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The Most In-Demand Soft Skills for QA Professionals in Brazil

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Background: Software quality assurance (QA) is carried out in tandem with software development. Essentially, QA activities are conducted in hopes of assessing the extent to which a software product aligns with predefined requirements. Although QA includes highly technical tasks, much like software development, it remains largely a human-centered endeavor. Consequently, soft skills can play a significant role in contributing to the success of a project and product quality, as well as boosting the productivity of QA professionals. **Aim:** Our objective is to investigate: *(i)* the most sought-after soft skills for QA professionals, *(ii)* potential correlations among these in-demand soft skills, *(iii)* variations in soft skill requirements based on the seniority level of positions, and *(iv)* potential differences in soft skills expectations according to the size of the hiring companies. Our analysis is centered around organizations in Brazil. **Method:** We looked for soft skills in 2,164 job advertisements from Brazilian companies. Our data extraction process followed an inductive, data-driven approach that included both manual and automated steps. **Results:** approximately 91% of the job advertisements list at least one soft skill. We identified 32 soft skills in our study, with five soft skills standing out as the most sought-after among them: communication-related skills, planning, innovation, collaboration, and written communication. Notably, companies of various sizes consistently prioritize communication-related and planning skills, deeming them crucial for QA professionals. **Conclusions:** Our findings underscore the critical importance of five soft skills: communication-related skills, planning, innovation, collaboration, and written communication. The results of our study hold potential value for QA professionals in Brazil seeking to enhance their employability and provide insights to those tasked with staffing, curriculum design, and professional development.

Keywords: *Quality assurance; Software testing; Soft skill; Job advertisements; Exploratory study; Human aspects of software engineering; Expectations of the software industry*

1 Introduction

Developing software is a complex process (Parnas, 2011). This complexity arises from both technical and human factors (Buhrer, 2003). On the technical side, software developers must understand and translate complex business requirements into working software while coping with the constantly evolving landscape of technology. On the human side, successful software development requires collaboration and communication among developers and other stakeholders.

The increasing complexity of software systems and the increasingly rapid pace of development pose a significant challenge for ensuring that software works as intended (Charette, 2005). Nevertheless, in today's competitive market, companies are placing a growing emphasis on delivering high-quality software to users. This focus on quality has led to an increasing demand for quality assurance (QA) professionals. QA professionals play a pivotal role in achieving and assessing the quality of a software product.

QA is a highly technical activity that requires individuals with diverse knowledge and experience in a range of tools and techniques. Usually, the QA team is separated from the development team, with their own designated headcount and budget. Software companies tend to prioritize hard skills as algorithms, data structures, programming, and technical certifications when staffing teams or hiring new professionals (Matturro, 2013). Over the years, it has become increasingly evident that the key to successful software projects transcends mere technical prowess. In effect, human factors may play a more pivotal role in shaping outcomes than the hard skills traditionally emphasized in the field. Given that people working on software projects must engage and communicate with teammates and stakeholders, negotiate with customers, and produce reports, among other nontechnical activities, the human dimension is just as vital as the technical one (Acuna et al., 2006). A relatively new trend that may place a high value on *soft skills* (e.g., team and communication skills) is the widespread use of virtual team setups: many software projects comprise geographically separated teams that must rely heavily on digital communication tools. It has been shown that soft skills tend to contribute to project success and productivity: meeting skills (Sadowski et al., 2019), team work (Treude and Filho, 2019), and communication (Wagner and Murphy-Hill, 2019) play a pivotal role as productivity enablers. Additionally, the combination of hard skills with soft skills leads to increased productivity of the former (Balcar, 2016; Hendarman and Tjakraatmadja, 2012).

QA involves a mix of automated and manual activities (i.e., noncomputer-based testing) (Myers et al., 2011): hence, not all QA activities revolve around computer-based, hard skills exclusively. For example, QA professionals need to assess the quality of software products from the perspective of end-users (e.g., usability testing), taking into account feedback from stakeholders and making collaborative decisions. Thus, in addition to conventional computer-based testing techniques, soft skills have a crucial role to play in ensuring the development of high-quality software products.

Although the importance of soft skills has been acknowledged by QA researchers and practitioners (Burbekova, 2021; Kassab et al., 2021), there remains a lack of empirically grounded insights into the specific soft skills that are most in demand by the industry. Online job advertisements serve as a valuable source of information to probe into the soft skills that are in high demand. These advertisements define what hard and soft skills employers expect from job candidates and are often collectively created by human resource specialists and hiring managers.

