Instrument to measure the perceptions of software development communities regarding communication, coordination and cooperation: Result of validation through expert judgment

Instrumento para medir las percepciones de las comunidades de desarrollo de software respecto a la comunicación, coordinación y cooperación: Resultado de la validación mediante juicio de expertos

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Abstract

Introduction: Software development is a sociotechnical activity that requires both social and technical factors to achieve any proposed objective. These factors characterize Sociotechnical Congruence (STC), which focuses on the proper use of soft skills such as coordination, communication, and cooperation within software development teams.

Objective: The objective of this study is to introduce a measurement tool that enables the assessment of perceptions among members of a software development community, based on 42 questions formulated across three dimensions: communication, cooperation, and coordination.

Method: The validation of the measurement instrument was carried out through expert judgment. Nine professionals were selected to evaluate the instrument using four quality criteria: sufficiency, clarity, relevance, and coherence. To determine the agreement among the experts, the Fleiss' Kappa coefficient was employed, and Landis and Koch's criteria were applied to measure the degree of concordance.

Results: The agreement strength for each dimension was substantial and nearly perfect. Considerable agreement was identified for the sufficiency, coherence, and clarity quality criteria, with clarity having the highest coefficient (0.85). The relevance quality criterion showed moderate agreement, being the lowest (0.583). A significance level of 5% was considered, with the clarity quality criterion being the most significant, with a p-value of 0.02.

Conclusions: Once the adjustments to the instrument are made, it can be used to measure perceptions of the dimensions: communication, cooperation, and coordination within software development communities.

Key Words: Anti-patterns; Fleiss' Kappa coefficient; Communication; Cooperation; Coordination; Software communities; Sociotechnical Congruence (STC); Social debt; Expert judgment; Community smells.

Resumen

Introducción: El desarrollo de software es una actividad sociotécnica que requiere de factores sociales y técnicos para el logro de cualquier objetivo propuesto. Estos factores caracterizan a la Congruencia Sociotécnica (STC), que se centra en el uso debido de habilidades blandas como la coordinación, comunicación y cooperación de los equipos de desarrollo de software.

Objetivo: El objetivo de este estudio es presentar un instrumento de medición que permite determinar las percepciones de los miembros de una comunidad de desarrollo de software a partir de 42 preguntas formuladas a través de tres dimensiones: comunicación, cooperación y coordinación.

Metodología: La validación del instrumento de medición se realizó por juicio de expertos; se seleccionaron 9 profesionales, quienes evaluaron el instrumento mediante 4 criterios de calidad: *suficiencia, claridad, relevancia* y *coherencia*. Para determinar el acuerdo entre los expertos, se utilizó el coeficiente Kappa Fleiss y, para medir el grado de concordancia, se aplicó Landis y Koch.

Resultados: La fuerza de concordancia para cada dimensión fue considerable y casi perfecta. Para los criterios de calidad del suficiencia, coherencia y claridad, se identificó una concordancia considerable, siendo la claridad el coeficiente más alto (0.85). El criterio de calidad *relevancia* fue moderado, siendo la más baja (0.583). Se tuvo en cuenta un nivel de significancia del 5%, siendo el criterio de calidad *claridad* el más relevante con un valor p=0.02.

Conclusiones: Realizado los ajustes al instrumento, podrá ser utilizado para medir las percepciones de las dimensiones: comunicación, cooperación y coordinación en las comunidades de desarrollo de software.

Palabras clave: Anti-patrones; Coeficiente kappa de Fleiss; Comunicación; Cooperación; Coordinación; Comunidades de software; Congruencia Sociotécnica (SCT); Deuda social; Juicio de expertos; Olores comunitarios.

I. INTRODUCTION

Software engineering as a discipline that is responsible for studying the development, operation and maintenance of software, covers everything from customer needs, construction, quality control and commissioning. In this sense, *"software engineering comprises a set of activities that are mostly labor intensive, that is, carried out by people. Most of them are carried out in organized specialized work groups, which is why aspects related to the so-called human factor are emphasized and gain great importance"[1].* This is why software development requires the execution of a process made up of steps, tasks and/or activities whose complexity depends on the type of software, scope of the project or client requirements. For this reason, the execution of a software development process requires the participation of professionals with technical and social skills that contribute to teamwork and assertive communication, *"which has led interested parties to recognize that it is also an activity. social in which interactions between people are central. This is why software development is a sociotechnical activity, where both social factors and technical factors are essential to achieve the objectives and success of a project"* [2].

It should be noted that the technical activities associated with the software life cycle are planned, assigned and divided among the members of the software development teams, which increases the need for social skills such as: communication, coordination and cooperation, for example. therefore, collaboration. The objective is to facilitate the interaction between the different members, given that the complexity of each project or software development varies. Therefore, the requirements and dependencies between tasks change at each stage of the process, thus altering the efficiency of team coordination. Therefore, coordination and collaboration mechanisms must be aligned with the underlying project organization to adapt to dynamic changes in task dependencies [3].

Therefore, the problem of task interdependence can be addressed by introducing soft skills into the software development process, i.e.; communication between team members that serves as a connector between developers who need coordination to complete interdependent tasks and achieve the same goal [4]. Inconsistency, disorganization, disagreement, non-compliance and changes in tasks due to poor communication and coordination between members of the development team, not only affects the efficiency and productivity of the team, but it also affects; "Developers' reactions to these changes can lead to distrust, irritation, and lack of communication. When these reactions persist, they increase costs and introduce social debt", leading to technical problems in software artifacts, for example; incomprehensible documentation, incomplete software components resulting in sociotechnical debt [5], which influences the quality of the product, which refers to the degree of performance of the main characteristics that a computer system must comply with during its life cycle, These characteristics in a certain way provide the client with a reliable system, which increases their satisfaction with the functionality and efficiency of the built system [6].

In order to mitigate communication, cooperation and coordination (hereinafter 3C) problems in software development communities, it is necessary to address sociotechnical congruence (STC), whose focus is the social and technical aspects of the software development process, Proper alignment of soft and technical skills within a software development team would help measure the level of team coordination and identify gaps that lead to delays in work and results, or overall project failure [7].

The objective of this work is to present an instrument to measure the perceptions of the members of a software development community based on the psychosocial factors that include intra-work aspects and individual conditions that can affect the dimensions of communication, cooperation and coordination. This instrument is made up of 42 questions with a Likert-type response scale. The attributes of the social relations dimension associated with: planning and assignment of work, achievement of results, conflict resolution, participation, motivation, support, interaction and communication with collaborators cited in the battery of instruments for the evaluation of psychosocial risk factors in Colombia presented in [8].

The instrument was validated through the expert judgment technique; for this, a questionnaire was developed with four quality criteria: sufficiency, clarity, relevance and coherence. The purpose was to receive feedback from professionals on the scope of the questions based on their experience and knowledge. Based on the results obtained in the validation questionnaire, the experts recommended applying two instruments, a first instrument to leaders, technology managers or IT directors due to the coordination activities that they carry out, and a second instrument to the others. roles present in software development (leaders and software team), the recommendations also involved adjusting the wording of some questions and adding 3 questions to the communication dimension.

Finally, this study is organized as follows. The first Section details the literature review on the topics SCT, community odors, and social debt. The second Section refers to the methodology used for this study. The third Section discusses the results found in the content validation of the proposed instrument through expert judgment and, finally, the conclusions, achievements achieved in this study and future work are presented.

