performed for “Iteration Planning.” Activities to refine the user stories understanding, tasks definitions, and estimates are generally considered citePMIProjectManagementInstitute2017. The team’s decision-making autonomy in planning and working collaboratively with the Product Owner has a lot of influence on the team’s organizational climate. “Unrealistic deadlines (6),” “Autonomy for the planning (3),” and “Urgent demands that break planning (3)” were the most cited factor. In many reports, we perceived that the team did not estimate the tasks. Participants wrote, “to make matters worse the climate, tight deadlines and lack of definition of the client,” “time to get things done,” and “the volume of work is a crucial point in this climate issue. In environments where everything is due ’yesterday,’ the demand is constantly high, or deliveries are always pressuring needs. That can harm the organizational climate.” Other team members reported that “a better gathering and analysis of customer requirements” and “having the freedom to make decisions and planning” are necessary. “Team in general (23)” factor encompasses influences not grouped in other categories. Concerning the “Good relationship among team members (3)” factor, a participant wrote, “having a good relationship with everyone on the team and everyone being willing always to help and collaborate.” About the “Avoiding blaming when unforeseen events happen (1)” the member reported that “the lack of ’guilty’ influences the climate. Everyone works together on the result and does not look for blame when unforeseen happens.”

As per Organization category Table 9.11, “Organizational Culture (10)” and “Management (8)” factors are the most cited. The participants did not elaborate on the cultural influence. For example, they wrote, “formal environment and outdated culture” and “political issues.” On the other hand, the participants reported that “clear communication among members and management” and “open dialogue with managers” influence the environment. These reports were coded as “Clear communication between the team and the management (2)”. Another factor cited by the team members was “Payment and benefits

Table 9.9: Critical factors that influence the teams' climate - Human factor category

Factor	Influence
Communication (29)	Open and constant communication among members (12) Freedom to talk/expose ideas on any topic (11) Harmonious and comfortable environment for discussions and clarification of doubts (1) Truncated communication (1) Difficulties in opening up due to fear of being judged (1) Ease of communication (1) Communication failures (1) Lack of opportunity to express yourself (1)
Collaboration (27)	Collaboration among team members (14) Freedom to expose an idea (4) Openness to clarify any problem or doubt (3) Mutual aid (3) Supporting new team members to perform their tasks (2) Communication influences collaboration (1) Different office hours for the team members (1)
Leadership (17)	Availability and openness (2) Servant leadership adoption (2) Positive approach believing in the agile philosophy (2) Leadership's concern to improve everyone's work (1) Support and commitment to clarifying the guidelines used in agile methods (1) Facilitator leads multiple teams simultaneously (1) Communication (1) Team and leadership engagement (1) Performance with excellence (1) Experience (1) Accumulating several roles (1) Constant changes in leadership (1) Presence of leader developer or leader architect (1)
Autonomy (4)	Planning autonomy (3) Complete autonomy for the team (1)
Decision-making (7)	External and internal pressure for deadlines (2) Tasks with pre-stipulated deadlines (2) Constant knowledge sharing at ceremonies (1) Autonomy to define the architecture (1) Freely discuss which solutions to adopt (1) Having the freedom to make decisions (1)
Client Involvement (6)	Client demands (2) Client availability and involvement (1) Lack of client proactiveness (1) Client feedback on the work performed (1) Client engagement in the iterations (1)
Trust (8)	Confidence in the team's ability (6) Confidence in team autonomy (1) Build a space of real trust (1)
Knowledge (11)	Team knowledge (2) Lack of training for specific projects (2) Supporting new team members to perform their tasks (2) Cooperation among team members regardless of knowledge level (1) Difficulty transferring knowledge (1) Qualified team (1) Lack of knowledge in agile methodologies (1) Knowledge Sharing (1) Respecting differences in technical knowledge (1)
Learning (6)	Know-sharing (3) Learning (1) The constant feeling of evolution and growth (1) Recognizing criticism as part of the learning process (1) Weekly study/presentation sessions on various subjects (1)
Motivation (9)	Recognition for work (2) Lack of motivation (2) Commitment to doing the job the best way possible (2) Discouragement and disinterest in improving delivery (1) Team understanding about the product's social motivations (1) Motivated people who like and believe in what they do (1)
Innovation (3)	Innovation climate (1) Freedom to implement improvements (1) Organization openness to innovation (1)
Sense of belonging (4)	Failure to perform the daily meeting (2) Trust as means to build a sense of belonging (1) Different office hours for the team members (1)
Other human factors (18)	Professionalism (2), Work recognition (2), Respect (2), Engagement (2), Committed team (2), Friendship (1), Competition (1), Empathy in resolving problems (1), Stress due to uneven performance among team members (1), Regular feedback (1), Harmony (1), Interaction (1), and Proactivity (1)

Table 9.10: Critical factors that influence the teams' climate - Project Category

Factor	Influence
Backlog preparation and refinement (6)	Lack of user stories definition (3) Lack of transparency in defining user stories priority (1) Constant changes (1) Effective participation of all team members (1)
Daily, demonstration, and retrospective meeting (5)	Absence of the daily meeting (2) Different working hours of team members (1) Long duration of ceremonies (1) Sessions to discuss improvement issues (1)
Iteration Planning (30)	Unrealistic deadlines (6) Autonomy for planning (3) Urgent demands that break planning (3) Schedule of deliveries (3) Lack of details in tasks and user stories (3) External influences attributing demands outside the planning (3) Tasks with pre-stipulated deadlines (2) Iteration planning (2) Failing to fulfil the delivery plan (1) Availability to help others achieve the iteration objective (1) External pressure for deliveries (1) A clear vision of responsibilities and the objectives to be achieved (1) Delay in completing tasks with critical dependencies (1)
Product Owner (11)	Servant leadership adoption (2) Attention to impediments (1) Authoritarianism (1) Knowledge of agile culture (1) Software engineering knowledge (1) Engagement with the team (1) Engagement in iterations (1) Experience (1) Lack of involvement (1) Lack of Product Owner role (1)
Software development process (11)	Flexibility to adapt the software process as needed (4) Knowledge of the software development process (1) Constant changes on how the work is done (1) DevOps implementation (1) Lack of homologation environment (1) Adaptation, inspection, and transparency (1) Bureaucratic processes (1) Tech Stack (1)
Software Quality (5)	Code quality (2) Discouragement and uninterest in improving the deliverables (1) Lack of expectation of the management (1) External and internal pressure for quality (1)
Project in general (3)	Fast and agile deliveries (1) Tension between the development team and product clients regarding the product development (1) Tension in the final stretch of large projects (1)
Team in general (23)	Good relationship between team members (3) Team members (2) Time flexibility (2) New Employee Onboarding (1) Light and relaxed environment among team members (1) Internal competitions (1) Commitment and goodwill of the team members (1) Team engagement with the leadership (1) Teams willing to improve (1) Team Experience (1) Lack of developers (1) Having a client-supplier relationship between team members (1) Team members interest in seeing the solution ready and satisfying the users (1) Interference in team attributions (1) Having key technology experts and feature teams (1) Accessible members (1) Avoiding blaming when unforeseen events happen (1) Having members responsible for holding meetings with the development team and client (1) Amount of time in which employees are allocated on the team (1)

(3)", grouped in "Human Resources Management (7)". The member wrote, "the lack of ORG4 <Omitted> support to deal with remuneration and benefits issues and difficulties in passing on knowledge influence the climate."

Table 9.11: Critical factors that influence the teams' climate - Organization category

Factor	Influence
Organizational culture (10)	Institutional climate and culture (5) Formal environment and outdated culture (1) Team member performance does not directly influence benefits or punishments (public employee) (1) Public employee stereotype (1) Organizational structure (1) Political issues that interfere in task executions (1)
Top management (2)	Higher Management commitment towards agile methodologies (1) Senior leadership (1)
Management (8)	Clear communication between the team and the management (2) Servant leadership style being adopted by the management (1) Corporate urgency for results (1) Company management (1) Effective management in conflict resolution (1) Implement agile methods effectively (1) Closeness between management and the team (1)
Human Resources Management (7)	Payment and benefits (3) Effective Training and Development Process (1) Improving the working conditions (1) Turnover (1) New Employee Onboarding (1)
Working from home (6)	Absence of informal social meetings (3) Frequent, time-consuming, and aimless meetings (3)

In an overall analysis, the "Open and constant communication among members (Communication)" factor contributes to an environment of collaboration, "Collaboration among team members (Collaboration)," allowing team learning (IT55). The autonomy to decision-making (IT30) and the environment collaborative (IT11) to iteration planning has a strong influence on the team's climate, and the fast planning due to changes affects the team motivation (IT60). The team facilitator's assistance in planning the iteration (IT11) and supporting the team's development of agility (IT17) also influences the climate strongly.

9.2.4 How to Improve the Agile Teams' Climate

We also applied the thematic analysis procedures described previously to answer the question *"How to improve your team's organizational climate?"* Again, we state that we did not make a value judgment of the suggestions given. We grouped the suggestions in categories nominated Human factor (Table 9.12), Project (Table 9.13), and Organization (Table 9.14). In this section, we only analyzed the most frequently cited actions.

Table 9.12 describes several actions that can be considered by the climate management responsible for improving the team's climate. The number in parentheses indicates the citation frequency for the action and the human factor. Communication was the factor with the most frequency (15). Communication is essential to collaboration, decision-making,

Table 9.12: Actions to improve the team's climate - Human factor perspective

Factor	Actions
Communication (15)	Having open, clear, and objective communication (3) Improving communication outside the team (2) Adopting an instant communication tool (1) Considering the vision and opinions of the group (1) Criticizing in private (1) Stimulating more excellent communication between team members (1) Experienced members should provide opportunities for the younger ones to speak (1) Listening to all team members (1) Promoting actions to ensure the safe participation of the members (1) Having more informal conversations (1) Promoting more proactive communication between management and teams (1) Promoting better communication about agile methods and practices (1)
Collaboration (8)	Increasing synergy between team members (2) Having team members to help and teach the team (2) Increasing collaboration (1) Team members should ask for assistance in their difficulties with tasks (1) Promoting actions for team members to get to know each other better (1) Promoting more interaction among the organizational sectors (1)
Leadership (11)	Having an excellent agile facilitator (3) Having a dedicated/exclusive facilitator (2) Having a facilitator (1) The organization should decrease the turnover of the team facilitators (1) Preventing the PO and the facilitator from playing the same role (1) Promoting leadership by example (1) Having the leadership more present day by day (1) The facilitator must develop active listening (1)
Autonomy (9)	Increasing team autonomy (2) Giving autonomy for developers to define the delivery deadline (2) Giving freedom to the team (2) Protecting the team autonomy (2) Promoting independence for task allocation (1)
Client Involvement (4)	Aligning agile practices with the customer (1) Creating opportunities for the team to be closer to stakeholders and other organizational areas (1) Involving the customer in product planning, prototyping, and validation meetings (1) Limiting customer action in iterations (1)
Trust (1)	The facilitator must promote actions to increase the team's confidence (1)
Knowledge (15)	Promoting technical training actions (9) Training the PO in project management and Software Engineering (2) Stimulating knowledge sharing among team members (3) Respecting team members according to their skills and knowledge (1)
Learning (9)	Training the team in agile methods (4) Empowering the team in emerging agile technologies (1) Sharing ideas and knowledge (1) Learning more about Software Engineering practices (1) Fostering knowledge sharing (1) Improving knowledge distribution (1)
Motivation (5)	Recognizing teamwork (3) Motivating the team to do their best (1) Motivating the team to acquire agile skills (1)
Sense of belonging (4)	Creating a culture of belonging (1) Showing the value and importance of the deliveries to the team (1) Promoting actions for team members to get to know each other better (1) Emphasizing the importance of each individual to the success of the team (1)
Other human factors (10)	Presenting formal and informal feedback on the performance of team members (3) Recognizing teamwork (3) Creating a poster with the team rules of engagement (1) Encouraging commitment (1) Respecting team members according to their skills and knowledge (1) The team member should be calm and try to have the patience to solve problems and mistakes made (1)

learning, and solving problems. The actions suggested indicated that the teams expect improvement in the communication process through more open and transparent communication in a respectful and safe environment. Knowledge and Learning factors describe some actions that can increase knowledge, learning, and motivation, such as "Stimulating more excellent communication among team members" and "Sharing ideas and knowledge." Then, informal training sessions organized by team members may be considered a great tool to increase the team's favorable climate for communication, knowledge, and learning.

Table 9.13: Actions to improve the team's climate - Project perspective

Factor	Actions
Backlog preparation and refinement (4)	Improving the identification, specification, and refinement of user stories (3) Creating mechanisms to ensure more detailed specification of user stories (1)
Daily, demonstration, and retrospective meeting (2)	Keeping focus on the Retrospective Meeting objective (1) Promoting actions to ensure the safe participation of the members (1)
Iteration Planning (18)	Improving iteration planning (8) Improving task estimates (3) Clear planning of the tasks (2) Having a balance between planned and urgent activities (1) Improving the team member allocation across multiple projects (1) Avoiding unplanned scope changes (1) Improving task divisions between the members (1) Better organizing the workflow (1)
Product Owner (8)	Training the PO in project management and Software Engineering (2) Maintaining a dedicated Product Owner for each project (2) Preventing the Product Owner and the facilitator from playing the same role (1) Ensuring the project has a Product Owner (1) Product Owner must keep frequent contact with stakeholders (1) Replacing the Product Owner (1)
Software development process (21)	Implementing agile methods effectively (4) Clearly establish the activities of each role on the team (2) Decreasing organizational bureaucracy (2) Improving software development process documentation (2) Improving the software development process (2) Automating tasks (1) Improving knowledge on the development process (1) Giving full autonomy to the team to decide on the development process (1) Defining metrics to support the software development process improvement (1) Making process documentation available to new members (1) Institutionalizing the software development process (1) Improving the knowledge transfer processes (1) Proposing improvements in the development process (1) Removing practices that hinder the process (1)
Software Quality (6)	Encouraging value delivery (2) Creating mechanisms to ensure more detailed user stories specification (1) Implementing a quality assurance process (1) Promoting product development efficiently (1) Promoting product development with quality (1)
Project in general (4)	Maintaining full project transparency (2) Hiring agile methods experts (1) Maintaining cordiality and respect between contractor and contractor (Outsourcing) (1)
Team in general (13)	Hiring more team members (4) Training the team in agile methodologies (2) Balancing team composition with new and experienced members (1) Having more friendly interactions (1) Fostering team self-management (1) Having more cross-functional teams (1) Having more long term vision (1) Promoting actions for team members to get to know each other (1) Emphasizing the importance of each individual to the success of the team (1)

As per Table 9.13, "Iteration Planning" and "Software development process" factors were the most cited and revealed actions aiming to improve the planning and the process.

"Improve iteration planning" action was the most cited (8 times). Concerning planning and process, an ORG2 team member reported that "carrying out better planning and reviewing the agile methodology used in a team of 30 people" may improve the climate. Another member reported dissatisfaction. He wrote, "lack of stories definition and unreal deadlines in the project make the climate unsatisfactory even for those trying to do a good job amid chaos." The software process must be defined formally to improve how planning is done, including describing activities, roles, and responsibilities. Two members suggested the action "Clearly establishing the activities of each role on the team." The effective involvement of team members, Product Owner, and team facilitator in "Backlog preparation and refinement" and "Iteration Planning" will undoubtedly refine the user stories, thus enabling a more comprehensive view, considering possible impacts in task planning.

Table 9.14: Actions to improve the team's climate - Organization perspective

Factor	**Actions**
Organizational culture (6)	Decreasing organizational bureaucracy (2) Deploying agile methods across the organization (1) Promoting actions for team engagement with the organizational culture (1) Promoting changes in the organizational culture (1) Talking about team's culture/climate as a group (1)
Top management (3)	Top management should define the environment (2) Top management support for the adoption/use of agile methods (1)
Management (3)	Taking the team's suggestions into account (1) Improving project cost management (1) Minimizing external disruption (1)
Human Resources Management (15)	Improving the organization's salary policy (4) Granting better benefits (3) Reducing turnover (1) Establishing an incentive program (1) Improving the new employee onboarding process (1) Offer capacity building training (1) Recognizing qualifications and experience (1) Promoting more significant interaction between the organizational sectors (1) Conducting assessments of technical and behavioral skills (1) Recruiting the best professionals for the team (1)
Working from home (11)	Promoting face-to-face meetings so team members can get to know each other better (9) Conducting objective meetings (2)

Table 9.14 reveals actions that the organization management can consider. We highlight the factors "Human Resources Management (15)" and "Working from Home (11)." The majority of survey participants (185, or 62%) have one year allocated to the team (see Table 9.2), which may be due to turnover or the increase in working from home due to the pandemic time[158].

The team members reported actions involving "Improving the organization's salary policy" and "Improving new employee onboarding process." About "Improving the organization's salary policy," a participant wrote, "the organization must provide a more assertive recognition environment, given the level of qualification and experience of each one." Concerning "Working from Home (11)," the need for members to have a face-to-

face meeting to get to know the team members is evident. Furthermore, better meetings planning should consider "Conduct objective meetings."

9.2.5 TACT Evaluation by Practitioners

We performed interviews to present the climate assessment to the six organizations participating in this study. During the interview, participants were asked questions such as *"How do you evaluate the results, by dimension/item, of the organizational climate assessment carried out by the team? Do the results by dimension/item represent your perception of the team's daily life?"* In a general way, the participants confirmed the TACT results and reported intentions for future use. Some reports made by those responsible for climate management in the agile teams investigated in this study are presented below.

The TI director from Organization 1 (ORG1) said, "excellent work <Assessment using TACT>. The graphs, the report, these results are true. Our positive assessment results from a lot of effort and dedication from the management. Your research confirmed it and cleared my doubt that we should improve. We have to improve the iteration planning and the user stories refining. We have made some analyses priorly, but it becomes easier to justify a decision when a report <TACT report> confirms our analyses. The result will add a lot for us to improve the climate. I understand that some negative reviews are personal, recurring, and constant inherent to public service." The tech leader from Organization 3 (ORG3) reported, "I would like to repeat the assessment in the future, but first, we need to improve our processes. We are restructuring the organization and redefining the development process. We are better describing the roles and their responsibilities (...) First of all, I would like to congratulate you on the <climate assessment> survey. I found the report <TACT report> very interesting. Maybe if we had a better definition of roles, some items could be evaluated positively. Regarding the implementation of Scrum, we have different degrees of maturity in each project. The adoption of practices depends on the need and will of each team. The negative evaluation regarding architecture <IT05> is not a determination of the organization. I believe it is due to system users' enormous volume of tickets. That generates a huge demand. We work with the legacy code, which can make the architecture discussions difficulty." The director from Organization 5, who is also the team facilitator, said, "the negative evaluation in item <IT14> is correct. The item <IT14> is fantastic. The methodology <TACT> really works. At that time, the PO was new, some people were new, and I decided I would not protect some people on the team. So, the result is very interesting... (...) I wish I had the opportunity to carry out the assessment again as it has been two months. Two months in a startup is crazy." When analyzing the TACT report, the manager from Organization 6 remarked, "I think

the assessment result confirmed my feelings about the teams. They <Team Members> are tight-knit, give the best to the company, and meet deadlines. Communication improved a lot during the pandemic; communication also improved due to the use of agile methods and the performance of the Scrum master. I really liked the result." The development manager completed "the evaluation represents the perception I have about the teams."

To continue the assessment of the performance of TACT, we asked the interviewed participants to evaluate TACT considering the dimensions of Intention to Use, Perceived Usefulness, and Output Quality of the TAM [84, 85]. At least one representative from each organization participated in the assessment (n = 9). Table 9.15 describes the result.

Table 9.15: Agreement percentage of TACT using TAM (n = 9)

TAM Dimension (Agreement %)	Item	D	N	A
Intention to Use (100%)	Assuming I have access to the instrument, I intend to use it.	0	0	9
	Given that I have access to the instrument, I predict that I would use it.	0	0	9
Perceived Usefulness (89%)	Using the instrument improves my performance in my job.	0	0	9
	Using the instrument in my job increases my productivity.	1	0	8
	Using the instrument enhances my effectiveness in my job.	1	1	7
	I find the instrument to be useful in my job.	1	0	8
Output Quality (96%)	The quality of the output I get from the system is high.	0	0	9
	I have no problem with the quality of the system's output.	0	1	8
	I rate the results from the system to be excellent.	0	0	9

D = Disagree; N = Neutral; A = Agree; For each team, the relative frequencies (count for each value assigned by the participants) were calculated according to the aforementioned Likert scale. We chose to count the values "somewhat agree," "moderately agree," and "strongly agree" in the column "Agree (A)," and "strongly disagree," "moderately disagree," and "somewhat disagree" in the column "Disagree (D)." Finally, the "neither disagree nor agree" option was considered in the column "Neutral (N)".

As per in Table 9.15, the "Agreement Percentage" for each TAM dimension was measured. Thus, we calculate the percentage of respondents who chose the options "somewhat agree," "moderately agree," and "strongly agree." The majority of the values were positive. Thus, we have evidence that TACT is useful, its reports have good quality, and the practitioners manifested intention of future use.

9.3 Discussion

This chapter describes the validation of TACT, an instrument for measuring the critical factors that influence agile teams' climate. We provided evidence of TACT factor structure based on Confirmatory Factor Analysis (CFA). Reliability (internal consistency) for TACT dimensions was high for most dimensions. Finally, the ones responsible for climate management in the teams investigated confirmed the usefulness, quality, and future use intention. These analyses support that TACT is appropriate to assess the agile team's organizational climate.

Organizational climate has been shown as a multifaceted theory [20, 47]. Schneider and Barbera [6] claimed that everything that happens in organizations is due to climate and culture, and everything that happens affects climate and culture. Agile teams are not different. Several factors influence the team's climate [21, 13]. Schneider [20] argued that the organizational assessment, to be useful, has to be strategically focused - "a climate for something." Thereby, aiming to support leaders, managers, and all persons in charge of the organizational climate management, we also identified the most critical TACT items and listed actions to improve teams' climate based on the survey participants' opinions.

In this Section, based on the literature, we discuss the results concerning the critical TACT items (see Section 9.2.3), the theoretical framework that underlies each item (see Appendix A.1), and the actions suggested by the team members (see Section 9.2.4).

9.3.1 Critical Factors that Influence the Agile Team's Climate

Several theories concerning Agility, Agile Software Development, and Agile Philosophy (principles, values, and ceremonies adoption) are under development and need more valid evidence [35, 180]. On the other hand, Vishnubhotla et al. [16] point out the need for further studies to investigate the influence of human factors on the organizational climate of agile teams.

Conforto [35] performed a systematic literature review and a survey to develop a definition of the agility construct. The author concluded that (i) agility should be considered a team's performance, rather than a mere adjective for practices and methods; (ii) agility, as a performance, might be dependent upon a combination of organization, team and project factors; and (iii) the agility performance level can be measured within two main factors: rapid project planning change and active customer involvement.

The theory of Agile Software Development proposed by Kakar [180], which is under evaluation and further development, provides four propositions: (i) a collaborative organizational culture promotes customer focus and an environment conducive to agile processes and outcomes, (ii) customer focus promotes rapid iterative development, reduction in waste and internal and external cooperation, (iii) internal and external collaboration, rapid iterative development, and minimization of waste lead to improved psychosocial and task outcomes, (iv) feedback on task and psychosocial outcomes lead to continuous improvement and learning.

In an overall analysis, the critical TACT items are supported by the mentioned theories about Agility and Agile Software Development [35, 180]. Corroborating these theories

[35, 180], Hohl et al. [36] analyzed the difference between "doing agile" and "being agile." "Doing Agile" is just adopting some ceremonies but without significant change to support the fundamental agile approach as end-to-end, business integration, value focus, and team empowerment. In contrast, "being agile" means that the individual, team, and organization have changed. The authors concluded that problems are "often hidden in management layers and bureaucracy." Based on the studies cited [35, 180, 36], we considered that the critical factors that most influence agility the most are mainly represented by the collaboration climate between the involved, aiming for rapid project planning. Besides, the collaboration climate primarily consists of the interaction quality between the team members and client representative (e.g., the PO role) in the project planning (scope definition and understanding, and project tasks). Furthermore, the leadership can assist and facilitate constructing a favorable collaborative climate. Next, we investigate the most critical factors of TACT from the perspective of the usual roles involved in agile methodologies.

To investigate the critical factors presented in TACT, we considered the most critical TACT items analyzed in Section 9.2.3. From them, we identified the prominent roles involved. Then, for each TACT item, we identified the other human factors and project elements involved (see Appendix A.1). Finally, we grouped the critical factors based on the generic agile roles [37]. Table 9.16 describes the critical factors influencing the agile teams' climate considering Team Member, Team Facilitator, and Product Owner.

Table 9.16: The most critical factors and the TACT items theoretical framework

Role	Critical factors	TACT Item	Human factor related	Possible involved project elements
Team Member	Team autonomy to make decisions about the planning	IT30	Decision-Making, Autonomy, Learning	Backlog Preparation and Refinement, Iteration Planning, and Software Construction
	Team performs tasks with high performance	IT40	Trust and Knowledge	Software Construction
	Deliveries meet client expectations	IT36	Client Involvement, and Effectiveness	Retrospective Meeting
	Quick responses to necessary changes	IT60	Motivation, Change/Adaptability, and Innovation	Backlog Preparation and Refinement, Iteration Planning, and User Story
	Team members help each other in their difficulties	IT55	Learning, Knowledge, Collaboration	Software Construction and Daily Meeting
Team Facilitator	Facilitator assistance in the iteration planning	IT06	Communication, Leadership, and Knowledge	Backlog Preparation and Refinement and Iteration Planning
	Protection of team autonomy	IT19	Autonomy and Trust	Backlog Preparation and Refinement, Iteration Planning, and Software Construction
	Facilitator support to improve team capability and velocity	IT17	Leadership, Communication, Coordination,	Iteration Planning, Retrospective Meeting, Estimate
Product Owner	Product Owner knowledge about the user needs	IT50	Knowledge	Backlog Preparation and Refinement, Iteration Planning, and Retrospective Meeting
	Product Owner collaboration with the team to plan the iteration	IT11	Collaboration, Communication, Team working, and Coordination	Iteration Planning

As per Table 9.16, five critical items (IT30, IT40, IT36, IT60, and IT55) were associated to "Team member." In a general analysis, the critical factors are (i) the [Autonomy] regarding [Decision-making] about the planning (IT30), (ii) meet client expectations [Client involvement] (IT36), (iii) quick responses to necessary changes [Motivation and Change/Adaptability] (IT60), and (iv) team [Learning] (IT55). Our results are consistent with [35]. Conforto et al. [35] investigated that the agility performance level can be measured within two main factors: rapid project planning change (IT30, IT60) and active customer involvement (IT36).