We set out to investigate what are the most sought after soft skills in the software industry in Brazil. The study reported in this article significantly enhances our previous findings by examining a substantially larger dataset of 2,164 job advertisements, compared to the 253 used in our earlier study (Lancetti et al., 2023). Our expanded dataset of job advertisements is more than eight times larger than the dataset used in our previous study, allowing us to strengthen the rigor of our analysis and broaden the generalizability of our results. Additionally, by grounding our discussion in this expanded dataset, we provide deeper insights into the evolving landscape of soft skills demanded by the software industry in Brazil. The broader dataset allows us to refine our understanding of the most in-demand soft skills for QA professionals, look into new trends, and confirm or challenge the findings presented in our previous study with greater confidence. To the best of our knowledge, before this expanded version, only our initial study (Lancetti et al., 2023) had investigated the soft skills sought by employers in Brazil for QA professionals. We believe the results from our investigation are of interest to researchers in human aspects of software engineering, to those in industry that are in charge of staffing and personnel, as well as to those seeking to propose research-informed approaches to curriculum and professional development. In summary, our article makes the following contributions:

- We show that companies in Brazil often refer to soft skills in job advertisements.
- Our results highlight the premium placed on communication skills for QA professionals across all career stages. Collaborative skills are also valued by Brazilian companies, indicating the importance of working effectively in teams. Employers also express a strong preference for an innovative mindset.
- Despite Brazil's diversity, encompassing people from varied social, educational, economic, and ethnic backgrounds, our findings suggest that the diversity of the Brazilian society has not yet significantly shaped the soft skills sought after in the job market. Notably, skills associated with interacting effectively within a diverse community are rarely mentioned.

The remainder of this article is organized as follows. Section 2 provides an overview of our research context and presents the questions we set out to answer. In Section 3 we discuss the key concepts underpinning our research. Section 4 presents related work. Section 5 lays out our research method. Results are presented in Section 6. We discuss our findings in Section 7 and present the concluding remarks in Section 8.

2 Context and Research Questions

This study centers around the software industry in Brazil. Specifically, the overarching goal of this article is to contribute to the understanding of the most in demand soft skills for QA professionals in the Brazilian software industry. Brazil is the largest country in South America and in 2022 was considered as the 11th largest economy in the world.[1] According to the Brazilian Association of Software Companies (ABES)[2], Brazil ranked 12th globally in the software and services market in 2022, accounting for roughly 40% of the Latin America market.

In order to investigate the most in-demand soft skills for QA professionals in Brazil, we conducted an analysis of job advertisements. While job advertisements have been analyzed in various studies for different objectives, there is a lack of studies specifically investigating the essential soft skills that QA professionals should possess to enhance their employability prospects. For example, studies have examined job advertisements in Brazil and Mexico (Calazans et al., 2017), Canada (Wang et al., 2018), China (Wang et al., 2020), Germany (Herrmann, 2013), and the Netherlands (Daneva et al., 2017) to gain a deeper understanding of the roles of requirements engineers. Although these studies acknowledge the importance of soft skills, none explore them in detail. Kassab et al. (2021) conducted an investigation using job advertisements as source of information to profile software tester positions in the United States. Nonetheless, their study predominantly emphasized the examination of hard skills, while giving less consideration to soft skills. In this study, we focus on answering the following research questions (RQs):

- **RQ_1: To increase their employability prospects in Brazil, what are the most relevant soft skills that QA professionals should focus on developing?** In contrast to studies that rely on surveys, our approach to identifying soft skills is based on the specific requirements mentioned by companies in job advertisements. This enables us to gain insight into the real demand for these skills, rather than relying solely on individual perceptions of relevance.
- **RQ_2: Is there a correlation (i.e., association) between the most in-demand soft skills?** We posit that exploring potential associations between soft skills could offer crucial insights for QA professionals. Specifically, identifying these associations can help QA professionals in pinpointing pairs of soft skills to enhance, thereby potentially increasing their employability prospects. Rather than concentrating on a single soft skill, we believe it could be more beneficial for QA professionals to focus on developing pairs of skills that exhibit strong associations. By doing so, their chances of securing employment in Brazil may improve.
- **RQ_3: Do the requirements for soft skills vary based on the seniority level of positions?** We examine whether the soft skills required for QA professionals

[1] `https://www.worlddata.info/largest-economies.php` - accessed in April, 2024.

[2] The full report is available online at `https://abes.com.br/en/dados-do-setor/` - accessed in April, 2024.

vary based on the seniority level and experience required for different positions. Specifically, we investigate how the set of soft skills expected from junior-level QA professionals differs from those expected from senior-level professionals.

- **RQ_4: Do the expectations for soft skills differ based on the size of the hiring organizations?** We explore whether the set of soft skills expected from QA professionals differs based on the size of hiring companies.

