




SWeeTComp: A Framework for Software Testing Competency Assessment

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Abstract: The quality of the process and product is critical for competitiveness in the software industry. Software testing, which spans all development phases, is essential to assess product quality. This requires testing professionals to master various technical and general skills. To address the competency gap in testing teams, a competency assessment of all team members is necessary. In response, SWeeTComp (A Framework for Software Testing Competency Assessment) was developed as a self-assessment tool to identify competency gaps. A study with 22 participants from a Software Engineering course at the Federal University of Amazonas evaluated SWeeTComp's effectiveness in identifying competencies and gaps. Participants also provided feedback on its usability and effectiveness. Results show that SWeeTComp helped participants identify their strengths and weaknesses. Feedback was positive, though areas for improvement, such as clearer instructions and more detailed feedback, were noted.

1 INTRODUCTION

The software industry continually evolves to meet market demands, emphasizing the need for high-quality products. Developing such products requires specific skills and best practices across development and operation phases (Casale et al., 2016). Software testing is crucial for assessing product quality and spans all stages of the development lifecycle (Pressman and Maxim, 2021). With recent technological advancements and the demand for rapid, reliable delivery, the complexity of software testing has increased (Valle et al., 2023), highlighting the importance of assessing the competencies of testing professionals to ensure effective processes and product quality (Maia et al., 2023).


Competency in software engineering encompasses the knowledge, skills, and attitudes required for development tasks. The *Software Engineering Competency Model* (SWECOM) (IEEE, 2014) and the *Software Engineering Body of Knowledge* (SWE-BOK) (IEEE, 2024) categorize competencies into cognitive skills, behavioral attributes, and technical


skills. In software testing, technical competencies include areas such as test planning, infrastructure, techniques, and defect tracking. This study focuses on a defined set of technical competencies, organized into specific categories and activities, detailed further in the supplementary material (Maia et al., 2024).


Effective software testing depends on the skills, intuition, and experience of testers (Kaner et al., 2011). Competency management must address both technical and non-technical skills (Pereira et al., 2010). Assigning tasks to unqualified teams risks compromising results and causing delays due to rework (Marques et al., 2013). Proper skill allocation is critical for project success (Ahmed et al., 2015), and a well-managed testing process directly influences product quality (Pressman and Maxim, 2021); (Juristo et al., 2004).

Challenges in understanding role responsibilities in the Competency Mapping Model, as discussed by (Maia et al., 2023), highlighted the increasing flexibility in organizational structures, where rigid role classifications are less common. This identified the need for a new framework to address these gaps, leading to the development of SWeeTComp.

This study introduces SWeeTComp (*Software Testing Competency Assessment Framework*) was created to support self-assessment and identify gaps

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in software testing competencies. Building on prior research comparing expected and actual competency levels (Maia et al., 2023), the framework adapts the set of competencies described in SWECOM (IEEE, 2014) to accommodate larger and more diverse testing teams. It addresses challenges such as aligning competencies with team roles and defining appropriate competency levels within organizational contexts. The framework categorizes technical competencies into specific domains and activities.

This article analyzes user perceptions of SWeeTComp, focusing on its usefulness, ease of use, workplace relevance, and the quality of results. It also identifies challenges faced by users and suggests opportunities for improvement. The study contributes to enhancing software testing practices by aligning individual and organizational competencies with industry needs.

2 METHODOLOGY

This research employed a combination of qualitative and quantitative analyses to obtain a comprehensive understanding of the user experience with SWeeTComp. The study identified successful aspects, areas requiring improvement, and challenges perceived by participants. This integrated approach aims to inform continuous enhancements and optimizations, ensuring the tool's perceived utility aligns with users' expectations and needs.

To assess user acceptance of SWeeTComp, this research adopted the *Technology Acceptance Model* (TAM) (Davis et al., 1989), which is widely recognized as one of the most frequently employed frameworks for analyzing technology acceptance among users.