Schneider and Barbera [6] claimed that leadership is central to climate formation and maintenance. For the "Team Facilitator [Leadership]" role (see Table 9.16), the critical items represent (i) assistance in the iteration plan [Leadership and Communication] (IT06), (ii) team [Autonomy] protection (IT19), and (iii) support to improve team capability and velocity [Leadership and Coordination] (IT17). In Scrum, for example, the "traditional" literature indicated that the main Scrum Master activities are process facilitation, ceremony facilitation, process management, and impediment removal [167, 37, 67]. Nool et al. [167] argued that the Scrum Master [Team Facilitator] would be free to support the Scrum [Team] when business requirements conflict with technical reality (IT06), and to support the Product Owner and the team when upper management pressure threatens to override or compromise the team's own decisions (IT19). In addition, the authors identified in the literature that the Scrum Master [Team Facilitator] should, in the Sprint planning [Iteration Planning], identify those stories on the product backlog that will fit into a single sprint, taking into account team velocity and capacity, and story estimate (IT17).

In agile projects, the authorization to perform the work is given to the Product Owner [66]. The PO is who authorizes the [Iteration] and is responsible for defining and controlling the scope [66]. The [Team] is responsible for planning and estimate the tasks [37, 99, 66]. On the other hand, the Product Owner (see Table 9.16) many times works [Collaboratively] (IT11) with the [Team] to refine the user stories [37]. In Scrum, for example, Sprint Planning [Iteration Planning] initiates by laying out the work to be performed for the Sprint. This resulting plan is created by the [Collaborative] (IT11) work of the entire Scrum Team (i.e., Scrum Master, Product Owner, and developers). Boehn and Turner [170] analyze that the customer representative [Product Owner] should be Collaborative (IT17), Representative, Authorized, Committed, and Knowledgeable (IT50) (CRACK). Gren [181] investigated that Iteration Planning was positively linked to the measurement of the developers' perceived team productivity. In the same sense, Kakar [180] proposed that a collaborative (IT11) organizational culture promotes customer focus and an environment conducive to agile processes and outcomes.

9.3.2 Guidance for Practitioners: Recommendations on how to improve the agile teams' climate

In this section, we make recommendations on improving the agile teams' climate based on the previous analysis of the critical factors. The recommendations comprise actions and behaviors that the management, team facilitators, Product Owners, and team members should potentialize to contribute to forming an excellent organizational climate in agile teams. It is key to communicate that we choose to use the word "sessions" instead of "ceremonies" to clarify that the central idea is not "doing the ceremonial (i. e., doing agile)" but "showing the behaviors (i. e., being agile)" represented in the following recommendations. For each recommendation, we inform the human factors associated with it.

- **During backlog refinement sessions**
  - Encourage the presence of the team members. If necessary, involve the relevant stakeholder [Client Involvement, Knowledge, and Learning];
  - Promote a safe environment where each one involved can openly discuss their doubts, uncertainties, and developments about the user stories and their possible impacts on planning [Communication, Trust, Collaboration, Knowledge, and Learning];
  - Make sure the Product Owner knows the real needs of users [Knowledge].

- **During continuous planning sessions**
  - Encourage the participation of the team members [Collaboration];
  - Ensure the team members have the freedom to make decisions about the planning and delivery [Autonomy, Trust, Motivation, and Decision-making];
  - Promote a safe environment where each one involved can discuss their doubts, uncertainties, and developments about the planning openly [Communication and Collaboration];
  - The team should be motivated to quickly respond to necessary changes [Motivation and Change/Adaptability];
  - The team facilitator assists the team in understanding the iteration objectives and resolving disagreements over user story priorities [Leadership and Communication];

  - The team facilitator should protect the team's autonomy [Leadership, Autonomy, and Decision-making].

- **During day by day activities**

  - Ensure all members have the freedom to express their opinion [Communication and Trust];
  - Make sure everyone knows the team members' skills and expertise [Knowledge];
  - Promote a safe environment where each one involved can share their difficulties in the tasks, knowing that other team members will help as needed [Learning, Collaboration, and Trust];
  - Ensure the team members perform their tasks with high-quality [Trust];
  - The team facilitator should constantly investigate how the team can be more agile and act accordingly [Leadership];
  - Promote formal training or self-learning team sessions about agility and emerging technologies [Learning, Knowledge, Innovation];
  - Ensure the client or their representative (e.g., the PO) provide feedback on the deliverables [Client Involvement].

9.4 Limitation and Threats to Validity

Wohlin et al. [172] discuss threats to validity concerning surveys. Next, we describe the study limitations and our actions to address the threats to the conclusion, construct, and external validity.

This study has some limitations inherent in the sample that restrict the findings' generalizability. Although the TACT structure is plausible, of 301 participants, 257 lived in Brazil, and only 44 (15%) lived in other countries. The Brazilian context of agile adoption may not represent other countries'. Furthermore, the sample is not representative and non-probabilistic. Wagner et al. [51] claim that for most intents and purposes, a sample size of more than 400 developers makes possible strong generalizability. However, we highlight that the validation is not an instrument characteristic but a process of accumulating relevant evidence [182]. It is also essential to communicate that it was not possible to perform the exploratory factor analysis (EFA) considering the estimators appropriate

to ordinal scales. Graziotin et al. [18] assert that EFA allows reducing the dimensionality of the problem space (i.e., lowering dimensions and/or associated items). Although the Kaiser-Meyer-Olkin (KMO) index was 0.95 (excellent [164]) and Bartlett's Test of Sphericity (640.71, df = 63, p < 0,001) suggested the interpretability of the data, it was not possible to calculate the polychoric matrix of the sample. To perform an EFA in the future, probably it will be necessary to increase the number of survey participants. In that case, our 301 participants sample can also be considered (See this link). An EFA allows, for instance, the development of a short version of TACT with fewer items and fewer dimensions.

Threats to the *conclusion validity* are concerned with issues that affect the ability to draw the correct conclusion about relations between the treatment and the outcome of an experiment [172]. Conclusion validity is sometimes referred to as statistical conclusion validity. There is divergence in the sample size needed to validate instruments that measure latent variables (such as TACT) [162]. However, Kyriazos [162] investigated that if a dimension has four or more loadings greater than 0.6 then it is reliable regardless of sample size. All TACT dimensions have more than 4 items with factor loadings > 0.6. Concerning possible violated assumptions in statistics, it is crucial to highlight that, in the Confirmatory Factor Analysis (CFA), we used the Unweighted Least Squares (ULS) estimator appropriated to ordinal scale and non normally distributed data [175, 174]. Kogar and Kogar [175] identified evidence that the ULS method yielded better results in smaller sample sizes than the Diagonally Weighted Least Squares method (DWLS). With respect to the reliability of measures, Wollin et al. [172] highlight the principle that when a phenomenon is measured twice, the outcome shall be the same. In TACT, reliability was investigated in all case studies and this survey. In all studies, Cronbach's alphas of all dimensions were over 0.7 (acceptable).

To address possible threats to the *construct validity*, we grounded TACT creation in the scientific literature (see Chapter 3). We performed two systematic reviews and considered other literature sources to define the constructs and create items to access them. We also performed two evaluations by specialists. In the second evaluation, judges experienced in agile methods evaluated TACT items for Simplicity, Cohesion, and Relevance/Representativeness. The values of the Content Validity Index (CVI) were acceptable (>= 0.7) [96].

Threats to the *external validity* are conditions limiting our ability to generalize the study results. Wollin et al. [172] exemplified that people, place, and time can be sources of threats to external validity. Concerning people and place, of 301 participants, 257 lived in Brazil, only 44 (15%) lived in other countries. Thereby, the majority of the participants

represent the culture of Brazil. Agile methodologies advocates, for example, that the path to agility involves changing the team members' behavior, active customer involvement, and support and trust of all management levels at the organization [10, 183, 36, 68, 35]. TACT was grounded in agile culture's values, principles, and practices independent of local culture. However, it is essential to further evaluate TACT for other cultures and team compositions. During the planning and execution of this thesis, teams allocated in the same physical environment were working from home due to the COVID-19 pandemic described in [158]. TACT was not developed considering the critical factors that influence virtual or geographically distributed teams. To investigate whether this fact could have impacted TACT's ability to measure the climate correctly, we performed two case studies (pilot) in four teams [44, 55]. We identified quantitative e qualitative evidence that TACT captured the organizational climate of the teams correctly.

Concerning the qualitative analysis, several threats can impact the coding of the critical factors that influence the team's climate and the suggestion to improve it. Two researchers participated in the coding process to address the main threats related to the interpretation. The thematic analysis procedures adopted were performed by this thesis author and revised by an experienced researcher. For that, the Atlas.ti project was shared, and each code was conferred with the original text by the auditor. Recker [63] proposes some principles for evaluating qualitative studies. Concerning *reliability*, we exemplified the encoding process and showed direct quotes from the survey participants. To address possible threats to *internal validity*, TACT dimensions were considered initial input (i.e., the main themes) in the thematic analysis. Furthermore, in the Discussion Section, we intertwine the critical factors and the recommendations with the literature. Thus, the results were triangulated with other sources and associated with a chain of evidence. *External validity* concerns how much and when the results of a study can be generalized to other cases or domains [63]. To mitigate this threat, we provide detailed descriptions of the study context.

9.5 Final Considerations

This study aimed to validate TACT (*"insTrument to Assess the organizational ClimaTe of agile teams"*) theoretical structure. For this, we performed a survey. Three hundred one agile team members used TACT. From six specific Brazilian organizations, 161 participants allocated to 34 teams assessed their climate. Other 140 individual members from Brazil and other countries also answered the survey. The results revealed that TACT has good psychometric properties and provides practitioners and researchers with a robust means for assessing ten critical dimensions of agility through team members' perceptions

of the process, the project, the typical agile roles, and behaviors expected by members of agile teams.

Moreover, the internal reliability of TACT dimensions was high. In addition, we identified the most critical factors that influence the formation of the organizational climate for ten dimensions of the TACT. Finally, we identified recommendations that should be considered by leaders, Product Owners, team members, and other stakeholders to potentialize the agile team's climate. In the next chapter, Chapter 10, we present the thesis Conclusions.

10. Conclusions

This chapter presents the research overview and its overall contributions. We also present the research limitations and possible future work.

10.1 Thesis Overview

This thesis aims to contribute to organizational climate research in agile software development teams. We investigated how organizations assess the organizational climate, the critical human factors that influence it, and the factors that contribute to team climate formation. All the investigations aimed to develop and validate TACT, *an "insTrument to Assess the organizational ClimaTe of agile teams."* TACT measures the critical human factors to agility, such as Communication, Collaboration, Leadership, Autonomy, Decision-making, Client Involvement, Trust, Knowledge, Learning, and Motivation. We used the Design Science Research (DSR) approach to assist all studies and activities performed in this thesis. The Relevance, Rigor, and Design cycles were essential to guide the identification, delimitation, and clarification of DSR project elements such as Problem, Requirements, Acceptance Criteria, Knowledge Base, and the development and validation of TACT.

In the Relevance Cycle, the Qualitative Study emphasized the necessity of adapting climate assessment instruments to the values, principles, practices and agile roles, the relevance of decreasing the assessment period and the number of items evaluated, and the importance of discussing the results and defining control actions with the team members. In the Rigor Cycle, the Knowledge base was established through two systematic reviews. We used the Tertiary Study results to delimit the TACT dimensions and their groundedness in the critical human factors. In the Systematic Literature Study, we identified measures used to evaluate the organizational climate in development teams. These measures inspired the TACT development and assisted in identifying the validation proce-

dures. Lastly, in the Design Cycle, we performed iterative activities to create TACT items, have them evaluated twice by specialists, and get subsequent user feedback in three Case Studies. In Evaluation by Specialists, experienced professionals in agile methods confirmed that TACT items are applied to agile teams, simple to understand, cohesive, and relevant. In addition, the specialists presented several suggestions to improve the item description. Continuing in the Design Cycle, we opted to conduct case studies to identify an evidence chain about the TACT performance. Therefore, we used open-ended questions and leaders' feedback in interviews during the climate assessment beyond TACT. In all studies, TACT captured the teams' climate correctly. Even though TACT was still embrionary, the quantitative analysis generated acceptable initial evidence of validity and reliability. Practitioners reported intention of future use. Ultimately, we conducted an extensive survey with members (n = 301) of agile teams to validate the English and Portuguese versions of TACT. Members of 6 Brazilian organizations representing 34 teams and some participants from other countries responded to the survey. Confirmatory Factor Analysis (CFA) proved the plausibility of the TACT structure. TACT shows good psychometric indices and high reliability. Once more, practitioners manifested intention for future use. CFA results and the qualitative analysis allowed us to identify the most critical factors. Survey respondents suggested actions for improving their teams' climate.

Based on all evidence, we concluded that TACT provides practitioners and researchers with a robust means for assessing ten critical dimensions of agility through team members' perceptions of the agile software process, the project, the typical agile roles, and behaviors expected by members of agile teams.

10.2 Research Questions Revisited

As follows, we answer the research questions formulated in the Introduction.

10.2.1 How to assess the organizational climate in agile teams? (RQ1)

Our findings cover general recommendations known in the literature to perform an organizational assessment to specific observations to assess agile teams' organizational climate. We summarize our findings below.

Practitioners should start by identifying critical factors helpful to the management, the team, or the agile adoption in a certain period. The catalog of human factors and their influences identified in the Tertiary Study and the other factors indicated in the Systematic

Literature Review can help on that task. Later, the challenge is locating and analyzing the climate instruments that measure the identified factors. TACT instrument and other climate measures identified in the Systematic Literature Review can be considered. When choosing the tool, one should consider the evidence of validity and reliability, whether the instrument items fit the agile teams' context, and issues regarding permission of use (e.g., copyright). It is essential to alert that any change in the item's description may alter its ability to measure the construct. Thereby, industry practitioners or researchers who indiscriminately change the original items or create their questionnaires using different items from different instruments are warned that they may be erroneously measuring the latent construct.

We are not discouraging the development of new measures or the use of measures with little evidence of validity or reliability. We emphasize that procedures disseminated in psychometrics for developing and validating instruments should be considered in these cases. Thus, we highlight that all evidence of validity and reliability are conditioned to the research data currently available, i.e., the more investigations conducted using the measure, the more evidence of validity and reliability there will be.

10.2.2 How do human factors can affect the organizational climate of agile software development teams? (RQ2)

We begin the discussion to answer RQ2 with the central thematic proposed by Schneider and Barbera [6] to conclude the splendid editorial work concerning the organizational climate. The authors summarized that *"everything that happens in organizations is due to climate and culture, and everything that happens affects climate and culture."* Considering that we acknowledge the challenge of identifying and investigating the influence of critical human factors on the organizational climate of agile teams.

Although psychology and administration have deeply investigated predecessors, mediators, and former factors of the organizational climate, there is still little evidence in the literature about the influence of human factors on the organizational climate in agile software development teams. In this context, we began our investigations by performing two literature reviews. The Tertiary Study investigated state of the state-of-the-art in ES teams to elicit the human factors and their influence. The SLR Study aimed to examine organizational climate research state-of-the-art in software development teams.

We identified 71 human factors and 60 influences in agile software development. Of 71 human factors, 38 influenced the Teams' Climate in the Tertiary Study. We identified in Soomro et al. [21] that the development of an agile team's organizational climate includes

factors that represent the involvement of the whole team, agile values (trust, openness, and respect during team interaction, for example), agile practices (feedback and negotiations), a culture favoring action and change (in terms of bringing progress and improvement to team activities) and collective thinking. To select the critical factors investigated in this thesis, we considered the most investigated factors in our Tertiary Study and those reported in Chagas et al. [10] to derive the ten TACT dimensions: Communication, Collaboration, Leadership, Autonomy, Decision-making, Client Involvement, Trust, Knowledge, Learning, and Motivation. From the SLR Study Results, we identified 19 climate measures that represent more than 80 dimensions involving a variety of constructs spanning from Intrinsic Fulfilment, Team Innovation, and Reluctance to Report Bad News to Tradition Organizational. All measures we identified with copyright have strong reliability and validity evidence published. Those measures are TCI [49], TSI [92], Team Climate [93], ECQ [94], and OCM [47]. In a general way, the measures used to assess organizational climate from software development teams in the SE research have the following main characteristics: (i) 6 out of 19 measures (31%) has copyrights; (ii) 4 out of 19 (21%) measures are specific to software development teams, but only two (10%) have initial validity and reliability evidence and were designed to operationalize a climate survey with the teams, (iii) 5 out of 19 (25%) measures adapted previous items or changed the original construct name. The SLR Study corroborated to (i) identify evidence concerning the necessity of specific organizational climate instruments for agile software development teams and (ii) discover the main procedures and indices reported in the literature to develop, evaluate and validate a climate instrument. Finally, based on our literature review results, we began the procedures to create the TACT items and continue our investigations into the influences of human factors on the climate of agile teams.

We conducted two evaluations with experienced experts in agile methods and three case studies to evaluate TACT. In the three studies, we considered evidence from multiple sources, e.g., interviews, open-ended questions, and an evaluation using TAM [84, 85], to identify improvements and investigate the capability and quality of TACT to assess the teams' climate. In the First and Second Case Studies, TACT captured that 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 could negatively influence the climate of teams communication, collaboration, and leadership. In the Third Case Study, we found evidence that the PO's experience and knowledge about the system's domain directly influence the teams' perception of the Trust and Knowledge dimension. Knowledge-sharing among team members impacted the Learning dimension positively. In the opposite direction, the lack of people promoting agile methodologies and the unwillingness to improve agile practices negatively influenced

Learning among teams. The lack of team autonomy in delivery planning has harmed the motivational dimension. Contrarily, recognition for the work done and satisfaction in seeing the product is helpful to the customer were motivating factors.

Our latest investigation, the Validation Study, used all TACT dimensions to identify validity and reliability evidence and investigate the human factors influencing the teams' organizational climate. Members from six Brazilian organizations and other individuals from Brazil and other countries responded to the survey. In the quantitative analyses, the Confirmatory Factorial Analysis (CFA) testified the plausibility of the TACT theoretical structure. After that, it was possible to investigate how the critical human factors influence the organizational climate. The main findings are presented below. We identified that (i) the collaboration among the team members to solve day-to-day problems highly affects the team climate for learning, (ii) the work performed between PO and team members involved in the iteration planning highly influences the team' climate of collaboration, and (iii) how quickly the team responds to necessary changes and the autonomy in decision-making about the planning strongly influences team motivation. We also identified that the PO's actual knowledge about the users' necessity influences the team climate for knowledge. Referring to the Team Facilitator role, we determined how the team understands the facilitator's performance to help the team be more effective and more agile influences how the team regards leadership. Furthermore, the Team Facilitator is mainly responsible for protecting and guaranteeing the team's autonomy. In the Validation Study, we also analyzed the frequencies assigned by the participants for each TACT item. In a general way, a favorable climate was perceived. The most positively evaluated items are presented in the Communication, Collaboration, and Learning dimensions. Therefore, a positive environment happened when the team members (i) talk about the impediments and how to address them (Communication), (ii) perceive the team's desire to learn about the project (Learning), and (iii) the team works together as a team (Collaboration). On the other hand, an adverse climate can be formed when the team members (i) perceive that there are not enough discussions on the software design and architecture (Communication), (ii) have no time to plan the changes without excessive stress or pressure (Decision-making), and (iii) know that new members would have difficulties understanding the code or the product backlog and its dependencies (Knowledge).

10.2.3 How to support continuous organizational climate assessment in agile software development teams? (RQ3)

The central goal of this thesis was to investigate how to support the companies in executing the agile teams' organizational climate assessment. The interviews, the reports

made by the teams' members in the open-ended questions, the quantitative results from the assessment climate using TACT, and the statements made by several responsible for climate management allowed us to establish a chain of evidence supporting our recommendations to answer RQ3. Obviously, our recommendations revisit some of those considered in RQ1, permeate some discussions presented in the Qualitative Study, and, finally, exalting the excellent initial results obtained with TACT. So, our main findings are listed below.

- Use an instrument that (i) measures the critical factors for agility, (ii) provides the opportunity for assessment in short cycles, and (iii) promotes reflections on the behavior of the prominent people involved in the team's activities;
- To know specific issues that influence the team climate and obtain suggestions of possible actions to be taken, the following questions can be considered: *"In your opinion, what most influences the organizational climate in your team?"* and *"How to improve your team's organizational climate?"*;
- Empower teams to analyze the climate assessment results and discuss and develop actions to improve the identified issues;
- Team members should know the benefits of climate assessment. That also involves understanding the actions taken to manage the organizational climate;
- Perform organizational climate assessment of agile teams using TACT.

TACT was grounded in the scientific literature and industry observations. TACT measures the main critical human factors commonly investigated in science and discussed by practitioners. TACT dimensions can be used individually in a climate assessment. TACT items (i) are simple to understand, (ii) ground in the "agile philosophy" and "agility," (iii) considered the most common agile practices, and (iv) allow reflections on the behaviors of the prominent involved roles in agile projects. TACT has items that represent behaviors that are easier to occur in agile teams, e.g., communication about the impediments and team problems (IT01) and more difficult discussions concerning software design and architecture (IT05). The background theoretical framework shown in the items' description, the other human factors related, and possible project elements indicated in each item allow the responsible for climate management to do reflections that extrapolate the common project indicators. The facilitators reported TACT use intention. In addition, we captured that TACT allowed the facilitators' reflections concerning their activities, for instance, "as a leader, I need to improve on these issues," "I have to train better the team in agile

methodologies," and "could we perform another assessment?" Participants who mediated the climate assessment in their companies in the Validation Study also reported that TACT assisted in reflections concerning the necessity of improving the software development process. All index values are acceptable from the TACT psychometric perspective, and the TACT factorial structure is plausible. Based on all the initial evidence presented, we conclude that industry practitioners and researchers can use TACT to measure the organizational climate of agile teams.

10.3 Contributions

The main contributions of this thesis are listed bellow:

- The investigation of the benefits, difficulties, and pitfalls concerning organizational climate assessments in agile teams;
- The catalog of human factors and their influence on software development teams;
- The catalog of the definitions and how to operationalize the ten constructs considered in TACT dimensions;
- The analysis of the organizational climate measures used in software development teams, their dimensions, validity and reliability evidence, and factors that significantly relate to the climate;
- The TACT instrument to assess the organizational climate of agile teams. TACT is available in two languages, Portuguese and English (see Appendix A.1);
- Instructions on how to use TACT (see Appendix A.2);
- The investigation of the critical factors that influence the teams' climate.
- The list of possible actions to improve the organizational climate;
- Recommendations of how to improvement the agile teams' organizational climate.

During this research, the following studies were published.

- Dutra, E. and Santos, G. 2020. Organisational climate assessments of Agile teams – a qualitative multiple case study. IET Software. 14, 7 (Dec. 2020), 861–870;

- Dutra, E., Lima, P. and Santos, G. 2020. An Instrument to Assess the Organizational Climate of Agile Teams - A Preliminary Study. 19th Brazilian Symposium on Software Quality (São Luis, Brazil, Dec. 2020), 1–10;
- Dutra, E., Diirr, B. and Santos, G. 2021. Human Factors and their Influence on Software Development Teams - A Tertiary Study. Brazilian Symposium on Software Engineering (SBES '21) (Joinville, Brazil, 2021), 1-10;
- Goncalves, E., Lima, P., Cerdeiral, C., Diirr, B. and Santos, G. 2022. TACT: An insTrument to Assess the organizational ClimaTe of agile teams - A Preliminary Study. Journal of Software Engineering Research and Development. 9, 1 (2022), 18:1 – 18:20;
- Dutra, E., Cerdeiral, C., Lima, P., Diirr, B. and Santos, G. 2022. Organizational Climate Assessment of Trust, Knowledge, Learning, and Motivation of Agile Teams - A Case Study. XVIII Brazilian Symposium on Information Systems (Curitiba, Brazil, 2022), 1–8.

10.4 Limitations

The main limitations of this research are listed hereunder.

The ten TACT dimensions are grounded in the critical human factors identified in the literature. Several of those studies are case studies and did not consider valid measures to conclude influence relations. Thus, the TACT dimensions may not represent agility's most critical factors despite our best efforts. Furthermore, the restricted number of dimensions limits TACT coverage of human factors that affect agile teams. To mitigate this limitation, in the chosen TACT dimensions, we considered our SLR results and Chagas et al. [10] results which performed an SLR and a survey with agile specialists. The other human factors indicated in the items also can be used as indicators.

Another limitation concerns the context where data were collected. In the Validation Study, from 301 participants, 257 lived in Brazil, and only 44 (15%) lived in other countries. The Brazilian context of agile adoption may not represent other countries'. To minimize this limitation, we analyzed the Third Case Study results in which three Canadian teams participated and the Validation Study results from the survey from participants residing outside Brazil. We did not identify significant differences among participants' locations concerning the quantitative and qualitative analysis. Furthermore, the sample is

not representative and non-probabilistic. However, our results should be considered in the investigated contexts.

The actions list suggested by the team members and our main recommendations to improve the team climate were not investigated in depth.

10.5 Future Work

The perspectives for future works are listed as follows.

- Use TACT in new empirical investigations to explore the relations of TACT dimensions with other constructs. Publicize the latest evidence of validity and reliability;
- Explorer different TACT theoretical structures considering the other human factors indicated in the items (Confirmatory Factor Analysis);
- Investigate other TACT factorial structures (Exploratory Factor Analysis);
- Develop and validate TACT for other languages besides Portuguese and English;
- Create a TACT short version;
- Create normative tables to assist the practitioners in interpreting the team's climate assessment result;
- Investigate actions to enhance the climate regarding TACT dimensions by surveying the literature and practitioners;
- Develop a tool to perform TACT assessments providing support to multiple teams, keeping assessments history, and managing improvement actions;
- Investigate the influence of other human factors on the organizational climate, such as gender, team size, team diversity, change/adaptability, and team members' experience with agile methodologies;
- Investigate the effect of the agile mindset in the organizational climate;
- Investigate the organizational climate on teams with outsourced members;
- Investigate the organizational climate concerning the localization of agile teams (i.e., local, remote, working in-home, or Global Software Development).