II. LITERATURE REVIEW

Software development requires the sequence of logical steps and specification of tasks based on the client's requirements or needs, and the execution of these tasks previously organized and related to each stage of the software life cycle. This process requires the work team to possess the technical skills that contribute to the quality of the product and social skills, such as: communication, coordination and cooperation that allow the members of the software development team to interact, achieve the established goals and achieve better performance.

Coordination is essential to ensure that projects are developed and, in this way; comply with customer requirements. Typically, in software projects, team members come together to develop or improve the software. Common coordination problems that arise and affect team performance are: time separation, culture, organization, and distance. Therefore, the identification of these problems is important to determine the difficulties in the spectrum of coordination activities of the members of a software development team. [9].

In a study carried out by [10], identified that coordination and communication in Global Software Development Teams (GSE) is a little more complex due to the problems of distance, difference in work schedules, diverse interpretations as well as difficulties in communicating synchronously. One of the challenges for these companies is to facilitate the successful communication of tasks in such a way that they can be understood by their respective members. Despite the difficulties identified, little help is available for GSE managers to evaluate their organizational structure and identify the communication and coordination processes that need to be strengthened. To this end, there are techniques and tools available to measure STC and the aspects related to it, allowing an appropriate socio-technical balance to be achieved. This study provides two contributions to help improve communication and coordination in GSE. The first of them is an architecture designed to take advantage of agent technology to improve communication and coordination in globally distributed environments, measuring and maintaining STC, and also helps detect and mitigate communication and coordination gaps. The second is a new approach to measuring STC in a Global Development Project, combining an existing measurement with a set of factors that adapt this measurement to the GSE context. This means that the analysis of STC values, adapted to GSE, can be carried out by agents with greater precision.

On the other hand in [11], identified that "…coordination in software development communities implies high levels of collaboration between multiple teams, their members and clients to achieve common objectives…", which allows us to glimpse and make clear that the complexity of modern software requires intervention of individuals with a wide diverse spectrum of: capabilities, skills and knowledge to understand and understand the domain of a given problem. The division, assignment, and integration of work to deliver a single coherent software product within a reasonable time, involves the coordination of deliverables, development of tasks, knowledge between teams and members, shared understanding of how to work together and resynchronization, understanding and change of the requirements. The results of the study highlighted that; Although coordination is achieved in both agile and traditional approaches, the activities and artifacts supported by various tools and structures must be carefully selected to form a coordination strategy. The model includes three basic coordination concepts: dependency taxonomy, coordination strategies and coordination efficiency [11].

Likewise, in [12] It is indicated that the development of software projects using geographically distributed teams is constantly growing, which implies that the members of the EDS must communicate and coordinate with each other to ensure the success of product development. This study explores the use of Facebook as a means of communication and coordination. Chat and comments were found to be the most used channels for both formal and informal communication. Informal communication accounted for one-fifth of the interaction between team members. Additionally, the sociotechnical congruence score indicated a high degree of coordination among team members using Facebook. Based on the results of the study, a usage model for DSD was proposed using Facebook as a means of communication and coordination.

It should be added that in a study presented in [13], The social effects of knowledge sharing in remote teams are addressed. In this study, the authors propose a conceptual model that hypothesizes a relationship between knowledge sharing, trust, collaboration, and team effectiveness in these types of environments. The results found indicate that the exchange of knowledge contributes positively to collaboration and trust between team members, but that it does not have a significant direct effect on its effectiveness, that is; which is not enough.

The study carried out by [14], Creating effective software teams is complex; the technical dimension is not enough to achieve it. In this article, a framework for assigning people to projects is defined from this sociotechnical perspective. Social networks become the main tool for communication, allowing interaction between teammates and in this way they build, analyze and predict productive collaborations and identify suitable team members according to the needs of the organization and the type of project. In turn, it is noteworthy that these social networks estimate compatibility between coworkers based on previous collaborations, but also based on the social skills of the individuals. This allows you to analyze compatibility between people who have not worked together before. The experiment carried out for more than two years allows us to significantly improve the expected results by characterizing and measuring social interaction between coworkers. The social aspects discussed can be of great relevance in the context of distributed software engineering, since it implies new challenges in the interaction between coworkers.

Also, in [15] It is specified that a virtual team is effective if they are: (i) geographically dispersed (in different time zones); (ii) driven by a common purpose; (iii) use effective tools for assertive communication; (iv) promote cross-border collaboration ; (v) working with the same communication processes. In this study, a model was developed to establish a conceptual framework of team efficiency in remote environments based on the sociotechnical perspective. In the study it was mentioned that both the interaction of technology, people and work systems lead to a favorable work environment as long as a technical system is created at the expense of a social system. In turn, the study references the theory of the sociotechnical system (STS), which is based on the interdependent and confusing relationships linked between the characteristics of any object or technological system and social norms, rules of use and the participation of a wide range of human stakeholders [15].

Likewise, in [16] a study on STC is carried out, the objective was to evaluate the impact of STC on software development through a literature review (SLR), of 46 publications found in 4 databases, including magazines, conferences and workshops, published between 2008 and 2019, it was observed that STC helps measure the alignment between the social and technical capabilities of an organization and teams at various stages of software development. Furthermore, it was found that there are some areas that require more research, for example: (1) there is literature related to STC, but only one research work mainly focuses on the risk of overloading STC (i.e., excessive measurement of STC can overload the software development process); (2) STC measurement techniques facilitate the identification of congruence gaps, but no attention has been paid to STC measurement models based on unweighted social network analysis; (3) STC measurement techniques are generally not applied in the requirements and testing phase. Finally, this SLR guided the proposal of four research directions: (1) identify STC risks, (2) determine STC metrics to overcome identified communication gaps, (3) use STC performance measures in different and all phases of the project life cycle, and (4) explore the factors that influence STC [16].

On the other hand, in [17] the modeling of lower-level technical dependencies is carried out to improve coordination in Software Engineering projects. The author indicates that STC is one of the most important current discussions in the Software Engineering community and has been used to measure the coordination of the development team. Additionally, there was increasing interest in improving metrics to determine STC and its relationship to task performance, software quality, and productivity. In this study, higher levels of congruence were found between lower-level technical dependencies associated with *task complexity*.

In [18], a current concept called social debt is referenced; The authors define it as: "…the additional cost in the state of the project whose cause is the result of suboptimal sociotechnical decisions, which result from the breakdown of the STC…". In turn, it complements that social debt is analogous to technical debt in many aspects: it represents the state of software development organizations as a result of "accumulated" decisions. In the case of social debt, decisions are about people and their interactions. The objective of this work was to study the causes of social debt through exploratory qualitative research in a large software company. The results obtained showed that there are different factors that are interrelated causing social debt; They represented these factors in a framework and identified anti-patterns that caused the debt. As a result, it could be inferred that there is a strong correlation between social debt and suboptimal characteristics in the organizational social structures behind software development communities. Furthermore, they concluded that social debt is related in many ways to technical debt. Among the findings found is the presence of "community smells", that is, precursors to the appearance of social debt, as well as code smells, which can lead to technical debt.

Similarly, in the study carried out by [19], it is mentioned that in geographically distributed organizations, agile teams can develop organizational and sociotechnical problems, defined as "community odors". In this study, the existence of unpleasant organizational phenomena is analyzed, which are indicators that software architectures are not explicitly designed, documented or maintained, and where organizational culture is emergent. "Community odors" spread and impact the quality of artifacts.