3 Background

3.1 Quality and QA

Delivering high-quality software has become a critical indicator of competitive differentiation, and the software industry has been responding to this by increasingly bringing software quality to the foreground. Owing to its multifaceted nature and importance, the term software quality is referred to in many knowledge areas (KAs) of the Guide to the Software Engineering Body of Knowledge (SWEBOK Guide) (Bourque et al., 2014). Due to its extensive usage, the term quality has become overloaded (Bourque et al., 2014) and challenging to define properly. A more recent definition highlights the essence of software (product) quality as "capability of a software product to satisfy stated and implied needs under specified conditions" (IEEE Std 730-2002, 2014). Expanding upon this, the definition also takes into account the involvement of stakeholders: "the degree to which a software product meets established requirements; however, quality depends upon the degree to which those established requirements accurately represent stakeholder needs, wants, and expectations" (IEEE Std 730-2002, 2014). In this context, software quality assurance (SQA) activities encompass the many QA activities that should be carried out in a software project's life cycle to ensure quality. It is worth noting that QA in software is not restricted to software testing (Feldman, 2005): SQA activities include various verification and validation (V&V) activities (including testing) as well as documenting and core reviews (Bourque et al., 2014). More specifically, QA encompasses testing as a pivotal activity in the sense that the purpose of a test plan is to uncover problems and provide a gauge of quality. Nevertheless, it is not possible to achieve quality solely through testing. A QA plan ensures that the design is sound, the implementation was carried out properly, and the software product meets all requirements prior to release (Feldman, 2005).

In the context of this study, the terms QA professional and QA practitioner are used interchangeably to refer to professionals who could potentially be eligible applicants for the job advertisements investigated in this article.

3.2 Soft Skills

Grant (2023) traces the inception of the term *soft skill*[3] to the late 1960s. This period marked a shift in training paradigms within the United States Army, as psychologists sought to broaden the scope of training beyond the technical proficiency required for operating mechanized equipment such as tanks and firearms. The pivot toward human-centric skills was catalyzed by the recognition of the pivotal role that leadership and teamwork play in enhancing group efficacy. This shift necessitated a terminological distinction to differentiate between conventional technical skills and emerging interpersonal competencies. In this context, the skills associated with the operation of machinery were termed *hard skills*. The term *soft skills* was then coined to encapsulate those competencies crucial to performance yet not involving direct interaction with machines. These encompassed a broad spectrum of social, emotional, and behavioral skills essential for soldiers to thrive in diverse roles. Therefore, the designation of these skills as "soft" was derived not from a perceived lack of importance but rather from their non-technical nature, which did not involve handling machinery.

More recently, the term soft skill has been proposed to encompass the description of many non-technical skills. Nonetheless, there is no widely agreed-upon definition for the term, nor a consensus regarding a set of soft skills. In the context of this study, soft skills refer to intrapersonal and interpersonal skills that are key for personal growth, taking part in social interactions, and better navigate social situations in the workplace (Galster et al., 2022). In our study, while we consider personality traits (e.g., extroversion), we primarily focus on non-technical, domain-independent skills. This emphasis is due to the inherently stable nature of personality traits over time and their relative difficulty to teach, as suggested by Ardelt (2000). For instance, individuals might enhance their communication skills through training, but they may still identify as introverts. Therefore, while acknowledging the influence of personality traits, our investigation is centered more around the more malleable soft skills.

4 Related Work

Matturro (2013) conducted an analysis of job advertisements related to software engineering positions in hopes of identifying the soft skills most in demand by software companies in Uruguay. Out of the 678 selected job advertisements, 43 were specifically for QA/software testing positions. As reported by Matturro, the three most frequently mentioned soft skills in these job advertisements for QA professionals were oral/written communication in English (approximately 65%), teamwork (around 62%), and initiative/proactive skills (47%).

Florea and Stray (2019) analyzed data from 400 job advertisements from 33 countries. The analysis was centered on identifying the most in-demand testing-related, technical, and domain-related skills. The results from this multi-country analysis suggest that most job advertisements emphasize testing-related skills. The most in-demand skills focus on the process of test automation.

Differently from Florea and Stray, Kassab et al. (2021) carried out a country-specific study focusing on identifying the most sought-after skills for the software testing role in the United States. Based on 1,000 job advertisements, Kassab

[3] Alternative terms that have been used to describe soft skills are *social skills*, *emotional intelligence*, *non-domain skills*, *non-technical skills*, and *qualitative skills*.

et al. conducted an analysis aimed at identifying the background and key skills for software testers in terms of *(i)* education level, training and experience, *(ii)* testing skills, *(iii)* technical skills, and *(iv)* soft skills. According to their findings, 70% of the job advertisements ask for at least one soft skill, and 56% highlight the necessity of possessing at least two soft skills. While Kassab et al. acknowledge the relevance of soft skills, their study does not place emphasis on soft skills and the exploration of these competences is not conducted in detail. In contrast to our study, which concentrates on identifying the most in-demand soft skills, the study conducted by Kassab et al. is broader in scope, and gives priority to the following aspects: education level, experience, technical skills, testing tools, development tools, and frameworks.

