Industry report: Soft skills assessment framework (2SAF)

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1 Introduction

This report introduces a *Soft Skills Assessment Framework* (2SAF) for practitioners to guide software engineering and human resource management professionals in the assessment of soft skills. We discuss the importance of soft skills for software engineering, challenges and opportunities for soft skills assessment, and a framework that can be used to guide soft skills assessment. We also provide some examples of recently developed assessment instruments.

1.1 Importance of soft skills

Soft skills are essential for software engineering work. These skills, such as communication, teamwork, and collaboration, enable effective interactions with others, including clients and team members [1, 2] and contribute to better team performance, product development, and job satisfaction [3]. We found that software professionals considered soft skills to be important for their roles and suggested that the value of having good soft skills has only increased over time [4]. It is therefore not surprising that soft skills are expected of software professionals, both for those in technical roles and of people leaders.

We define soft skills as '"intra- and inter-personal (socioemotional) skills" essential for personal development, social participation and workplace success [5] and include "nontechnical, domain-independent skills that underpin our behavior in the workplace [6]." Although some researchers include personality traits in their conceptualization of soft skills, we exclude personality characteristics in our work due to them being more stable and challenging to develop [7]. Rather, our focus has been on trainable, more malleable skills.

1.2 Critical Soft Skills for Software Engineers

There is no formally agreed upon set of soft skills, but research has produced various lists, including those identified as important for software engineering roles. Our own work has focused on software engineering roles specifically in Aotearoa New Zealand (NZ), where we have derived sets of soft skills from job advertisements and from discussions with software professionals.

Soft skills sought after in **job advertisements:** Our analysis of soft skills sought after in 530 software engineering-related job advertisements in NZ suggests that employers are clearly after soft skills: 82 percent of adverts mentioned soft skills. This was regardless of company size or business domain. We produced a set of 17 skills from these adverts (see Table 1), and found that Communication skills were in most demand.

Important soft skills from a **practitioner perspective**: Our interviews with software professionals illuminated which soft skills were perceived as critical in their roles. Table 2 presents the soft skills identified. The most frequently highlighted skills were communication (including written and verbal), teamwork, leadership, and interpersonal skills. There was significant overlap between the soft skills sought after in recruitment advertisements and those identified in our interviews with professionals; however, professionals identified additional skills of resilience and self-awareness (these are noted with * in the below table). Having empathy was also noted by professionals more frequently than listed in job adverts. More on empathy and its measurement in section 4.1.

1.3 Assessment of soft skills

Despite the clear value of soft skills for both organisational and team success, software engineering training has traditionally focused on technical skills, with less emphasis placed on these people-related competencies. This may be in part due to soft skills being resource intensive to develop and difficult to assess [8]. However, to effectively develop software professionals' soft skills, their assessment can be helpful [9].

The reasons for assessing soft skills can be about professional development, such as leadership training, but assessment can also be helpful for employee selection decisions, promotional decisions, and assigning the

Table 1: Identified soft skills from job adverts in alphabetical order.

Soft skill	**Description**
Analytical	Ability to think critically, analyze different types of information and from different sources
Collaboration	Qualities and competencies to collectively progress toward a common goal with other stakeholders
Communication (generic)	Ability to communicate with others in "two-way process", i.e., by exchanging ("sending" and "receiving") information
Communication (oral)	Ability to to exchange ("send" and "receive") information in different forms orally (e.g., in formal presentations or informal conversations)
Communication (written)	Ability to exchange ("send" and "receive") information in different forms of writing (e.g., technical documentation or customer documents)
Cultural awareness	Awareness and acceptance of other cultures and cultural identities related to the software itself (e.g., cultural responsiveness of apps) and its development and maintenance (e.g., culturally diverse teams)
Creativity	Ability to imagine and form original ideas to create something new and potentially innovative
Diversity	Ability to engage with people from a range of different social, educational, professional and ethnic backgrounds and of different genders
Empathy	Ability to understand or feel what another person (including subordinates, peers, managers, clients) is experiencing from within their frame of reference (cognitively, emotionally and compassionately)
Independence	Ability to act free from the influence or control of another person, group or organization (e.g., without detailed instructions from team leads, clients or peers)
Interpersonal	Ability to be in, establish, relate to, or be involved with relationships between individuals or groups of persons (e.g., customers, clients)
Leadership	Ability to influence and guide, motivate and inspire other members of a team, organization or community, including project, business, practice and technology leadership
Listening	Ability to receive language from other stakeholders (internal and external) without judgment or immediate response (unlike communication, listening is a "one-way" process and could be considered a "subskill" of communication)
Mentoring	Ability to form meaningful relationships with other individuals or groups (usually at the same or lower levels of hierarchy, experience or expertise) with the goal of professional, technology and personal development
Negotiation	Ability to efficiently and effectively discuss to reach agreement (maybe consensus) while handling (maybe resolving) conflicts with internal and external stakeholders
Problem solving	Ability to determine why an "issue" is happening and how to resolve it by defining and measuring a problem, analysing the problem and ultimately addressing the problem
Team	Ability to work well with others during conversations, projects, meetings or other collaborations

Table 2: Soft skills identified by practitioners in interviews, in alphabetical order (codes after quotes are participant codes; * signifies additional skills identified in interviews, not present in job advertisements).