2.1 Questionnaire Specification

The questionnaire was structured into three sections: (i) Sociodemographic characterization, designed to profile the participants; (ii) Self-assessment of technical competency levels corresponding to each phase of the testing process; and (iii) Evaluation of the proposed framework's acceptance using the Technology Acceptance Model (TAM). Additional details are provided in the supplementary material (Maia et al., 2024).

2.2 Data Collection

This study involved undergraduate students from a Software Engineering program at Federal Univer-

sity of Amazonas, focusing on their perceptions of SWeeTComp as a framework for software testing competency assessment. Data was collected in the classroom during the Verification, Validation, and Testing course, taught to fifth-semester students.

All participants voluntarily agreed to participate in the study by signing an Informed Consent Form (ICF), ensuring the confidentiality of the data provided. Participant names were included in the forms to facilitate the analysis of their competency levels at the beginning and end of the discipline. The competency assessment questionnaire was re-administered at the conclusion of the course to track and evaluate the progression of competency levels over time.

The study involved 22 participants, the majority of whom were between 18 and 24 years old (77.27%). In terms of gender distribution, the sample was predominantly male (68.18%). Regarding prior experience in software testing, 40.91% of participants reported no experience in software development, while 22.7% indicated having industry experience specifically related to software testing.

When evaluating prior knowledge of software testing, 50% of participants stated they had no knowledge beyond what was acquired during the course. However, 31.8% reported some level of industry experience, and 27.3% mentioned exposure to the topic through academic activities outside this course.

3 EVALUATED ARTIFACT: THE SWeeTComp FRAMEWORK

The SWeeTComp (A Framework for Software Testing Competency Assessment), incorporates technical competencies relevant to the software tester role, aligned with the core activities of the software testing process: Software Testing Planning, Software Testing Infrastructure, Software Testing Techniques, Software Testing Measurement, and Defect Tracking. The SWeeTComp allows users to assign knowledge levels to each competency presented in a questionnaire.

In this research, we adopted the definition of *framework* according to the Cambridge Dictionary (Cambridge University, 2025), which describes it as *a supporting structure around which something can be built and a system of rules, ideas, or beliefs used to plan or decide something*. Frameworks are often used as tools to address specific issues within a domain. They provide support in decision-making by presenting organized processes, procedures, techniques, and tools, offering structured options as potential solutions (Shehabuddeen et al., 2000).

The main objective of this framework is to system-

atize the assessment of competencies within a software testing team, considering the most required technical skills for the software tester role available in SWECOM (IEEE, 2014). Through the evaluation of competency levels in the product quality assurance process, the aim is to efficiently identify potential expertise that may not have been previously recognized, as well as gaps that can be developed according to project needs. This approach is intended to enhance team productivity and the quality of both the process and the product and provides the improvement of skills management. The full version of the SWeeTComp framework is available in the supplementary material (Maia et al., 2024).

To develop the SWeeTComp, we conducted a gap analysis between the technical competencies of the framework by (Saldaña-Ramos et al., 2012) and the technical testing competencies of SWECOM. The goal was to identify potential gaps between the competencies outlined in both artifacts. We observed that the competencies listed in SWECOM encompassed all the technical competencies from (Saldaña-Ramos et al., 2012). Therefore, SWeeTComp is based solely on the technical competencies extracted from SWECOM, organized into Test Planning (17 questions), Test Infrastructure (12 questions), Test Techniques (12 questions), and Measurement and Defect Tracking (15 questions) sections. Each section contains competencies aligned with software tester roles, with professionals assigning competency levels.

Table 1: Competency Levels Assessment.

Competency Level	Meaning
Follow	Performs the activity following instructions
Watch/Assist	Performs the activity under supervision
Participate/Execute	Performs the activity independently
Lead/Conduct	Supervises and/or leads the activities
Create	Responsible for creating new approaches and solutions

The main differences between the two artifacts, in addition to the total number of competencies, are in the format of the questions and the response options. While SWECOM presents competencies through statements already linked to their levels, with responses limited to 'Has', 'Needs' and 'Lacks'; SWeeTComp presents competencies in the form of questions, with options related to the levels of mastery that the professional must attribute to each one. In short, SWECOM seeks to identify the presence or absence of competencies, while SWeeTComp aims to assess the level of mastery of each competency by the professional, as showed in Table 1.