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A. Appendix

A.1 Appendix: TACT Final Version

Table A.1: Communication dimension

ID	Item (EN)	Item (PT)	Inspired by	Human factors related	Possibly involved projects elements	OD (*)
IT01	Team members always talk about impediments and how to address them	Os membros do time sempre conversam sobre impedimentos e como lidar com eles	[49]	Communication [66, 37], Trust [49, 134], Coordination (2)	Backlog Preparation and Refinement, Iteration Planning, Retrospective Meeting, Daily Meeting, Estimate	COM.07
IT02	During the retrospectives, the team discusses the best way to improve the work	Durante as retrospectivas, o time discute como melhorar o trabalho	[93]	Communication [97], Leaning [97], Decision-Making [115], Coordination (2)	Retrospective Meeting	COM.08
IT03	The daily meeting allows the team to know the project problems and team difficulties	A reunião diária permite conhecer os problemas do projeto e as dificuldades do time		Communication [97, 72], Knowledge [97], Coordination (2)	Daily Meeting, Impediment List	COM.05 COM.06 COM.07
IT04	The team and the product owner always reach a consensus about the user stories priority by negotiating which bug to fix or functionality to add	O time e o dono do produto sempre chegam a um consenso sobre a prioridade das histórias de usuário, negociando qual bug corrigir ou funcionalidade adicionar	[53]	Communication [97], Client Involviment (1), Collaboration (2), Decision-making (2)	Backlog Preparation and Refinement, Iteration Planning, User Story	COM.07
IT05	In the current project, there are enough discussions on the software design and architecture	No projeto atual, há discussões suficientes sobre o design e a arquitetura do software		Communication [72], Trust (2), Decision-Making [115], Learning (2), Coordination (2)	Iteration Planning, Software Construction, Estimate	COM.06 COM.07
IT06	The team facilitator assists in understanding whether the iteration objectives are clear and whether the team agrees with these objectives	O facilitador do time ajuda a entender se os objetivos da iteração são claros e se o time concorda com esses objetivos		Communication [135, 167], Leadership [135, 167], Knowledge (2)	Backlog Preparation and Refinement, Iteration Planning	COM.07 COM.09

(*) Based on the Operational definition (OD) of the construct (see Appendix A.3); (1) Represents that the human factor occurs in the item description; (2) Represents that the researchers inferred a relationship among the human factor and the item (for imbasing and exploring new analysis).

Table A.2: Collaboration dimension

ID	Item (EN)	Item (PT)	Inspired by	Human factors related	Possibly involved projects elements	OD (*)
IT07	Team members share their know-how with the team	Os membros do time compartilham seus conhecimentos com o time	[184, 49]	Collaboration [97], Knowledge (1), Learning (2), Sharing (1)	Backlog Preparation and Refinement, Iteration Planning, Software Construction, Retrospective Meeting	COL.01 COL.02
IT08	The team collaborates very well with other teams involved in the product development	O time colabora muito bem com outros times envolvidos no desenvolvimento do produto		Collaboration [185], Team working (2)	Backlog Preparation and Refinement, Iteration Planning, Software Construction	COL.01 COL.02
IT09	Team members work together as a team	Os membros do time trabalham juntos como uma equipe	[28]	Collaboration [28, 97], Team working (2), Trust (2)		COL.02
IT10	The team collaborates to look for new ways to analyze and solve the problems	O time colabora para buscar novas maneiras de analisar e resolver os problemas	[47]	Collaboration [90], Innovation [90], Decision-making (2)	Iteration Planning, Software Construction	COL.02
IT11	In the current project, the team, the product owner, and the team facilitator work very well together to plan the iteration	No projeto atual, o time, o dono do produto e o facilitador do time trabalham muito bem juntos para planejar a iteração		Collaboration [72, 167], Communication (2), Team working (2), Coordination (2)	Iteration Planning	COL.01 COL.02

(*) Based on the Operational definition (OD) of the construct (see Appendix A.3); (1) Represents that the human factor occurs in the item description; (2) Represents that the researchers inferred a relationship among the human factor and the item (for imbasing and exploring new analysis).

Table A.3: Leadership dimension

ID	Item (EN)	Item (PT)	Inspired by	Human factors related	Possibly involved projects elements	OD (*)
IT12	The team facilitator eliminates impediments, encourages, and facilitates the use of agile methods	O facilitador do time elimina impedimentos, incentiva e facilita o uso de métodos ágeis		Leadership [87, 37, 167], Communication (2)	Software Construction, Retrospective Meeting, Risk Management, Impediment List	LSH.02
IT13	The team facilitator listens to my ideas and concerns	O facilitador do time ouve minhas ideias e preocupações	[30]	Leadership [30, 97], Communication (1)	Software Construction, Retrospective Meeting, Risk Management, Impediment List	LSH.03
IT14	The team facilitator protects the team from external interference	O facilitador do time protege o time de interferências externas	[186]	Leadership [187, 81, 97, 167], Decision-making (2)		LSH.02
IT15	The team facilitator helps the team to identify and solve conflicts	O facilitador do time ajuda o time a identificar e resolver conflitos	[188]	Leadership [167], Communication (2)		LSH.01 LSH.02
IT16	The team facilitator provides helpful feedback on how to be more agile	O facilitador do time fornece feedback útil sobre como ser mais ágil	[30]	Leadership [37, 30, 167], Knowledge (2), Learning (2)		LSH.01 LSH.02
IT17	The team facilitator investigates and helps the team to be more effective, taking into account the team velocity and capacity	O facilitador do time investiga e ajuda o time a ser mais efetivo, levando em consideração a velocidade e a capacidade do time	[30]	Leadership [10, 66, 167], Communication (1), Coordination (2)	Iteration Planning, Retrospective Meeting, Estimate	LSH.01 LSH.02

(*) Based on the Operational definition (OD) of the construct (see Appendix A.3); (1) Represents that the human factor occurs in the item description; (2) Represents that the researchers inferred a relationship among the human factor and the item (for imbasing and exploring new analysis).

Table A.4: Autonomy dimension

ID	Item (EN)	Item (PT)	Inspired by	Human factors related	Possibly involved projects elements	OD (*)
IT18	I am free to choose the tasks I want to execute in the iteration	Eu tenho liberdade para escolher as tarefas que quero executar na iteração		Autonomy [187], Decision-Making (2)	Iteration Planning, Software Construction	AUT.01
IT19	The team facilitator protects the team autonomy from external interferences	O facilitador do time protege a autonomia do time de interferências externas		Autonomy [187, 81, 97], Trust [97]	Backlog Preparation and Refinement, Iteration Planning, Software Construction	AUT.03
IT20	In this organization, we have the autonomy to suggest changes to the team's software process development	Nesta organização, temos autonomia para sugerir mudanças no processo de desenvolvimento de software utilizado pelo time	[47]	Autonomy [12], Trust (2), Decision-making (2)	Retrospective Meeting, Iteration Planning, Software Construction	AUT.01 AUT.02
IT21	In this team, we switch tasks assignments to avoid specialization and individualism	Neste time, trocamos atribuições em tarefas para evitar a especialização e o individualismo		Autonomy [81, 97], Knowledge [81]	Iteration Planning, Software Construction	AUT.01
IT22	The team has the autonomy to adopt technical solutions without consulting the product owner or the management	O time tem autonomia para adotar soluções técnicas sem precisar consultar o dono do produto ou a gerência	[47]	Autonomy [47, 68], Trust [68, 47, 12]	Iteration Planning, Software Construction, Daily Meeting	AUT.01
IT23	The team has the autonomy to communicate with the product owner and other stakeholders	O time tem autonomia para conversar com o dono do produto e outras partes interessadas		Autonomy [81, 97] Communication (1)	Backlog Preparation and Refinement, Iteration Planning, Software Construction, Retrospective Meeting	AUT.04
IT24	The team has decision authority and responsibility to plan the iteration	O time tem responsabilidade e autoridade de decisão para planejar a iteração		Autonomy [187, 37], Decision-Making(1)	Iteration Planning	AUT.02

(*) Based on the Operational definition (OD) of the construct (see Appendix A.3); (1) Represents that the human factor occurs in the item description; (2) Represents that the researchers inferred a relationship among the human factor and the item (for imbasing and exploring new analysis).

Table A.5: Decision-making dimension

ID	Item (EN)	Item (PT)	Inspired by	Human factors related	Possibly involved projects elements	OD (*)
IT25	The team has time to plan the changes without excessive stress or pressure	O time tem tempo para planejar mudanças sem estresse ou pressão excessiva		Decision-Making [115, 189], Stress (1), Pressure (1), Motivation [80, 12, 89],	Backlog Preparation and Refinement, Iteration Planning, Software Construction, Daily Meeting	DEC.05 DEC.06
IT26	When needed, the team reprioritizes tasks or defines new tasks	Quando necessário, o time reprioriza tarefas ou cria novas tarefas		Decision-Making [75], Learning (2), Autonomy [75]	Iteration Planning, Software Construction, Daily Meeting	DEC.02 DEC.08
IT27	In the iteration planning, the team analyzes the technical alternatives and chooses the most appropriate one	No planejamento da iteração, o time analisa as alternativas técnicas e seleciona a mais adequada		Decision-Making [97, 190, 37, 75], Learning (2), Autonomy [75], Motivation [80, 12]	Iteration Planning, Daily Meeting	DEC.02 DEC.07 DEC.08
IT28	In the retrospective, the team identifies, analyzes, and selects items to improve how to work	Na retrospectiva, o time identifica, analisa e seleciona itens para melhorar a forma de trabalho		Decision-Making [115, 37, 75], Learning (2), Autonomy [75],	Retrospective Meeting	DEC.02
IT29	Team members talk about their views and uncertainties concerning the iteration execution freely	Os membros do time conversam livremente sobre suas opiniões e incertezas relativas à execução da iteração		Decision-Making [97], Communication (1), Trust (2),	Backlog Preparation and Refinement, Iteration Planning, Software Construction, Daily Meeting	DEC.02 DEC.05
IT30	When the dependencies between tasks hinder the project execution, the team makes decisions to resolve or mitigate possible impacts	Quando as dependências entre as tarefas atrapalham a execução do projeto, o time toma decisões para resolver ou diminuir possíveis impactos		Decision-Making [75], Autonomy [75], Learning (2)	Backlog Preparation and Refinement, Iteration Planning, Software Construction	DEC.02 DEC.03 DEC.08
IT31	The team's decisions are NOT changed by stakeholders or individual members arbitrarily	As decisões do time NÃO são alteradas arbitrariamente por terceiros ou algum membro do time		Decision-Making [75], Trust (2), Motivation [80, 12, 75]	Backlog Preparation and Refinement, Iteration Planning, Software Construction, Retrospective Meeting	DEC.01 DEC.02

(*) Based on the Operational definition (OD) of the construct (see Appendix A.3); (1) Represents that the human factor occurs in the item description; (2) Represents that the researchers inferred a relationship among the human factor and the item (for imbasing and exploring new analysis).

Table A.6: Client Involvement dimension

ID	Item (EN)	Item (PT)	Inspired by	Human factors related	Possibly involved projects elements	OD (*)
IT32	During the demo review, the team shows and validates the new features with the right people	Durante a reunião de demonstração, o time apresenta e valida novas funcionalidades com as pessoas adequadas	[186, 30]	Client Involvement [37, 30], Feedback (2), Interaction (2)	Demonstration Meeting	CLI.01 CLI.06
IT33	In the current project, there are frequent meetings with business representatives and the team	No projeto atual, há reuniões frequentes com representantes de negócio e o time	[43, 30]	Client Involvement [43, 37], Trust [43], Feedback (2)	Backlog Preparation and Refinement, Iteration Planning, Cost Management, Resource Management	CLI.01 CLI.04 CLI.08
IT34	Stakeholders have the opportunity to suggest changes or improvements to the software product	As partes interessadas têm oportunidades de sugerir mudanças ou melhorias no software	[43]	Client Involvement [43, 37], Trust [43], Feedback (2)	Backlog Preparation and Refinement, Demonstration Meeting	CLI.01 CLI.06 CLI.08
IT35	In the demo review, stakeholders participate in the identification of software problems and improvements	Na revisão de demonstração, as partes interessadas participam da identificação de problemas e melhorias no software	[43]	Client Involvement [43, 37], Trust [43], Feedback (2),	Demonstration Meeting	CLI.01 CLI.06
IT36	The current project has met or exceeded the client expectations	O projeto atual atendeu ou excedeu as expectativas do cliente	[28]	Client Involvement [191, 12], Effectiveness [28] (2)	Retrospective Meeting	CLI.03
IT37	The product owner is always available to explain the user stories' details	O dono do produto está sempre disponível para explicar detalhes sobre as histórias de usuário		Client Involvement [192, 37, 97]	Backlog Preparation and Refinement, Iteration Planning, Software Construction, User Story	CLI.02 CLI.05

(*) Based on the Operational definition (OD) of the construct (see Appendix A.3); (1) Represents that the human factor occurs in the item description; (2) Represents that the researchers inferred a relationship among the human factor and the item (for imbasing and exploring new analysis).

Table A.7: Trust dimension

ID	Item (EN)	Item (PT)	Inspired by	Human factors related	Possibly involved projects elements	OD (*)
IT38	In the current project, there is a feeling of trust among team members	No projeto atual, há um sentimento de confiança entre os membros do time	[49]	Trust [97]	Daily Meeting	TRU.02
IT39	In this organization, the management knows and supports the agile values, principles, and practices	Nesta organização, a gestão conhece e apoia os valores, princípios e práticas ágeis	[49]	Trust [87], Knowledge (1)		TRU.01
IT40	In the current project, team members develop tasks with high quality and good performance	No projeto atual, os membros do time desenvolvem tarefas com alta qualidade e bom desempenho	[149]	Trust [72, 87], Knowledge [97]	Software Construction TRU.02 TRU.04	
IT41	Team members would feel a sense of loss if they could no longer work together	Os membros do time sentiriam uma sensação de perda se não pudessem mais trabalhar juntos	[149]	Trust [97, 149]		TRU.02
IT42	I see no reason to question each team members' competence and technical skills	Não vejo razão para duvidar da competência e habilidades técnicas de cada membro do time	[149]	Trust [97, 149], Competency (1)		TRU.02
IT43	The product owner is fully committed to providing clear information about user stories	O dono do produto está totalmente comprometido em fornecer informações claras sobre histórias de usuários		Trust [97], Commitment (1), Client Involvement (2)	Backlog Preparation and Refinement, Iteration Planning, Retrospective Meeting, User Story	TRU.03
IT44	The client is fully committed to providing clear information about user stories	O cliente está totalmente comprometido em fornecer informações claras sobre histórias de usuários		Trust [97], Commitment (1), Client Involvement (1)	Backlog Preparation and Refinement, User Story	TRU.03

(*) Based on the Operational definition (OD) of the construct (see Appendix A.3); (1) Represents that the human factor occurs in the item description; (2) Represents that the researchers inferred a relationship among the human factor and the item (for imbasing and exploring new analysis).

Table A.8: Knowledge dimension

ID	Item (EN)	Item (PT)	Inspired by	Human factors related	Possibly involved projects elements	OD (*)
IT45	If key members decide to leave the team, the new members would NOT have difficulties understanding the code or the product backlog and its dependencies	Se membros-chave do time decidirem deixá-lo, os novos membros NÃO teriam dificuldades em entender o código nem o backlog do produto e suas dependências	[193]	Knowledge [97]	Backlog Preparation and Refinement, Iteration Planning, Software Construction, User Story	KNO.02
IT46	The team knows the skills and technical expertise of the team members	O time conhece as habilidades e conhecimentos técnicos dos membros do time	[115, 184]	Knowledge [97], Collaboration (2), Communication [115], Trust (2)	Backlog Preparation and Refinement, Iteration Planning, Software Construction, Estimate	KNO.04
IT47	The knowledge transfer chain between the client and the team does NOT suffer information distortions or loss	A cadeia de transferência de conhecimento entre o cliente e o time NÃO sofre distorções ou perda de informações		Knowledge [97], Communication (2)	Backlog Preparation and Refinement, Iteration Planning, Retrospective Meeting, User Story	KNO.01 KNO.03
IT48	The team has excellent knowledge about the domain of the software developed	O time tem excelente conhecimento sobre o domínio do software desenvolvido		Knowledge [97]	Backlog Preparation and Refinement, Software Construction	KNO.01
IT49	The organization offers training opportunities	A organização oferece oportunidades de capacitação	[52]	Knowledge [194], Innovation [99]		KNO.05
IT50	The product owner has sufficient knowledge about the users' actual needs	O dono do produto tem conhecimento suficiente sobre a real necessidade dos usuários		Knowledge [97]	Backlog Preparation and Refinement, Iteration Planning, Retrospective Meeting	KNO.01

(*) Based on the Operational definition (OD) of the construct (see Appendix A.3); (1) Represents that the human factor occurs in the item description; (2) Represents that the researchers inferred a relationship among the human factor and the item (for imbasing and exploring new analysis).

Table A.9: Learning dimension

ID	Item (EN)	Item (PT)	Inspired by	Human factors related	Possibly involved projects elements	OD (*)
IT51	In each iteration, the team improves its ability to handle the most significant problems	Em cada iteração, o time melhora sua capacidade de lidar com os problemas mais significativos	[154, 188]	Learning [27], Knowledge [97], Client Involvement (2)	Backlog Preparation and Refinement, Iteration Planning, Retrospective Meeting	LEA.01 LEA.05
IT52	In this organization, people are promoting the effective use of agile methodologies	Nesta organização, pessoas estão promovendo o uso efetivo de metodologias ágeis		Learning [87], Motivation [87]		LEA.03
IT53	Team members have a willingness to learn about the project	Os membros do time estão dispostos a aprender sobre o projeto		Learning [87], Knowledge (2)		LEA.05
IT54	The team aims to continuously improve the use of existing agile practices and incorporate new Software Engineering practices	O time visa melhorar continuamente o uso das práticas ágeis existentes e incorporar novas práticas da Engenharia de Software	[47]	Learning [87, 90], Knowledge (2)	Retrospective Meeting, Daily Meeting	LEA.05
IT55	The team teaches me how to handle my difficulties in the tasks	O time me ensina como lidar com minhas dificuldades nas tarefas	[188]	Learning [87, 90], Knowledge (2), Collaboration (2)	Software Construction, Daily Meeting	LEA.02 LEA.05
IT56	The team discusses new emerging technologies	O time discute novas tecnologias emergentes	[47]	Learning [87, 90], Knowledge (2), Innovation [47]	Retrospective Meeting	LEA.04 LEA.05

(*) Based on the Operational definition (OD) of the construct (see Appendix A.3); (1) Represents that the human factor occurs in the item description; (2) Represents that the researchers inferred a relationship among the human factor and the item (for imbasing and exploring new analysis).

Table A.10: Motivation dimension

ID	Item (EN)	Item (PT)	Inspired by	Human factors related	Possibly involved projects elements	OD (*)
IT57	In the current project, the team fulfills very well the definition of "done" and the acceptance criteria of the user stories	No projeto atual, o time cumpre muito bem a definição de "pronto" e os critérios de aceitação das histórias de usuário	[30, 53]	Motivation [80, 12], Moral [53], Ownership [53]	Iteration Planning, Software Construction, Demonstration Meeting, Retrospective Meeting, User Story	MOT.01 MOT.07
IT58	In the current project, I have opportunities to develop my skills and knowledge	No projeto atual, tenho oportunidades de desenvolver minhas habilidades e conhecimentos	[30]	Motivation [80, 12], Knowledge (1), Learning (2), Competency (1),	Iteration Planning, Software Construction, Retrospective Meeting	MOT.05 MOT.12
IT59	In the current project, I am recognized for the work done	No projeto atual, eu me sinto reconhecido pelo trabalho realizado	[93]	Motivation [80, 12], Recognition(1)	Software Construction, Demonstration Meeting	MOT.03
IT60	The team responds quickly to changes that need to be done	O time responde rapidamente quando mudanças precisam ser feitas	[47]	Motivation [12], Change/Adaptability (1,2), Innovation [47]	Backlog Preparation and Refinement, Iteration Planning, User Story	MOT.08 MOT.09
IT61	In the current project, I DO NOT feel stressed or under much pressure to execute my tasks	No projeto atual, eu NÃO me sinto estressado ou excessivamente pressionado para executar as minhas tarefas	[52]	Motivation [80, 12, 89], Stress (1), Pressure (1)	Iteration Planning, Software Construction, Retrospective Meeting, Risk Management	MOT.10
IT62	The team organizes and plans its tasks clearly	O time organiza e planeja suas tarefas com clareza	[30]	Motivation [80, 12, 89], Coordination (2), Autonomy (2)	Backlog Preparation and Refinement, Iteration Planning, Software Construction	MOT.04
IT63	The team has the autonomy to discuss with the product owner how and when to deliver the project outcomes	O time tem autonomia para discutir com o dono do produto como e quando entregar os resultados do projeto	[47]	Motivation [80, 12], Autonomy [81], Communication [103], Coordination (2),	Backlog Preparation and Refinement, Iteration Planning, Retrospective Meeting, Risk Management, Estimate	MOT.06 MOT.04
IT64	The team can use new ideas to improve the performance in the tasks and the deliverables	O time pode usar novas ideias para melhorar o desempenho nas tarefas e nas entregas	[93]	Motivation [80], Autonomy (2), Innovation [90], Decision-Making (2)	Iteration Planning, Software Construction, Retrospective Meeting	MOT.04 MOT.11

(*) Based on the Operational definition (OD) of the construct (see Appendix A.3); (1) Represents that the human factor occurs in the item description; (2) Represents that the researchers inferred a relationship among the human factor and the item (for imbasing and exploring new analysis).

A.2 Appendix: TACT Use

TACT can be applied in agile teams or teams that adopt hybrid strategies in their process. Each TACT dimension can be used individually in a pulse or another period (e.g., monthly, semi-annual, or annual). We recommend the performance of pulse surveys due to its brief assessments held quickly in a short term period. A suggestion of the order of the dimensions to apply in a pulse survey is Collaboration, Learning, Motivation, Leadership, Decision-making, Client Involvement, Autonomy, Trust, Communication, and Knowledge. To carry out the assessment, the penultimate week of the iteration can be considered. In assessments that consider all TACT dimensions, the order that can be regarded is Communication, Collaboration, Leadership, Autonomy, Decision-making, Client Involvement, Trust, Knowledge, Learning, and Motivation. 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. Two open-ended questions can be used to identify specific issues and action suggestions such as *"In your opinion, what most influences the organizational climate in your team?"* and *"How to improve your team's organizational climate?"*

To summarize the assessment, for each team, the relative frequencies and absolute frequencies should be calculated according to the Likert scale. For example, to categorize the organizational climate, count the values "strongly agree" and "agree" as "Positive", and "strongly disagree", "disagree" as "Negative', and "neutral" as "Neutral." Neutral and negative results represent points of attention for analyzing possible causes and impacts on active roles, elements of the process, the development project, or the team's culture in general. 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. We do not identify or set boundaries for an organization to classify team climate. A simple way would be to establish the upper and lower limits for each classification. This strategy is similar to the one used in the Risk Management process. TACT theoretical framework, i.e., other hu-

man factors and project elements indicated in each item should be used to identify possible influence relations.

Finally, the results should be discussed with the team. The Review Planning can be considered to identify and select actions of control or mitigation.

A.3 Appendix: Conceptual and Operational definition of the constructs

Construct Communication

- **Conceptual definition**
  - ”The process that allows people to exchange information, feeling or thoughts” [11].
  - “The transmission of information, which may be by verbal (oral or written) or nonverbal means (see nonverbal communication). Humans communicate to relate and exchange ideas, knowledge, feelings, and experiences and for many other interpersonal and social purposes” [8]
  - Frequent communication between project stakeholders is core to agile software development [10, 97].

- **Operational definition**
  - COM.01. “The perception of participatory safety could encourage team members to be open in communicating their ideas with the team, which could otherwise be risky” [137].
  - COM.02. Vishnubhotla et al. [90] 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”.
  - COM.03. “Gap in communication between developer and customer can guarantee the success of the project while in contrast lack of communication skill causes project problems” [126].
  - COM.04. Communication is a capability for the team member [90].

- COM.05. Communication is an attribute for team [90].
- COM.06. The team has formal and informal communication [72].
- COM.07. The team discusses the project and impediments [81, 37].
- COM.08. The team discusses how to improve the process and the project [81, 37].
- COM.09. The leader is a "communication integrator" [135].

Construct Collaboration

- **Conceptual definition**
  - "The act or process of two or more people working together to obtain an outcome desired by all, as in collaborative care and collaborative learning. An interpersonal relationship in which the parties show cooperation and sensitivity to the others' needs. [first described by Henry Stack Sullivan]" [8].
  - "Team collaboration is a set of functions and activities carried out before, during, and after teamwork to achieve team objectives" [28].
  - "Customer collaboration over contract negotiation" [68].
  - "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" [187].

- **Operational definition**
  - COL.01. Team collaboration involves communication and coordination [187].
  - COL.02. Collaboration involves work as a team with i) the client (or their representative), ii) the team, and iii) others stakeholders [139, 10, 90].

Construct Leadership

- **Conceptual definition**
  - The leadership (in agile projects) is based on the role of the servant leader [37].

  - "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" [135].
  - "Agile software engineering adopts a leadership style that empowers the people involved in the development process" [97].

- **Operational definition**

  - LSH.01. Leadership is played by a formal role (Servant leadership) [37, 167].
  - LSH.02. The leader facilitates ceremonies, removes impediments, and shields the team from outside interference [37, 167].
  - LSH.03. The leader is a "communication integrator" [135].

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" [195].
  - "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" [187].

- **Operational definition**
  - AUT.01. Individual, internal, and external autonomy [187].
  - AUT.02. The team planning the tasks [187].
  - AUT.03. The leader protects the team [167, 37].
  - AUT.04. The team has good communication with the client [102].

Construct Decision-Making

- **Conceptual definition**
  - The cognitive process of choosing between two or more alternatives [8].
  - "Responding to change over following a plan" [68].
  - "At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly" [68].

- **Operational definition**
  - DEC.01. "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" [115].
  - DEC.02. "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" [29].

- DEC.03. Task identity and significance [115].
- DEC.04. The member perceives recognition of management and leadership [115].
- DEC.05. The team has fast and effective communication [97, 10].
- DEC.06. The team plains the project without stress or pression [115].
- DEC.07. The team shares decision-making [97, 10].
- DEC.08. The team autonomy influences decision-making [97, 10].

Construct Client Involvement

- **Conceptual definition**
  - "In an Agile project, the client is the person who works continuously with the software implementation team until he gets the outcome with his desired expectations [P4]. According to [P3], clients who employ project teams that follow the Agile software development process are required to be more involved with the team on a regular basis. This is to ensure that before committing to each piece of work in an iteration, all expected background knowledge and scope to be delivered to all parties" [196].
  - Having a client focus is one of the main aims of an agile team [187].
  - "Customer collaboration over contract negotiation" [68].
  - "Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely" [68].