Skill	**Example quote**
Collaboration	"collaborate with the product owners and other developers" (I09)
Communication (generic)	"it's nice to foster an environment where people feel good about giving feedback and are willing to receive it..." (I07)
Communication (written)	"how to write, like English type of skills with the programming knowledge as well..." (I19)
Communication (verbal)	"you're expected to be able to present to people, debate" (I13)
Critical thinking	"critical thinking, to be able to figure out best way to do, to get around the problem" (I17)
Creativity	"creative thinking and thinking outside the box." (I02)
Cultural competence	"I mean you'll be working with Chinese, Indian, Pakistani, you're working with Americans. Be aware of their culture." (I04)
Empathy	"that empathy to try and actually see it from their perspective to get [...] to do your job" (I05)
Independence	"initiative or being able to think for yourself." (I17)
Interpersonal	"general interpersonal skills is important." (I03)
Leadership	"it's all about leadership [...], how do you drive the team" (I02)
Negotiation	"Negotiation is obviously one." (I03)
Resilience*	"... staying calm under pressure. So being able to handle pressure [...] when something goes wrong. It's usually a high pressure situation, and you have a lot of people very upset." (I18)
Self-awareness*	"...being sort of aware of your own soft skills or where your limits are, which soft skills maybe you're not so good at." (I17)
Teamwork	"... getting along with team-mates, learning to hear ideas, bounce ideas off each other, work as a team" (I13)

right team members to project teams. Regardless of the objectives of the assessment, having valid and reliable tools to do so is essential for making good decisions, but also to comply with employment and human rights legislation.

However, assessing soft skills can be complex [9, 10] and there is limited research on how assessment is (or isn't) conducted in practice. The complexity in assessment may be partly due to their conceptual ambiguity (i.e., *what are considered soft skills?*), as there is no one agreed taxonomy nor definition of soft skills; lack of appropriate (valid and reliable) measurement tools, and their assessment can be resource-intensive [11, 10]. Soft skills assessment can also be considered more difficult than the assessment of technical skills [12, 13]. Our own interviews with software professionals suggest that many professionals considered assessment to be challenging due to their perceived subjectivity, and that simply, evaluation was not common practice [4]. Although we offer suggestions for soft skills assessment in this report, it is noteworthy that some practitioners considered putting metrics on soft skills as not necessarily beneficial and preferred informal feedback from their peers or managers. We therefore put forward our suggestions for assessment with some caveats (see discussion in section 3.1 to ensure the assessment supports goals of the employee and organisation).

To guide software practitioners in their decision making on whether and how to assess soft skills, we have developed a Soft Skills Assessment Framework (2SAF), introduced in the next section.

2 Soft Skills Assessment Framework (2SAF)

Choosing whether to assess soft skills and how to do so requires information on various elements, such as the purpose of the assessment and the available assessment methods. To guide practitioners in these decisions, we introduce a framework for industry use.

Before going further, a few definitions may be helpful here. An *approach* to assessment refers to the general method of assessment, such as observation or the use of scales. *Tool* refers to a technique used for assessment, such as a check-list or an interview guide. The term *instrument* is used for a measurement device, such as a scale, and a *scale* in turn is a set of items (questions) that measure an unobservable (latent) construct.

The development of the framework involved various parallel studies, including a systematic review of existing assessment methods in the literature (a "mapping study"), industry interviews, and development of new measures to fit the software industry context. The methods used for each study are briefly outlined below.

2.1 Methods for framework development

We used three main approaches to develop our framework.

1. A *mapping study,* where we systematically reviewed primary scholarly literature on soft skills assessment, and in particular, the types of assessment approaches that are available. A brief summary of the results can be found later in this section (2.2).

2. We also conducted *interviews* with software professionals to understand their perceptions of soft skills, including their assessment.

3. Finally, as we failed to find many existing assessment tools suitable for the software engineering context, we *developed new instruments* to measure team empathy and meeting communication skills. These two measures can be found towards the end of this report, in section 4.

Further detail on these methods can be found in the Appendix of this report, see section 7.

2.2 Overview of results from the mapping study

For the literature mapping study, to understand what assessment approaches are already available in literature, we searched for studies on soft skills assessment in eight high-quality scientific databases related to engineering, computing, technology, and organisational psychology: PubMed, ACM, Science Direct, Scopus, Sage, PsychINFO, IEEE, Springer. We found a total of 1,127 publications in these databases. After filtering publications based on inclusion, exclusion, and quality criteria (i.e., if these articles were relevant for our study), we collected data from 136 papers.

We aimed at identifying *what, why, and how* soft skills are evaluated and *who* the target (e.g., employee, student) and the evaluator of the assessments are. Within the publications searched, we also identified whether and which soft skills assessments were applied to software engineering professionals. The research questions and brief summaries of our findings are detailed here. Further information can be found in the Appendix (section 7).

- RQ1. What are the approaches used to assess soft skills in professionals?