4 RESULTS AND DISCUSSIONS

This section presents the results and discussions regarding of the data collected during the empirical study using all artifacts described in Section 3. We present the findings from the responses provided by the participants (students in the role of testers) to the post-study questionnaire.

4.1 Analysis of Sweetcomp's Utility Perception

Figure 1 illustrates the participants' perceptions, addressing the following question:

Q1. I find SWeeTComp useful in identifying my skill level in activities related to software testing:

A majority of respondents (45.45%) strongly agree that SWeeTComp is useful for assessing competencies in software testing activities. This indicates that many users consider SWeeTComp a valuable tool for this purpose. Additionally, a considerable number (22.73%) partially agree, while a similar proportion (22.73%) fully agrees with its usefulness. However, neutral responses (4.55%) and partial disagreement (4.55%) suggest some users are uncertain or unconvinced about its effectiveness. The analyses reflect diverse perceptions, from positive feedback to concerns about clarity and applicability. Integrating these insights into tool development can enhance user satisfaction. Some participants find SWeeTComp aligns with expectations, facilitating competency assessments and matching their skills. Improvement areas include clarity in terms and questions, connecting with specific work tasks, and understanding the tool's benefits. Participants' experiences and knowledge significantly influence their perception of SWeeTComp's utility, with some finding it beneficial based on existing knowledge, while others express disinterest due to limited involvement in testing.

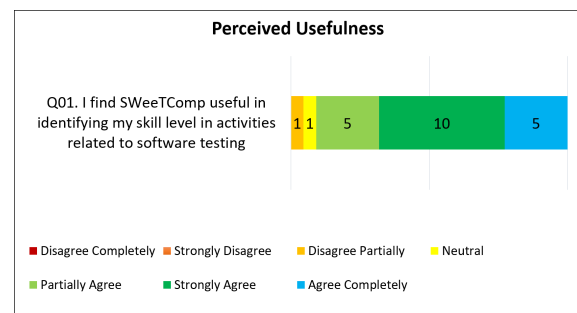


Figure 1: SWeeTComp - Perceived Usefulness.

4.2 Analysis of SWeeTComp’s Ease of Use Perception

Figure 2 illustrates the participants’ perceptions, aiming to address the following questions:

Q2. My interaction with SWeeTComp is clear and understandable: The majority of participants (31.82%) strongly agree that the interaction with SWeeTComp is clear and understandable, indicating a significant positive perception. A considerable number (18.18%) partially agree, suggesting overall positivity with room for improvement. Neutral responses (13.64%) indicate ambivalence or indecision among participants about the clarity of interaction. Disagreements (9.09% strongly disagree and 13.64% partially disagree) highlight a minority perceiving the interaction as not clear. Qualitative responses offer diverse perspectives on clarity, emphasizing positive aspects and areas for improvement in usability and communication. These insights guide future adjustments, with positive feedback indicating satisfaction, while neutral and dissenting responses identify opportunities for improvement. The overall suggestion is to enhance clarity in communication and interaction, possibly through improvements in documentation, instructions, or interfaces for a more intuitive user experience.

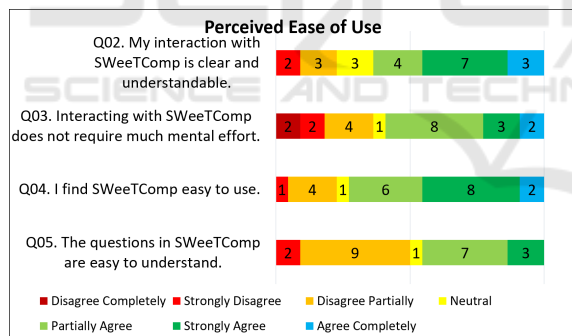


Figure 2: SWeeTComp - Perceived Ease of Use.