- **Operational definition**
  - CLI.01. "The client bears the role of the product owner and participates in iteration meetings with the engineering team. The client usually participates in the following activities: story workshop, iteration planning meeting, backlog grooming, iteration review meeting, and user acceptance test" [196].

- CLI.02. Product owner focuses on scope and stakeholder management activities. The product owner is responsible for the scope before the project starts, during the project, and after the project is completed [66].
- CLI.03. Client satisfaction, collaboration, and commitment are features of client involvement. [115].
- CLI.04. A good relationship with users/clients is a motivating aspect for the team [122].
- CLI.05. The client (or their representative) provides and elucidates requirements [72].
- CLI.06. The client (or their representative) validates the software [72].
- CLI.07. "Lack of client involvement is 'the biggest problem' because Agile [requires] fairly strong client involvement" [187].
- CLI.08. "Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage" [68].

Construct Trust

- **Conceptual definition**
  - Reliance on or confidence in the dependability of someone or something. In interpersonal relationships, trust refers to the confidence that a person or group of people has in the reliability of another person or group; specifically, it is the degree to which each party feels that they can depend on the other party to do what they say they will do [8].
  - Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done [68].

- **Operational definition**
  - TRU.01. Lack of management confidence and support in agile methods can impact the enthusiasm and motivation of team members [87].
  - TRU.02. Team members trust the others to do their part [72].
  - TRU.03. Lack of client involvement can be due lack of trust [97].
  - TRU.04. Self-organizing and collaboration increase trust [97].

Construct Knowledge

- **Conceptual definition**
  - The state of being familiar with something or aware of its existence, usually resulting from experience or study. The range of one's understanding or information [8].
  - "Development of software is the process of sharing data. To create a quality product [P25] in which no member as part of the extended team has accurate and complete knowledge of all aspects of the project [P25] [P26], the knowledge of an individual, unless linked to the work of the group has no value [P27]. It involves sharing of knowledge among team members engaged in software development, client and other stakeholders are necessary for the successful project development [P25]" [194].

- **Operational definition**
  - KNO.01. Team and Product Owner know the software domain and client necessity [97, 194].
  - KNO.02. When a person or several people move out from a team, knowledge retention or poor documentation can be evidenced [97].
  - KNO.03. User stories are viewed as an essential tool for knowledge sharing [97].
  - KNO.04. Good knowledge sharing in the team is imperative for the success of agile project [97].
  - KNO.05. The organization offers training opportunities [52, 194, 99].

Construct Learning

- **Conceptual definition**
  - Team learning is conceptualized as the collective acquisition, combination, creation, and dissemination of team members' knowledge [27].
  - Learning in new product development teams spans many activities, such as acquiring, processing, disseminating, retaining and retrieving information [154].

- **Operational definition**

- LEA.01. The team member has an attitude from willingness to learn. Attitude refers to team members' prominent positive or negative beliefs about the consequences of continuing to use agile methods [87].
- LEA.02. Better communication leads to better learning and knowledge transfer [97].
- LEA.03. There are people using a variety of influences (e.g., social, political) to eliminate barriers to successful diffusion of agile methods, facilitate and encourage their on-going usage, and mentor teams [87].
- LEA.04. Teams which focused on continuously improving their existing practices and included new techniques/artefacts experienced major improvements [87].
- LEA.05. Active learning and improvement [90].

Construct Motivation

- **Conceptual definition**
  - The impetus that gives purpose or direction to behavior and operates in humans at a conscious or unconscious level [8].
  - Motivation is mainly described by the engagement and focus of individuals. What differentiates the engaged individual from an unengaged is: the level of involvement with work, applied effort, concern with results and proactivity in a work episode [197].
  - Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done [68].
  - Motivation refers to the individual/team members' aspirations and is recognized as a key success factor for software projects [87].

- **Operational definition**
  - MOT.01. Sense of belonging: Software engineers have assigned different tasks which have divided per interval. These tasks demand a sense of belonging from practitioners. This sense of belonging can be divided into intrinsic and extrinsic factors. Intrinsic belonging contain self doing of work, whereas extrinsic belonging may contain supportive role of management [12, 89].

- MOT.02. Employee participation: Individual participation is like owning a problem and try to solve it by individual force; however, as a team each member participation is necessary [12, 89].
- MOT.03. Recognition: The credit of work should be given to the employee. By given the due recognition of work motivate them to work better for the future work [12, 89].
- MOT.04. Clear Identification with Task: Understanding project requires the clarity of doing work. By clearing understanding, productivity of the system can be increased [12, 89, 80].
- MOT.05. Variety of work [12, 89].
- MOT.06. The team autonomy [12, 89, 80].
- MOT.07. High quality performance [12, 89, 80].
- MOT.08. Decision time (prioritize work product; completion; business satisfaction) [12, 89].
- MOT.09. Dynamic and fast changing adopted environment [12, 89].
- MOT.10. Stress/pressure [12, 89].
- MOT.11. Lack of bureaucracy in the development process [80, 12].
- MOT.12. Experience/skill [12, 89].
- MOT.13. Problem solving (Decision-making) [80]

A.4 Appendix: Second Evaluation by Specialists

This appendix shows the results of the second evaluation performed by specialists. The aim was to evaluate the TACT items. We invited specialists in agile methods to assess as judges the items through the perspective of Simplicity (CVIs), Cohesion (CVIc), and Relevance/Representativeness (CVIr) [83, 96]. Almanasreh et al. [83] explain that Content Validity Index (CVI) provides evidence about the degree to which elements of an assessment instrument is relevant to and representative of the targeted construct for a particular assessment purpose. In addition, we asked whether items in a dimension were redundant and captured suggestions for improvement. The comments and suggestions made by the judges were written in Portuguese, the original language of judges and researchers. The **input items** considered in the evaluation are listed in the following.

Communication: [IT1.1] In this team, we can freely talk to each other about our difficulties in the tasks, [IT1.2] Team members always talk about impediments and how to address them, [IT1.3] During the retrospectives, the team discusses the best way to improve the work, [IT1.4] The daily meeting allows us to know the project problems and team difficulties, [IT1.5] The team and the product owner always reach a consensus about the user stories priority by negotiating which bug to fix or functionality to add ,[IT1.6] In the current project, there are enough discussions on the design and the architecture of the software, [IT1.7] The team facilitator assists in understanding whether the iteration objectives are clear and whether the team agrees with these objectives.

Collaboration: [IT2.1] Team members share their know-how with the team, [IT2.2] My team collaborates very well with other teams they are working to develop the product, [IT2.3] My team works efficiently together when in the face of difficulties, [IT2.4] Team members work together as a team, [IT2.5] The team collaborates to look for new ways analyze and to solve the problems, [IT2.6] The team has excellent ability to design the software based on user stories, [IT2.7] In the current project, the team, the product owner, and the team facilitator work excellently together to plan the iteration.

Leadership: [IT3.1] The team facilitator eliminates barriers, encourages, and facilitates the use of agile methods, [IT3.2] The team facilitator listens to my ideas and concerns, [IT3.3] The team facilitator protects the team from external interference, [IT3.4] The team facilitator helps my team to identify and solve conflicts, [IT3.5] The team facilitator provides helpful feedback on how to be more agile, [IT3.6] The team facilitator investigates and helps the team to be more effective, taking into account the team velocity and the team capacity.

Autonomy: [IT4.1] In the current project, I am free to choose the tasks I want to execute in the iteration, [IT4.2] In the current project, the team facilitator protects the team autonomy from external interferences, [IT4.3] In this organization, we have autonomy to suggest changes to the team's software process development, [IT4.4] In this team, we switch assignments in tasks to avoid specialization and individualism, [IT4.5] The team has autonomy to adopt technical solutions without consulting the product owner or the management , [IT4.6] My team has autonomy to communicate with the product owner and other relevant stakeholders, [IT4.7] My team has decision authority and responsibility to plan the iteration.

Decision-making: [IT5.1] My team have time to plan the changes without excessive stress or pressure, [IT5.2] In my team, members must NOT need to think equally, [IT5.3] In the iteration planning, the team analyzes the technical alternatives and chooses the most appropriate one, [IT5.4] In the retrospective, the team identifies, analyzes and selects improvement items, [IT5.5] My team has open and effective communication, [IT5.6] This organization allows the team to make their own technical decisions about the best way to develop the project, [IT5.7] When the dependencies between tasks hinder the project execution, the team makes decisions to resolve or mitigate possible impacts, [IT5.8] In the current project, my work is recognized by the management.

Client Involvement: [IT6.1] During the demo review, the team shows and validates the new functionalities with the right people, [IT6.2] In the current project, there are frequent meetings with business representatives and the team, [IT6.3] Stakeholders always have the opportunity to suggest changes or improvements to the software, [IT6.4] In the demo review, software problems and improvements are identified with stakeholders participation, [IT6.5] The current project does NOT have frequent requirement changes due to bad user stories definition, [IT6.6] The current project has met or exceeded the client expectations, [IT6.7] The product owner is always available to explain the user stories' details,

Trust: [IT7.1] In the current project, there is a feeling of trust among team members, [IT7.2] In this organization, the management knows and supports the values, principles, and practices agile, [IT7.3] In the current project, team members develop tasks with high quality and performance, [IT7.4] In the current project, team members would feel a sense of loss if we could no longer work together, [IT7.5] I see no reason to question each team members' competence and technical skills, [IT7.6] The product owner is fully committed to providing clear information about user stories, [IT7.7] The client is fully committed to providing clear information about user stories.

Knowledge: [IT8.1] If key members decide to leave the team, the new members would NOT have difficulties to understand the code or the product backlog and its dependencies, [IT8.2] The product owner scans the organizational environment to deepen knowledge about software requirements, [IT8.3] The team knows the skills and technical expertise of the team members, [IT8.4] The knowledge transfer chain between the client and the team is NOT long and does NOT suffer information distortions and loss, [IT8.5] My team has excellent knowledge about the domain of the software developed, [IT8.6] The organization offers training opportunities, [IT8.7] The product owner has sufficient knowledge about the users' actual needs.

Learning: [IT9.1] In each iteraction, the team improves its hability to handle the most significant problems, [IT9.2] In this organization, people are promoting the effective use of agile methodologies, [IT9.3] My team has the necessary training to perform their tasks, [IT9.4] Team members have a willingness to learn about the project, [IT9.5] The team aims to continuously improve the use of existing agile practices and incorporate new practices of the Software Engineering, [IT9.6] This team improve my skills to resolve team disagreements/conflicts, [IT9.7] The team teaches me how to handle my difficulties in the tasks, [IT9.8] The team discusses new emerging technologies.

Motivation: [IT101] In the current project, my team fulfills very well the definition of done and the acceptance criteria of the user stories, [IT102] The team is experienced and have the skill to finish the current project, [IT103] In the current project, I have opportunities to develop my skills and knowledge, [IT104] The activities used in the current project are NOT bureaucratic to agile methodologies, [IT105] In the current project, I am recognized for the work done, [IT106] The team responds quickly when changes need to be done, [IT107] In the current project, I DO NOT feel stressed or excessively pressioned to execute my tasks, [IT108] The team clearly organizes and plans its work tasks, [IT109] The team has autonomy to discuss with the product owner how and when to deliver the project outcomes, [IT110] The team can use new ideas to improve the performance in the tasks and the deliverables, [IT111] Team members monitor each other's work to maintain excellence in the software quality.

Questão: Em sua opinião, algum item da dimensão é redundante? Qual(is)?	
Dimensão	**(Juiz) Sugestão**
Comunicação	(J3) Não (J7) T.1 e T.2
Colaboração	(J3) Não (J7) T2.1 e T2.2
Liderança	(J3) Não (J7) IT3.4, IT3.5 e IT3.6
Autonomia	(J1) Eu achei que sempre a resposta do 2 irá coincidir com ado 3. Se não permite mensurar, não será relevante. E vice-versa. (J2) Não. (J3) Não (J5) Creio que não. (J7) 4.3 e 4.4
Tomada de Decisão	(J1) Eu achei que sempre a resposta do 2 irá coincidir com ado 3. Se não permite mensurar, não será relevante. E vice-versa. (J2) Sim. O item IT5.6 conforme justificativa fornecida no item. (J3) NÃO (J5) Achei esta dimensão com perguntas que não autoexplicam o que se busca entender em relação a tomada de decisao, e por vezes se misturam com a dimensão de autonomia.
Envolvimento do Cliente	(J1) Eu achei que sempre a resposta do 2 irá coincidir com ado 3. Se não permite mensurar, não será relevante. E vice-versa. (J3) Não (J5) Creio que não.
Confiança	(J1) Idem ao anterior (J3) Não (J6) Não.
Conhecimento	(J1) Idem ao anterior (J3) Não (J6) Não
Aprendizado	(J1) Senti falta de algo relacionado a short learning cycles ou fail fast, um princípio importante em equipes ágeis (J3) Não (J6) Não
Motivação	(J1) Não
Tomada de Decisão (Ciclo 2)	Não

Figure A.1: Judges' comments about the existence of redundant items by dimensions. For each dimension (Dimensão in Portuguese) considered, we collected suggestions (Sugestão) from the judges (Juiz) who answered the question (Questão) "In your opinion, is any item of this dimension redundant?"

Por favor, indique uma sugestão caso você considere que o item deva ser alterado para melhor descrever o comportamento avaliado	
Item	**(Juiz) Sugestão**
[IT1.1]	
[IT1.2]	(J4) Os impedimentos deveriam ser tratados entre os membros do time somente? Não poderiam ser tratados com o PO ou Scrum Master? Não sei se fica claro se o PO ou Scrum master fazem parte dos membros do time.
[IT1.3]	(J4) Defina "a melhor maneira", acho que é bem difícil de saber isto a menos de um problema de otimização. Não seria melhor mudar para "uma maneira melhor"?(J7) Para a comunicação ser efetiva o ambiente deve ter confiança entres os membros
[IT1.4]	
[IT1.5]	(J4) Considerando o Scrum como processo de gestão de projetos, até onde sei, a definição das prioridades de desenvolvimento é prerrogativa do PO. Não há necessidade de consenso, mas sim de transferência de informação para que o PO decida de forma informada.(J7) Mensurar relacionamentos é complexo.
[IT1.6]	(J4) Defina "suficiente". Suficiente para que? Qual é o processo? A arquitetura é feita a priori ou via refactoring? Repare podemos ter muitos casos de como tratar a arquitetura em projetos ágeis. Como este questionário vai se comportar em cada um deles? (J7) Complexo mensurar essa iteração
[IT1.7]	(J4) Facilitador de equipe = Scrum Master? Iteração = Sprint ? A equipe precisa concordar com os objetivos ou só precisa ficar claro para ela quais são? Não seria melhor quebrar em duas perguntas?(J7) Deve ser medido com mais de uma variável/pergunta tipo assessment
[IT2.1]	
[IT2.2]	

Figure A.2: Judges' suggestions to improve the items. For each item (Item in Portuguese) considered, we collected suggestions (Sugestão) from the judges (Juiz) who answered the question (Questão) "Do you have any suggestion to improve the item description?"

Por favor, indique uma sugestão caso você considere que o item deva ser alterado para melhor descrever o comportamento avaliado	
Item	**(Juiz) Sugestão**
[IT2.3]	(J7) Complexo medir a eficiência em situações de dificuldades
[IT2.4]	(J7) através de um item somente não é representativo
[IT2.5]	
[IT2.6]	(J4) No que projetar o software com base nas histórias de usuário tem a ver com colaboração? Se somente uma pessoa projeta não tem colaboração. Precisa incluir na pergunta se a equipe/stakeholders colaboram para isto.(J7) Medir excelência de histórias de usuários pode ser subjetivo, definição de critérios é essencial.
[IT2.7]	(J4) Defina "muito bem". Somente eles (PO e SM) deveriam colaborar para planejar a iteração?(J7) Necessário ter mais do que um item para poder avaliar.
[IT3.1]	(J4) Repare, o facilitador pode fazer isto de forma reativa, o que para mim, não repersenta liderança de forma alguma. Ele deveria tomar ações de forma pró-ativa para isto, ai concordo que representaria liderança. O mesmo comentário serve para os outros itens da dimenção liderança.(J7) Necessário ter mais do que um item para poder avaliar.
[IT3.2]	
[IT3.3]	(J7) Necessita outra métrica ou dimensão para validar, tipo se não aumentaram os pontos de histórias de usuários ou o sprint backlog.
[IT3.4]	(J7) Indicador próprio
[IT3.5]	(J4) Defina "ser mais ágil", é trabalhar mais rápido ou seguir melhor os métodos ágeis?(J7) Indicador próprio
[IT3.6]	(J4) Não seria ser mais eficiente? velocidade e capacidade dizem respeito a eficiência, eficaz seria fazer o trabalho de maneira acertiva. (J7) Indicador próprio

Figure A.3: Judges' suggestions to improve the items. For each item (Item in Portuguese) considered, we collected suggestions (Sugestão) from the judges (Juiz) who answered the question (Questão) "Do you have any suggestion to improve the item description?" (Continuation)

Por favor, indique uma sugestão caso você considere que o item deva ser alterado para melhor descrever o comportamento avaliado	
Item	**(Juiz) Sugestão**
[IT4.1]	(J5) Escolher é diferente de definir / criar. Escolher remete que alguem está dando uma lista possível e outro alguem escolhe nesta lista. Isso é autonomia mais ou menos. Na agilidade o time pode criar novas tarefas a medida q identifica a necessidade para entregar o objetivo. Quanto a mesurar a dimensão, creio que nenhum isoladamente mensure. Este comentário serve para todos os itens.
[IT4.2]	(J2) Devido ao fato de cada empresa possuir um organograma diferente, o "team facilitator" vai gerar perguntas para mapeá-lo ao papel correto dentro da empresa. Isso afeta um pouco a clareza do item.(J5) NA
[IT4.3]	(J1) Sugiro, em inglês, usar "software development process"(J5) A análise de time e corporativa deve ser separada, pois um time que tem autonomia, a tem dentro do spectro de desenvolvimento. Ela pode sugerir melhorias no processo de desenvolvimento, mas pode não ter poder para mudar o processo. Ainda assim, entendo que se o time tem liberdade para desenvolver seu produto, mas não tem liberdade para mudar o processo organizacional... ainda entendo como um time autonomo. O processo de desenvolvimento da equipe ainda é da organização. Se cada equipe tiver o seu processo, desconectado de uma estratégia organizacional, pode trazer alto risco para a organização como um todo.
[IT4.4]	(J1) Não estou certa se troca de tarefas entre entre membros da equipe seria uma medida de autonomia. (J2) Acho que o item é fácil de ser entendido e relevante, mas acho que a dimensão associada é gestão de conhecimento e não autonomia. Autonomia para mim seria a liberdade de escolher quando e como fazer isso. Isso porque estou considerando autonomia do time e não de cada profissional. Também acho que o item IT4.1 está mais diretamente relacioano a isso. Se eu tenho liberdade de escolher minhas tarefas, elas não estão associadas a determinadas pessoas/papéis dentro da equipe.(J5) Talvez o trecho "trocamos responsabilidades em tarefas" traga algumas confusões. Eu prefiro palavra atribuições do que responsabilidade, pois a reponsabilidade é compartilhada. Talvez: "trocamos atribuições entre as tarefas para .... "
[IT4.5]	(J1) Em inglês, eu trocaria "management" por "manager"(J5) NA

Figure A.4: Judges' suggestions to improve the items. For each item (Item in Portuguese) considered, we collected suggestions (Sugestão) from the judges (Juiz) who answered the question (Questão) "Do you have any suggestion to improve the item description?" (Continuation)

Por favor, indique uma sugestão caso você considere que o item deva ser alterado para melhor descrever o comportamento avaliado	
Item	**(Juiz) Sugestão**
[IT4.6]	(J2) Acho muito vago. O que seria uma comunicação excelente? Sugiro trocar por atributos mais claros.(J3) Acredito que esta pergunta seria mais adequada para analisar a dimensão Comunicação. Dentro desta dimensão uma proposta de questão seria: "Minha equipe tem total acesso para discutir qualquer assunto com o dono do projeto e o cliente"(J5) Qual é a relação com a autonomia ? Não peguei o ponto. Existem times que não tem comunicação com o cliente, mas podem ter um defeso muito bem feito de sua autonomia por outras roles e áreas ... é difícil dizer que a comunicação tenha relação direta com a autonomia. Acho que indiretamente a comunicação é relevante para todas as dimensões.
[IT4.7]	(J1) O que seria "substancial autoridade de decisão"? Não seria simplesmente "autoridade"? Minha equipe tem responsabilidade e autoridade para planejar as interações". "My team has responsbility and authority to plan interactions". Ou, talvez, a palavra "ownership", que o é sentimento de responsabilidade e pertença a algo. Ownership quanto ao planejamento das iterações.(J5) Acho que é importante definir quem é a equipe. Pois aqui pode gerar uma confusão. Existem várias topologias de equipes e pode ser verdade para umas e não para outras. Por exemplo: a equipe é apenas o time de engenharia? Se for, é um antipadrão.
[IT5.1]	(J3) O estresse e a pressão faem parte da tomada de decisão. Acredito que uma proposta para esse dimensão seria: "Minha equipe planena mudanças"(J5) Eu acho que o trecho da frase "sem stress ou pressão excessiva" ruim. Quem mede o stress? ou a pressão excessiva ? o item é importante, mas deve-se usar "ritmo sustentável". Este inclusive é um dos princípios do manifesto ágil.
[IT5.2]	(J3) Acredito que seria mais clara a questão se reescreveê-la para retirar a sentença negativa.(J5) NA(J7) como medir de forma fácil?
[IT5.3]	(J1) Cuidado com a voz passiva no inglês. O ideal é sempre escrever "my team analyzes and selects technical solutions". Sugiro que você faça repasse as questões em inglês a um revisor nativo. Além do uso da voz passiva, em muitas delas sinto uma tradução literal. Um revisor nativo irá mudar a forma em que a frase é escrita e deixar mais palatável ao leitor estrangeiro..(J5) NA(J7) parece redundante aos itens 4.3 e 4.4
[IT5.4]	(J5) NA(J7) mensurar os itens de melhoria requer um esforço que pode ser grande
[IT5.5]	(J5) Acho que aqui precisamos de uma adequação do que está buscando visualizar da dimensão no time ágil. Acho este item aberto demais. O que é uma decisão eficaz para Tomada de Decisão ? é a que decidem ? ou é a que decidem e deu certo ? ou a que todos concordam ? Acho que precisa repensar.(J7) a comunicação na tomada de decisão é complexa

Figure A.5: Judges' suggestions to improve the items. For each item (Item in Portuguese) considered, we collected suggestions (Sugestão) from the judges (Juiz) who answered the question (Questão) "Do you have any suggestion to improve the item description?" (Continuation)

Por favor, indique uma sugestão caso você considere que o item deva ser alterado para melhor descrever o comportamento avaliado	
Item	**(Juiz) Sugestão**
[IT5.6]	(J2) Vejo uma forte relação com autonomia, item IT4.5. Sinto que esse item pode ser redundante dados os itens IT4.5 e IT5.3.(J5) Esta é redundante com o IT5.3(J7) redundante a itens anteriores, ou seja, itens com a mesma descrição abrangem diversas possibilidades
[IT5.7]	(J1) Não vejo que a dependência entre as tarefas tenha a ver com tomada de decisão.(J2) Sinto que isso mede melhor a auto-gestão da equipe ou sua autonomia no sentido de se planejar adequadamente com relação as dependências.(J3) Segue uma proposta de questão para essa dimensão: "Quando dependências entre tarefas atrapalham a fluidez do projeto, a equipe toma decisões para resolver ou minimizar esses impactos" (J5) Não está claro o vinculo das dependencias com a tomada de decisão. Outro ponto é que as dependencia atrapalham, este é um fato, mas o time precisa organizar como vencem as dependências, e isso depende do time inteiro, inclusive o PO. (J7) complexidade envolvida, pois são muitas as dimensões de interdepência
[IT5.8]	(J1) Idem ao anterior(J2) Fico na dúvida se reconhecimento é relacionado à tomada de decisão... podemos ter liberdade de tomada de decisão e não reconhecimento e vice-versa.(J5) Reconhecimento em que sentido, e qual o vínculo com a tomada de decisão?
[IT6.1]	(J5) NA
[IT6.2]	(J5) NA
[IT6.3]	(J5) NA
[IT6.4]	(J2) Sugiro trocar por review ou adicionar a palavra review, como no critérios IT6.1.(J5) Aqui sugiro uma melhoria: na demo são discutidas melhorias para o produto e não para o projeto. Sugiro que troque a palavra, pois para alguns metódos como o Scrum, vai parecer um erro.
[IT6.5]	(J1) Não estou certa se problemas na definição dos requisitos estariam relacionados ao envolvimento do cliente.(J5) Aqui é mais complexo do que isso, é pode ser utilizado como bengala pelo time para não assumir a sua parte da reponsabilidade. Item complicado.
[IT6.6]	(J5) Aqui é o cliente que pode usar este item como bengala. São vários os motivos que podem fazer com que as expectativas não sejam atendidas.
[IT6.7]	(J5) NA

Figure A.6: Judges' suggestions to improve the items. For each item (Item in Portuguese) considered, we collected suggestions (Sugestão) from the judges (Juiz) who answered the question (Questão) "Do you have any suggestion to improve the item description?" (Continuation)

Por favor, indique uma sugestão caso você considere que o item deva ser alterado para melhor descrever o comportamento avaliado	
Item	**(Juiz) Sugestão**
[IT7.1]	(J6) Se o foco é apenas times ágeis, trocaria sempre a palavra project/projeto por product or service/produto ou serviço.(J7) Mensuração qualitativa
[IT7.2]	(J3) Acredito que seria mais simples e objetivo atribuir um foco único a questão. Exemplo: "Nesta organização a gerência apoia metodologias ágeis". Pode-se também criar duas perguntas, uma para cada questão. Exemplo2: "Nesta organização a gerência conhece metodologias ágeis"(J6) Mudaria a frase para "apoia o uso de práticas e valores ágeis". Além disso, moveria para a dimensão de liderança.(J7) Mensuração qualitativa
[IT7.3]	(J3) O que é alta qualidade? O que é desempenho? Acredito que estas questões poderiam ser melhor definidas para o entrevistado e serem separadas em perguntas distintas.(J6) Trocaria performance/desempenho por eficiência/efficiency pois traduz melhor o conceito e simplifica o entendimento. Moveria para a dimensão de conhecimento.
[IT7.4]	(J6) Se o foco é apenas times ágeis, trocaria sempre a palavra project/projeto por product or service/produto ou serviço.
[IT7.5]	
[IT7.6]	(J6) Manter o termo product owner mesmo em português porque é mais utilizado que dono do produto. Sobre a pergunta em si, achei específica demais, se for mensurar este papel, é necessário mensurar também o Scrum Master e o Time de Desenvolvimento.
[IT7.7]	(J1) Talvez você possa incluir em Confiança o comprometimento do PO/cliente em validar o produto final. E também a confiança dada nas estimativas da equipe. (J6) O cliente não é responsável por fornecer informações sobre as histórias de usuário de acordo com o Scrum Guide. Se quiser adicionar uma pergunta sobre a relação com o cliente eu colocaria no âmbito de satisfação do cliente com o produto/serviço.
[IT8.1]	(J3) Acredito que seria mais simples e objetivo atribuir um foco único a questão ou criar uma pergunta para cada item: código, backlog e dependências.(J6) O uso da palavra "most/maioria" me parece drástico, trocaria por alguns/some.
[IT8.2]	(J1) Acho importante o PO conhecer também o processo de desenvolvimento da equipe.(J3) Acredito que seria mais simples e objetivo atribuir um foco único a questão ou criar uma pergunta para cada item: ambiente interno e ambiente externo.(J6) Trocaria requisitos do software por necessidades do cliente/mercado.
[IT8.3]	(J3) Acredito que seria mais simples e objetivo atribuir um foco único a questão ou criar uma pergunta para cada item: "A equipe conhece as habilidades e conhecimentos técnicos dos membros da equipe" e "A equipe usa as habilidades e conhecimentos técnicos de forma adequada".