Another of the studies found [20] focuses on social debt in a context where software architecture is subject to anti-patterns, better known as "community smells". During the process, four smells were identified in software architectures: (i) *solitary architecture*, where roles other than architects make decisions, generating debt; In this case, it is associated with delays in knowing the decisions and applying the necessary modifications, and from the social point of view, this circumstance translates into the loss of the vision of the project; (ii) *obfuscated architecture*, this anti-pattern manifested itself when new or modified architectural decisions imply implementation changes that require new people to be included in the development team; (iii) *architecture by osmosis*, means making architectural decisions using knowledge that filters through many semi-permeable communication links; and (iv) *invisible architecture*, which occurs when experts or members in charge of transmitting architectural knowledge to novices become oppressive instead of clarifying.

Furthermore, it is relevant to cite the article developed by [21], who state that there is a diversity of studies on DT technical debt, but there is still much to explore when talking about social factors, people and processes. It is important to note that the term "non-technical debt" (NTD) will be used to address social, process and people debts. Therefore, this study investigates the scientific evidence on NTDs to date by conducting a systematic literature review in software engineering between January 2000 and October 2021. The search strategy resulted in 175 studies, 17 of which were identified as unique and relevant primary articles. Primary studies show that NTD and DT are linked. Furthermore, this study also captured a large number of causes and mitigation strategies for NTD management. Therefore, it provides four important contributions: (i) highlighting the most advanced research on NTD; (ii) identifies the reported causes and mitigation strategies in the primary articles; and (iii) determines opportunities for future research on NTD.

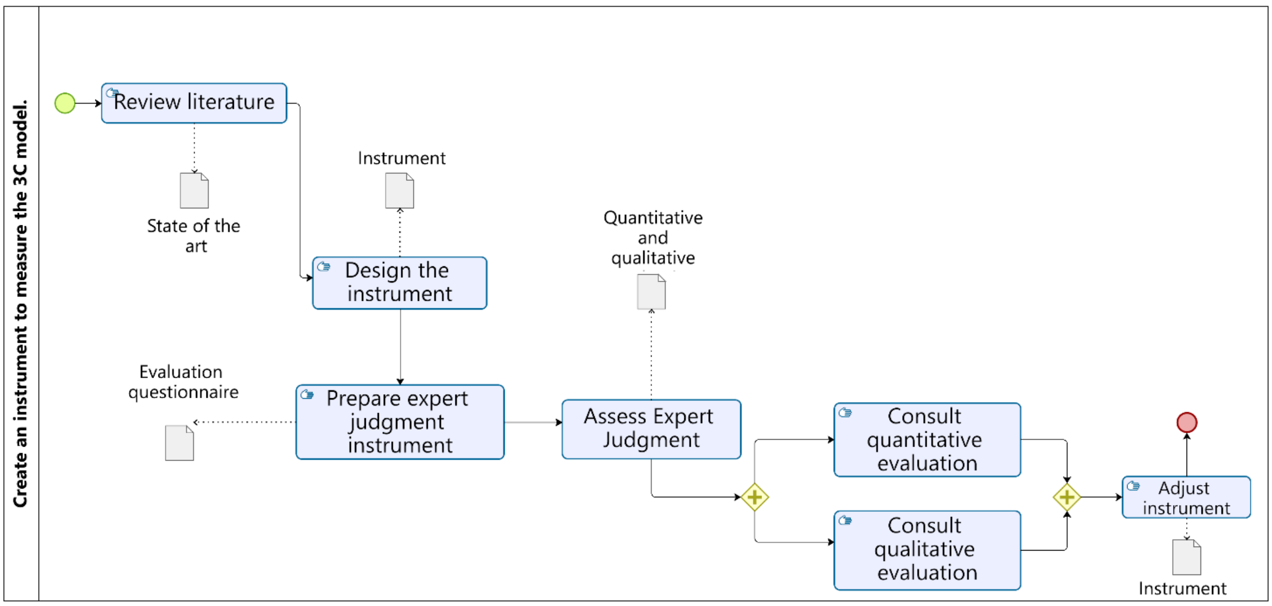
It is worth highlighting the contribution made by [22], where it is pointed out that software development requires high skills of its members for problem solving and creativity. Participants in the Software Development Team must maintain productivity, enjoyment, and intrinsic motivation towards the activity in their work environment. This study aims to better understand the barriers that prevent software developers from experiencing fluidity at work. A qualitative questionnaire was used to collect data on the flow experiences of 405 respondents. The most prominent flow barriers that emerged from these responses were interruptions, tasks that are too easy, boring, or repetitive, lack of opportunities, requirements, insufficient schedules, and deadlines, as well as problems with technology or software. The results suggest that there are more flow barriers in software development than have been discussed in the context of productivity.

Based on the reviewed literature, it can be seen that metrics have been developed and implemented to evaluate STC in software development teams. However, it is recommended to define additional metrics to overcome communication gaps between teams. These metrics must be applied in each of the stages of the development life cycle, analyze the results and determine the presence of community odors that can affect communication, cooperation, and coordination, thus generating social debt. This situation could have a negative impact on the productivity and well-being of members. In this sense, the purpose of this work is to present an instrument that allows determining, through metrics, the perceptions of individuals about communication, cooperation, and coordination in software development communities. To this end, the instrument was subjected to validation using the expert judgment technique to determine four quality criteria (sufficiency, clarity, relevance and coherence) of the questions associated with each of the dimensions: communication, cooperation and coordination.

III. METHODOLOGY

The purpose of the research is to measure, using an instrument, the perceptions of the members of a software development community on the dimensions associated with the 3C model and determine: its impact on the development of the assigned tasks, consequences on the proposed objectives, appearance of psychosocial risk factors that can affect the individual well-being of its employees, and the presence of anti-patterns or "community odors" that can lead to social and technical debt, known as sociotechnical debt. For the development of this study, a first stage was defined, which consisted of the design and validation of the instrument. Therefore, (Fig. 1) illustrates the steps taken to comply with this initial stage.

Fig. 1. Steps for the design and validation of the instrument to measure perception of the 3C model.

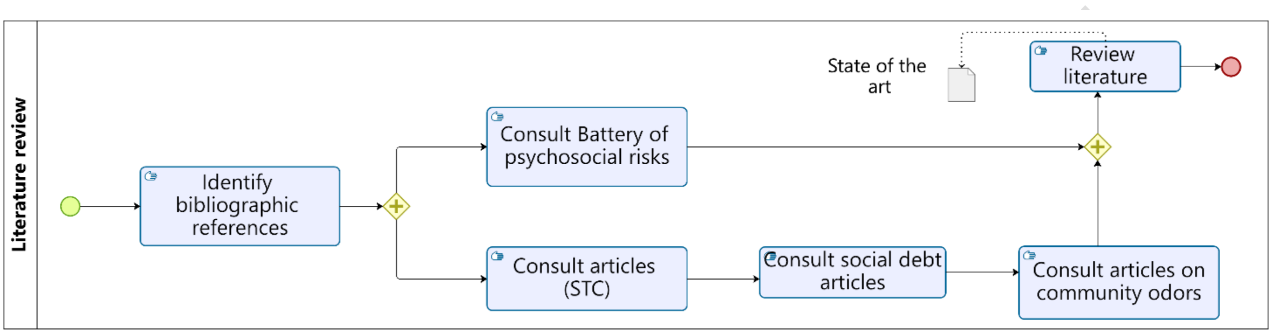


Source: Prepared by the authors.