Q3. Interacting with SWeeTComp does not require much mental effort: A majority of participants (36.36%) partially agree that interacting with SWeeTComp requires some mental effort, indicating a perception of complexity or effort. A smaller proportion (18.18%) partially disagrees, suggesting a considerable portion finds the interaction mentally demanding. Neutral responses (4.55%) and total disagreement (9.09% Completely Disagree and 9.09% Strongly Disagree) show a division among participants regarding the ease of interaction. With partial agreement being the most frequent response, the majority acknowledges some level of mental effort. This diversity underscores the importance of consid-

ering different user experiences and needs when designing and enhancing SWeeTComp’s usability. Responses indicating the need for mental effort suggest opportunities to enhance SWeeTComp’s interface or design for improved usability and reduced cognitive load. Leveraging feedback on mental effort can identify specific areas for simplification, creating a more seamless and intuitive user experience. Varied responses suggest ease of interaction with SWeeTComp may depend on users’ individual experience and knowledge. Qualitative insights highlight potential improvements, including language simplification, questionnaire length reduction, and instruction clarification, aiming for a more positive and efficient user experience.

Q4. I find SWeeTComp easy to use: Most participants (36.36%) strongly agree that SWeeTComp is easy to use, with 27.27% partially agreeing, indicating an overall positive view but room for improvement. Minority responses (4.55% neutral, 4.55% strongly disagree, and 18.18% partially disagree) suggest some participants do not find SWeeTComp easy to use. The majority recognizes SWeeTComp’s usability, meeting expectations for many users. Disagreement and neutral responses highlight areas for improvement, providing insights to enhance the user experience. Perceptions of SWeeTComp’s ease of use may vary based on individual factors. Qualitative insights reveal strengths like language clarity and simplicity, along with areas for improvement such as formatting and the intuitiveness of the “not applicable” option. These insights will guide adjustments in the SWeeTComp interface.

Q5. The questions in SWeeTComp are easy to understand: Most participants (40.91%) partially disagree that SWeeTComp questions are easy to understand, indicating a significant perception of complexity. A considerable proportion (31.82%) partially agrees, suggesting some find the questions understandable to some extent but face challenges in other aspects. Low neutral responses (4.55%) indicate clear opinions on question comprehension. Disagreement responses (9.09% strongly disagree and 13.64% strongly agree) show a significant portion perceives the questions as difficult to understand. The majority finds SWeeTComp questions challenging, indicating a need for revisions. Specific areas for improvement include clarity, conciseness, and language in question formulation. Varied responses suggest perceptions may depend on users’ experience, knowledge, and contextual factors. These qualitative insights highlight challenges in understanding SWeeTComp questions, such as lack of experience, technical knowledge, and the need for clarity.

4.3 Analysis of Sweetcomp’s Usage Intent Perception

Figure 3 illustrates the participants’ perceptions, aiming to address the following questions:

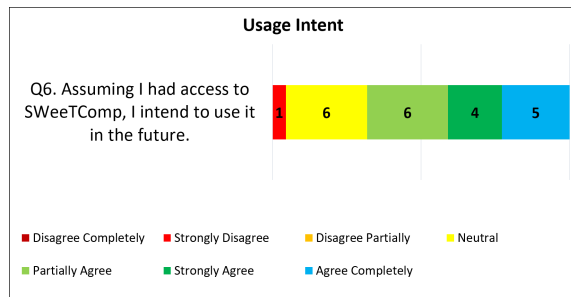


Figure 3: SWeeTComp - Usage Intent.

Q6. Assuming I had access to SWeeTComp, I intend to use it in the future: A substantial number of participants express a neutral inclination toward future usage of SWeeTComp, accounting for 27.27% of responses. Positive intent for usage (Partially Agree and Completely Agree) constitutes 50%, signifying that half of the participants exhibit some level of interest in utilizing the tool in the future. The response Strongly Disagree is relatively minimal (4.55%), indicating a small fraction of participants who unequivocally lack interest. The analysis reveals diverse levels of interest among participants regarding the future use of SWeeTComp. Further exploration of the reasons behind neutral responses and efforts to improve communication about the tool’s benefits can potentially enhance the intention to use. These qualitative responses present various perspectives on the inclination to use SWeeTComp in the future, with recurring themes such as the absence of a personal use case, context dependence, and professional relevance influencing participants’ intentions toward the tool.