> **Key insights:**
> Most articles found were in the domain of medicine, with only 6 articles in the context of software engineering. The most common soft skills in question were communication, teamwork, and leadership.

- RQ2. Who participates in the assessment of soft skills?

> **Key insights:**
> The majority of studies located evaluated medical teams' soft skills, but we also found some articles evaluating soft skills of early career professionals and managers.
> Most articles focused on self-assessment, where the employee/student themselves conducted the evaluation of their soft skills. Self-evaluation, combined with another person (such as a manager) evaluating soft skills, was noted in 15 articles, and in 25 studies, an observer evaluated the employees' skills. In 27 studies, researchers conducted the soft skills evaluation.

- RQ3. Why are soft skills assessed?

> **Key insights:**
> Soft skills are assessed for various reasons, including assessment after training on soft skills has been completed. In studies related to software engineering and IT, soft skills were assessed either following an intervention or to evaluate/validate an assessment approach.

- RQ4. How are soft skills assessed?

> **Key insights:**
> The majority of studies found used lists of behaviours to assess soft skills. Some studies also used questionnaires and check-lists. Only a few studies were located in the context of software engineering, but within these, studies used lists of behaviours, questionnaires, and one study used an interview to assess soft skills.

- RQ5. Which approaches for soft skills assessment are applied to software engineering professionals?

> **Key insights:**
> From the six articles on software engineering, only two developed assessment tools to evaluate soft skills of IT/SE professionals. The approaches used in these articles were questionnaires/scales to assess various soft skills. Further detail on these studies can be found in the Appendix.

2.3 2SAF Elements

The 2SAF is comprised of various elements, which can be considered when choosing an assessment approach. Each of these elements is briefly described in Figure 1. Each element is further explained in Table 3.

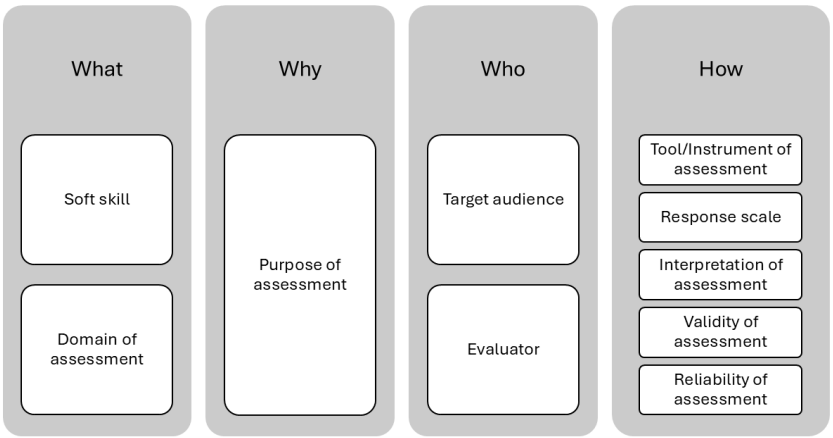

Figure 1: 2SAF elements.

Table 3: 2SAF elements and descriptions.

Element	**Description**
Soft skills	A key element of the framework is the target soft skills that is being assessed, for example: Communication, Teamwork, Empathy.
Domain of assessment	Assessment tools are developed in diverse contexts. The domain of assessment identifies this context (e.g., software development, higher education, banking). It is noteworthy that most tools found have been developed for contexts other than software development.
Purpose	This element identifies the reason the soft skill is being assessed, such as to support administrative decisions (e.g., promotional decisions) or for leadership or professional development.
Tool/Instrument	The type of technique (i.e., tool) used or developed, such as a questionnaire, observation or an interview. Instrument refers to a specific measurement device, such as a scale.
Response scale	Descriptions or markers of the degree to which the domain/skill is present. For example, a Likert-type response scale, where 1=strongly disagree with the statement/item to 5= strongly agree with the statement/item. Some response scales have only end anchors (i.e., only the first and last number has descriptions), while others have anchors for each response option (e.g., 1=never, 2=rarely, 3=sometime, 4=often, 5=always). These response scales vary from whether one agrees with the statement (disagree to agree-type of response scale), to frequency-type scales (e.g., from never to daily).
Target audience	The assessment approach is developed for the use of different target audiences, such as employees, leaders, or others. The 'target' element identifies the intended group the assessment was developed for.
Evaluator	The evaluator is the person completing the responses on the tool. For self-assessment, the employee completes the assessment themselves, but at times, the assessment can be completed by a researcher, manager, client/customer or a peer.
Interpretation of the assessment	How the results of the assessment can be interpreted considering the type of response scale used in the tool.
Validity & reliability information	This element outlines the measures and strategies that have been used to evaluate if (and how) the assessment of soft skills is valid (measuring what it was intended to measure) and reliable (consistency over time).

3 How to use the 2SAF

Figure 2 suggests steps that can be taken into account, when considering the assessment of soft skills. This is a guideline only and the steps should not necessarily be completed in order.