Literature Review

A Systematic Literature Review (RLS) was carried out that allowed us to gain an insight into the knowledge of the topic and identify the most relevant primary studies. Likewise, the design of the instrument was carried out and a sequence of steps illustrated in (Fig. 2) was followed, which describes the following steps: (i) identify the literature associated with the topics of sociotechnical congruence (STC) in software development communities; (ii) consult the battery of instruments for the evaluation of psychosocial risk factors in Colombia and study its adaptation to the domain of the software industry, and identify intra-labor psychosocial risk factors [8]; and finally, (iii) the articles related to the topic social debt and "community odors", assuming that the presence of anti-employers or "community odors" can lead to social and technical debt.

Fig. 2. Steps for SLR on the topic under study



Source: Prepared by the authors.

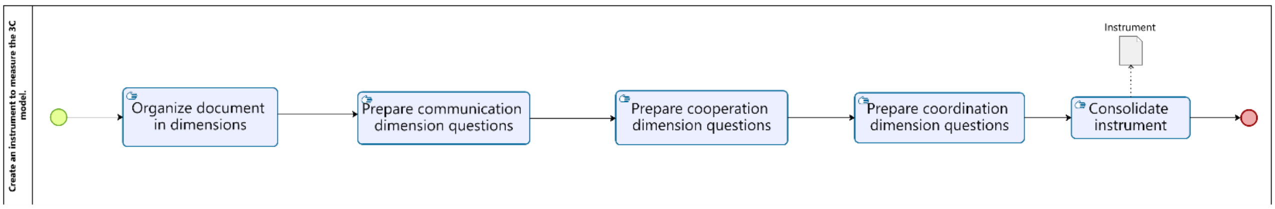
Instrument design

Research instruments are tools that allow evidence to be obtained, and when this is provided in terms of units of measurement then the instrument is classified as scientific according to [23]. The instrument designed to submit to the content validation technique by expert judgment is a questionnaire that seeks to measure the perceptions of the members of a software development community on the factors associated with the 3C model. (Fig.3) illustrates the questionnaire to measure communication, cooperation and coordination in a software development community that consists of 42 items distributed in three dimensions. The items of the instrument have a Likert-type response scale, which inquires about the frequency of occurrence of a situation and is one of the most reliable ways to measure people's opinions and behaviors, it is an instrument for collecting quantitative data, and Attitudes can be measured with this type of scale [24]. Furthermore, this scale has been used in social studies where non-quantitative perceptions on topics of specific interest are collected [25] (the evaluation scale consists of 5 options ranging from: "always" to "never", these alternatives are: Always (4), Many times (3), Sometimes (2), Only sometimes (1) and Never (0).

The responses recorded by the participants were not classified as correct and incorrect; The important thing was to reflect their way of thinking and acting. In the following links you can view a first instrument designed for leaders: https://tinyurl.com/28a5n85v and a second instrument designed for the other members of the team https://tinyurl.com/22mahs38.

The first dimension is communication, according to Manucci [26]: Communication *"... is one of the bases of collaborative work, given that it is strengthened through the construction of links, emotions and experiences. People, as social beings, are shaped in their daily lives through their experiences, relationships and contexts. Communication articulates coexistence and, above all, allows us to build and manage shared realities".* This dimension is made up of 13 questions (1-13) whose objective is to assess: the quality of interactions between colleagues, teamwork, the execution of activities that require collaboration to achieve a common objective, cohesion and integration. of the team members and the feedback or information that the worker receives about the development of their work. Below, in Table 1, the list of questions asked for this dimension is listed.

Fig. 3. Dimensions of the instrument to measure perceptions of the 3C model in software development communities.



Source: Prepared by the authors.

Table 1. Communication dimension questions.

Id	Questions.	Scale				
		4	3	2	1	0
1	Is the work environment in my software development community pleasant?					
2	An unfavorable work environment in my software development community leads to various negative outcomes, such as?					
3	Does a favorable work environment in my software development community lead to?					
4	Are tools used in my software development community?					
5	Do the tools used for communication in my software development community allow me?					
6	If the answer to the previous question is: almost never (1) or never (0): The lack of tools in the development of my tasks generates: Problems in feedback on tasks.					
	a) Little participation in the development of activities.					
	b) Little commitment.					
	c) Problems exchanging information and ideas with the team.					
7	Is the treatment between members of the software development community respectful?					
8	Do I feel like I can trust my fellow software development community members?					
9	Do I feel comfortable with my fellow software development community members?					
10	In my software development community, do some people treat me poorly?					
11	Are the problems presented in my software development community resolved respectfully?					
12	Are company objectives and work goals communicated to members of the software development community?					
13	Are the tasks socialized, reviewed and discussed by the different members of the development community before going to the execution process?					

Source: Prepared by the authors based on the psychosocial risks battery.

The second dimension is cooperation, made up of 9 items (14-22) as shown in Table 2, which has the purpose of: determining the opportunities provided to the work team to apply, learn and develop their skills and knowledge, the integration and union between the members to achieve the proposed objectives, the help offered by the leader and other colleagues when there are technical and social difficulties, and the instructions and guidance on what each individual should do.

Table 2. Cooperation dimension questions.

id	Questions	Scale				
		4	3	2	1	0
14	Is there integration between members of my software development community?					
15	Is my software development community tight-knit, leading to proper project development?					
16	The members of my software development community make me feel part of the group.					
17	When we have to do group work, my colleagues from my software development community collaborate.					
18	Is it easy to get members of the software development community to agree to do the work?					
19	My fellow software development community members help me when I have difficulties.					
20	Members of my software development community support each other.					
21	Some colleagues in my software development community listen to me when I have problems.					
22	They give me clear instructions on the tasks I must complete.					

Source: Prepared by the authors based on the psychosocial risks battery.

Finally, the third dimension is coordination with 20 questions, distributed as follows: 9 questions to be completed by the leader as shown in Table 4, and 11 questions for the other community roles as shown in Table 3. These questions measure the management of leaders in relation to: planning, assignment, execution and achievement of results, conflict resolution, participation, motivation, support, interaction and communication with their work team.

Table 3. Coordination dimension questions – Work team.

id	Questions	Scale				
		4	3	2	1	0
23	The leader of my software development community helps to better organize the work to be executed.					
24	The leader of my software development community takes my point of view into account for the development of activities					
25	The leader of my software development community motivates members to do better.					
26	Tasks are assigned in a way that facilitates the development of my work.					
27	The activities associated with my work are communicated on time.					

28	The guidance provided by my software development community leader helps get the job done better.					
29	The leader of my software development community helps me feel better about my job.					
30	The leader of my software development community helps me advance the development of my tasks.					
31	I can trust the leader of my software development community.					
32	The leader of my software development community listens to me when I have problems.					
33	The leader of my software development community is supportive when I need it.					

Source: Prepared by the authors based on the psychosocial risks battery.