4.4 Analysis of Sweetcomp’s Relevance at Work Perception

Figure 4 illustrates the participants’ perceptions, aiming to address the following questions:

Q7. In identifying competency levels in activities related to software testing, using SWeeTComp is important: The majority of participants (86.36%) agree to varying degrees that using SWeeTComp is important for identifying competencies in software testing. Specifically, 22.73% partially and completely agree, while 40.91% strongly agree with SWeeTComp’s importance in this context. Conversely, 4.55% of participants partially disagree with the tool’s importance, and 9.09% maintain a neutral stance.

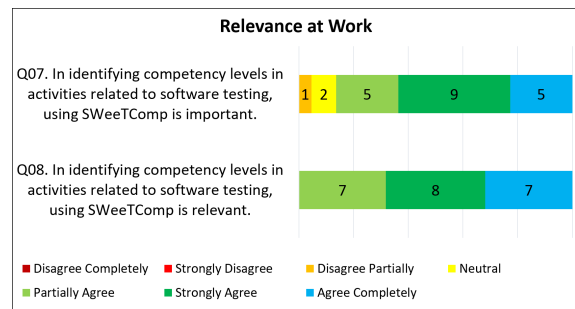


Figure 4: SWeeTComp - Relevance at Work.

These qualitative justifications offer diverse perspectives on SWeeTComp’s perceived importance in competency identification, emphasizing its utility, scope, and effectiveness. Additionally, they acknowledge the existence of alternative methods for measuring competencies.

Q8. In identifying the level of competencies in software testing-related activities, using SWeeTComp is relevant: The majority of participants find SWeeTComp highly relevant for assessing competencies in software testing. “Strongly Agree” responses are most frequent, at 36.36%, with “Completely Agree” responses also significant, at 31.82%. This widespread agreement indicates SWeeTComp’s perceived relevance. Together, these responses exceed 68%, demonstrating a high perception of its relevance. Qualitative justifications highlight its utility, organization, scope, and effectiveness while recognizing the importance of considering different contexts and technologies.

4.5 Analysis of SWeeTComp’s Quality of Results Perception

Figure 5 illustrates participants’ perceptions, mainly showing positive views, with only one negative perception regarding the quality of SWeeTComp.

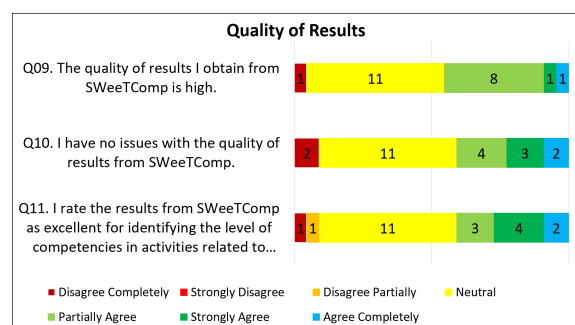


Figure 5: SWeeTComp - Quality of Results.

Q9. The quality of the results I obtain from SWeeTComp is high: The neutral option received

the highest percentage of responses (50%), indicating many participants lack a clear opinion on the quality of SWeeTComp results. A significant portion (36.36%) partially agrees with the results' quality, suggesting recognition of some value but with reservations. Extreme options (Completely Disagree, Strongly Agree, Completely Agree) received low percentages (4.55% each), indicating that few participants expressed strong opinions. The neutral perception may suggest a lack of clarity on evaluation criteria or varied experience with SWeeTComp results. Feedback emphasizes the need for detailed feedback to enhance perceived result quality, with positive and negative responses highlighting strengths and areas for improvement. Qualitative responses reflect diverse perceptions and challenges users face, suggesting improvements in communication, result delivery, and guidance on interpretation and effective use.