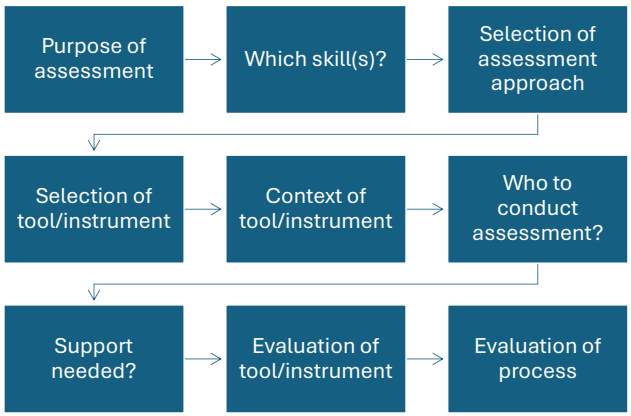

Figure 2: 2SAF steps.

Each of the steps illustrated in Figure 2 are described here:

- The **purpose of the assessment** is a key issue to consider before any assessment takes place. The purpose may be for a) administrative decisions, such as promotions, b) assignment of employees to projects or teams, or c) professional or leadership development. If the tool was developed for one purpose, its use may be limited for other purposes. For example, if a tool was developed for professional development, to track progress in skill development, it may not be suitable for making employee selection decisions.
- **Which soft skill** is one hoping to assess? A systematic job analysis can be conducted to determine which soft skills are important for particular roles. In addition, some soft skills are very broad and include various aspects to them. For example, communication skills may be include verbal, written, and non-verbal communication. It is important to consider and identify which soft skill or aspects of a soft skill one wishes to assess.
- **Which approach to use**? Once the purpose and skill have been identified, one needs to decide the general approach that would be useful and practical for assessment. This could be an informal discussion e.g., between an employee and their manager, or something more formal, like a use of measurement scales for a specific soft skill.
- **Which tool/instrument to use**? As can be seen from our mapping study, there are multiple approaches and tools/instruments for the same skill. That is, many assessment tools may exist for the same skill, with diverse definitions for the same skill. It is therefore important to be clear on the skill one wishes to assess and to scrutinize the tool with the intended skill definition in mind. For example, our tool on Team Empathy would not be suitable for employees who do not work within a team nor would it be appropriate to assess interpersonal empathy between two people.
- **Context of assessment:** To use an assessment tool for administrative decisions, the tool has to be shown to be valid in the specific context it is being used for. That is, the **tool has to be relevant to the successful performance of the role or the workplace**. Otherwise, using such assessment may be considered discriminatory. See Employment New Zealand (https://www.employment.govt.nz/) for further information and get advice from your HR professional.
- **Who to conduct the assessment?** Many instruments have been created for developmental, self-assessment purposes, including our two scales found in the next section. That is, these scales can be used by a software professional to track their own progress if they are aiming to develop these two soft skills. They may also find it useful to have another person complete the scales about them for feedback purposes, or to have a discussion with their peers or a manager about the scale items to promote their own self awareness and professional development. The self-assessment of soft skills need not to be a formal part of an organisation's performance evaluation; rather, these tools can be a useful way for employees to reflect on and improve their own soft skills.

- **Support and resource needed:** In most cases, the tools are easy to use. They may require the completion of a short questionnaire on one's own perceptions of a specific skill. However, their interpretation may need support from someone else, e.g., a human resources professional. For example, many tools have different 'dimensions' to them, that is, different aspects of soft skills are measured with different questions. When calculating an average of the ratings, it is important to take such dimensionality into consideration. It is advisable to consult your HR professional or an organisational psychologist to ensure the appropriate use of assessment tools.
- **Evaluation of tool/instrument:** With any assessment tool, it is important to ensure their *validity/robustness*. To do so, you can find this information in our mapping study for existing tools, but when considering a new tool, it is important that the tool has been shown to be appropriate for the specific purpose and domain in question. In scholarly articles, this information is usually provided, and if using an external consultant to conduct assessment, they can usually provide this information.
- **Evaluation of process**: As with any initiative in the workplace, it is important to evaluate and reflect on the usefulness of the information collected. How was the instrument/tool perceived by employees? Did it provide useful information for their professional development? What improvements could be made to the assessment procedure for the future?

3.1 Limitations of framework

Our 2SAF framework is largely based on existing assessment instruments, so it is good to keep in mind that soft skills assessment is still in its infancy in the context of software engineering. This is therefore a developing area and more assessments related to this specific context is needed.

- As briefly mentioned above, the development and validation of assessment tools occurs in different domains, often outside of the context of software engineering. It is therefore important to evaluate the applicability of the tool, and specific questions, to the context in question. Threats to face validity - whether a tool appears to measure the construct in question [14] - can result in inaccurate evaluations and reduce the quality of the information derived from assessment tools.
- It is also noteworthy that formal assessment of soft skills may not always be helpful. Whether to assess or not depends on the objective of the assessment and this may change over time. Continuous reflection on assessment needs is necessary by both the software engineer and their manager (and HR professional, where relevant).

4 Examples of assessment scales

4.1 Team Empathy

Empathy was identified as a key soft skills in our software professional interviews [4], supported by other research on empathy in software engineering context [15, 16, 17]. Empathy has also been shown to be an essential leadership competence [18] and critical for effective teamwork [19, 20, 21]. It can be defined as the process of interpersonal understanding of a person by imagining oneself in another person's context [22], and includes both cognitive and affective components. In a team context, cognitive empathy refers to the ability of team members to understand the feelings of others within the team, whereas affective empathy is the emotional (i.e., feeling) reaction team members have to the affective states of their team members.