Rabelo et al. (2022) sought to map the current landscape of soft (i.e., non-technical) skills in the field of software development. To this end, Rabelo et al. carried out a twofold study. Initially, they went over 566 job advertisements to gauge the frequency with which soft skills are sought. Most of the job advertisements (430 in total) were sourced from Europe: the countries with the highest number of job advertisements were Germany (194), the Netherlands (77), and the United Kingdom (65). Subsequently, Rabelo et al. interviewed 15 entry-level developers to determine the soft skills they deemed essential within their organizations and to better understand how these soft skills play a fundamental role in daily software development practices. According to their analysis of the job advertisements, the substantial number of soft skills listed in these postings indicates a genuine interest from companies in these skills. Additionally, the authors discovered that teamwork and communication skills are the most frequently mentioned soft skills.

5 Research Method

We posed RQs (Section 2) with the overarching goal of uncovering the soft skills that are most sought after and valued within Brazilian companies that employ QA professionals and whose core business is software. Our research is exploratory in nature, given that, to the best of our knowledge, no other study apart from our initial investigation has examined the most in-demand soft skills for QA professionals within the Brazilian software industry context. Therefore, although this is an expanded version of our initial investigation into the most in-demand soft skills for QA professionals, it remains a tentative analysis informed by related work. Given the exploratory nature of our study, we do not test specific hypotheses, nor do we approach the RQs with preconceived notions of the answers.

To answer the RQs, we started by performing data collection. Our source of data comes from job advertisements. Unlike studies that investigated soft skills through surveys, we turned to job advertisements to determine the soft skills that Brazilian employers look for in QA professionals. Specifically, we collected job advertisements from the LinkedIn[4] professional social networking platform, which has 930 million members in more than 200 countries and territories worldwide.[5] We decided to explore job advertisements on LinkedIn due to its widespread adoption among job seekers and recruiters alike. More specifically, LinkedIn was selected over other professional social networks due to its focus on career development and recruitment, making it the most relevant platform for our study. Additionally, its established reputation in Brazil as the leading professional network ensures greater credibility in job postings, thereby further enhancing the reliability of our findings.

We created a Python script to scrape job advertisement information from LinkedIn into a spreadsheet, which was later turned into a CSV file. Specifically, our script leverages the *Tags* filter to streamline the search process. We ran a search with the following tags (provided in both Portuguese and English): *QA*, *QA Tester*, *Tester*, *Automation Tester*, *Software Quality Assurance Analyst*, and *Software Quality Analyst*. Since we were interested in the latest trends in the QA-related job market in Brazil, we focused on job advertisements posted from March 14, 2023 to March 14, 2024. Data collection took place from March 14 to 15, 2024. We manually filtered out job advertisements from companies or recruitment agencies whose core business was not software. The initial data collection resulted in 2,209 job advertisements. Following the initial data extraction, we also filtered out duplicate job advertisements: resulting in 2,178 entries. Additionally, we filtered out the entries that were not related to QA, resulting in a total of 2,164 job advertisements after the data collection and filtering process.

Our dataset, comprising 2,164 job advertisements, is significantly more extensive than those used in similar studies, marking a considerable advancement in the scale of data analysis for soft skills among QA professionals. Related research in this area has utilized considerably smaller datasets, such as 101 job advertisements (Daneva et al., 2017), 190 (Wang et al., 2018), 200 (Herrmann, 2013), and 1,000 (Kassab et al., 2021). Our expanded dataset enables a more robust and comprehensive analysis, thereby setting a new benchmark for studies in this domain.

5.1 Data Extraction

We read through all job advertisements and extracted the relevant data, which is shown in Table 1. Given that the job advertisements are not organized in such a way as to make the extraction of the information in Table 1 easy to retrieve and synthesize, all job advertisements had to be analyzed by two researchers, one of which is an expert in Software Engineering. Specifically, throughout the soft skill extraction process, a tool was employed to assist in the identification and extraction of soft skills from the selected job advertisements. The results generated by this tool were utilized to streamline the soft skill extraction process, allowing for a more efficient examination of all job advertisements. Furthermore, in cases where ambiguities arose regarding the extraction of specific information, a collaborative approach was adopted: the two researchers involved in the soft skill extraction process convened to discuss and resolve these ambiguities, with the aim of achieving a more consistent interpretation and extraction

[4] `https://www.linkedin.com/` - accessed on May, 2024.