Figure A.7: Judges' suggestions to improve the items. For each item (Item in Portuguese) considered, we collected suggestions (Sugestão) from the judges (Juiz) who answered the question (Questão) "Do you have any suggestion to improve the item description?" (Continuation)

Por favor, indique uma sugestão caso você considere que o item deva ser alterado para melhor descrever o comportamento avaliado	
Item	**(Juiz) Sugestão**
[IT8.4]	(J1) O que seria uma cadeia de transferência de conhecimento?(J3) Acredito que seria mais simples e objetivo atribuir um foco único a questão e reescrever para retirar a sentença negativa.(J6) Trocaria transferência de conhecimento por troca de informações ou comunicação de necessidades.
[IT8.5]	
[IT8.6]	(J6) Trocaria treinamento por capacitação, dado que muitas formas de adquirir conhecimento não são necessariamente treinamentos.
[IT8.7]	(J6) Practice/prática me parece dificil de entender, trocaria por product usage / uso do produto.
[IT9.1]	
[IT9.2]	(J1) Este item é bastante amplo para ser avaliado: "uso eficaz de métodos ágeis"
[IT9.3]	(J1) Sobrescreveu com o treinamento do item anterior [IT8.6](J6) Se manter em treinamento, colocaria na dimensão de conhecimento. Se quiser manter aqui minha sugestão é trocar treinamento por competências.
[IT9.4]	
[IT9.5]	(J6) Adicionaria um item sobre melhoria contínua e ciclos curtos.
[IT9.6]	(J6) Não entendi a conexão de resolução de conflitos ser algo que o time desenvolve na pessoa. Talvez valha a pena reescrever para algo como "Nessa equipe resolvemos conflitos de forma saudável".
[IT9.7]	
[IT9.8]	
[IT101]	(J5) De forma excelente é difícil de tangir. Por mim rira esta parte da frase.
[IT102]	(J1) Tenho dúvidas do quanto à experiência estaria relacionada à motivação. Posso ter membros experientes, com habilidades, e desmotivados.(J3) Um colaborador da equipe pode ter uma habilidade que auxilia a equipe a terminar o projeto, porém ela não é experiente. Nesta situação o entrevistado pode ter dúvidas ao responder e gerar um viés de pesqusa.(J5) Talvez não seja verdade que pessoas sem algumas habilidades para terminar o projeto impacte na motivação. Um time ágil deveria ser provocado para aprender contínuamente. Algumas descobertas são feitas com técnicas ágeis, como o spike. Na verdade a liderança deve direcionar o time para que entendam que é normal não conhecermos tudo.
[IT103]	(J5) Este item conflita com o anterior.

Figure A.8: Judges' suggestions to improve the items. For each item (Item in Portuguese) considered, we collected suggestions (Sugestão) from the judges (Juiz) who answered the question (Questão) "Do you have any suggestion to improve the item description?" (Continuation)

Por favor, indique uma sugestão caso você considere que o item deva ser alterado para melhor descrever o comportamento avaliado	
Item	**(Juiz) Sugestão**
[IT104]	(J1) Sim. Trabalhos menos burocráticos parecem ser mais motivantes para a maioria dos desenvolvedores.(J5) Aqui pode estar sendo criado um gatilho gerador de problema e não algo para capturar o nível de motivação. Alguns pontos: o que são atividades burocráticas? Quais são elas ? É vago demais perguntar desta forma. Um processo ágil é um tipo de organização burocrática. Resta saber se esta organização (full ou adaptada) está clara, é seguida, passa por ciclos de melhoria, se adequa a organização, tem medidas relevantes.
[IT105]	
[IT106]	(J5) Aqui deveria tratar mais do entenimento sobre as mudanças, do que da capacidade de mudar. Uma equipe pode não mudar tão rápido mas se ela entende que mudanças são algo natural na agilidade, podemos ter algo para trabalhar no sentio de melhorar a motivação.
[IT107]	(J3) A negativa nas duas partes do item torna a questão possível de interpretação errônea. Além disso, uma pessoa pode estar estressada e não ter pressão no ambiente de trabalho.
[IT108]	
[IT109]	
[IT110]	
[IT111]	(J1) Tenho dúvidas quanto ao fato de monitorar os trabalhos dos outros membros da equipe. Não acredito que isso seja fator de motivação para um desenvolvedor. Sem dúvida é para o gerente de projetos. Só uma opinião empírica.(J5) Acho que o IT 109 captura isso sem entrar em discussão do que é exatamente monitorar trabalho para manter excelência. O que é monitorar? Olhar o quadro e ver se está feito ou não ? Fazer algum tipo de ação?

Figure A.9: Judges' suggestions to improve the items. For each item (Item in Portuguese) considered, we collected suggestions (Sugestão) from the judges (Juiz) who answered the question (Questão) "Do you have any suggestion to improve the item description?" (Continuation)

O item é simples de ser entendido											
Simplicidade						Total			%	CVI(s)
Item	DT	DP	N	CP	CT	D	N	C	C	
[IT1.1]	0	0	0	0	3	0	0	3	100,0	1,00
[IT1.2]	0	0	0	1	2	0	0	3	100,0	1,00
[IT1.3]	0	1	0	1	1	1	0	2	66,7	0,67
[IT1.4]	0	0	0	0	3	0	0	3	100,0	1,00
[IT1.5]	0	0	0	2	1	0	0	3	100,0	1,00
[IT1.6]	0	1	1	0	1	1	1	1	33,3	0,33
[IT1.7]	0	0	0	1	2	0	0	3	100,0	1,00
[IT2.1]	0	0	0	0	3	0	0	3	100,0	1,00
[IT2.2]	0	0	0	0	3	0	0	3	100,0	1,00
[IT2.3]	0	1	0	0	2	1	0	2	66,7	0,67
[IT2.4]	0	0	1	0	2	0	1	2	66,7	0,67
[IT2.5]	0	0	0	0	3	0	0	3	100,0	1,00
[IT2.6]	0	1	0	1	1	1	0	2	66,7	0,67
[IT2.7]	0	0	0	2	1	0	0	3	100,0	1,00
[IT3.1]	0	1	0	0	2	1	0	2	66,7	0,67
[IT3.2]	0	0	0	0	3	0	0	3	100,0	1,00
[IT3.3]	0	1	0	0	2	1	0	2	66,7	0,67
[IT3.4]	0	0	0	1	2	0	0	3	100,0	1,00

O item permite mensurar a dimensão associada										
Coerência						Total			%	CVI(c)
Item	DT	DP	N	CP	CT	D	N	C	C	
[IT1.1]	0	0	0	0	3	0	0	3	100,0	1,00
[IT1.2]	0	0	0	1	2	0	0	3	100,0	1,00
[IT1.3]	0	0	2	1	0	0	2	1	33,3	0,33
[IT1.4]	0	0	0	0	3	0	0	3	100,0	1,00
[IT1.5]	0	0	0	2	1	0	0	3	100,0	1,00
[IT1.6]	0	1	0	1	1	1	0	2	66,7	0,67
[IT1.7]	0	0	0	1	2	0	0	3	100,0	1,00
[IT2.1]	0	0	0	0	3	0	0	3	100,0	1,00
[IT2.2]	0	0	0	0	3	0	0	3	100,0	1,00
[IT2.3]	0	1	0	0	2	1	0	2	66,7	0,67
[IT2.4]	0	0	1	0	2	0	1	2	66,7	0,67
[IT2.5]	0	0	0	0	3	0	0	3	100,0	1,00
[IT2.6]	2	0	0	1	0	2	0	1	33,3	0,33
[IT2.7]	0	0	0	2	1	0	0	3	100,0	1,00
[IT3.1]	0	0	0	2	1	0	0	3	100,0	1,00
[IT3.2]	0	0	0	0	3	0	0	3	100,0	1,00
[IT3.3]	0	0	0	1	2	0	0	3	100,0	1,00
[IT3.4]	0	0	0	1	2	0	0	3	100,0	1,00

O item é relevante/representativo										
Relev./Repres.						Total			%	CVI(r)
Item	DT	DP	N	CP	CT	D	N	C	C	
[IT1.1]	0	0	0	0	3	0	0	3	100,0	1,00
[IT1.2]	0	0	0	1	2	0	0	3	100,0	1,00
[IT1.3]	0	0	2	1	0	0	2	1	33,3	0,33
[IT1.4]	0	0	0	0	3	0	0	3	100,0	1,00
[IT1.5]	1	0	0	2	0	1	0	2	66,7	0,67
[IT1.6]	0	0	1	0	2	0	1	2	66,7	0,67
[IT1.7]	0	0	0	1	2	0	0	3	100,0	1,00
[IT2.1]	0	0	0	0	3	0	0	3	100,0	1,00
[IT2.2]	0	0	0	0	3	0	0	3	100,0	1,00
[IT2.3]	0	0	0	1	2	0	0	3	100,0	1,00
[IT2.4]	0	0	0	0	3	0	0	3	100,0	1,00
[IT2.5]	0	0	0	0	3	0	0	3	100,0	1,00
[IT2.6]	0	1	0	2	0	1	0	2	66,7	0,67
[IT2.7]	0	0	0	1	2	0	0	3	100,0	1,00
[IT3.1]	0	0	0	0	3	0	0	3	100,0	1,00
[IT3.2]	0	0	0	0	3	0	0	3	100,0	1,00
[IT3.3]	0	0	0	1	2	0	0	3	100,0	1,00
[IT3.4]	0	0	0	1	2	0	0	3	100,0	1,00

Figure A.10: CVI value by item to Simplicity (CVIs), Cohesion (CVIc), and Relevance/Representativeness (CVIr). The statements used were “The item is simple to understand” (Simplicity) - (O item é simples de ser entendido in Portuguese); “The item allows measuring the associated dimension” (Coherence) - (O item permite mensurar a dimensão associada); and “The item is relevant/representative” (Relevance/Representativeness) - (O item é relevante/representativo). The calculation was made by dividing the number of judges who attributed values (4 and 5) of the Likert scale (5 points) by the total number of judges who evaluated the item [96].

O item é simples de ser entendido											
Simplicidade						Total			%	CVI(s)	
Item	DT	DP	N	CP	CT	D	N	C	C		
[IT3.5]	0	0	0	2	1	0	0	3	100,0	1,00	
[IT3.6]	0	0	0	2	1	0	0	3	100,0	1,00	
[IT4.1]	0	0	0	1	4	0	0	5	100,0	1,00	
[IT4.2]	0	0	0	2	3	0	0	5	100,0	1,00	
[IT4.3]	0	1	0	0	4	1	0	4	80,0	0,80	
[IT4.4]	0	0	0	1	4	0	0	5	100,0	1,00	
[IT4.5]	0	0	0	0	5	0	0	5	100,0	1,00	
[IT4.6]	0	1	0	1	3	1	0	4	80,0	0,80	
[IT4.7]	0	0	0	2	3	0	0	5	100,0	1,00	
[IT5.1]	0	0	0	1	4	0	0	5	100,0	1,00	
[IT5.2]	0	1	0	1	3	1	0	4	80,0	0,80	
[IT5.3]	0	0	0	0	5	0	0	5	100,0	1,00	
[IT5.4]	0	0	0	0	5	0	0	5	100,0	1,00	
[IT5.5]	0	0	0	0	5	0	0	5	100,0	1,00	
[IT5.6]	0	0	0	0	5	0	0	5	100,0	1,00	
[IT5.7]	0	0	0	1	4	0	0	5	100,0	1,00	
[IT5.8]	0	1	0	0	4	1	0	4	80,0	0,80	
[IT6.1]	0	0	0	0	5	0	0	5	100,0	1,00	

O item permite mensurar a dimensão associada										
Coerência						Total			%	CVI(c)
Item	DT	DP	N	CP	CT	D	N	C	C	
[IT3.5]	0	0	0	2	1	0	0	3	100,0	1,00
[IT3.6]	0	0	0	2	1	0	0	3	100,0	1,00
[IT4.1]	0	0	0	2	3	0	0	5	100,0	1,00
[IT4.2]	0	0	0	2	3	0	0	5	100,0	1,00
[IT4.3]	1	0	0	0	4	1	0	4	80,0	0,80
[IT4.4]	0	2	0	1	2	2	0	3	60,0	0,60
[IT4.5]	0	0	0	1	4	0	0	5	100,0	1,00
[IT4.6]	0	1	1	1	2	1	1	3	60,0	0,60
[IT4.7]	0	0	0	2	3	0	0	5	100,0	1,00
[IT5.1]	0	1	0	1	3	1	0	4	80,0	0,80
[IT5.2]	0	1	0	2	2	1	0	4	80,0	0,80
[IT5.3]	0	1	0	1	3	1	0	4	80,0	0,80
[IT5.4]	0	0	0	2	3	0	0	5	100,0	1,00
[IT5.5]	0	1	3	0	1	1	3	1	20,0	0,20
[IT5.6]	0	0	1	1	3	0	1	4	80,0	0,80
[IT5.7]	0	3	2	0	0	3	2	0	0,0	0,00
[IT5.8]	1	2	1	1	0	3	1	1	20,0	0,20
[IT6.1]	0	0	0	2	3	0	0	5	100,0	1,00

O item é relevante/representativo										
Relev./Repres.						Total			%	CVI(r)
Item	DT	DP	N	CP	CT	D	N	C	C	
[IT3.5]	0	1	0	1	1	1	0	2	66,7	0,67
[IT3.6]	0	0	0	2	1	0	0	3	100,0	1,00
[IT4.1]	0	0	0	2	3	0	0	5	100,0	1,00
[IT4.2]	0	0	0	1	4	0	0	5	100,0	1,00
[IT4.3]	0	0	0	1	4	0	0	5	100,0	1,00
[IT4.4]	0	1	0	0	4	1	0	4	80,0	0,80
[IT4.5]	0	0	0	0	5	0	0	5	100,0	1,00
[IT4.6]	0	1	0	2	2	1	0	4	80,0	0,80
[IT4.7]	0	0	0	1	4	0	0	5	100,0	1,00
[IT5.1]	0	1	0	1	3	1	0	4	80,0	0,80
[IT5.2]	0	1	0	1	3	1	0	4	80,0	0,80
[IT5.3]	0	0	0	0	5	0	0	5	100,0	1,00
[IT5.4]	0	0	0	0	5	0	0	5	100,0	1,00
[IT5.5]	0	1	3	0	1	1	3	1	20,0	0,20
[IT5.6]	0	0	0	0	5	0	0	5	100,0	1,00
[IT5.7]	0	2	1	1	1	2	1	2	40,0	0,40
[IT5.8]	2	1	1	0	1	3	1	1	20,0	0,20
[IT6.1]	0	0	0	0	5	0	0	5	100,0	1,00

Figure A.11: CVI value by item to Simplicity (CVIs), Cohesion (CVIc), and Relevance/Representativeness (CVIr). The statements used were “The item is simple to understand” (Simplicity) - (O item é simples de ser entendido in Portuguese); “The item allows measuring the associated dimension” (Coherence) - (O item permite mensurar a dimensão associada); and “The item is relevant/representative” (Relevance/Representativeness) - (O item é relevante/representativo). The calculation was made by dividing the number of judges who attributed values (4 and 5) of the Likert scale (5 points) by the total number of judges who evaluated the item [96]. (Continuation)

O item é simples de ser entendido											
Simplicidade						Total			%	CVI(s)	
Item	DT	DP	N	CP	CT	D	N	C	C		
[IT6.2]	0	0	0	1	4	0	0	5	100,0	1,00	
[IT6.3]	0	0	0	0	5	0	0	5	100,0	1,00	
[IT6.4]	0	0	0	1	4	0	0	5	100,0	1,00	
[IT6.5]	1	0	0	0	4	1	0	4	80,0	0,80	
[IT6.6]	0	0	0	0	5	0	0	5	100,0	1,00	
[IT6.7]	0	0	0	0	5	0	0	5	100,0	1,00	
[IT7.1]	0	0	0	1	3	0	0	4	100,0	1,00	
[IT7.2]	0	0	0	1	3	0	0	4	100,0	1,00	
[IT7.3]	0	0	0	2	2	0	0	4	100,0	1,00	
[IT7.4]	0	0	0	1	3	0	0	4	100,0	1,00	
[IT7.5]	1	0	0	0	3	1	0	3	75,0	0,75	
[IT7.6]	0	0	0	1	3	0	0	4	100,0	1,00	
[IT7.7]	0	0	0	1	3	0	0	4	100,0	1,00	
[IT8.1]	0	0	0	1	3	0	0	4	100,0	1,00	
[IT8.2]	0	0	0	1	3	0	0	4	100,0	1,00	
[IT8.3]	0	0	0	1	3	0	0	4	100,0	1,00	
[IT8.4]	0	2	0	0	2	2	0	2	50,0	0,50	
[IT8.5]	0	0	0	1	3	0	0	4	100,0	1,00	

O item permite mensurar a dimensão associada										
Coerência						Total			%	CVI(c)
Item	DT	DP	N	CP	CT	D	N	C	C	
[IT6.2]	0	1	0	1	3	1	0	4	80,0	0,80
[IT6.3]	0	0	0	2	3	0	0	5	100,0	1,00
[IT6.4]	0	0	0	2	3	0	0	5	100,0	1,00
[IT6.5]	0	3	0	0	2	3	0	2	40,0	0,40
[IT6.6]	0	1	0	1	3	1	0	4	80,0	0,80
[IT6.7]	0	0	0	2	3	0	0	5	100,0	1,00
[IT7.1]	0	0	0	2	2	0	0	4	100,0	1,00
[IT7.2]	0	1	0	2	1	1	0	3	75,0	0,75
[IT7.3]	0	1	1	1	1	1	1	2	50,0	0,50
[IT7.4]	0	0	0	1	3	0	0	4	100,0	1,00
[IT7.5]	1	0	0	0	3	1	0	3	75,0	0,75
[IT7.6]	0	1	0	1	2	1	0	3	75,0	0,75
[IT7.7]	1	0	1	0	2	1	1	2	50,0	0,50
[IT8.1]	0	1	0	0	3	1	0	3	75,0	0,75
[IT8.2]	0	2	0	0	2	2	0	2	50,0	0,50
[IT8.3]	0	1	0	0	3	1	0	3	75,0	0,75
[IT8.4]	0	1	1	1	1	1	1	2	50,0	0,50
[IT8.5]	0	0	0	1	3	0	0	4	100,0	1,00

O item é relevante/representativo										
Relev./Repres.						Total			%	CVI(r)
Item	DT	DP	N	CP	CT	D	N	C	C	
[IT6.2]	0	0	0	1	4	0	0	5	100,0	1,00
[IT6.3]	0	0	0	0	4	0	0	4	100,0	1,00
[IT6.4]	0	0	0	1	4	0	0	5	100,0	1,00
[IT6.5]	0	3	0	0	2	3	0	2	40,0	0,40
[IT6.6]	0	1	0	1	3	1	0	4	80,0	0,80
[IT6.7]	0	0	0	1	4	0	0	5	100,0	1,00
[IT7.1]	0	0	0	1	3	0	0	4	100,0	1,00
[IT7.2]	0	0	0	1	3	0	0	4	100,0	1,00
[IT7.3]	0	0	0	2	2	0	0	4	100,0	1,00
[IT7.4]	0	0	0	0	4	0	0	4	100,0	1,00
[IT7.5]	1	0	0	0	3	1	0	3	75,0	0,75
[IT7.6]	0	2	0	0	2	2	0	2	50,0	0,50
[IT7.7]	1	0	0	1	2	1	0	3	75,0	0,75
[IT8.1]	0	1	0	0	3	1	0	3	75,0	0,75
[IT8.2]	0	1	0	1	2	1	0	3	75,0	0,75
[IT8.3]	0	0	0	1	3	0	0	4	100,0	1,00
[IT8.4]	0	1	1	1	1	1	1	2	50,0	0,50
[IT8.5]	0	0	0	1	3	0	0	4	100,0	1,00

Figure A.12: CVI value by item to Simplicity (CVIs), Cohesion (CVIc), and Relevance/Representativeness (CVIr) The statements used were “The item is simple to understand” (Simplicity) - (O item é simples de ser entendido in Portuguese); “The item allows measuring the associated dimension” (Coherence) - (O item permite mensurar a dimensão associada); and “The item is relevant/representative” (Relevance/Representativeness) - (O item é relevante/representativo). The calculation was made by dividing the number of judges who attributed values (4 and 5) of the Likert scale (5 points) by the total number of judges who evaluated the item [96]. (Continuation)

O item é simples de ser entendido											
Simplicidade						Total			%	CVI(s)
Item	DT	DP	N	CP	CT	D	N	C	C	
[IT6.2]	0	0	0	1	4	0	0	5	100,0	1,00
[IT6.3]	0	0	0	0	5	0	0	5	100,0	1,00
[IT6.4]	0	0	0	1	4	0	0	5	100,0	1,00
[IT6.5]	1	0	0	0	4	1	0	4	80,0	0,80
[IT6.6]	0	0	0	0	5	0	0	5	100,0	1,00
[IT6.7]	0	0	0	0	5	0	0	5	100,0	1,00
[IT7.1]	0	0	0	1	3	0	0	4	100,0	1,00
[IT7.2]	0	0	0	1	3	0	0	4	100,0	1,00
[IT7.3]	0	0	0	2	2	0	0	4	100,0	1,00
[IT7.4]	0	0	0	1	3	0	0	4	100,0	1,00
[IT7.5]	1	0	0	0	3	1	0	3	75,0	0,75
[IT7.6]	0	0	0	1	3	0	0	4	100,0	1,00
[IT7.7]	0	0	0	1	3	0	0	4	100,0	1,00
[IT8.1]	0	0	0	1	3	0	0	4	100,0	1,00
[IT8.2]	0	0	0	1	3	0	0	4	100,0	1,00
[IT8.3]	0	0	0	1	3	0	0	4	100,0	1,00
[IT8.4]	0	2	0	0	2	2	0	2	50,0	0,50
[IT8.5]	0	0	0	1	3	0	0	4	100,0	1,00

O item permite mensurar a dimensão associada										
Coerência						Total			%	CVI(c)
Item	DT	DP	N	CP	CT	D	N	C	C	
[IT6.2]	0	1	0	1	3	1	0	4	80,0	0,80
[IT6.3]	0	0	0	2	3	0	0	5	100,0	1,00
[IT6.4]	0	0	0	2	3	0	0	5	100,0	1,00
[IT6.5]	0	3	0	0	2	3	0	2	40,0	0,40
[IT6.6]	0	1	0	1	3	1	0	4	80,0	0,80
[IT6.7]	0	0	0	2	3	0	0	5	100,0	1,00
[IT7.1]	0	0	0	2	2	0	0	4	100,0	1,00
[IT7.2]	0	1	0	2	1	1	0	3	75,0	0,75
[IT7.3]	0	1	1	1	1	1	1	2	50,0	0,50
[IT7.4]	0	0	0	1	3	0	0	4	100,0	1,00
[IT7.5]	1	0	0	0	3	1	0	3	75,0	0,75
[IT7.6]	0	1	0	1	2	1	0	3	75,0	0,75
[IT7.7]	1	0	1	0	2	1	1	2	50,0	0,50
[IT8.1]	0	1	0	0	3	1	0	3	75,0	0,75
[IT8.2]	0	2	0	0	2	2	0	2	50,0	0,50
[IT8.3]	0	1	0	0	3	1	0	3	75,0	0,75
[IT8.4]	0	1	1	1	1	1	1	2	50,0	0,50
[IT8.5]	0	0	0	1	3	0	0	4	100,0	1,00

O item é relevante/representativo										
Relev./Repres.						Total			%	CVI(r)
Item	DT	DP	N	CP	CT	D	N	C	C	
[IT6.2]	0	0	0	1	4	0	0	5	100,0	1,00
[IT6.3]	0	0	0	0	4	0	0	4	100,0	1,00
[IT6.4]	0	0	0	1	4	0	0	5	100,0	1,00
[IT6.5]	0	3	0	0	2	3	0	2	40,0	0,40
[IT6.6]	0	1	0	1	3	1	0	4	80,0	0,80
[IT6.7]	0	0	0	1	4	0	0	5	100,0	1,00
[IT7.1]	0	0	0	1	3	0	0	4	100,0	1,00
[IT7.2]	0	0	0	1	3	0	0	4	100,0	1,00
[IT7.3]	0	0	0	2	2	0	0	4	100,0	1,00
[IT7.4]	0	0	0	0	4	0	0	4	100,0	1,00
[IT7.5]	1	0	0	0	3	1	0	3	75,0	0,75
[IT7.6]	0	2	0	0	2	2	0	2	50,0	0,50
[IT7.7]	1	0	0	1	2	1	0	3	75,0	0,75
[IT8.1]	0	1	0	0	3	1	0	3	75,0	0,75
[IT8.2]	0	1	0	1	2	1	0	3	75,0	0,75
[IT8.3]	0	0	0	1	3	0	0	4	100,0	1,00
[IT8.4]	0	1	1	1	1	1	1	2	50,0	0,50
[IT8.5]	0	0	0	1	3	0	0	4	100,0	1,00

Figure A.13: CVI value by item to Simplicity (CVIs), Cohesion (CVIc), and Relevance/Representativeness (CVIr). The statements used were “The item is simple to understand” (Simplicity) - (O item é simples de ser entendido in Portuguese); “The item allows measuring the associated dimension” (Coherence) - (O item permite mensurar a dimensão associada); and “The item is relevant/representative” (Relevance/Representativeness) - (O item é relevante/representativo). The calculation was made by dividing the number of judges who attributed values (4 and 5) of the Likert scale (5 points) by the total number of judges who evaluated the item [96]. (Continuation)

Item		Ação Executada
ID antigo	ID Novo	
[IT1.1]	-	Item excluído. Redundância com o item 1.2.
[IT1.2]	IT01	Item alterado.
[IT1.3]	IT02	Item alterado.
[IT1.4]	IT03	Descrição mantida.
[IT1.5]	IT04	Descrição mantida.
[IT1.6]	IT05	Descrição mantida.
[IT1.7]	IT06	Descrição mantida.
[IT2.1]	IT07	Descrição mantida.
[IT2.2]	IT08	Descrição alterada.
[IT2.3]	-	Item excluído. Redundância com o item 2.2 e 2.4.
[IT2.4]	IT09	Item mantido.
[IT2.5]	IT10	Item mantido.
[IT2.6]	-	Item excluído.
[IT2.7]	IT11	Descrição mantida.
[IT3.1]	IT12	Item mantido.
[IT3.2]	IT13	Item mantido.
[IT3.3]	IT14	Item mantido.
[IT3.4]	IT15	Item mantido.
[IT3.5]	IT16	Item mantido.
[IT3.6]	IT17	Item alterado.