As no existing measures of empathy in teams within the context of software engineering teams were found, we engaged in a process to develop a new scale on team empathy. This process for the new scale development included multiple studies with software engineering students, and we also consulted software engineering practitioners in our work (see the Appendix in section 7 for further information). This work resulted in a 18-item (question) scale that can be used as a self-evaluation tool for the purpose of professional development.

Table 4 describes each of the 2SAF elements in the context of the Team Empathy scale.

The items (i.e., questions) for each 'dimension' (type of team empathy: cognitive vs. affective) can be found in Table 5.

4.2 Meeting Communication Skills

Software engineers spend a significant amount of time communicating with others, sharing and discussing information. Much of this communication occurs in team meetings [23, 24], where effective communication is beneficial for product development, team success and job satisfaction [3]. In our own research, we identified communication skills as the most critical soft skill for software development roles, both in industry interviews

Table 4: 2SAF elements in the context of the Team Empathy scale.

Element	**Description**
Soft skill	Team empathy
Domain of assessment	Software engineering
Purpose	Professional development
Tool/Instrument	Scales
Response scale	7-point Likert-type scale: 1=Does not describe me at all 2=Barely describes me 3=Somewhat describes me 4=Neutral 5=Generally describes me 6=Mostly describes me 7=Completely describes me
Target audience	Professionals working in a team
Evaluator	Self-assessment
Interpretation of the assessment	The scale has three dimensions: Perspective taking; Emotion imagining, and Affective empathy. Dimensions should be analysed separately. A mean score calculated for each dimension. The higher the average, the better the self-evaluated team empathy skill the person has.
Validity & reliability information	Studies show good reliability and validity [4]. Validation process ongoing.

Table 5: Team Empathy scale items.

Cognitive empathy: Perspective taking
I am good at predicting how my team members will feel
I am good at predicting what my team members will do
I quickly spot when a team member feels awkward or uncomfortable
I can easily tell if my team members are interested or bored with what I am saying
I can easily tell if a team member wants to enter a conversation
I can sense if I am intruding, even if my team members do not tell me
I can tell if my team member is masking their true emotion
I can easily work out what my team member might want to talk about
Cognitive empathy: Emotion imagining
I try to look at my team members' side of a disagreement before I make a decision
Before criticizing a team member, I try to imagine how I would feel if I was in their place
When I am upset at my team member, I usually try to "put myself in their shoes" for a while
I sometimes try to understand my team members better by imagining how things look from their perspective
I can usually appreciate my team members' viewpoints, even if I do not agree with them
I find it easy to put myself in my team member's shoes.
Affective empathy
I tend to get emotionally involved with others' feelings on my team
I get influenced by the feelings and moods of others on my team
I experience similar emotions in response to the feelings of others on my team
My attitudes are affected by the feelings of others on my team

Table 6: 2SAF elements in the context of the Face-to-face meeting communication scale.

Element	**Description**
Soft skill	Face-to-face meeting communication skills
Domain of assessment	Software engineering
Purpose	Professional development
Tool/Instrument	Scale
Response scale	7-point Likert-type scale from "1=Never" to "7=Always".
Target audience	Professionals working in a team
Evaluator	Self-assessment
Interpretation of the assessment	The scale has four dimensions: Empathetic engagement; Self-regulation; Expression of feelings; and, Contribution of ideas. Dimensions analysed separately. A mean score calculated for each dimension. The higher the average, the better the self-evaluated communication skills the person has.
Validity & reliability information	Studies show good reliability and validity [27]. Validation process ongoing.

and in analysis of job advertisements [25, 4]. However, not all team members are aware of their own behavior in meetings, including the effectiveness of their communication skills [26].

We defined meeting communication skills as personal knowledge, perceptions, and assessment of verbal communication, giving and receiving feedback, active listening, and meeting participation or contributing behaviours during face-to-face meetings [27].

We conducted multiple studies with software engineering students, which resulted in a 17-item scale which can be used as a self-evaluation for the purpose of professional development (see items in Table 7).

Table 6 describes each 2SAF element in the context of the Face-to-Face meeting communication scale.

The items (i.e., questions) for each 'dimension' (Empathetic engagement, Self-regulation, Expression of Feelings, and Contribution of ideas) can be found in Table 7.

Table 7: Face-to-face meeting communication skills scale ('R' in the "Self-regulation" dimension indicates reverse coded items).