[5] `https://about.linkedin.com/` - accessed on May, 2024.

of the data. More details regarding this tool-supported data extraction process are provided in Section 5.2.

Below, we further detail the extraction process for some of the data items in Table 1:

- **Soft skill(s):** soft skills were only extracted if a job advertisement explicitly requested them. For example, *"ability to work well in a team and collaborate with colleagues to achieve common goals"* would count as the *teamwork* soft skill; *"our company is all about team collaboration and innovating together"* would not.
- **Position:** we have adopted a broad definition for this data item, encompassing any role associated with QA. Hence, our definition extends beyond that of a software tester.
- **Seniority level:** we categorized seniority levels as entry-level (i.e., junior), mid-level, and senior based on the terms mentioned in the advertisements. When the roles lead, manager, and principal were mentioned, we categorized them as senior positions. Similarly, junior or graduate positions were categorized as entry-level roles. Some advertisements included a range of seniority levels (e.g., entry-level or mid-level); in such cases, we took a conservative approach and categorized these to the lower level in the range.
- **Company size:** to identify the source of a job advertisement, we relied on the company names mentioned in the advertisements. However, the lion's share of the job advertisements did not include information about the size of the hiring company or the recruitment agency. Thus, we had to track this information down based on company or recruitment agency names. We collected information about the sizes of companies and recruitment agencies from public sources and categorized them based on the government's classification of businesses.[6] Specifically, the Employer Identification Number (EIN) of each company was obtained by using the company's name as a reference. Based on their sizes, companies and recruitment agencies were mapped to four categories: micro, small, medium, and large.

Table 1. Information extracted from the job advertisements.

Data Item	Description	RQ
Soft skills	Soft skill(s) mentioned in the advertisement: some advertisements mention no soft skill, while others mention one or multiple soft skills.	RQ_1, RQ_2
Position	Job title as mentioned in the advertisement.	—
Seniority level	Seniority level required for the position, which can vary from entry-level to senior.	RQ_3
Company	Name of the hiring company.	RQ_4
Company size	The name of the hiring company was used to determine the company's size.	RQ_4

5.2 Data Analysis

While analyzing soft skills, we followed an inductive, data-driven approach: we did not establish a predefined set of soft skills up front; instead, we examined whether job advertisements explicitly mentioned them. Therefore, several soft skills emerged and evolved during this manual analysis. Additionally, we leveraged a tool called SkillNER[7] (Fareri et al., 2021) to automatically extract soft skills from the 2,164 selected job advertisements. SkillNER implements a data-driven methodology for soft skill extraction from text: this named entity recognition (NER) system was trained using a support vector machine (SVM) on a corpus comprising over 5,000 scientific papers. To overcome the fact that soft skills are vaguely defined, SkillNER was trained with data labeled by domain experts (i.e., psychologists). Thus, the tool is able to extract soft skills in an accurate and reliable fashion (Fareri et al., 2021).

During our data extraction process, we had to analyze job advertisements in both English and Portuguese. Since SkillNER is designed to extract soft skills only from text in English, we had to translate the Portuguese job advertisements prior to analysis. To accomplish this, we used Google Translate to render the Portuguese job advertisements into English.

For each job advertisement, we manually merged the manually extracted list of soft skills with the automatically extracted one generated by SkillNER. Specifically, for each job advertisement, we went over two lists of soft skills: one derived from a manual analysis and the other generated by SkillNER. We chose the SkillNER list as our reference, believing it to contain the most accurate soft skill information. We compared each item from the manual list against the reference list. If the manual list had additional elements, we discussed whether these should be incorporated into the SkillNER list. After analyzing discrepancies, we decided whether the elements from the manual list should be merged into the reference list. Once all elements had been analyzed and necessary changes had been made to the reference list, we reviewed the updated reference list for consistency. This merging entailed filtering out any duplicate entries and performing data cleansing to ensure the soundness of the final set of soft skills requirements for each job posting.[8]

[6] When mapping a company's name to its respective size, we used information from the following sources: `https://econodata.com.br/`, `http://cnpj.info/`, and `https://www.glassdoor.com.br/` (all accessed in March, 2024).

[7] `https://github.com/AnasAito/SkillNer`

[8] The Python code for data analysis, along with the dataset (in CSV format), can be found in the replication package available on Zenodo: `https://doi.org/10.5281/zenodo.11186887`.

6 Results

6.1 Overview

The 2,164 selected job advertisements were posted by 982 different hiring companies and recruitment agencies. Approximately 8.96% (194) of the 2,164 job advertisements did not mention any soft skills.