Item		Ação Executada
ID antigo	ID Novo	
[IT4.1]	IT18	Item alterado.
[IT4.2]	IT19	Descrição Mantida.
[IT4.3]	IT20	Descrição alterada.
[IT4.4]	IT21	Descrição alterada.
[IT4.5]	IT22	Descrição mantida.
[IT4.6]	IT23	Item alterado.
[IT4.7]	IT24	Descrição alterada.
[IT5.1]	[IT5.1]	Descrição mantida.
[IT5.2]	[IT5.2]	Item alterado
[IT5.3]	[IT5.3]	Item alterado
[IT5.4]	[IT5.4]	Item alterado
[IT5.5]	[IT5.5]	Item Alterado
[IT5.6]	-	Item excluído.
[IT5.7]	[IT5.7]	Item alterado
[IT5.8]	[IT5.8]	Item alterado
[IT6.1]	IT32	Descrição mantida.
[IT6.2]	IT33	Descrição mantida.
[IT6.3]	IT34	Descrição alterada.
[IT6.4]	IT35	Descrição alterada.
[IT6.5]	-	Item excluído.
[IT6.6]	IT36	Descrição mantida.
[IT6.7]	IT37	Descrição mantida.
[IT7.1]	IT38	Descrição mantida.

Item		Ação Executada
ID antigo	ID Novo	
[IT7.2]	IT39	Item alterado.
[IT7.3]	IT40	Descrição mantida.
[IT7.4]	IT41	Descrição mantida.
[IT7.5]	IT42	Descrição mantida.
[IT7.6]	IT43	Descrição mantida.
[IT7.7]	IT44	Item alterado.
[IT8.1]	IT45	Item alterado.
[IT8.2]	-	Item excluído.
[IT8.3]	IT46	Item alterado.
[IT8.4]	IT47	Item alterado.
[IT8.5]	IT48	Descrição mantida.
[IT8.6]	IT49	Item alterado.
[IT8.7]	IT50	Item alterado.
[IT9.1]	IT51	Item alterado.
[IT9.2]	IT52	Descrição mantida.
[IT9.3]	-	Item excluído.
[IT9.4]	IT53	Descrição mantida.
[IT9.5]	IT54	Descrição mantida.
[IT9.6]	-	Item excluído.
[IT9.7]	IT55	Item alterado
[IT9.8]	IT56	Descrição mantida.
[IT101]	IT57	Descrição alterada.
[IT102]	-	Item excluído.

Item		Ação Executada
ID antigo	ID Novo	
[IT103]	IT58	Descrição mantida.
[IT104]	-	Item excluído.
[IT105]	IT59	Descrição alterada.
[IT106]	IT60	Descrição Mantida.
[IT107]	IT61	Item alterado.
[IT108]	IT62	Descrição mantida.
[IT109]	IT63	Descrição mantida.
[IT110]	IT64	Descrição mantida.
[IT111]	-	Item excluído.

Figure A.14: Action executed by the researchers considering the judges' evaluations. ID Antigo (ID old) refers to the original code of the item considered in the evaluation, ID Novo (ID new) is the new item code, and Ação Execute (Action executes) describes the decision-making by the researchers considering all comments of judges.

The CVIs and CVIr of the decision-making dimensions were, respectively, 0.58 and 0.68. Therefore, considering the CVI value < 0.7, the judges' comments, and suggestions, we chose to rewrite and create some new items to the Decision-making dimension. The specialists who participated in the first stage were again invited to evaluate the new items in the decision-making dimension. Three judges agree to participate in the new evaluation. The **input items** considered in **second cycle** of evaluation are listed in the following.

Decision-making: [IT5.1] My team have time to plan the changes without excessive stress or pressure, [IT5.2] When needed, during the iteration execution, the team members reprioritize tasks, define new tasks, or change the acceptance criteria, [IT5.3] In the iteration planning, the team analyzes the technical alternatives and chooses the most appropriate one, [IT5.4] In the retrospective, the team identifies, analyzes and selects improvement items, [IT5.5] Team members freely talk about your views and uncertainties concerning the iteration executing, [IT5.7] When the dependencies between tasks hinder the project execution, the team makes decisions to resolve or mitigate possible impacts, [IT5.8] The team's decisions are NOT changed by stakeholders or individual members arbitrarily.

Figure A.15: Judges suggestions to improve the item descriptions (new cycle to Decision-making dimension). For each item (Item in Portuguese) considered, we collected suggestions (Sugestão) from the judges (Juiz) who answered the question (Questão) "Do you have any suggestion to improve the item description?" (Continuation)

Por favor, indique uma sugestão caso você considere que o item deva ser alterado para melhor descrever o comportamento avaliado	
Item	**(Juiz) Sugestão**
Ciclo 2	
[IT5.1]	
[IT5.2]	(J6) Mudanças nos critérios de aceitação podem ser mais profundas e impactar o negócio, fiquei na dúvida se ao falar time estaria abrangendo o PO.
[IT5.3]	(J2) Nem sempre isso é feito no sprint planning. Algumas vzes fazemos isso no refinement.
[IT5.4]	(J6) Na retrospectiva os itens de melhoria referem-se à forma como o time organiza seus processos, se comporta e gere o dia a dia, e não ao produto em si, isso deveria estar explícito para não causar ambiguidade.
[IT5.5]	(J3) Por mais que a comunicação seja importante, ela não está diretamente relacionada a tomada de decisão.
[IT5.7]	(J6) Esse cenário apesar de ser comum nas empresas, é uma disfunção em termos de agilidade porque um time multidisplinar com competencias ponta a ponta para entregar um produto não teria grandes problemas nesse aspecto. As dependências ou são externas, demonstrando baixa autonomia, ou se são internas ao time demonstram que as prioridades não são as mesmas para todos os membros.
[IT5.8]	

O item é simples de ser entendido										
Simplicidade						Total			%	CVI(s)
Item	DT	DP	N	CP	CT	D	N	C	C	
[IT5.1]	0	0	0	0	3	0	0	3	100,0	1,00
[IT5.2]	0	0	0	0	3	0	0	3	100,0	1,00
[IT5.3]	0	0	0	0	3	0	0	3	100,0	1,00
[IT5.4]	0	0	0	0	3	0	0	3	100,0	1,00
[IT5.5]	0	0	1	0	2	0	1	2	66,7	0,67
[IT5.7]	0	0	0	0	3	0	0	3	100,0	1,00
[IT5.8]	0	0	0	0	3	0	0	3	100,0	1,00

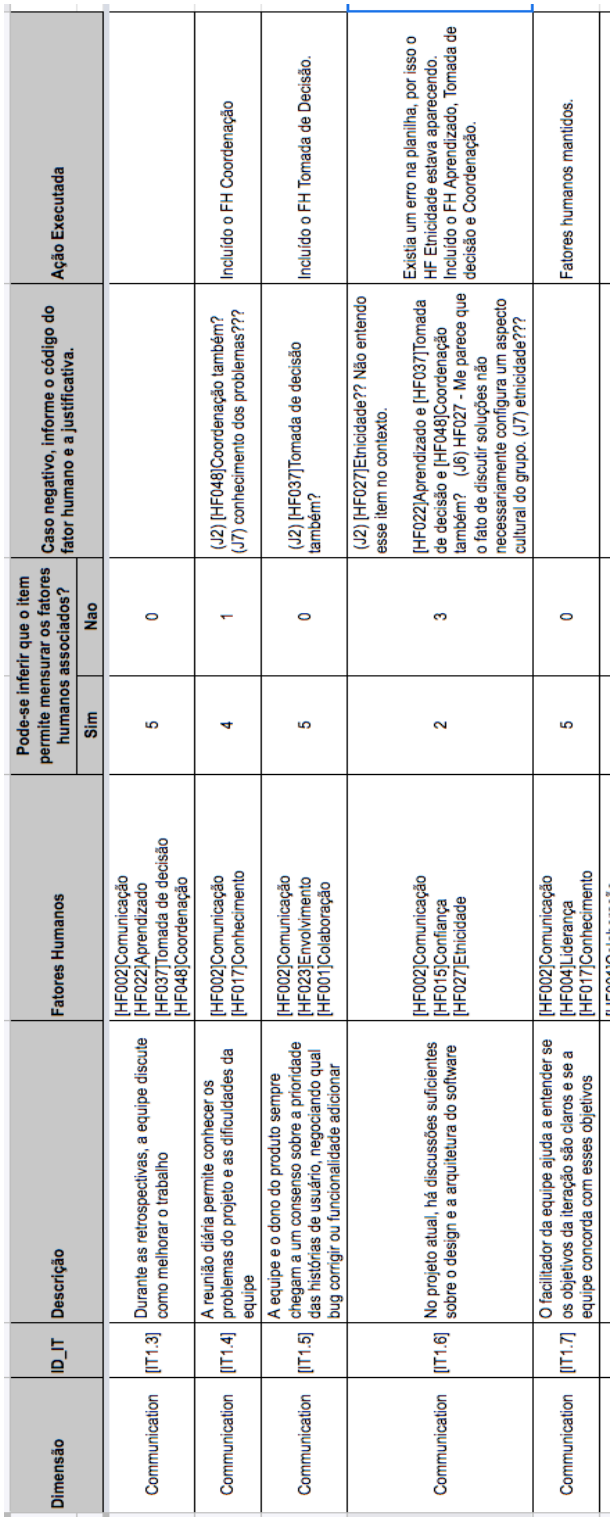
O item permite mensurar a dimensão associada										
Coerência						Total			%	CVI(c)
Item	DT	DP	N	CP	CT	D	N	C	C	
[IT5.1]	0	0	0	0	3	0	0	3	100,0	1,00
[IT5.2]	0	0	0	1	2	0	1	2	66,7	0,67
[IT5.3]	0	0	0	0	3	0	0	3	100,0	1,00
[IT5.4]	0	0	0	1	2	0	0	3	100,0	1,00
[IT5.5]	0	0	1	0	2	0	1	2	66,7	0,67
[IT5.7]	0	0	0	1	2	0	0	3	100,0	1,00
[IT5.8]	0	0	0	0	3	0	0	3	100,0	1,00

O item é relevante/representativo										
Relev./Repres.						Total			%	CVI(r)
Item	DT	DP	N	CP	CT	D	N	C	C	
[IT5.1]	0	0	0	0	3	0	0	3	100,0	1,00
[IT5.2]	0	0	0	1	2	0	0	3	100,0	1,00
[IT5.3]	0	0	0	0	3	0	0	3	100,0	1,00
[IT5.4]	0	0	0	0	3	0	0	3	100,0	1,00
[IT5.5]	0	0	0	0	3	0	0	3	100,0	1,00
[IT5.7]	0	0	0	1	2	0	0	3	100,0	1,00
[IT5.8]	0	0	0	0	3	0	0	3	100,0	1,00

Figure A.16: CVI value by item (new cycle to Decision-making dimensions). The statements used were "The item is simple to understand" (Simplicity) - (O item é simples de ser entendido in Portuguese); "The item allows measuring the associated dimension" (Coherence) - (O item permite mensurar a dimensão associada); and "The item is relevant/representative" (Relevance/Representativeness) - (O item é relevante/representativo). The calculation was made by dividing the number of judges who attributed values (4 and 5) of the Likert scale (5 points) by the total number of judges who evaluated the item [96].

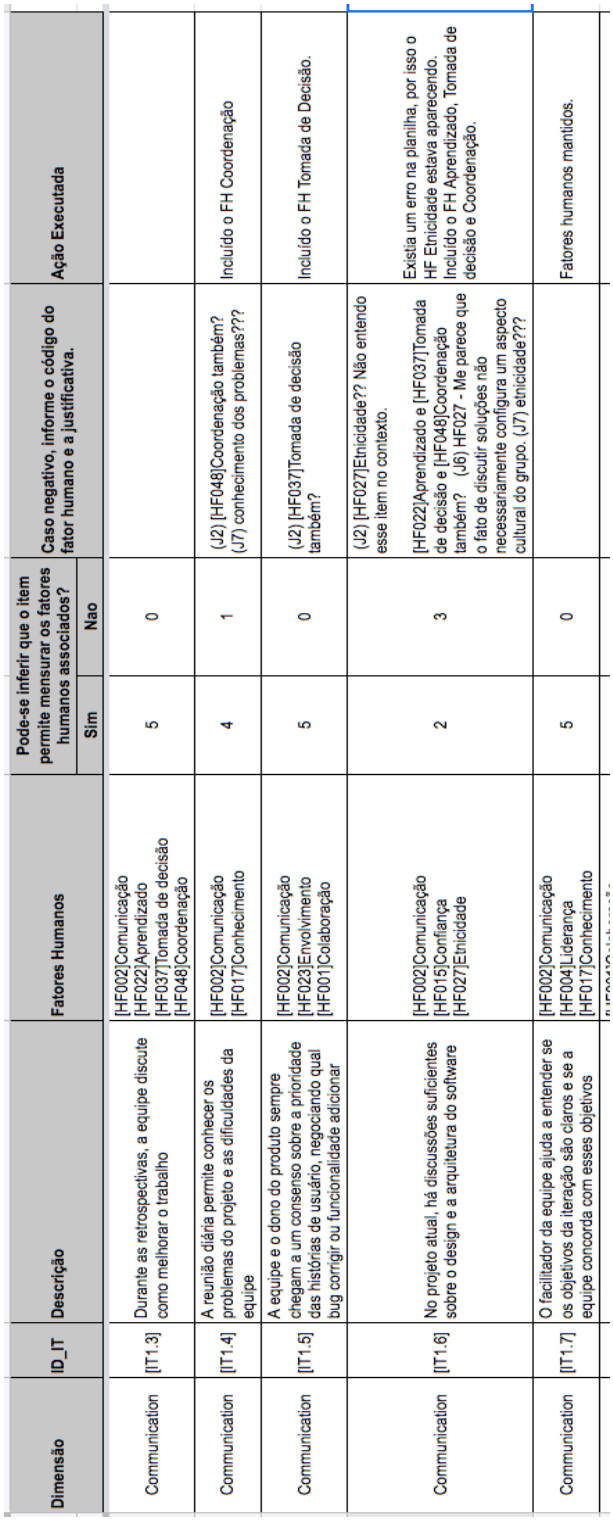
Item		Ação Executada
ID antigo	ID Novo	
[IT5.1]	IT25	Descrição mantida.
[IT5.2]	IT26	Descrição alterada.
[IT5.3]	IT27	Descrição mantida.
[IT5.4]	IT28	Descrição alterada.
[IT5.5]	IT29	Descrição mantida.
[IT5.7]	IT30	Descrição alterada.
[IT5.8]	IT31	Descrição mantida.

Figure A.17: Action executed by the researchers considering the judges' evaluations (new cycle to Decision-making dimensions). ID Antigo (ID old) refers to the original code of the item considered in the evaluation, ID Novo (ID new) is the new item code, and Ação Execute (Action executes) describes the decision-making by the researchers considering all comments of judges.



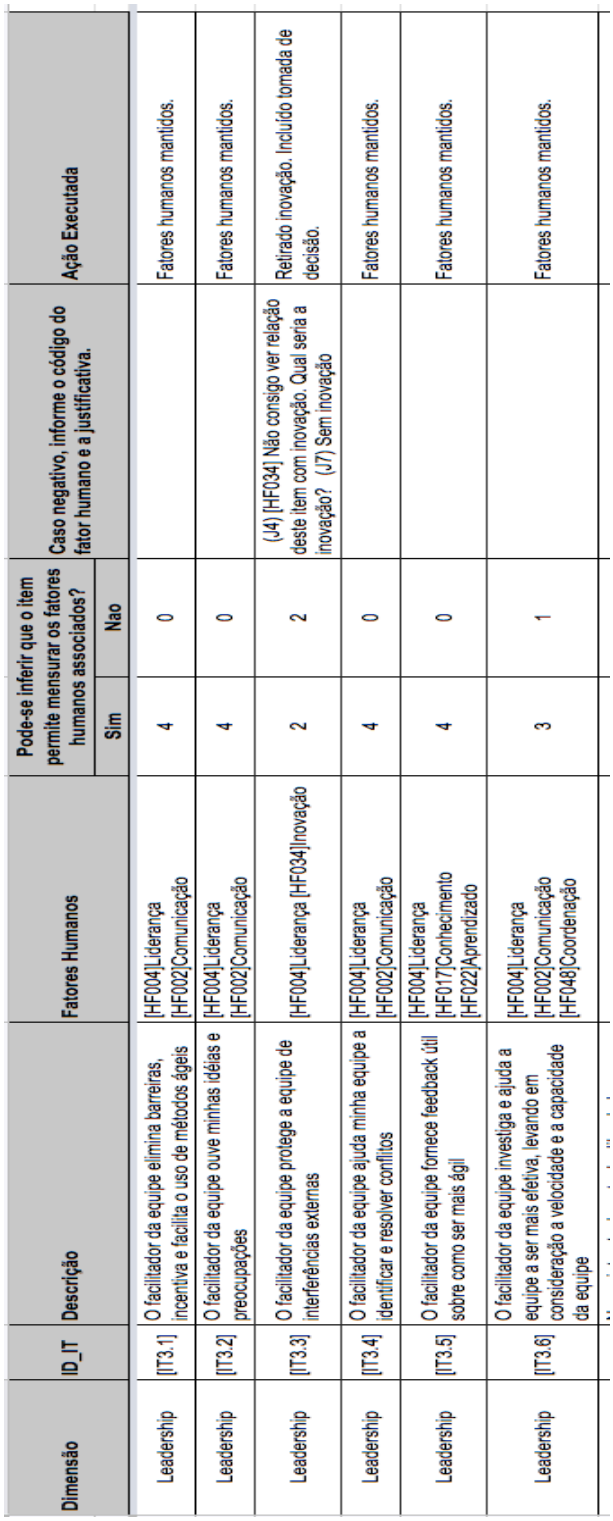
Dimensão	ID_IT	Descrição	Fatores Humanos	Pode-se inferir que o item permite mensurar os fatores humanos associados?		Caso negativo, informe o código do fator humano e a justificativa.	Ação Executada
				Sim	Nao		
Communication	[IT1.3]	Durante as retrospectivas, a equipe discute como melhorar o trabalho	[HF002]Comunicação [HF022]Aprendizado [HF037]Tomada de decisão [HF048]Coordenação	5	0		
Communication	[IT1.4]	A reunião diária permite conhecer os problemas do projeto e as dificuldades da equipe	[HF002]Comunicação [HF017]Conhecimento	4	1	(J2) [HF048]Coordenação também? (J7) conhecimento dos problemas???	Incluído o FH Coordenação
Communication	[IT1.5]	A equipe e o dono do produto sempre chegam a um consenso sobre a prioridade das histórias de usuário, negociando qual bug corrigir ou funcionalidade adicionar	[HF002]Comunicação [HF023]Envolvimento [HF001]Colaboração	5	0	(J2) [HF037]Tomada de decisão também?	Incluído o FH Tomada de Decisão.
Communication	[IT1.6]	No projeto atual, há discussões suficientes sobre o design e a arquitetura do software	[HF002]Comunicação [HF015]Confiança [HF027]Etnicidade	2	3	(J2) [HF027]Etnicidade?? Não entendo esse item no contexto. [HF022]Aprendizado e [HF037]Tomada de decisão e [HF048]Coordenação também? (J6) HF027 - Me parece que o fato de discutir soluções não necessariamente configura um aspecto cultural do grupo. (J7) etnicidade???	Existia um erro na planilha, por isso o HF Etnicidade estava aparecendo. Incluído o FH Aprendizado, Tomada de decisão e Coordenação.
Communication	[IT1.7]	O facilitador da equipe ajuda a entender se os objetivos da iteração são claros e se a equipe concorda com esses objetivos	[HF002]Comunicação [HF004]Liderança [HF017]Conhecimento	5	0		Fatores humanos mantidos.

Figure A.18: Judges' evaluation concerning possible other human factors and project elements involved to Communication dimensions (In Portuguese)



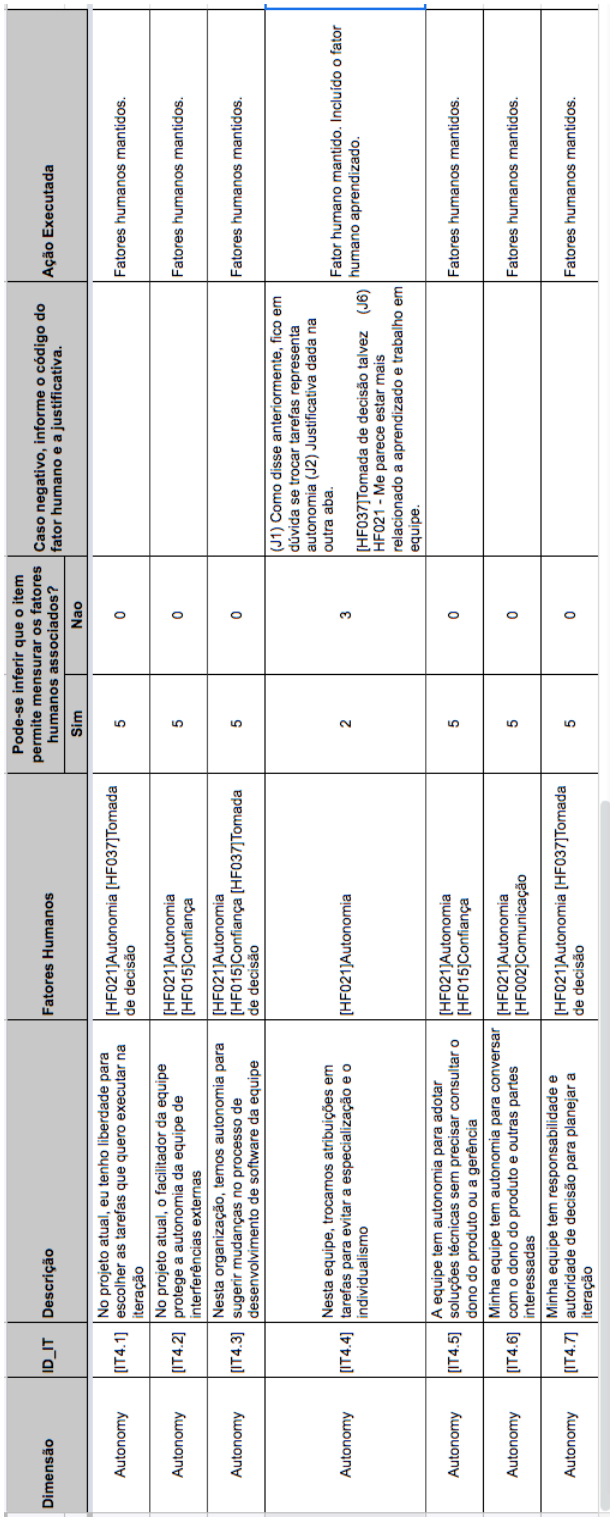
Dimensão	ID_IT	Descrição	Fatores Humanos	Pode-se inferir que o item permite mensurar os fatores humanos associados?		Caso negativo, informe o código do fator humano e a justificativa.	Ação Executada
				Sim	Nao		
Communication	[IT1.3]	Durante as retrospectivas, a equipe discute como melhorar o trabalho	[HF002]Comunicação [HF022]Aprendizado [HF037]Tomada de decisão [HF048]Coordenação	5	0		
Communication	[IT1.4]	A reunião diária permite conhecer os problemas do projeto e as dificuldades da equipe	[HF002]Comunicação [HF017]Conhecimento	4	1	(J2) [HF048]Coordenação também? (J7) conhecimento dos problemas???	Incluído o FH Coordenação
Communication	[IT1.5]	A equipe e o dono do produto sempre chegam a um consenso sobre a prioridade das histórias de usuário, negociando qual bug corrigir ou funcionalidade adicionar	[HF002]Comunicação [HF023]Envolvimento [HF001]Colaboração	5	0	(J2) [HF037]Tomada de decisão também?	Incluído o FH Tomada de Decisão.
Communication	[IT1.6]	No projeto atual, há discussões suficientes sobre o design e a arquitetura do software	[HF002]Comunicação [HF015]Confiança [HF027]Etnicidade	2	3	(J2) [HF027]Etnicidade?? Não entendo esse item no contexto. [HF022]Aprendizado e [HF037]Tomada de decisão e [HF048]Coordenação também? (J6) HF027 - Me parece que o fato de discutir soluções não necessariamente configura um aspecto cultural do grupo. (J7) etnicidade???	Existia um erro na planilha, por isso o HF Etnicidade estava aparecendo. Incluído o FH Aprendizado, Tomada de decisão e Coordenação.
Communication	[IT1.7]	O facilitador da equipe ajuda a entender se os objetivos da iteração são claros e se a equipe concorda com esses objetivos	[HF002]Comunicação [HF004]Liderança [HF017]Conhecimento	5	0		Fatores humanos mantidos.