Dimension	**Item**
Empathetic engagement	I make eye contact with meeting participants during discussions. I am mindful of other meeting participants' feelings when providing feedback. I listen to the other meeting participants, putting myself in his/her shoes. I pay attention to the other meeting participants' body language. I am aware of my feelings while am listening to other meeting participants.
Self-regulation	I get defensive when receiving other meeting participants' negative feedback. (R) I am respectful to other meeting participants. I often begin to talk before the other meeting participants finish talking. (R) I begin arguing with the other meeting participants before I have heard their entire idea. (R) When I want to say something, I talk about it, even if I interrupt the other meeting participants. (R)
Expression of feelings	I express my personal feelings when I agree with other meeting participants. I express my personal feelings when I disagree with other meeting participants. I encourage other meeting participants to express their personal feelings.
Contribution of ideas	I express technical ideas clearly so that every meeting participant can understand. I express non-technical ideas clearly so that every meeting participant can understand. If I do not understand what another meeting participant said, I ask questions for clarification. I contribute my ideas and suggestions during team meetings.

5 Conclusion

The importance of soft skills in software engineering is undeniable. This is true for all software professional roles, and leaders in particular, and the criticality of soft skills appears to be only increasing. To develop soft skills effectively, their measurement can be beneficial. We have therefore developed a Soft Skills Assessment Framework - 2SAF - to guide practitioners in their approach to soft skills assessment.

The 2SAF is dynamic and we will continue updating it as further evidence becomes available. If you are keen to learn more about soft skills training or assessment, please get in touch:

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7 APPENDIX

The appendix presents additional information on research methods to develop 2SAF, including the Mapping Study, Industry Interviews, and Scale Development.

7.1 Mapping study

Mapping study is an approach to systematically reviewing primary scholarly literature on a topic and synthesizing the literature. We reviewed existing literature on soft skills assessment, both within the software industry context and more generally.

This mapping study addressed five research questions, and we present a brief synopsis of the results for each question in section 2.2. More detail on the findings can be found in section 7.1.1.

- RQ1. What are the approaches used to assess soft skills in professionals?
- RQ2. Who participates in the assessment of soft skills?
- RQ3. Why are soft skills assessed?
- RQ4. How are soft skills assessed?
- RQ5. Which approaches for soft skills assessment are applied to software engineering professionals?

Mapping study methods and findings:

We created data elements to describe the information we were looking for in articles based on our research questions (see Figure 3). These data items were used to guide the data collection and understanding of searched studies.

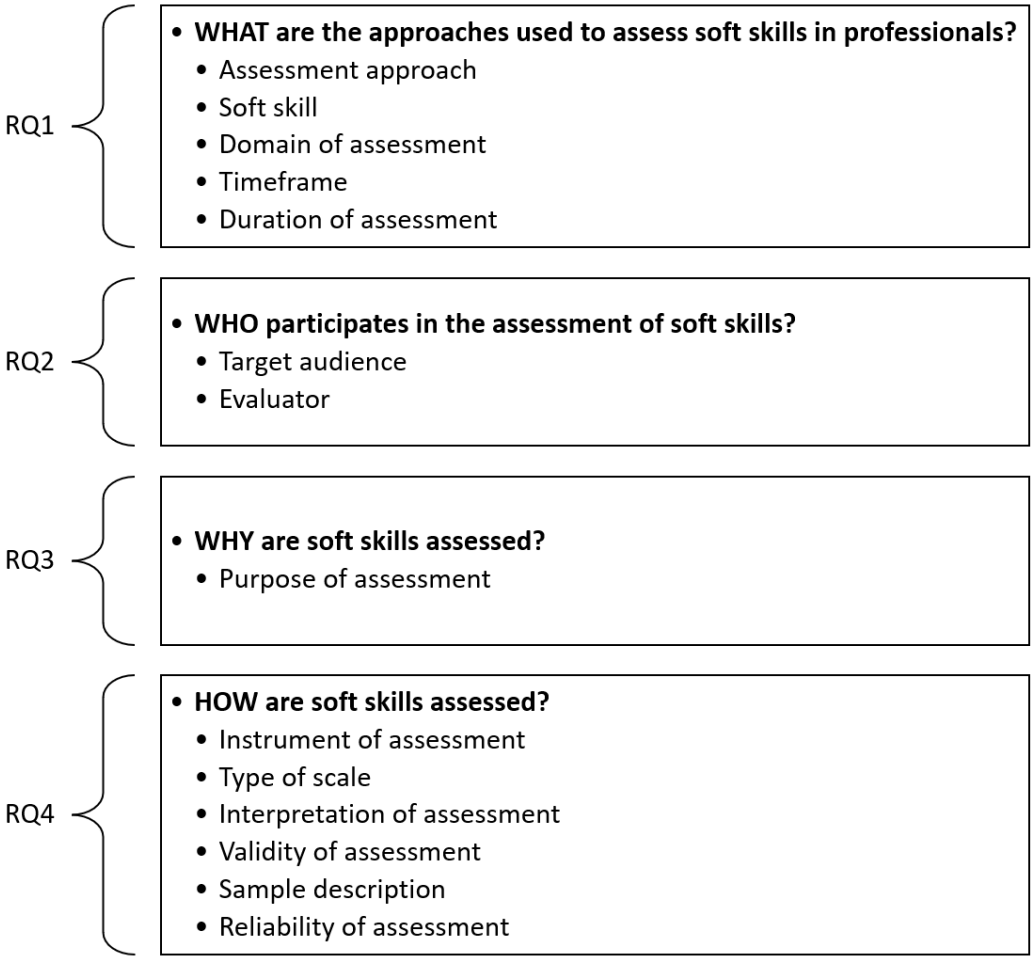

Figure 3: Research questions and data items of the literature mapping.