6.2 RQ_1: Most Relevant Soft Skills for QA Professionals

Job advertisements varied in the number of soft skills mentioned, ranging from one to 11. On average, each job advertisement included 3.28 mentions of soft skill related terms. Some skills were clearly expressed through the wording of the job advertisements, while others required interpretation or analysis. In Table 2, the 32 soft skills identified from our analysis of job advertisements are listed along with their respective frequencies across these advertisements: the percentages presented in Table 2 indicate the proportion of advertisements that listed a particular soft skill. It is worth noting that since a job advertisement may mention multiple soft skills, the total percentage exceeds 100%. The distribution of the top 10 most frequent soft skills is shown in Figure 1.

We incorporated three communication-related skills into our analysis, namely, *Communication (generic)*, *Communication (oral)*, and *Communication (written)*. This decision was made due to the different ways in which some job advertisements referred to "communication": some job advertisements referred to communication without providing further details, while others explicitly referenced written or oral communication skills. For instance, in our initial study (Lancetti et al., 2023), a number of job advertisements highlighted the importance of oral communication skills in order to facilitate effective collaboration among team members, stakeholders, and clients. Figure 1 illustrates the prevalence of communication-related skills, highlighting *Communication (generic)* as the most commonly required skill, appearing in 1,203 job advertisements.

Similarly to Galster et al. (2022), we also took into account the fact that soft skills are not independent from each other. Additionally, some soft skills might be considered "subskills" of other soft skills. For instance, *Problem solving* might encompass a combination of other skills such as *Analytical* and *Creativity*. Nevertheless, we list soft skills separately based on their individual appearances in the job advertisements.

As highlighted in Table 2, the 10 most sought after soft skills are, in descending order, *Communication (generic)*, *Planning*, *Innovation*, *Collaboration*, *Communication (written)*, *Leadership*, *Problem solving*, *Analytical*, *Curiosity*, and *Team* (i.e., teamwork). Therefore, to increase their chances of finding employment in Brazil, QA professionals should focus on developing the most frequently mentioned soft skills presented in Table 2.

Our findings indicate that the top three most sought-after skills are highly valued by employers. Given that *Communication (generic)* was the most commonly listed soft skill (55.59%) and written communication (16.45%) also ranks among the top 10 most sought-after soft skills, we believe it is crucial for QA professionals to effectively convey information, ideas, and opinions both orally and in writing. Additionally, active listening and engaging in productive dialogue with coworkers and stakeholders are essential.

Table 2. Identified soft skills (in alphabetical order).

Soft Skill	Percentage
Adaptable	3.84%
Analytical	**10.49%**
Assertive	1.71%
Collaboration	**32.35%**
Communication (generic)	**55.59%**
Communication (oral)	0.92%
Communication (written)	**16.45%**
Cooperation	2.40%
Creativity	9.38%
Critical thinking	0.14%
Curiosity	**11.37%**
Decision making	6.24%
Diversity	3.33%
Dynamism	0.28%
Empathy	1.57%
Enthusiasm	0.14%
Flexibility	0.65%
Innovation	**35.17%**
Interpersonal	7.86%
Investigative	5.27%
Leadership	**13.63%**
Mentoring	3.05%
Negotiation	4.53%
Organization	0.18%
Planning	**41.40%**
Proactive	1.94%
Problem solving	**11.92%**
Resilience	4.71%
Self disciplined	1.80%
Self management	0.32%
Self motivated	0.79%
Team	**9.47%**

According to our findings, planning skills (i.e., *Planning*) rank as the second most sought-after soft skill for QA professionals (41.40%). This significance probably stems from the necessity for QA professionals to manage testing schedules and coordinate with multiple development teams, ensuring that testing activities are aligned with development cycles. Consequently, those with planning skills are better equipped to organize testing tasks effectively, thereby meeting crucial deadlines. Moreover, planning involves anticipating potential issues and devising strategies to mitigate risks. Our results suggest that companies highly value QA professionals who can identify high-risk areas and formulate appropriate testing strategies to maintain product quality.

Developing an innovative mindset (35.17%) is also highly valued by employers. Thus, it is vital for QA professionals to think critically and stay ahead in a rapidly evolving technological landscape. Our results would seem to suggest that