Table 4. Coordination dimension questions – Leaders.

id	**Questions**	**Scale**				
		4	3	2	1	0
34	I have members of my software development community who communicate work issues late.					
35	I have members in my software development community who engage in disrespectful behavior.					
36	I have members in my software development community who make it difficult to organize work.					
37	I have members in my software development community who are silent when asked for opinions.					
38	I have members in my software development community who make it difficult to achieve work results.					
39	I have members in my software development community who disrespectfully express their disagreements.					
40	I have members in my software development community who are uncooperative when needed.					
41	I have members in my software development community who worry me about their performance.					
42	I have members in my software development community who ignore suggestions to improve their work.					

Source: Prepared by the authors based on the psychosocial risks battery.

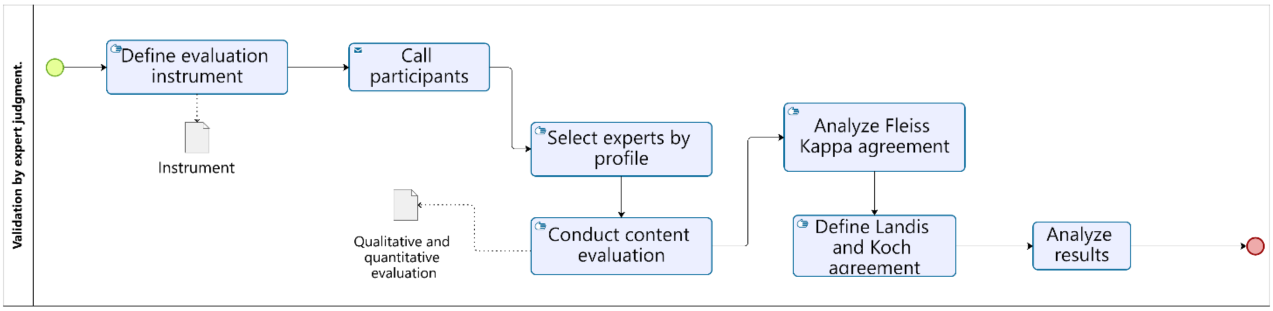
It should be noted that, to validate the content of the instrument, the experts were asked for their opinion based on the knowledge and experience they had regarding; whether they agree or not with the questions that make up the questionnaire and whether they measure the defined dimensions.

Content validation using the expert judgment technique.

Content validation "*refers to the degree to which an instrument reflects a specific domain of the content of what is to be measured, it is about determining to what extent the items or reagents of an instrument are representative of the universe of content of the characteristic or trait. that you want to measure, answers the question how representative is the behavior chosen as a sample of the universe you are trying to represent* " [27]. In addition,[28] indicates that "*content validation is determined by the validity and representativeness of the definition of the construct, representativeness of the group of items, grammatical aspects of the items and clarity of the instructions*". It is necessary to clarify that content validity can be carried out through expert judgment, which consists of asking a group of people to make a judgment about an instrument or other material to provide their opinion regarding a specific aspect or dimensions [29]. In the same way [30] indicates that expert judgment is represented by a number of people with extensive knowledge about a topic, who analyze and evaluate an instrument. To apply this technique, some criteria must be taken into account such as the identification of experts regarding the degree of knowledge, number of experts involved, as well as the evaluation methods that they apply to a research instrument. This strategy requires the selection of people who will make up the group to carry out the trial. The following criteria are proposed to select them: (i) Experience in making judgments and decision-making based on evidence or expertise (degrees, research, publications, position, experience and awards, among others), (ii) reputation in the community, (iii) availability and motivation to participate, and (iv) fairness and inherent qualities, such as self-confidence and adaptability. They also suggest that experts may be related by similar education, training and experience [31].

To carry out content validation by expert judgment in this study, (Fig. 4) shows the steps carried out.

Fig. 4. Steps for content validation by expert judgment.



Source: Prepared by the authors.

Definition of the instrument to validate the content by expert judgment

The validation of the content of the instrument to measure perceptions about the 3C model in software development communities was organized into 3 dimensions (coordination, cooperation, and communication) to be evaluated by the experts. The expert judgment template proposed by[31] and which proposes four quality criteria with their respective indicators for qualification (sufficiency, clarity, coherence, relevance and relevance). For the quality criterion, *sufficiency* is verified if the items in the instrument to be evaluated measures the aspect of the dimension and whether the number of items is necessary. The *relevance* quality criterion is used to determine if the item is essential and whether or not the evaluated instrument should be included. Furthermore, the *clarity* criterion validates that the item is easily understood and finally the *coherence* quality criterion sought to measure whether the item is related to the indicator that is being measured. This proposal also describes a defined scale for qualification based on four levels: (i) Does not meet the criteria, (ii) Low level, (iii) Moderate and (iv) High level. Likewise, each expert recorded their qualitative observations per item, leaving a record of the validation. To do this, in each item of the form prepared in Google Drive, the option to comment or make observations was placed taking into account the established quality criteria

Selection of participants for expert judgment

For the development of this activity, the selection of the group of experts was carried out taking into account the following criteria: (i) knowledge about the STC topic, community odors and social debt; (ii) experience as software engineers in development communities; (iii) experience as teachers in the area of Software Engineering and (iv) knowledge of research methodology. Psychologists with a specialty and professional experience in organizational psychology were also invited to participate in the expert judgment, because these professionals can analyze the behavior of individuals within companies to guarantee their well-being and promote a favorable work environment. Having the previous criteria, the population was made up of professionals with experience in software development, IT administration and teaching and research in the area of Software Engineering, with a level of training in specialization, master's degree and/or doctorate in Computer Sciences. Computing or Software Engineering and psychologists with a specialty in organizational psychology and human management. In this sense, the sample included 7 experts from the area of Software Engineering and 2 psychologists with a profile in organizational psychology and human management from different companies, universities and software development communities, who agreed to participate and be part of this process. with experience between 6 and 40 years.

The invitation and confirmation was made by email explaining the objective of the expert judgment, purpose of the instrument and instructions on how to perform the validation. Among the exclusion criteria was the availability during the time the instrument was enabled. For the explanation, a remote meeting was called due to geographical distances. During the meeting, the objective of the judgment, the instrument to be validated and subsequently the template for the expert judgment with the evaluation criteria, indicators, and evaluation scale were shared. The steps for the content validation process through expert judgment, which includes the selection of participants and the time established for each step, are detailed in Table 5.

Table 5. Steps for the content validation process by expert judgment.

id	Step	Time in days	Time in hours
1	Review literature.	30	240
2	Design the instrument to measure the 3C model.	10	80
3	Define the questionnaire for evaluation by expert judgment.	3	24
4	Selection of participants for the expert judgment. For this case (9) professionals were selected.	3	24
5	Socialize the selected team of experts (9 professionals), the instrument to measure the 3C model and the template for content evaluation using the expert judgment technique.	2	16
6	Data collection (template for content validation through expert judgment).	7	56
7	Data processing.	6	48

8	Analysis of results.	6	48
	Total:	***67***	***536***

Source: Prepared by the authors.

Method

To collect the data concerning the evaluation of the content of the instrument using the expert judgment template, a form designed in Google Drive was used, which can be consulted through the following link. https://tinyurl.com/24opoav4. Subsequently, the collected data were stored in the Microsoft Excel spreadsheet with Office 365 and statistically processed in the IBM SPSS Statistics program, version 29.0.1. Then, the degree of agreement between the experts was determined with the Fleiss Kappa coefficient. This statistic is used to evaluate the reliability of agreement between 2 or more raters, who assign categorical ratings to a number of items. In this case, they are the questions or items registered in the instrument to be evaluated. The criterion for using the Fleiss Kappa coefficient is because it is the most used currently to determine the agreement of experts and is also contrasted with other Kappas, such as Cohen's Kappa, which is recommended to be used when evaluating agreement. between no more than two evaluators [31].