Here are more extensive summaries on the findings for each of the research questions.

7.1.1 RQ1. What are the approaches used to assess soft skills in professionals?

Regarding the approaches used to assess soft skills, we identified that 61 articles applied an existing assessment tool, 37 articles contributed to the development of an assessment tool, while the remaining 38 articles developed and applied a new assessment, but the study contribution was not the assessment tool itself. The most frequent

domain of assessment was Medicine, with a total of 60 articles (out of 136), followed by the Management domain, with a total of 18 papers. From all the remaining domains identified in searches, only 6 articles were on Software engineering.

Most of the studies described the assessment of at least two soft skills, only 13 (out of 136) assessed a single skill (e.g., Communication, Leadership, Teamwork, Stress management). The soft skills most frequently evaluated in studies were Communication (79 articles), Teamwork (64 articles), Leadership (52 articles), Decision making (42 articles), Situation awareness (39 articles), and Problem solving (17 papers).

The assessment tools found: Anesthesiologists' Non-Technical Skills (ANTS), Scrub Practitioners List of Intra-operative Non-Technical Skills (SPLINTS), Non-technical Skills for Surgeons (NOTSS), Oxford Non-Technical Skills (NOTECHS), and Objective Teamwork Assessment System (OTAS) were frequently used by studies when applying (rather than developing) an assessment approach. These tools/approaches were developed in the context of Healthcare and Medicine, except by NOTECHS which was originally created based on the aviation's Crew Resource Management (CRM) principles.

7.1.2 RQ2. Who participates in the assessment of soft skills?

We identified that 56 studies evaluated the soft skills of medical teams, such as physicians, nurses, midwives and anesthetists, and other 8 evaluated soft skills of professionals working in healthcare-related jobs. This could be expected since most of the studies were in the Medicine domain. We also identified studies evaluating soft skills of early-stage career professionals, such as undergraduate students (12), trainees (3) and residents (5), and studies evaluating soft skills of managers or leaders (8 papers). Regarding Software engineering as a domain of assessment (total of 6 out of 136 articles), we found 5 studies evaluating soft skills of ICT professionals, such as software testers and software developers, and one evaluating soft skills of students. Four of these articles were in the context of agile software development teams.

For the evaluators, we identified 15 articles with assessments performed by two or more types of evaluators. This means that in a study, participants self-evaluated and were evaluated by other people (e.g. peers, supervisors or trained experts). From these 15 articles, two described performing 360-degree evaluations. Considering the articles that assessed soft skills with only one evaluator, we identified 25 studies that asked observers to perform assessments. Such observers were usually experienced professionals (in the field of the study, e.g., surgeons) who were trained to use an assessment tool. In other 27 studies, researchers themselves assessed soft skills of participants. Most articles (58) described that participants self-assessed their soft skills. For the remaining articles, five studies had peers evaluating each other, four studies had supervisors evaluating subordinates, and three where subordinates evaluated supervisors. For the six Software engineering-related articles, we identified studies that had: two self-evaluations, two peer evaluations, one researcher assessing skills, and one where a self-evaluation and a researchers' observation were performed.

7.1.3 RQ3. Why are soft skills assessed?

We identified that 25 articles assessed the soft skills of professionals (experienced or early-stage career) *before and after* an intervention, 31 assessed soft skills *after* an intervention, and 2 *during* an intervention. 'Intervention" refers to training programs on soft skills (or on a relevant hard skill). Studies usually assessed how skills were affected or acquired with the programs. Three articles described that assessments were performed during a specific period, such as working hours or an academic year. For these studies, the evaluation was performed because an assessment tool was developed (or reused in a different context) and was being tested. Regarding the studies on software engineering, we identified these purposes for assessing soft skills of IT/SE professionals:

- Assess soft skills in expert software developers to relate skills with software requirements engineering processes
- Identify the degree to which a software developer (student) faces contingencies according to their flexibility to change (using a gamified assessment)
- Assess non-technical skills in agile teams after the implementation of team leader rotation
- Identify the importance of traits in software testers based on agile team members' perception
- Assess teamwork-related skills in agile team members using an assessment approach developed in the study
- Assess teamwork-related skills in software developers using an assessment approach presented in the study.

7.1.4 RQ4. How are soft skills assessed?

Regarding the instrument, its response scale and interpretation, we identified 50 articles (out of 136) that used lists of behaviors (i.e. statements describing a behavior) to represent soft skills in assessments. From these 50 articles, 38 articles used Likert scales that represented, for example, how often a behavior was observed, the importance of a behavior, or the level of agreement the participant had with the behaviors described. We also identified that 17 articles (out of 136) used questionnaires to assess soft skills, while 3 used checklists. From the remaining articles, we also identified seven studies that applied more than one instrument to assess soft skills: five studies evaluated a group of soft skills with several instruments, while two studies used one instrument for each soft skill being assessed. Regarding software engineering articles, three studies used lists of behaviors (and Likert scales), two used questionnaires, and one a semi-structured interview for the assessment.