Figure A.19: Judges' evaluation concerning possible other human factors and project elements involved to Collaboration dimensions (In Portuguese)



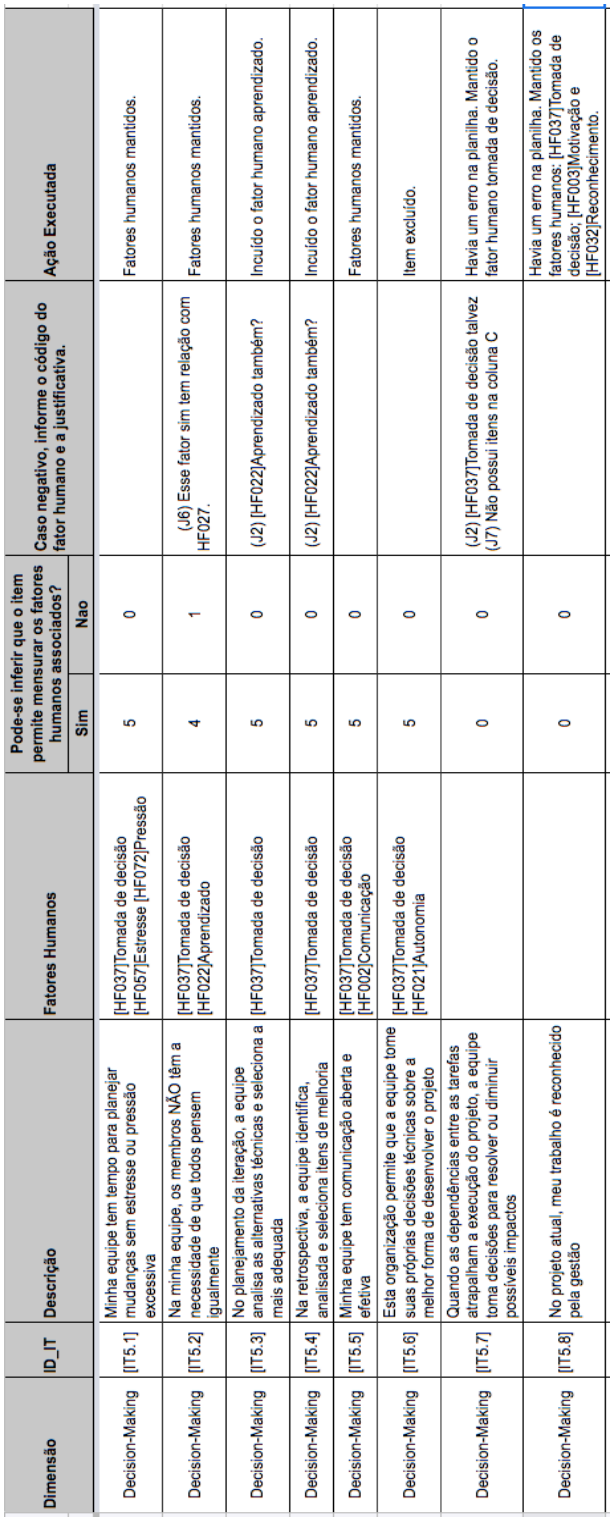
Dimensão	ID_IT	Descrição	Fatores Humanos	Pode-se inferir que o item permite mensurar os fatores humanos associados?		Caso negativo, informe o código do fator humano e a justificativa.	Ação Executada
				Sim	Não		
Leadership	[IT3.1]	O facilitador da equipe elimina barreiras, incentiva e facilita o uso de métodos ágeis	[HF004]Liderança [HF002]Comunicação	4	0		Fatores humanos mantidos.
Leadership	[IT3.2]	O facilitador da equipe ouve minhas idéias e preocupações	[HF004]Liderança [HF002]Comunicação	4	0		Fatores humanos mantidos.
Leadership	[IT3.3]	O facilitador da equipe protege a equipe de interferências externas	[HF004]Liderança [HF034]Inovação	2	2	(J4) [HF034] Não consigo ver relação deste item com inovação. Qual seria a inovação? (J7) Sem inovação	Retirado inovação. Incluído tomada de decisão.
Leadership	[IT3.4]	O facilitador da equipe ajuda minha equipe a identificar e resolver conflitos	[HF004]Liderança [HF002]Comunicação	4	0		Fatores humanos mantidos.
Leadership	[IT3.5]	O facilitador da equipe fornece feedback útil sobre como ser mais ágil	[HF004]Liderança [HF017]Conhecimento [HF022]Aprendizado	4	0		Fatores humanos mantidos.
Leadership	[IT3.6]	O facilitador da equipe investiga e ajuda a equipe a ser mais efetiva, levando em consideração a velocidade e a capacidade da equipe	[HF004]Liderança [HF002]Comunicação [HF048]Coordenação	3	1		Fatores humanos mantidos.

Figure A.20: Judges' evaluation concerning possible other human factors and project elements involved to Leadership dimensions (In Portuguese)



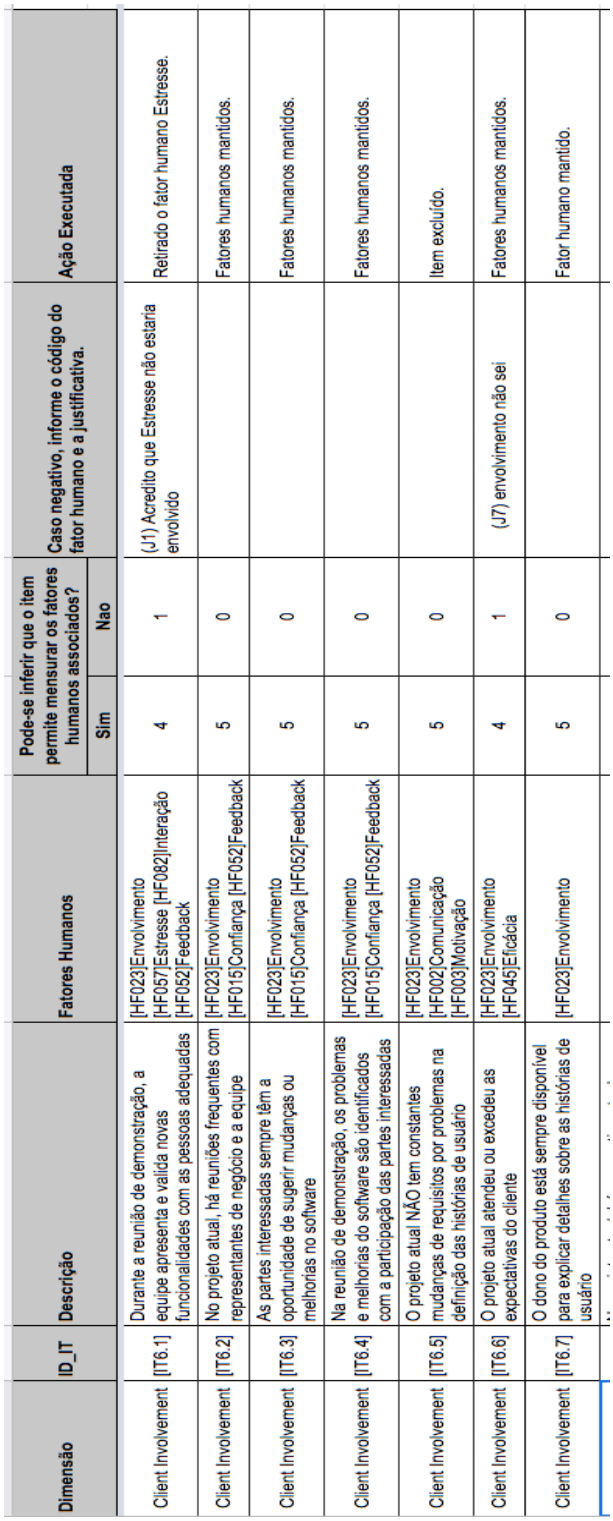
Dimensão	ID_IT	Descrição	Fatores Humanos	Pode-se inferir que o item permite mensurar os fatores humanos associados?		Caso negativo, informe o código do fator humano e a justificativa.	Ação Executada
				Sim	Nao		
Autonomy	[IT4.1]	No projeto atual, eu tenho liberdade para escolher as tarefas que quero executar na iteração	[HF021]Autonomia [HF037]Tomada de decisão	5	0		Fatores humanos mantidos.
Autonomy	[IT4.2]	No projeto atual, o facilitador da equipe protege a autonomia da equipe de interferências externas	[HF021]Autonomia [HF015]Confiança	5	0		Fatores humanos mantidos.
Autonomy	[IT4.3]	Nesta organização, temos autonomia para sugerir mudanças no processo de desenvolvimento de software da equipe	[HF021]Autonomia [HF015]Confiança [HF037]Tomada de decisão	5	0		Fatores humanos mantidos.
Autonomy	[IT4.4]	Nesta equipe, trocamos atribuições em tarefas para evitar a especialização e o individualismo	[HF021]Autonomia	2	3	(J1) Como disse anteriormente, fico em dúvida se trocar tarefas representa autonomia (J2) Justificativa dada na outra aba. [HF037]Tomada de decisão talvez (J6) HF021 - Me parece estar mais relacionado a aprendizado e trabalho em equipe.	Fator humano mantido. Incluído o fator humano aprendizado.
Autonomy	[IT4.5]	A equipe tem autonomia para adotar soluções técnicas sem precisar consultar o dono do produto ou a gerência	[HF021]Autonomia [HF015]Confiança	5	0		Fatores humanos mantidos.
Autonomy	[IT4.6]	Minha equipe tem autonomia para conversar com o dono do produto e outras partes interessadas	[HF021]Autonomia [HF002]Comunicação	5	0		Fatores humanos mantidos.
Autonomy	[IT4.7]	Minha equipe tem responsabilidade e autoridade de decisão para planejar a iteração	[HF021]Autonomia [HF037]Tomada de decisão	5	0		Fatores humanos mantidos.

Figure A.21: Judges' evaluation concerning possible other human factors and project elements involved to Autonomy dimensions (In Portuguese)



Dimensão	ID_IT	Descrição	Fatores Humanos	Pode-se inferir que o item permite mensurar os fatores humanos associados?		Caso negativo, informe o código do fator humano e a justificativa.	Ação Executada
				Sim	Nao		
Decision-Making	[IT5.1]	Minha equipe tem tempo para planejar mudanças sem estresse ou pressão excessiva	[HF037]Tomada de decisão [HF057]Estresse [HF072]Pressão	5	0		Fatores humanos mantidos.
Decision-Making	[IT5.2]	Na minha equipe, os membros NÃO têm a necessidade de que todos pensem igualmente	[HF037]Tomada de decisão [HF022]Aprendizado	4	1	(J6) Esse fator sim tem relação com HF027.	Fatores humanos mantidos.
Decision-Making	[IT5.3]	No planejamento da iteração, a equipe analisa as alternativas técnicas e seleciona a mais adequada	[HF037]Tomada de decisão	5	0	(J2) [HF022]Aprendizado também?	Incuído o fator humano aprendizado.
Decision-Making	[IT5.4]	Na retrospectiva, a equipe identifica, analisada e seleciona itens de melhoria	[HF037]Tomada de decisão	5	0	(J2) [HF022]Aprendizado também?	Incuído o fator humano aprendizado.
Decision-Making	[IT5.5]	Minha equipe tem comunicação aberta e efetiva	[HF037]Tomada de decisão [HF002]Comunicação	5	0		Fatores humanos mantidos.
Decision-Making	[IT5.6]	Esta organização permite que a equipe tome suas próprias decisões técnicas sobre a melhor forma de desenvolver o projeto	[HF037]Tomada de decisão [HF021]Autonomia	5	0		Item excluído.
Decision-Making	[IT5.7]	Quando as dependências entre as tarefas atrapalham a execução do projeto, a equipe toma decisões para resolver ou diminuir possíveis impactos		0	0	(J2) [HF037]Tomada de decisão talvez (J7) Não possui itens na coluna C	Havia um erro na planilha. Mantido o fator humano tomada de decisão.
Decision-Making	[IT5.8]	No projeto atual, meu trabalho é reconhecido pela gestão		0	0		Havia um erro na planilha. Mantido os fatores humanos: [HF037]Tomada de decisão; [HF003]Motivação e [HF032]Reconhecimento.

Figure A.22: Judges' evaluation concerning possible other human factors and project elements involved to Decision-making dimensions (In Portuguese)

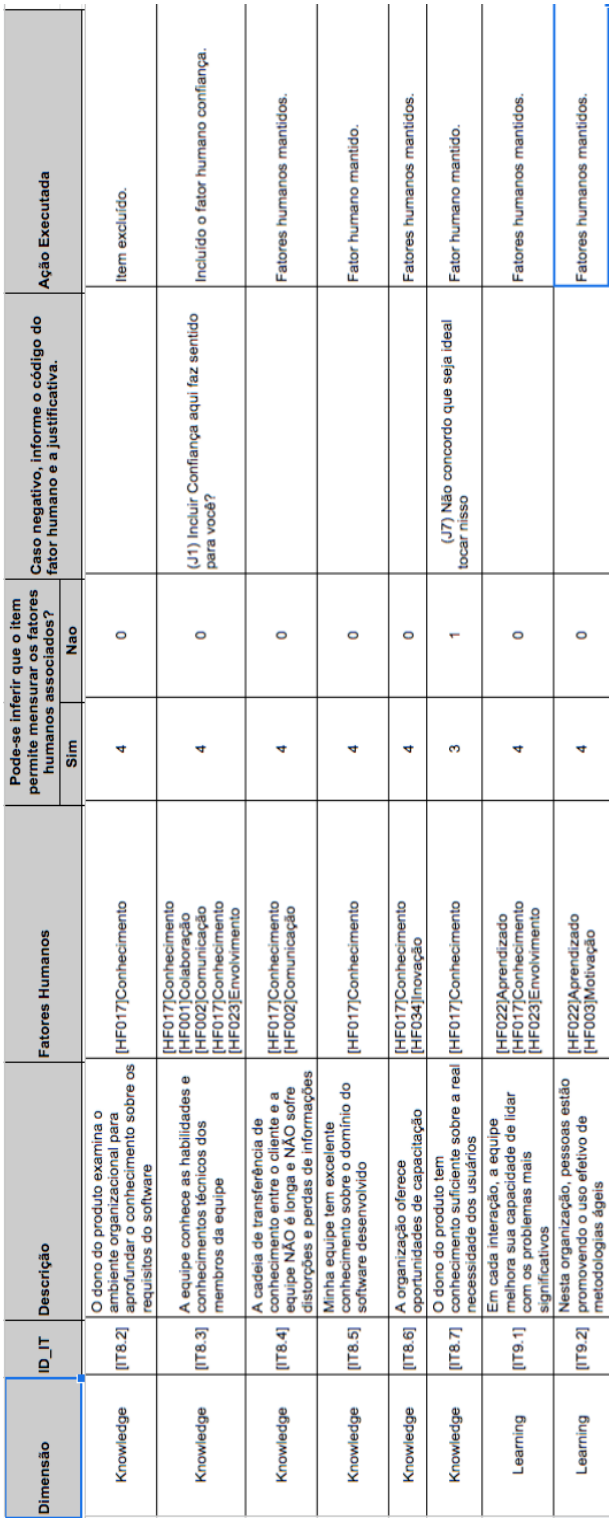


Dimensão	ID_IT	Descrição	Fatores Humanos	Pode-se inferir que o item permite mensurar os fatores humanos associados?		Caso negativo, informe o código do fator humano e a justificativa.	Ação Executada
				Sim	Nao		
Client Involvement	[IT6.1]	Durante a reunião de demonstração, a equipe apresenta e valida novas funcionalidades com as pessoas adequadas	[HF023]Envolvimento [HF057]Estresse [HF082]Interação [HF052]Feedback	4	1	(J1) Acredito que Estresse não estaria envolvido	Retirado o fator humano Estresse.
Client Involvement	[IT6.2]	No projeto atual, há reuniões frequentes com representantes de negócio e a equipe	[HF023]Envolvimento [HF015]Confiança [HF052]Feedback	5	0		Fatores humanos mantidos.
Client Involvement	[IT6.3]	As partes interessadas sempre têm a oportunidade de sugerir mudanças ou melhorias no software	[HF023]Envolvimento [HF015]Confiança [HF052]Feedback	5	0		Fatores humanos mantidos.
Client Involvement	[IT6.4]	Na reunião de demonstração, os problemas e melhorias do software são identificados com a participação das partes interessadas	[HF023]Envolvimento [HF015]Confiança [HF052]Feedback	5	0		Fatores humanos mantidos.
Client Involvement	[IT6.5]	O projeto atual NÃO tem constantes mudanças de requisitos por problemas na definição das histórias de usuário	[HF023]Envolvimento [HF002]Comunicação [HF003]Motivação	5	0		Item excluído.
Client Involvement	[IT6.6]	O projeto atual atendeu ou excedeu as expectativas do cliente	[HF023]Envolvimento [HF045]Eficácia	4	1	(J7) envolvimento não sei	Fatores humanos mantidos.
Client Involvement	[IT6.7]	O dono do produto está sempre disponível para explicar detalhes sobre as histórias de usuário	[HF023]Envolvimento	5	0		Fator humano mantido.

Figure A.23: Judges' evaluation concerning possible other human factors and project elements involved to Client Involvement dimensions (In Portuguese)

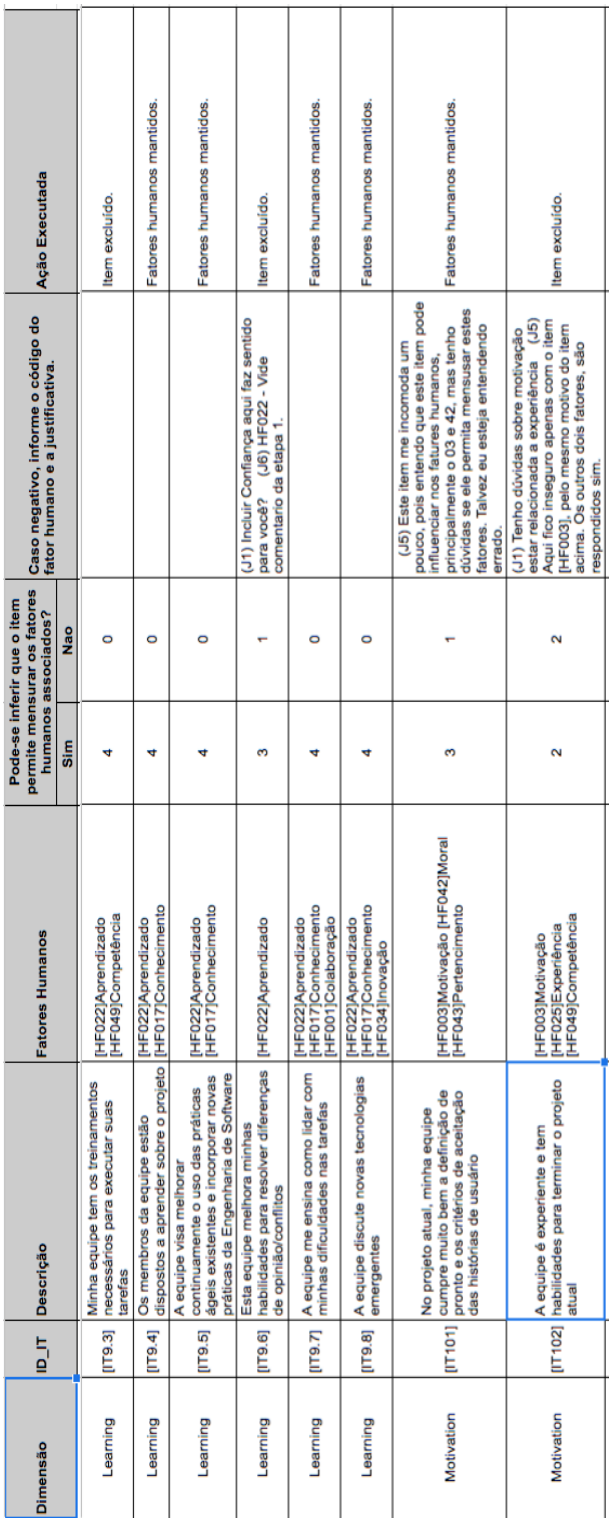
Dimensão	ID_IT	Descrição	Fatores Humanos	Pode-se inferir que o item permite mensurar os fatores humanos associados?		Caso negativo, informe o código do fator humano e a justificativa.	Ação Executada
				Sim	Nao		
Trust	[IT7.1]	No projeto atual, há um sentimento de confiança entre os membros da equipe	[HF015]Confiança	4	0		Fator humano mantido.
Trust	[IT7.2]	Nesta organização, a gestão conhece e apoia os valores, princípios e práticas ágeis	[HF015]Confiança [HF017]Conhecimento	4	0		Fatores humanos mantidos.
Trust	[IT7.3]	No projeto atual, os membros da equipe desenvolvem tarefas com alta qualidade e desempenho	[HF015]Confiança	3	1	(J1) Acho que colocar Conhecimento e Competência aqui também seria uma boa	Incluído o fator humano conhecimento.
Trust	[IT7.4]	No projeto atual, os membros da equipe sentiriam uma sensação de perda se não pudéssemos mais trabalhar juntos	[HF015]Confiança	4	0		Fator humano mantido.
Trust	[IT7.5]	Não vejo razão para duvidar da competência e habilidades técnicas de cada membro da equipe	[HF015]Confiança [HF049]Competência	4	0		Fatores humanos mantidos.
Trust	[IT7.6]	O dono do produto está totalmente comprometido em fornecer informações claras sobre histórias de usuários	[HF015]Confiança [HF014]Comprometimento [HF023]Envolvimento	4	0		Fatores humanos mantidos.
Trust	[IT7.7]	O cliente está totalmente comprometido em fornecer informações claras sobre histórias de usuários	[HF015]Confiança [HF014]Comprometimento [HF023]Envolvimento	4	0		Fatores humanos mantidos.
Knowledge	[IT8.1]	Se membros-chave da minha equipe decidir deixá-la, os novos membros NÃO terão dificuldades em entender o código nem o backlog do produto	[HF017]Conhecimento	3	1	(J1) Incluir Confiança aqui faz sentido para você?	Fator humano mantido.

Figure A.24: Judges' evaluation concerning possible other human factors and project elements involved to Trust dimensions (In Portuguese)



Dimensão	ID_IT	Descrição	Fatores Humanos	Pode-se inferir que o item permite mensurar os fatores humanos associados?		Caso negativo, informe o código do fator humano e a justificativa.	Ação Executada
				Sim	Nao		
Knowledge	[IT8.2]	O dono do produto examina o ambiente organizacional para aprofundar o conhecimento sobre os requisitos do software	[HF017]Conhecimento	4	0		Item excluído.
Knowledge	[IT8.3]	A equipe conhece as habilidades e conhecimentos técnicos dos membros da equipe	[HF017]Conhecimento [HF001]Colaboração [HF002]Comunicação [HF017]Conhecimento [HF023]Envolvimento	4	0	(J1) Incluir Confiança aqui faz sentido para você?	Incluído o fator humano confiança.
Knowledge	[IT8.4]	A cadeia de transferência de conhecimento entre o cliente e a equipe NÃO é longa e NÃO sofre distorções e perdas de informações	[HF017]Conhecimento [HF002]Comunicação	4	0		Fatores humanos mantidos.
Knowledge	[IT8.5]	Minha equipe tem excelente conhecimento sobre o domínio do software desenvolvido	[HF017]Conhecimento	4	0		Fator humano mantido.
Knowledge	[IT8.6]	A organização oferece oportunidades de capacitação	[HF017]Conhecimento [HF034]Inovação	4	0		Fatores humanos mantidos.
Knowledge	[IT8.7]	O dono do produto tem conhecimento suficiente sobre a real necessidade dos usuários	[HF017]Conhecimento	3	1	(J7) Não concordo que seja ideal tocar nisso	Fator humano mantido.
Learning	[IT9.1]	Em cada interação, a equipe melhora sua capacidade de lidar com os problemas mais significativos	[HF022]Aprendizado [HF017]Conhecimento [HF023]Envolvimento	4	0		Fatores humanos mantidos.
Learning	[IT9.2]	Nesta organização, pessoas estão promovendo o uso efetivo de metodologias ágeis	[HF022]Aprendizado [HF003]Motivação	4	0		Fatores humanos mantidos.

Figure A.25: Judges' evaluation concerning possible other human factors and project elements involved to Knowledge dimension(In Portuguese)



Dimensão	ID_IT	Descrição	Fatores Humanos	Pode-se inferir que o item permite mensurar os fatores humanos associados?		Caso negativo, informe o código do fator humano e a justificativa.	Ação Executada
				Sim	Nao		
Learning	[IT9.3]	Minha equipe tem os treinamentos necessários para executar suas tarefas	[HF022]Aprendizado [HF049]Competência	4	0		Item excluído.
Learning	[IT9.4]	Os membros da equipe estão dispostos a aprender sobre o projeto	[HF022]Aprendizado [HF017]Conhecimento	4	0		Fatores humanos mantidos.
Learning	[IT9.5]	A equipe visa melhorar continuamente o uso das práticas ágeis existentes e incorporar novas práticas da Engenharia de Software	[HF022]Aprendizado [HF017]Conhecimento	4	0		Fatores humanos mantidos.
Learning	[IT9.6]	Esta equipe melhora minhas habilidades para resolver diferenças de opinião/conflitos	[HF022]Aprendizado	3	1	(J1) Incluir Confiança aqui faz sentido para você? (J6) HF022 - Vide comentario da etapa 1.	Item excluído.
Learning	[IT9.7]	A equipe me ensina como lidar com minhas dificuldades nas tarefas	[HF022]Aprendizado [HF017]Conhecimento [HF001]Colaboração	4	0		Fatores humanos mantidos.
Learning	[IT9.8]	A equipe discute novas tecnologias emergentes	[HF022]Aprendizado [HF017]Conhecimento [HF034]Inovação	4	0		Fatores humanos mantidos.
Motivation	[IT101]	No projeto atual, minha equipe cumpre muito bem a definição de pronto e os critérios de aceitação das histórias de usuário	[HF003]Motivação [HF042]Moral [HF043]Pertencimento	3	1	(J5) Este item me incomoda um pouco, pois entendo que este item pode influenciar nos fatures humanos, principalmente o 03 e 42, mas tenho dúvidas se ele permita mensusar estes fatores. Talvez eu esteja entendendo errado.	Fatores humanos mantidos.
Motivation	[IT102]	A equipe é experiente e tem habilidades para terminar o projeto atual	[HF003]Motivação [HF025]Experiência [HF049]Competência	2	2	(J1) Tenho dúvidas sobre motivação estar relacionada a experiência. (J5) Aqui fico inseguro apenas com o item [HF003], pelo mesmo motivo do item acima. Os outros dois fatores, são respondidos sim.	Item excluído.