The Fleiss Kappa coefficient has a range between -1 and 1, but is normally between 0 and 1. If the coefficient is 1, it indicates perfect agreement between the evaluators; if it is 0, it indicates that the agreement is not greater than that expected by chance; and if the value of the coefficient is negative, the level of agreement is lower than expected by chance [32]. For the qualitative interpretation of the results obtained with this coefficient, the scale defined by Landis and Koch [33] was applied, presented in Table 6, which also relates the strength of agreement between the evaluators given the Kappa coefficient. Agreement according to [34] is a term that refers to the extent to which two or more judges agree with each other. It is understood as the proportion of agreements among the total number of judges. Once the data processing was carried out, the next step was to analyze the results obtained based on the Kappa coefficient found in the dimensions evaluated.

Table 6. Assessment of the kappa coefficient (Landis and Koch).

Coefficient de kappa	Strength of agreement
0.00	Poor (Pobre)
0.01 - 0.20	Slight (Leve)
0.21 - 0.40	Fair (Aceptable)
0.41 - 0.60	Moderate (Moderada)
0.61 - 0.80	Substantial (Considerable)
0.81 - 1.00	Almost perfect (Casi perfecta)

Source: Taken from [33].

IV. RESULTS AND Y DISCUSSION

Once the experts reviewed and carried out the evaluation of the original instrument, data processing was carried out, which yielded the following results: the values found in the Fleiss Kappa coefficient show the proportion of possible agreements present in each of the dimensions evaluated (coordination, communication and cooperation), then the Kappa coefficient was analyzed and based on it the strength of agreement was determined, which for the case under study was interpreted as considerable in the dimensions of communication and coordination, and almost perfect in the dimension of cooperation, according to the criteria of the judges. Below, in Table 7, the coefficients found and the strength of agreement are detailed.

Table 7. Strength of agreement between evaluators for the dimensions of the original instrument.

Dimensions	Coefficient Kappa de Fleiss	Strength of agreement Interpretation Landis and Koch, 1977
Communication	0.64	Substantial (Considerable)
Coordination	0.79	Substantial (Considerable)
Cooperation	0.85	Almost perfect (Casi perfecta)

Source: Prepared by the authors.

Regarding the qualitative evaluation carried out by the experts, the following observations can be highlighted in Table 8 in general terms:

Table 8. Qualitative evaluation of the experts.

Id	Questions	Observation
2	Does an unfavorable work environment in my software development community lead to?	Add the Likert scale to the list of possible reasons.

3	Does a favorable work environment in my software development community lead to?	Add the Likert scale to the list of possible reasons.
4	Are tools used in my software development community?	Experts recommend complementing what type of tools and for what work.
5	Do the tools used for communication in my software development community allow me?	Add the Likert scale to the list of possible reasons.
8	Do I feel like I can trust my fellow software development community members?	It is recommended to indicate whether the trust is from a personal or professional point of view.
12	Are company objectives and work goals communicated to members of the software development community?	Experts recommend indicating whether it refers to the business objectives, company and/or project requirements, complementing or better organizing the question.
14	Is there integration between members of my software development community?	They recommend specifying the type of integration (technical or social).
15	Is my software development community tight-knit, leading to proper project development?	It is recommended to word this question better and indicate what type of union you are referring to.

Source: Prepared by the authors.

Regarding the communication dimension, experts suggest measuring it taking into account the contracting modality (remote, in-person, work-related, among others), taking into account that the interaction changes a little depending on the modality.

Likewise, the magnitude of the strength of agreement according to Landis and Koch was obtained by pairs of experts. Table 9 shows the results obtained. In the communication dimension, almost perfect agreement was observed between the judges (J1-J3, J6-J1, J7-J5); Furthermore, considerable agreement between the judges (J2-J4, J3-J9, J5-J6, J9-J8) and moderate agreement between the judges (J8-J2, J5-J6, J4-J7), demonstrating contrariety between the latter. Likewise, in the coordination dimension, almost perfect agreement was observed between the following judges (J3-J9, J5-J6, J6-J1, J9-J8), considerable agreement (J1-J3, J2-J4, J4 -J7, J7-J5) and moderate agreement (J8-J2). Finally, in the cooperation dimension the following agreements were found: almost perfect (J2- J4,) considerable (J6- J1, J7- J5, J9- J8) and moderate (J1-J3, J3- J9, J4- J7, J5- J6, J8- J2). It can be seen that the dimension in which the greatest disagreement occurred among the judges is cooperation.

Table 9. Fleiss Kappa coefficient agreement by pair of experts.

Dimensions	**Experts in pairs**								
	Fleiss Kappa coefficient								
	J1- J3	J2- J4	J3- J9	J4- J7	J5- J6	J6- J1	J7- J5	J8- J2	J9- J8
Communication	0.96	0.79	0.62	0.48	0.52	1.1	0.86	0.48	0.67
Coordination	0.75	0.76	0.87	0.77	0.88	0.97	0.8	0.55	0.85
Cooperation	0.43	0.97	0.447	0.45	0.55	0.69	0.78	0.59	0.76

Quality criteria	**Fleiss Kappa coefficient**	**p**
Sufficiency	0.801	0.025
Coherence	0.692	0.023
Relevance	0.583	0.033
Clarity	0.85	0.02

Source: Prepared by the authors.

In turn, Table 10 illustrates the coefficient achieved in each of the indicators associated with each quality criterion (sufficiency, coherence, relevance, clarity), defined to carry out the evaluation of the dimensions of the initial instrument. Therefore, a considerable strength of agreement was found for the quality criteria: sufficiency, coherence and clarity, the latter being the highest coefficient (0.85). For the relevance criterion, the coefficient found is moderate, being the lowest (0.583).

In statistical significance, a reliability level of 95% and a significance level of 5% were taken into account, where $p < 0.05$. It is notable that the clarity characteristic has a value of $p=0.02$ (reliability), which makes the found value of p relevant.

Table 10. Fleiss Kappa agreement coefficient for the measurement categories of the instrument.

Source: Prepared by the authors.

Subsequently, the qualitative assessments were assessed, making the pertinent adjustments to the instrument to measure the perceptions of the 3C model in software development communities. The changes made are reflected taking into account the recommendations given regarding the criteria indicators. of quality: relevance and consistency is concerned. The wording of each question was reviewed, and 3 questions were also added to complement the communication dimension, leaving a total of 16 questions. The final version of the instrument consists of 45 questions, the adjustments given to the communication dimension are presented in Table 11, the cooperation and coordination dimension did not undergo adjustments and are presented in Table 3 and Table 4. Following suggestions from the experts, they were added. sociodemographic data, the instructions were detailed and the instrument was socialized prior to its completion.

Table 11. Communication dimension questions - Adjusted instrument.