7.1.5 RQ5. Which approaches for soft skills assessment are applied to software engineering professionals?

From the six articles on software engineering, only two developed assessment tools to evaluate soft skills of IT/SE professionals. In the study of Yousef et al. (2022) [28], authors proposed a 60-item questionnaire to assess Problem solving, Willingness to learn, Commitment, Withstand pressure, Critical thinking, and Interpersonal skills of experienced software developers. Lindsjrn et al. (2016) [29], proposed a 61-item scale (i.e. a list of behaviors) to assess Teamwork of agile teams. Unlike the assessment approach of Yousef et al. (2022) [28], which is a self-evaluation tool, the approach proposed by Lindsjrn et al. (2016) [29] requires peers to assess each other.

In general, we identified that software engineering studies applied new or adapted soft skill assessment approaches to evaluate mainly Teamwork in agile teams (4 articles), among other related skills, such as Communication and Flexibility. These studies involved between 16 to 477 participants, who were assessed mostly during their working time, by peers (2 articles), observers (2 articles), and sometimes, in self-evaluations (3 articles).

7.2 Industry interviews

We interviewed 18 software professionals to understand their perceptions of soft skills, including their development and assessment. Our interviews focused on four key questions:

1. How do software engineering practitioners define and perceive soft skills? 2. What are the soft skills that are required by software professionals? 3. How are soft skills developed and trained? 4. How are software professionals' soft skills assessed?

Details of study participants can be found in Table 8. Further details of the interview were published in: Soft Skills in Software Engineering: Malinen S, Galster M, Mitrovic A, Iyer SS, Peiris P, and Clarke A. (2025) Insights from the Trenches. IEEE/ACM 47th International Conference on Software Engineering: Software Engineering in Practice.

7.3 Scale development studies

Our mapping study suggested various existing approaches for soft skills assessment. However, we failed to find existing scales for some skills, including empathy within teams and meeting communication skills, particularly in the software engineering context. Therefore, as part of our research, we developed two scales, specifically aimed at software engineers. These were scales for ***Team Empathy*** and ***Face-to-Face Meeting Communication Skills***. Empathy was identified as a key capability in our industry interviews [4], and skills relating to effective team meetings are essential for software profession.

To develop new measures for these two constructs, we followed typical scale development processes [30, 31, 32], with the different phases noted in figure 4. For further information on the scale development process, please get in touch.

Table 8: Interviewees ("Experience": years of experience in the software industry).

ID	Gender	Age	Experience	Role	Training
I01	Male	45-64	25	Product manager	Certificate
I02	Male	45-64	25	Project manager	Bachelor
I03	Male	35-44	14	Consultant	Bachelor
I04	Male	35-44	15	Consultant	Bachelor
I05	Male	18-34	3	Software engineer	Bachelor
I06	Male	45-64	27	Software engineer	Bachelor
I07	Male	45-64	37	Team leader	Bachelor
I08	Male	18-34	3	Software engineer	Bachelor
I09	Male	18-34	12	Lead developer	Master
I10	Female	18-34	6	Team leader	Bachelor
I11	Female	18-34	10	Project manager	Bachelor
I12	Male	35-44	10	Software engineer	Bachelor
I13	Male	35-44	15	Software engineer	Master
I14	Female	18-34	5	Software engineer	Bachelor
I15	Female	18-34	8	Software engineer	Bachelor
I16	Female	18-34	10	Software engineer	Bachelor
I17	Female	18-34	5	Consultant	Bachelor
I18	Male	45-64	24	Security manager	Bachelor

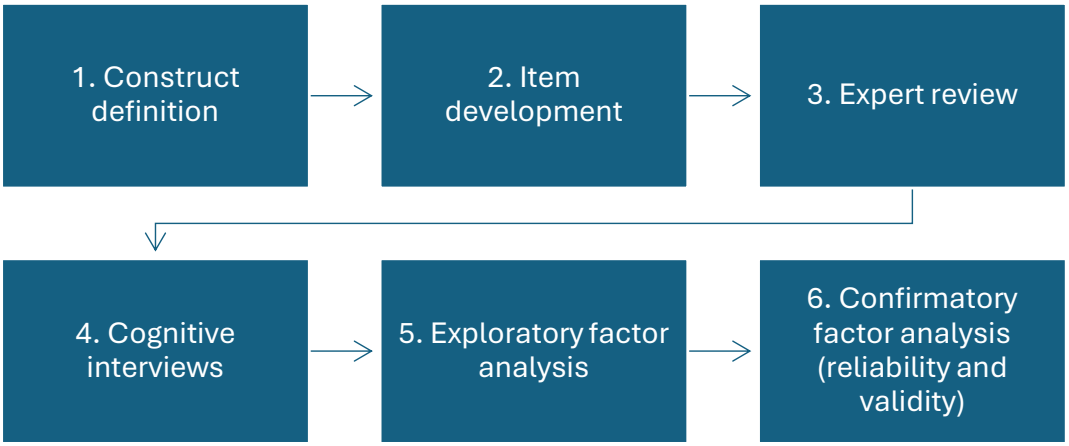

Figure 4: Scale validation steps.