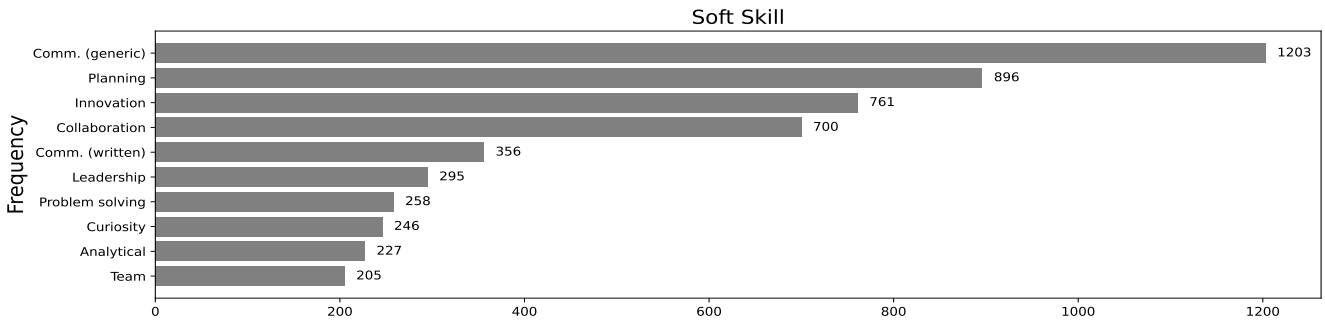

Figure 1. Distribution of the top 10 most frequent soft skills in job advertisements.

collaborative skills (i.e, *Collaboration*), which ranked forth at 32.35%, are also crucial for QA professionals.

Leadership is a pivotal factor in achieving organizational and project success (Bass and Riggio, 2005), underscoring its importance as a soft skill for QA professionals (13.63%). The demand for leadership capabilities arises from the necessity for QA leaders to effectively oversee diverse teams, including testers and various QA specialists. Such leadership is important for navigating complex technical challenges and mediating any disputes that may arise. Furthermore, in the context of QA, leadership acumen is instrumental in persuading other stakeholders of the importance of maintaining quality standards throughout the project lifecycle.

It is also worth mentioning that, similar to software developers (Orsted, 2000), QA professionals should also focus on honing their problem-solving abilities (11.92%).

QA professionals aiming to enhance their marketability and effectiveness in their roles, should focus on developing the top soft skills highlighted in Table 2. Essentially, QA professionals have to work effectively in teams, share knowledge, foster an innovative mindset, and contribute to collective problem-solving efforts.

Brazil is a country that encompasses people from diverse social, educational, economic, and ethnic backgrounds. However, our findings indicate that these unique Brazilian characteristics have not yet influenced the demand for soft skills. For instance, soft skills associated with *Diversity*, which involve the ability to engage with individuals from various social, educational, professional, and ethnic backgrounds, as well as different genders (Galster et al., 2022), are rarely mentioned. This suggests that employers may not place explicit emphasis on diversity-related skills while devising their hiring criteria, despite the diverse nature of the Brazilian population.

Key insights for RQ$_1$: The paramount importance of communication skills is evident, with *Communication (generic)* leading at 55.59%, indicating an essential need for QA professionals to articulate information clearly and effectively both orally and in writing. *Planning*, as the second most sought-after skill at 41.40%, reflects the importance for QA professionals to be able to foresee potential challenges and devise preemptive solutions to ensure the quality and timely delivery of projects. Employers also highly value an innovative mindset, followed by collaborative skills. Skills related to working with a range of individuals in a diverse community are seldom mentioned.

6.3 RQ$_2$: Exploring Associations Among the Most In-Demand Soft Skills

In this section we are interested in the possible *relationships* among soft skills. Thus, the discussion here is centered around a pairwise association matrix (Figure 2), representing the strength of association among the 10 most sought after soft skills (i.e., nominal variables). Soft skills were measured at the nominal level (Wohlin et al., 2012), meaning values were mapped to the names of each soft skill, so there is no inherent ranking. The associations shown in Figure 2 were computed using Cramér's V. While Pearson's correlation (r) is employed for examining potential linear relationships between two numeric variables, we used Cram'er's V for examining the strength of association between the soft skills given that they are nominal variables. This statistical measure is specifically designed to evaluate the association between two nominal variables (Drennan, 1996). Cramér's V values range from 0 to 1; a value of 0 suggests no association between variables, while a value of 1 denotes a perfect association (Akoglu, 2018).

According to the pairwise associations matrix shown in Figure 2,[9] the most robust association appears between *Communication (written)* and *Planning*, with a Cramér's V value of 0.82. This result suggests a near-perfect relationship, suggesting these skills are often required together, possibly due to the need for clear communication in strategic roles.

The pairwise association matrix shown in Figure 2 highlights the varying strengths of relationships among the top five soft skills – i.e., *Communication (generic)*, *Planning*, *Innovation*, *Collaboration*, and *Communication (written)* – indicating how often these skills are mentioned together in job advertisements. The matrix illustrates the complexity and interdependence of soft skills as dictated by the requirements of the modern workplace, emphasizing that while the top five soft skills stand out for QA roles, a broad base of capabilities is often necessary for success.

There is a strong association between communication-related skills and *Planning* (V = 0.82), suggesting these skills are often required together, possibly due to the need for clear communication in strategic roles. There is also a strong association between *Collaboration* and *Communication (generic)* (V = 0.80), we conjecture this is the case because collaborative efforts typically hinge on effective communication to succeed. It is also worth mentioning that there is a con-

[9] To compute the statistics presented in Figure 2, we utilized the `Dython` library, available at: `https://pypi.org/project/dython/`.