Id	Questions	Scale				
		4	3	2	1	0
1	Is the work environment in my software development community pleasant?					
2	Does an unfavorable work environment in my software development community lead to?					
	a. Demotivation					
	b. Decreases productivity and efficiency					
	c. Staff turnover increases					
	d. Does not allow goals to be achieved					
	e. Affects product quality					
	f. Little participation of team members					
	g. Stressful environment					
	h. Corruption within reach					
	i. Customer dissatisfaction					
3	Does a favorable work environment in my software development community lead to?					
	a. Motivation					
	b. Increase productivity					
	c. Reduces staff turnover.					
	d. Allows you to achieve goals					
	e. Increases product quality.					
	f. Participation of team members					
	g. Stress management					
	h. Customer satisfaction					
	i. Collaboration in the development of projects.					
4	Are project management tools used in my software development community?					
5	Do the tools used for communication in my software development community allow me?					
	a. Share knowledge freely					
	b. Helps the decision-making process					
	c. Collaborate effectively and efficiently on projects					
	d. Facilitates communication with members of the software development community					
	e. Participate without creative restrictions					
6	If the answer to the previous question is: almost never (1) or never (0): The lack of tools in the development of my tasks generates: Problems in feedback on tasks.					
	d) Little participation in the development of activities.					
	e) Little commitment.					
	f) Problems exchanging information and ideas with the team.					
7	Is the treatment between members of the software development community respectful?					
8	Do I feel like I can trust my fellow software development community members?					
9	Do I feel comfortable with my fellow software development community members?					
10	In my software development community, do some people treat me poorly?					
11	Are the problems presented in my software development community resolved respectfully?					
12	Are company objectives and work goals communicated to members of the software development community?					
13	Are the tasks socialized, reviewed and discussed by the different members of the development community before going to the execution process?					
14	Is the language used by members of your software development community understandable?					
15	Do you think that any information is hidden among your peers at the same level?					
16	Do you find communication flows well in your software development community?					

Source: Prepared by the authors.

Taking into account the study carried out by [20], the relevance of STC in software development and the visible effects in software development teams are added. It is indicated that it is necessary to deepen and improve the metrics that allow determining communication, cooperation and collaboration, identifying risks and establishing strategies that contribute to mitigating bad practices not only from a technical but also a social point of view. In this way, the appearance of community odors is avoided, which not only affect the organization's processes, but also have a significant impact on the well-being of its members. These odors can be influenced by different aspects, such as very rigid processes in the company, poor communication between team members, poor coordination, frequent changes in assigned tasks, and knowledge is not shared because the organization does not provide communication channels. necessary communication.

Based on the recommendations given by the authors and taking into account that Software Engineering, in the development of its activities, requires qualified or specialized labor not only from the technical point of view, but also from the human point of view, this new instrument to determine the perception of the members of a software development team on the factors of: communication, cooperation and coordination, fundamental in all activities associated with the software life cycle. To this end, the formulated metrics were validated by experts on the subject, starting from the perspective that the content of an instrument must be validated, given that it reflects a specific domain of the content of what is to be measured and at the same time determine the relevance. coherence, sufficiency and scope of the proposed items.

V. CONCLUSIONS

Individuals, tools and processes are fundamental factors in software development; Therefore, monitoring these is key to achieving the success or failure of a project. For this reason, the so-called sociotechnical congruence (STC) aims to maintain adequate communication, coordination and cooperation between the members of an organization. To do this, each member of the software development team is required to apply social and technical skills in interaction situations with other people, which contribute to successfully resolving social or professional difficulties.

The communication component is fundamental for the development of activities that require individual or group effort, teamwork, task feedback, distribution of responsibilities, planning and execution of tasks that lead to the achievement of a common objective. That is, this factor has an impact on the cooperation and coordination of software development teams, therefore, it is directly proportional to these dimensions.

Based on the relevance of STC in the workplace, for the case study of software development communities, it is necessary to formulate an instrument that allows determining through metrics the perceptions on the dimensions of: communication, coordination and cooperation in software development communities. Given the importance of the topic, an instrument was developed that measures the three dimensions through 42 questions, which was subjected to the expert validation technique to evaluate the relevance, coherence, clarity, sufficiency and relevance of the proposed items. After collecting the data, they were processed. Among the results found, it was observed that 77% of the items were evaluated by the 9 experts at a high level (4), 15% at a moderate level. (3), 5% at low level (2) and 3% do not meet criterion (1).

For the statistical analysis, the Fleiss Kappa coefficient was applied to measure the agreement between the judges. Likewise, to measure the strength of agreement between the judges, the scale defined by Landis and Koch was applied. The results showed that a considerable strength of agreement was found for the quality criteria of sufficiency, coherence and clarity. However, for the relevance criterion, the coefficient found is moderate, this being the lowest. The magnitude of the strength of agreement according to Landis and Koch was obtained by pairs of experts. In the dimensions of communication and coordination, almost perfect and moderate agreement was observed between the judges; while the dimension in which there was the greatest disagreement between the judges is cooperation. It is recommended that the people who participate in the evaluation of the evaluation instrument must know the topic, have professional experience as a complement to the theoretical concepts and academic career. In addition, it is necessary to have the contributions of psychologists who are specialists in the organizational area or human talent. Finally, the validation of the instrument by experts contributes to the significant improvement of the proposed instrument, to better express what is to be obtained and to define a better scope of the proposed objective. The final instrument based on the recommendations currently consists of 45 questions, complementing the communication dimension with 3 additional questions.

As future work, it is expected to carry out a new evaluation of the instrument through pilot testing and generate a version that is expected to be applied as a case study in at least one software development company.

CRediT AUTHORSHIP CONTRIBUTION STATEMENT

Eydy del Carmen Suárez Brieva: Conceptualización, Metodología, Investigación, Escritura- Borrador original, Escritura – Revisión y edición, Análisis formal. **César de Jesús Pardo Calvache:** Curación de datos, Escritura – Revisión y edición, Supervisión Validación. **Hugo Armando Ordoñez Eraso:** Recursos, Conceptualización, Visualización, Análisis formal y Escritura – Revisión y edición.

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REFERENCES

[1] J. Moe *et al.*, «Characterizing people with frequent emergency department visits and substance use: a retrospective cohort study of linked administrative data in Ontario, Alberta, and B.C., Canada», *BMC Emerg. Med.*, vol. 22, n.º 1, 2022, doi: 10.1186/s12873-022-00673-x.

[2] E. Caballero-Espinosa, J. C. Carver, y K. Stowers, «Community smells—The sources of social debt: A systematic literature review», *Inf. Softw. Technol.*, vol. 153, ene. 2023, doi: 10.1016/J.INFSOF.2022.107078.

[3] B. Raza, R. Ahmad, M. H. N. B. M. Nasir, y S. S. M. Fauzi, «Socio-Technical Congruence as an Emerging Concept in Software Development: A Scientometric Analysis and Critical Literature Review», *IEEE Access*, vol. 9, pp. 129051-129077, 2021, doi: 10.1109/ACCESS.2021.3113637.

[4] M. Kuhrmann y J. Munch, «Distributed software development with one hand tied behind the back: A course unit to experience the role of communication in GSD», *Proc. - 11th IEEE Int. Conf. Glob. Softw. Eng. Companion Proceedings, ICGSEW 2016*, pp. 25-30, 2016, doi: 10.1109/ICGSEW.2016.13.

[5] E. Caballero-Espinosa, J. C. Carver, y K. Stowers, «Community smells—The sources of social debt: A systematic literature review», *Inf. Softw. Technol.*, vol. 153, p. 107078, ene. 2023, doi: 10.1016/J.INFSOF.2022.107078.