Figure A.26: Judges' evaluation concerning possible other human factors and project elements involved to Learning dimension (In Portuguese)

Dimensão	ID_IT	Descrição	Fatores Humanos	Pode-se inferir que o item permite mensurar os fatores humanos associados?		Caso negativo, informe o código do fator humano e a justificativa.	Ação Executada
				Sim	Nao		
Motivation	[IT104]	As atividades utilizadas no projeto atual NÃO são burocráticas para metodologias ágeis	[HF003]Motivação	3	1	(J5) Sou adepto da exclusão deste item	Item excluído.
Motivation	[IT105]	No projeto atual, eu me sinto reconhecido pelo trabalho realizado	[HF003]Motivação [HF032]Reconhecimento	4	0		Fatores humanos mantidos.
Motivation	[IT106]	A equipe responde rapidamente quando mudanças precisam ser feitas	[HF003]Motivação [HF010]Adaptabilidade a mudança [HF034]Inovação	3	1	(J5) Não vejo relação com [HF003] e [HF034]	Fatores humanos mantidos.
Motivation	[IT107]	No projeto atual, eu NÃO me sinto estressado ou excessivamente pressionado para executar as minhas tarefas	[HF003]Motivação [HF011]Balanceamento entre trabalho e vida pessoal [HF057]Estresse	4	0	(J5) Esse item influi ... mas estamos dizendo que quem sofre pressão está desmotivado ? Esta é uma relação complicada	Fatores humanos mantidos.
Motivation	[IT108]	A equipe organiza e planeja claramente suas tarefas de trabalho	[HF003]Motivação [HF048]Coordenação	4	0		Fatores humanos mantidos.
Motivation	[IT109]	A equipe tem autonomia para discutir com o product owner como e quando entregar os resultados do projeto	[HF003]Motivação [HF021]Autonomia	4	0	(J2) Eu sugeriria [HF048] Coordenação também.	Incluído o fator humano coordenação.
Motivation	[IT110]	A equipe pode usar novas ideias para melhorar o desempenho nas tarefas e nas entregas	[HF003]Motivação [HF021]Autonomia [HF034]Inovação	4	0		Fatores humanos mantidos.
Motivation	[IT111]	Os membros da equipe monitoram o trabalho uns dos outros para manter a excelência na qualidade do software	[HF003]Motivação	2	2	(J1) Não acredito que monitoramento de outras pessoas gere motivação. (J2) Eu sugeriria [HF021] Autonomia também. (J3) (J5) Sou adepto da exclusão deste item	Item excluído.

Figure A.27: Judges' evaluation concerning possible other human factors and project elements involved Motivation dimension (In Portuguese)

Dimensão	ID_IT	Descrição	Fatores Humanos	Pode-se inferir que o item permite mensurar os fatores humanos associados?		Caso negativo, informe o código do fator humano e a justificativa.	Ação Executada
				Sim	Nao		
Tomada de Decisão	[IT5.1]	Minha equipe tem tempo para planejar mudanças sem estresse ou pressão excessiva	[HF037]Tomada de decisão [HF057]Estresse [HF072]Pressão [HF003]Motivação	3	0		Fatores humanos mantidos.
Tomada de Decisão	[IT5.2]	Quando necessário, durante a execução da iteração, os membros da equipe repriorizam tarefas, criam novas tarefas ou alteram os critérios de aceitação	[HF037]Tomada de decisão [HF022]Aprendizado [HF021]Autonomia	3	0		Fatores humanos mantidos.
Tomada de Decisão	[IT5.3]	No planejamento da iteração, a equipe analisa as alternativas técnicas e seleciona a mais adequada	[HF037]Tomada de decisão [HF022]Aprendizado [HF021]Autonomia [HF003]Motivação	3	0		Fatores humanos mantidos.
Tomada de Decisão	[IT5.4]	Na retrospectiva, a equipe identifica, analisada e seleciona itens de melhoria	[HF037]Tomada de decisão [HF022]Aprendizado [HF021]Autonomia	3	0	(J3) Aqui colocaria Motivação também	Fatores humanos mantidos. Sem alterações.
Tomada de Decisão	[IT5.5]	Os membros da equipe conversam livremente sobre suas opiniões e incertezas relativas à execução da iteração	[HF037]Tomada de decisão [HF002]Comunicação [HF015]Confiança	3	0		Fatores humanos mantidos.
Tomada de Decisão	[IT5.7]	Quando as dependências entre as tarefas atrapalham a execução do projeto, a equipe toma decisões para resolver ou diminuir possíveis impactos	[HF037]Tomada de decisão [HF021]Autonomia [HF022]Aprendizado	3	0		Fatores humanos mantidos.
Tomada de Decisão	[IT5.8]	As decisões da equipe NÃO são alteradas arbitrariamente por terceiros ou algum membro da equipe	[HF037]Tomada de decisão [HF015]Confiança [HF003]Motivação	3	0		Fatores humanos mantidos.

Figure A.28: Judges' evaluation concerning possible other human factors and project elements involved Decision-making dimension (new cycle)

A.5 Appendix: TACT Items Used in the First and Second Case studies

Table A.11: 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	[134]
IT02. The team keeps the list of impediments, risks and control actions updated	[49, 66, 37]
IT03. My opinion is always listened to by my team	[49]
IT04. Team members frequently talk about club, entertainment, gym, parties, sports, and films	[49, 168, 99]
IT05. During the retrospectives, the team finds the best way to do things	[10, 97, 93]
IT06. The team knows the skills and technical expertise of team members, and they use the skills and technical expertise appropriately and adequately	[53]
IT07. In the current project, the daily meeting allows to know project problems and team difficulties	[10, 72]
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	[97, 53]
IT09. In the current project, the team and the product owner always solve the disagreements about the iteration scope	[66, 167]

Table A.12: Items used to measure the Collaboration dimension

Items	Source
IT10. Team members consider sharing know-how with each other	[184]
IT11. Team members always help each other when there is a need	[99]
IT12. My team works efficiently together when in the face of difficulties	[28, 99]
IT13. Team members work together as a whole	[49]
IT14. All project-related decisions are applied consistently across to affected team members	[49]
IT15. The team collaborates to look for new ways to analyze the problems	[47, 90]
IT16. The team has excellent ability to design the software based on user stories	[139, 37]
IT17. In the current project, the team, the product owner, and team facilitator work excellently together to plan the iteration	[72, 167]

Table A.13: Items used to measure the Leadership dimension

Items	Source
IT18. The team facilitator gives me helpful feedback on how to be more effective	[30]
IT19. The team facilitator eliminates barriers, encourages, and facilitates the use of agile methods	[167, 87]
IT20. The team facilitator listens to my ideas and concerns	[30]
IT21. The team facilitator discusses the problems of the team	[26]
IT22. The team facilitator protects the team from outside interference	[186]
IT23. The team facilitator helps my team to acknowledge and solve our disagreements	[188]
IT24. The team facilitator assists to understand whether the iteration objectives are clear and whether the team agrees with these objectives	[135, 37]
IT25. The team facilitator gives the team helpful feedback on how to be more agile	[37, 30]
IT26. The team facilitator is always free to support the team when business requirements conflict with the technical reality	[167, 37]
IT27. The team facilitator investigates and helps the team to be more effective, taking into account the team velocity and the team capacity	[10, 66, 167]

Table A.14: 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	[187]
IT29. In the current project, the team facilitator protects the team autonomy from external interferences	[187, 81]
IT30. In this organization, we have the autonomy to suggest change the team's software process development	[47]
IT31. In this team, we switch assignments in tasks to avoid specialization and individualism	[81, 97]
IT32. The team has autonomy to adopt technical solutions without consulting the product owner or the management	[47]
IT33. My team has autonomy to communicate with the product owner and other relevant stakeholders	[81, 97]
IT34. My team has decision authority and responsibility to plan the iteration	[187, 37]

Table A.15: Items used to measure the Decision-Making dimension

Items	Source
IT35. My team has time to plan the changes without excessive stress or pressure	[115, 189]
IT36. In my team, members must NOT need to think equally	[97, 198]
IT37. In the iteration planning, the team analyzes the technical alternatives and chooses the most appropriate one	[97, 190, 37]
IT38. In the retrospective, the team identifies, analyzes and selects improvement items	[115, 37]
IT39. My team has open and effective communication	[191]
IT40. This organization allows the team to make their own technical decisions about the best way to develop the project	[47, 97]
IT41. The dependencies between the tasks do NOT hinder the fluidity of the project and do NOT cause major restrictions	[115, 37]
IT42. In the current project, my work is recognized by management	[115]

Table A.16: 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	[186, 37]
IT44. In the current project, there are frequent meetings with business representatives and the team	[43, 199]
IT45. Stakeholders always have the opportunity to suggest changes or improvements to the software	[37]
IT46. In the demo review, project problems and improvements are identified with stakeholders participation	[43, 37]
IT47. The current project does NOT have frequent requirement changes due to bad user stories definition	[30, 12]
IT48. The current project has met or exceeded the client expectations	[191, 12]
IT49. The product owner is always available to explain the user stories' details	[192, 37]

A.6 Appendix: First Evaluation by Specialists

This appendix shows the results of the first evaluation performed specialists. The aim was to identify possible improvements in the items and verify if the items were related to 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 comments and suggestions made by the judges were written in Portuguese, the original language of judges and researchers. The input items considered in the first evaluation are listed in the following.

Communication: [IT007] In this team we can talk freely with each other about difficulties we are having and know that others will want to listen, [IT016] The team keeps the list of impediments, risks and control actions updated, [IT062] My opinion is always listened to by my team, [IT085] Team members frequently talk about clubs, movies, entertainment, fitness, parties, sports, and films, [IT143] During the retrospectives, the team finds the best way to do things, [IT162] The team knows the skills and technical expertise of team members, and they use the skills and technical expertise appropriately and adequately, [IT183] In the current project, the daily meeting allows to know project problems and team difficulties, [IT192] The team and product owner always agree on user story prioritized, focusing on bug-fixing or adding more functionality, [IT223] In the current project, the team and product owner always resolve the disagrements about the iteration scope

Collaboration: [IT020] Team members consider sharing know-how with each other, [IT083] Team members always help each other when there is a need, [IT084] My team works efficiently together when in the face of difficulties, [IT124] Team Members work together as a whole, [IT128] All project-related decisions are applied consistently across to affected team members, [IT173] The team collaborates to look for new ways to analyze the problems, [IT180] The team has excellent ability to design the software based on user stories, [IT203] In the current project, the team, product owner, and team facilitator work excellently together to plan the iteration.

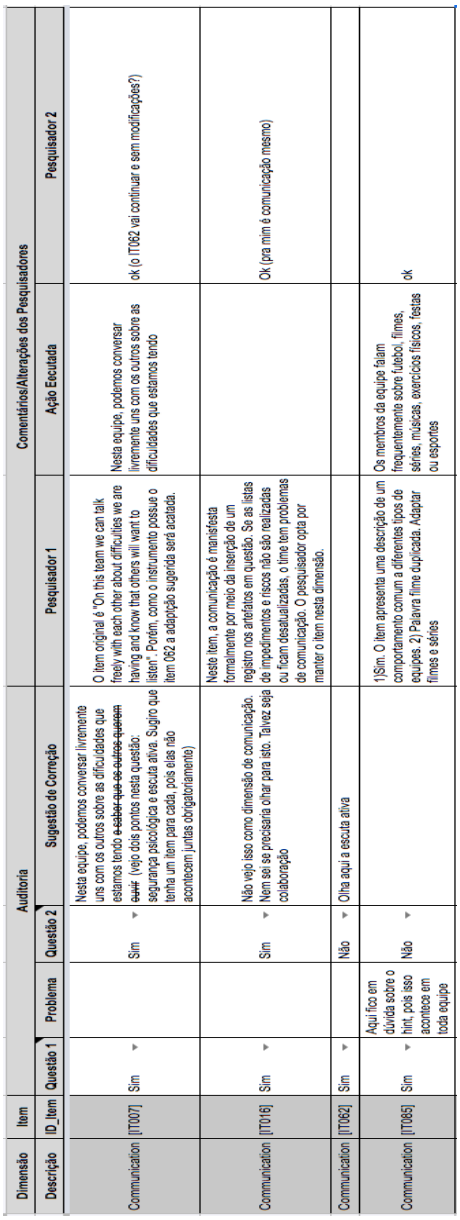
Leadership: [IT021] The team facilitator gives me helpful feedback on how to be more effective, [IT033] The team facilitator eliminates barriers, encourages, and facilitates the use of agile methods, [IT045] The team facilitator listens to my ideas and concerns, [IT047] The team facilitator discusses the problems of the team, [IT049] The team facilitator protects the team from outside interference, [IT145] The team facilitator helps

my team to acknowledge and solve our disagreements, [IT206] The team facilitator assists to understand whether the iteration objectives are clear and whether the team agrees with these objectives, [IT215] The team facilitator gives the team helpful feedback on how to be more agile, [IT217] The team facilitator is always free to support the team when business requirements conflict with the technical reality, [IT230] The team facilitator investigates and helps the team to be more effective, taking into account the team velocity and the team capacity.

Autonomy: [IT541] In the current project, I am free to choose my tasks, [IT542] In the current project, the team facilitator protects the team autonomy from external interferences, [IT543] In this organization, we have the autonomy to suggest change the team's software process development, [IT544] In this team, we switch assignments in tasks to avoid specialization and individualism, [IT545] The team has autonomy to adopt technical solutions without consulting the product owner or the management, [IT546] My team has excellent communication with the product owner and the client, [IT547] My team has substantial decision authority and responsibility to iteration planning.

Decision-making: [IT551] My team have time to plan the changes without excessive stress or pressure, [IT552] In my team, members must NOT need to think equally [IT553] In the iteration planning, technical decisions about the project are analyzed and selected by the team, [IT554] In the retrospective, improvement items are identified, analyzed and selected by the team, [IT555] My team has fast and effective communication, [IT556] This organization allows the team to make their own technical decisions about the best way to develop the project, [IT557] The dependencies between the tasks do NOT hinder the fluidity of the project and do NOT cause major restrictions, [IT558] In the current project, my work is recognized by management.

Client Involvement: [IT561] During the demo review, the team shows and validates the new functionalities with the right people, [IT562] In the current project, there are frequent meetings with business representatives and the team, [IT563] Stakeholders always have the opportunity to suggest changes or improvements to the software, [IT564] In the demo review, product problems and improvements are identified with stakeholders participation, [IT565] The current project does NOT have frequent requirement changes due to bad user stories definition, [IT566] The current project has met or exceeded the client expectations, [IT567] The product owner is always available to explain the user stories' details.

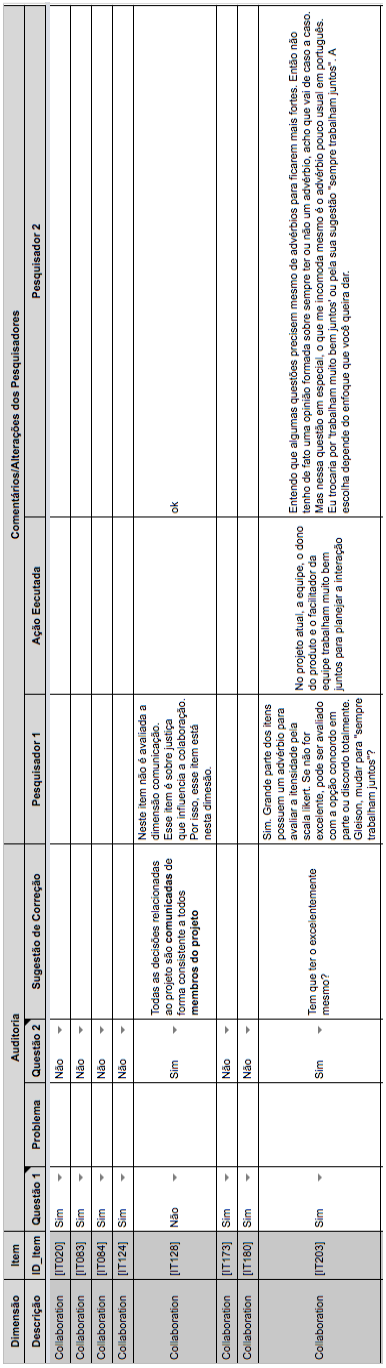


Dimensão	Item	Auditoria			Comentários/Alterações dos Pesquisadores		
Descrição	ID_Item	Questão 1	Problema	Questão 2	Sugestão de Correção	Pesquisador 1	Ação Executada	Pesquisador 2
Communication	[IT007]	Sim		Sim	Nesta equipe, podemos conversar livremente uns com os outros sobre as dificuldades que estamos tendo ~~e saber que os outros querem ouvir~~ (vejo dois pontos nesta questão: segurança psicológica e escuta ativa. Sugiro que tenha um item para cada, pois elas não acontecem juntas obrigatoriamente)	O item original é "On this team we can talk freely with each other about difficulties we are having and know that others will want to listen". Porém, como o instrumento possue o item 062 a adaptção sugerida será acatada.	Nesta equipe, podemos conversar livremente uns com os outros sobre as dificuldades que estamos tendo	ok (o IT062 vai continuar e sem modificações?)
Communication	[IT016]	Sim		Sim	Não vejo isso como dimensão de comunicação. Nem sei se precisaria olhar para isto. Talvez seja colaboração	Neste item, a comunicação é manifesta formalmente por meio da inserção de um registro nos artefatos em questão. Se as listas de impedimentos e riscos não são realizadas ou ficam desatualizadas, o time tem problemas de comunicação. O pesquisador opta por manter o item nesta dimensão.		Ok (pra mim é comunicação mesmo)
Communication	[IT062]	Sim		Não	Olha aqui a escuta ativa			
Communication	[IT065]	Sim	Aqui fico em dúvida sobre o hint, pois isso acontece em toda equipe	Não		1)Sim. O item apresenta uma descrição de um comportamento comum a diferentes tipos de equipes. 2) Palavra filme duplicada. Adaptar filmes e séries	Os membros da equipe falam frequentemente sobre futebol, filmes, séries, músicas, exercícios físicos, festas ou esportes	ok

Figure A.29: Judge evaluations and suggestions and Researchers' comments and actions to communication dimension items

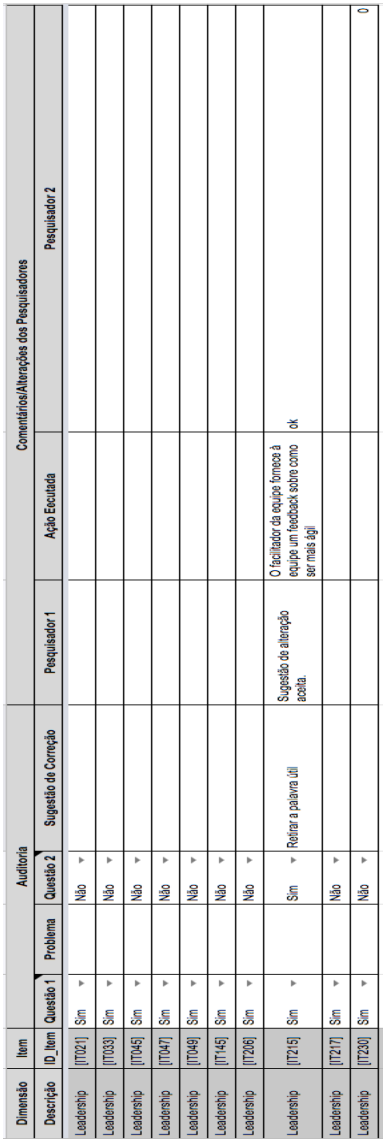
Dimensão	Item	Auditoria				Comentários/Alterações dos Pesquisadores		
Descrição	ID_Item	Questão 1	Problema	Questão 2	Sugestão de Correção	Pesquisador 1	Ação Executada	Pesquisador 2
Communication	[IT143]	Sim	O que são as coisas?	Sim	Creio que deveria especificar (talvez com base no artigo de origem), o que são as coisas. São as ações? E o comportamento do time na retroapectiva?	O item original trata da estratura informal (IT044. Help us to find the best way to do things). O pesquisador adaptará atividades do processo e tarefas.	Durante as reuniões de retrospectiva, a equipe encontra a melhor maneira de tratar as questões pertinentes e melhorar a forma como o trabalho é realizado	Entendo a preocupação do Revisor, mas a mudança não resolve o problema. No original 'coisas' é muito genérico e vago. Na sua sugestão, você especificou uma única opção de 'saída' da retrospectiva, que é a adaptação do processo. A alteração pode ser uma mudança de conduta, uma melhor forma de se comunicar com o cliente. Escrever 'adaptar o processo' me remete a algo mais formal (pode ser pelo meu viés de trabalhar com processos formalizados e com base em modelos de maturidade). Como estava: During the retrospectives, the team finds the best way to do things / Durante as reuniões de retrospectiva, a equipe encontra a melhor maneira de fazer as coisas Como me parece ser o que você quer descobrir: During the retrospectives, the team finds the best way to address the underlying issues and to improve the way the work is done / Durante as reuniões de retrospectiva, a equipe encontra a melhor maneira de tratar as questões pertinentes e melhorar a forma como o trabalho é realizado
Communication	[IT162]	Sim		Não				
Communication	[IT183]	Sim		Não				
Communication	[IT192]	Não	Não há prerrogativa de haver concordância.	Sim	Revise algumas questões conceituais, pois na hora do time analisar eles podem achar estranho, pois a equipe não precisa sempre concordar com a priorização, ele devem chegar a um consenso. Outro ponto é quanto a concentração, é um limitador racional. Ela infere que eles não devem se preocupar com mais nada, apenas em bug e inserir funcionalidade.	1) O pesquisador alterará concordam por consenso. Concentrando-se por dialogando.	A equipe e o dono do produto sempre chegam a um consenso sobre a prioridade das histórias do usuário, dialogando sobre correções de bugs ou na adição de mais funcionalidades	ok
Communication	[IT223]	Sim		Sim	escopo da **iteração**	O pesquisador corrigirá a tradução.	No projeto atual, a equipe e o dono do produto sempre resolvem as divergências sobre o escopo da iteração	ok

Figure A.30: Judge evaluations and suggestions and Researchers' comments and actions to communication dimension items (Continuation)



Dimensão	Item	Auditoria			Comentários/Alterações dos Pesquisadores		
Descrição	ID_Item	Questão 1	Problema	Questão 2	Sugestão de Correção	Pesquisador 1	Ação Eecutada	Pesquisador 2
Colaboration	[IT020]	Sim		Não				
Colaboration	[IT083]	Sim		Não				
Colaboration	[IT084]	Sim		Não				
Colaboration	[IT124]	Sim		Não				
Colaboration	[IT126]	Não		Sim	Todas as decisões relacionadas ao projeto são comunicadas de forma consistente a todos membros do projeto	Neste item não é avaliada a dimensão comunicação. Esse item é sobre outra coisa que influencia a colaboração. Por isso, esse item está nesta dimesão.		ok
Colaboration	[IT173]	Sim		Não				
Colaboration	[IT180]	Sim		Não				
Colaboration	[IT203]	Sim		Sim	Tem que ter o excelentemente mesmo?	Sim. Grande parte dos itens possui um advérbio para avaliar a intensidade pela scala likert. Se não for excelente, pode ser avaliado com a opção concordo em parte ou discordo totalmente. Gleison, mudar para "sempre trabalham juntos"?	No projeto atual, a equipe, o dono do produto e o facilitador da equipe trabalham muito bem juntos para planejar a interação	Entendo que algumas questões precisem mesmo de advérbios para ficarem mais fortes. Então não tenho de fato uma opinião formada sobre sempre ter ou não um advérbio, acho que vai de caso a caso. Mas nessa questão em especial, o que me incomoda mesmo é o advérbio pouco usual em português. Eu trocaria por "trabalham muito bem juntos' ou pela sua sugestão "sempre trabalham juntos". A escolha depende do enfoque que você queira dar.

Figure A.31: Judge evaluations and suggestions and Researchers' comments and actions to collaboration dimension items



Dimensão	Item	Auditoria				Comentários/Alterações dos Pesquisadores		
Descrição	ID_Item	Questão 1	Problema	Questão 2	Sugestão de Correção	Pesquisador 1	Ação Executada	Pesquisador 2
Leadership	[IT021]	Sim		Não				
Leadership	[IT033]	Sim		Não				
Leadership	[IT045]	Sim		Não				
Leadership	[IT047]	Sim		Não				
Leadership	[IT049]	Sim		Não				
Leadership	[IT145]	Sim		Não				
Leadership	[IT206]	Sim		Não				
Leadership	[IT215]	Sim		Sim	Retirar a palavra útil	Sugestão de alteração aceita.	O facilitador da equipe fornece à equipe um feedback sobre como ser mais ágil	ok
Leadership	[IT217]	Sim		Não				
Leadership	[IT230]	Sim		Não				0

Figure A.32: Judge evaluations and suggestions and Researchers' comments and actions to leadership dimension items

Dimensão	Item	Auditoria			
Descrição	ID_Item	Questão 1	Problema	Questão 2	Sugestão de Correção
Client Involvement	[IT561]	Sim		Não	
Client Involvement	[IT562]	Sim		Não	
Client Involvement	[IT563]	Sim		Não	
Client Involvement	[IT564]	Sim		Não	
Client Involvement	[IT565]	Sim		Não	
Client Involvement	[IT566]	Sim		Não	
Client Involvement	[IT567]	Sim		Não	

Figure A.33: Judge evaluations to autonomy and decision-making dimensions

Dimensão	Item	Auditoria			
Descrição	ID_Item	Questão 1	Problema	Questão 2	Sugestão de Correção
Team Autonomy	[IT541]	Sim		Não	
Team Autonomy	[IT542]	Sim		Não	
Team Autonomy	[IT543]	Sim		Não	
Team Autonomy	[IT544]	Sim		Não	
Team Autonomy	[IT545]	Sim		Não	
Team Autonomy	[IT546]	Sim		Não	
Team Autonomy	[IT547]	Sim		Não	
Team Decision-Making	[IT551]	Sim		Não	
Team Decision-Making	[IT552]	Sim		Não	
Team Decision-Making	[IT553]	Sim		Não	
Team Decision-Making	[IT554]	Sim		Não	
Team Decision-Making	[IT555]	Sim		Não	
Team Decision-Making	[IT556]	Sim		Não	
Team Decision-Making	[IT557]	Sim		Não	
Team Decision-Making	[IT558]	Sim		Não	

Figure A.34: Judge evaluations to client involvement dimension