Q10. I have no issues with the quality of SWeeTComp results: The neutral option received the highest percentage of responses (50%), indicating many participants did not strongly express their opinion about result quality. Partially Agree and Strongly Agree (31.82%) show a significant portion agrees with the results, recognizing some value, although with possible reservations. Completely Disagree and Completely Agree (9.09% each) received relatively low percentages, suggesting only a minority expressed strong opinions. The high percentage of neutral responses suggests potential ambiguity in evaluation criteria or varied experience with SWeeTComp results. Responses at both extremes indicate strong opinions about result quality, influenced by factors like understanding evaluation criteria and previous experience with similar tools. Participants highlighted a need for improved communication and transparency in delivering and interpreting SWeeTComp results. Lack of familiarity with evaluation criteria can impact the accuracy of assessment of result quality. Additional support and guidance to users are crucial for maximizing the benefits of SWeeTComp results.

Q11. I rate the results of SWeeTComp as excellent for identifying the level of competencies in activities related to software testing: A minority of participants (4.55%) strongly disagreed with SWeeTComp's excellence in competency identification, possibly indicating skepticism. Another small fraction (4.55%) expressed partial disagreement, suggesting reservations. The majority (50%) chose the neutral option, indicating mixed opinions. A significant portion (13.64%) partially agreed, acknowledging merit but with reservations. A substantial number (18.18%) strongly agreed, indicating belief in SWeeTComp's

effectiveness. A smaller proportion (9.09%) completely agreed, signifying trust in SWeeTComp's capability. Most participants took a neutral stance, indicating uncertainty or lack of clarity. Responses in the 'Partially Agree' and 'Strongly Agree' categories suggest varying levels of conviction among users. The absence of strong disagreement implies overall acceptance. Concerns about result access highlight the need for clear delivery. Uncertainty underscores the importance of an intuitive interface and clear instructions. Despite concerns, a positive outlook suggests value with enhancements.

4.6 Analysis of Sweetcomp's Demonstrability of Results Perception

Figure 6 illustrates the participants' perceptions, predominantly reflecting positive views, with only one negative perception regarding the demonstrability of SWeeTComp.

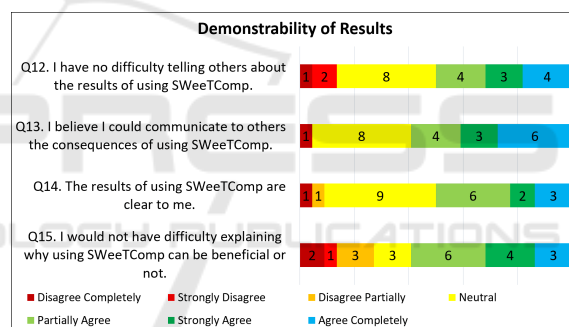


Figure 6: SWeeTComp - "Demonstrability of Results".

Q12. I have no difficulty telling others about the results of using SWeeTComp: The majority (36.36%) had a neutral stance, indicating an ambiguous view or no definitive opinion on SWeeTComp's demonstrability. A substantial portion (18.18%) partially agrees, acknowledging positive aspects and areas for improvement. Another significant group (18.18%) completely agrees, suggesting some users find SWeeTComp highly effective in demonstrating results. A smaller portion (13.64%) strongly agrees, indicating a positive perception among these participants. A few participants (4.55%) completely disagree, possibly reflecting a lack of clarity or experience in presenting results. A slightly larger group (9.09%) strongly disagrees, pointing to potential improvements needed in the presentation or accessibility of results. Notably, no participant expressed partial disagreement, emphasizing that demonstrability is not a middle point of contention. The prevalence

of neutral responses suggests an opportunity to improve communication about SWeeTComp's ability to present results. Additionally, disagreement responses highlight specific areas needing adjustments to better align with user expectations, particularly regarding feedback to the user.

Q13. I believe I could communicate to others the consequences of using SWeeTComp: The majority of participants (36.36%) took a neutral stance regarding their ability to communicate the consequences of using SWeeTComp. This suggests a lack of clarity in conveying the implications, indicating that many participants may not feel entirely confident in explaining the tool's effects. A significant portion agrees, to varying degrees (18.18% Partial + 13.64% Strongly + 27.27% Completely), that they could communicate the consequences of using SWeeTComp. These participants express confidence in their ability to explain the tool's implications, reflecting a positive indication of understanding and effective communication about SWeeTComp results. Complete disagreement is relatively low (4.55%), indicating that only a small percentage of participants strongly disagree with the ability to communicate the consequences.