[6] M. Callejas-Cuervo, A. Alarcón-Aldana, y A. M. Álvarez-Carreño, «Software quality models, a state of the art», *Entramado*, vol. 13, n.º 1, pp. 236-250, 2017, doi: 10.18041/entramado.2017v13n1.25125.

[7] R. Ahmed *et al.*, «binish raza 1 ,Rodina Ahmed 1, * ,Mohd HNM Nasir 1 , Shukor SM Fauzi 2 », vol. 49, n.º 1, pp. 1-43, 2022.

[8] S. Ministerio de la Protección Social – Pontificia Universidad Javeriana y de S. S. y R. Profesionales., *Batería de instrumentos para la evaluación de factores de riesgo psicosocial*. 2010.

[9] W. A. W. Sobri, S. S. M. Fauzi, M. H. N. Nasir, R. Ahmad, y A. J. Suali, «Coordination issues and its impact on project performance: A systematic literature review», *J. Telecommun. Electron. Comput. Eng.*, vol. 9, n.º 3-3 Special Issue, pp. 33-37, 2017.

[10] J. Portillo-Rodríguez, A. Vizcaíno, M. Piattini, y S. Beecham, «Using agents to manage Socio-Technical Congruence in a Global Software Engineering project», *Inf. Sci. (Ny).*, vol. 264, pp. 230-259, 2014, doi: 10.1016/j.ins.2014.01.009.

[11] A. B. M. N. A. Talukder, «Understanding Social Debt in Software Engineering», n.º September, 2022.

[12] S. Ferdous y N. Ikram, «Communication and Coordination Using Facebook: A Case Study of Distributed Software Development», *J. Inf. Sci. Eng.*, vol. 33, n.º 6, pp. 1501-1517, 2017, doi: 10.6688/JISE.2017.33.6.7.

[13] M. Alsharo, D. Gregg, y R. Ramirez, «Virtual team effectiveness: The role of knowledge sharing and trust», *Inf. Manag.*, vol. 54, n.º 4, pp. 479-490, 2017, doi: 10.1016/j.im.2016.10.005.

[14] R. Latorre y J. Suárez, «Measuring social networks when forming information system project teams», *J. Syst. Softw.*, vol. 134, pp. 304-323, 2017, doi: 10.1016/j.jss.2017.09.019.

[15] H. T. M. Chau y N. M. Tuan, «A conceptual framework of virtual team effectiveness from the socio-technical perspective», *Hcmcoujs - Econ. Bus. Adm.*, vol. 8, n.º 2, pp. 65-94, 2020, doi: 10.46223/hcmcoujs.econ.en.8.2.164.2018.

[16] Wulansari y C. F. Nida, «A Systematic Literature Review», vol. 49, n.º 1, pp. 1-6, 2020, doi: 10.1145/3452144.3452277.

[17] N. M. Nor, «Modelling Lower-level Technical Dependencies to Improve Coordination in Software Engineering Projects : A Conceptualization», *Int. J. Adv. Trends Comput. Sci. Eng.*, vol. 9, n.º 3, pp. 3695-3699, 2020, doi: 10.30534/ijatcse/2020/182932020.

[18] D. A. Tamburri, P. Kruchten, P. Lago, y H. van Vliet, «Social debt in software engineering: insights from industry», *J. Internet Serv. Appl.*, vol. 6, n.º 1, 2015, doi: 10.1186/s13174-015-0024-6.

[19] D. A. Tamburri, R. Kazman, y W. J. van den Heuvel, «Splicing community and software architecture smells in agile teams: An industrial Study», *Proc. Annu. Hawaii Int. Conf. Syst. Sci.*, vol. 2019-January, pp. 7037-7047, 2019, doi: 10.24251/hicss.2019.843.

[20] D. A. Tamburri, «Software Architecture Social Debt: Managing the Incommunicability Factor», *IEEE Trans. Comput. Soc. Syst.*, vol. 6, n.º 1, pp. 20-37, 2019, doi: 10.1109/TCSS.2018.2886433.

[21] M. O. Ahmad y T. Gustavsson, «The Pandora's box of social, process, and people debts in software engineering», *J. Softw. Evol. Process*, n.º July, pp. 1-24, 2022, doi: 10.1002/smr.2516.

[22] S. Ritonummi, V. Siitonen, M. Salo, y H. Pirkkalainen, «Flow barriers: What prevents software developers from experiencing flow in their work», *CEUR Workshop Proc.*, vol. 3239, pp. 247-264, 2022.

[23] M. E. Castillo Gonzáles, J. R. Tenezaca Sánchez, y R. I. Cando Pilatuña, «Estandarización del test de dependencia al móvil para estudiantes universitarios de Ecuador», *Rev. Ecuatoriana Psicol.*, vol. 6, n.º 15, pp. 109-120, 2023, doi: 10.33996/repsi.v6i15.93.

[24] S. M. Maldonado Luna, «Manual Práctico Para El Diseño De La Escala Likert», *Xihmai*, vol. 2, n.º 4, pp. 6-8, 2012, doi: 10.37646/xihmai.v2i4.101.

[25] Á. G. Canto de Gante, W. E. Sosa González, J. Bautista Ortega, J. Escobar Castillo, y A. Santillán Fernández, «Escala de Likert: Una alternativa para elaborar e interpretar un instrumento de percepción social», *Rev. la Alta Tecnol. y Soc.*, vol. 12, n.º 1, pp. 38-45, 2020.

[26] M. Manucci, «Competitividad emocional», *Buenos Aires B. Argentina SA*, 2016.

[27] Y. Corral, «Validez y confiabilidad de los instrumentos de investigación para la recolección de datos», *Rev. Ciencias la Educ.*, vol. 19, n.º 33, pp. 228-247, 2009, doi: 10.36791/tcg.v0i15.90.

[28] L. G. Juárez-Hernández y S. Tobón, «Analysis of the elements implicit in the validation of the content of a research instrument», *Espacios*, vol. 39, n.º 53, 2018.

[29] J. Cabero y M. Llorente, «Aplicación de juicio de experto como técnica de evaluación de las TIC», *Rev. Tecnol. Inf. y Comun. en Educ.*, vol. 7, n.º 2, pp. 11-22, 2013.

[30] C. Ruiz, «Un Enfoque Cuantitativo y Cualitativo para la Recolección y Análisis de Datos», 2015.

[31] J. Escobar-Pérez y Á. Cuervo-Martínez, «Validez De Contenido Y Juicio De Expertos: Una Aproximación a Su

Utilización», *Av. en Medición*, vol. 6, n.º September, pp. 27-36, 2008, doi: 10.32870/ap.v9n2.993.
[32] J. Sim y C. C. Wright, «The kappa statistic in reliability studies: Use, interpretation, and sample size requirements», *Phys. Ther.*, vol. 85, n.º 3, pp. 257-268, 2005, doi: 10.1093/ptj/85.3.257.
[33] J. R. Landis y G. G. Koch, «The Measurement of Observer Agreement for Categorical Data», *Biometrics*, vol. 33, n.º 1, p. 159, 1977, doi: 10.2307/2529310.
[34] J. Torres y V. Perera, «Cálculo de la fiabilidad y concordancia entre codificadores de un sistema de categorías para el estudio del foro online en e-learning», *Rev. Investig. Educ.*, vol. 27, n.º 1, pp. 89-103, 2009.