Q14. The results of using SWeeTComp are evident to me: The majority of participants (40.91%) were neutral about the clarity of SWeeTComp results, showing uncertainty. A substantial portion agreed to various extents (27.27% Partial + 13.64% Completely), suggesting perceived effectiveness. Complete and partial disagreement was relatively low (4.55% Completely + 4.55% Partially), indicating only a small percentage disagreed. This suggests that, even if neutral, most participants do not strongly disagree. Insights provided emphasize areas needing clarification or improvement in communication and presentation of SWeeTComp results, highlighting the importance of enhancing clarity and understandability for user adoption. Participant justifications underscore the significance of experience, context, and clarity in presenting results, guiding improvements for enhanced demonstrability.

Q15. I would not have difficulty explaining why using SWeeTComp can be beneficial or not: A significant portion agrees, to varying degrees (27.27% Partial + 18.18% Strongly + 13.64% Completely), that they would not have difficulty explaining the potential benefits of using SWeeTComp. These participants expressed confidence in their ability to articulate the advantages of the tool. Complete and partial disagreement is relatively low (9.09% Completely + 4.55% Strongly + 13.64% Partially), indicating only a small percentage disagree regarding the ease of explaining the benefits. This suggests that the majority of par-

ticipants, even if neutral, do not strongly object. A considerable proportion (13.64%) adopted a neutral stance, possibly due to a lack of clarity or knowledge about the perceived advantages. Overall, responses vary from a positive understanding of the benefits to specific concerns. This analysis highlights the need to improve communication and accessibility of results to enhance understanding and perceived utility.

5 LIMITATIONS AND THREATS TO VALIDITY

This section outlines the limitations of the methodology and potential threats to the validity of the research on users' perception of SWeeTComp, along with the corresponding mitigations. Firstly, the research sample was limited to academics in software testing, potentially restricting the generalization of competencies to roles beyond testing. To address this, considering that studies such as those by Host et al. (2000) (Höst et al., 2000) and Salman et al. (2015) (Salman et al., 2015) have demonstrated that students can adequately represent industry professionals, these students were deemed a suitable sample for evaluating the framework. Secondly, data collection relied on participants' self-perception, introducing subjectivity that may affect the accuracy of conclusions. There is a potential researcher bias in the creation of the questionnaire and the analysis of the results. To mitigate this, all artifacts and results were reviewed by two renowned researchers in software engineering and a professional with 10 years of experience. This peer review process aimed to ensure the objectivity and reliability of the study. These mitigations are intended to enhance the validity of the findings and the reliability of the conclusions drawn from the study.

6 CONCLUSION

The study aimed to evaluate the effectiveness of SWeeTComp, a framework developed to assess software testing competencies. Data was collected from participants enrolled in a Software Engineering program at a Federal University, who were asked to complete self-assessments of their competencies in software testing. The results from the Technology Acceptance Model (TAM) were analyzed to gauge user acceptance and inform potential improvements to the framework. These include enhancing the user interface for better usability, refining instructions for ease of use, providing real-time feedback during

questionnaire completion, and generating detailed reports post-assessment. Additionally, expanding the range of relevant competencies, incorporating practical evaluation elements, allowing customization for different testing contexts, and ensuring regular updates to keep the tool aligned with emerging trends are important steps for future development. Future work should focus on expanding the sample to include industry professionals, incorporating real-world contexts into evaluations, and adding more customization options. By adopting an iterative approach and incorporating continuous user feedback, SWeeTComp can evolve into a more robust tool for assessing software testing competencies, effectively bridging the gap between academia and industry. Software industry can benefit from SWeeTComp by assessing software testing team skills, identify gaps, and align individual competencies with organizational goals, improving team performance and product quality. For academia, it identifies areas for enhancing educational programs, ensuring that graduates possess the skills required by industry. By aligning curricula with real-world competencies, SWeeTComp bridges the gap between theoretical education and practical skills, thus increasing employability.

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