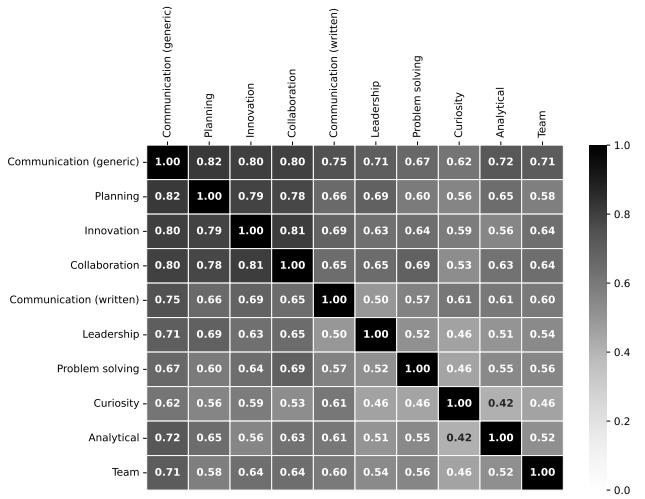

Figure 2. Pairwise Cramér's V associations matrix showing the strength of association among the 10 most in-demand soft skills.

siderable association (V = 0.75) between *Communication (generic)* and *Communication (written)*, underscoring that roles demanding high levels of communication skills often necessitate competence in written communication as well.

Innovation and *Collaboration* show a relatively strong connection (V = 0.81), which might indicate that an innovative mindset entails collaborative efforts. *Planning* and *Innovation* are moderately associated (V = 0.79), reflecting that roles involving planning may also necessitate creative thinking. A moderate, yet significant, association between *Planning* and *Collaboration* (V = 0.78) suggests that planning activities often involve interdependent work with other team members. The moderate association (V = 0.65) between *Collaboration* and *Communication (written)* is interesting, as it may reflect the need for documenting collaborative efforts or communicating within teams through written formats.

The pairwise association matrix also provides insights into the interplay among the top five soft skills and the other soft skills. For instance, *Communication (generic)* shows a strong association with *Leadership* (V = 0.71), which might indicate that leadership roles often demand strong communication-related skills. Given that teamwork inherently involves collaboration, there is a strong association between *Collaboration* and *Team*. It is also worth mentioning the association between *Innovation* and *Curiosity* (V = 0.61), likely because roles that value innovation also favor an inquisitive approach that drives creative solutions.

Based on the analysis of the weakest associations in the pairwise association matrix (Figure 2), *Curiosity* appears to be the soft skill least related to the rest. It has several notably weak connections with other soft skills, *Leadership* (V = 0.46) and *Communication (written)* (V = 0.46). These low Cramér's V values suggest that *Curiosity* does not frequently co-occur with other soft skills that are often sought in job advertisements. Essentially, this indicates that *Curiosity* might be valued in more specialized or niche roles that require independent exploration and innovation, rather than being a common requirement across various standard job roles, which typically emphasize leadership and communication skills.

Key insights for RQ$_2$: Our results suggest that the top five soft skills frequently co-occur in job advertisements, indicating that these soft skills are universally required across various QA roles. The moderate association between *Communication (generic)* and *Communication (written)*, which would seem to indicate that employers highly value QA professionals with robust communication abilities. A strong association between *Collaboration* and *Communication (generic)* indicates a preference for articulate individuals who can navigate team dynamics and foster a collaborative work environment. The association between *Collaboration* and *Innovation* implies that the Brazilian QA industry particularly appreciates professionals that are both collaborative and inventive.

6.4 RQ$_3$: Variations in Soft Skill Requirements Based on Position Seniority

Table 3 shows the distribution of job advertisements according to position seniority levels. As mentioned, we categorized seniority levels as entry-level (i.e., junior), mid-level, and senior based on the terms mentioned in the job advertisements. Table 3 presents the corresponding number of occurrences, along with their respective percentages, giving an overview of the distribution of QA job opportunities across various experience levels.

With the expansion of our dataset, the distribution of job advertisements by seniority level has shifted notably compared to the initial findings (Lancetti et al., 2023). Previously, senior positions were the most frequently advertised, constituting 37.55% of the total. However, in the expanded dataset, these now represent only 9.24%, a significant decrease. Conversely, entry-level positions have seen an increase, now accounting for 39.05% of job advertisements compared to the previous 33.20%. Mid-level positions, previously accounting for approximately 15% of job advertisements, now make up 24.82% of the dataset, indicating a solid demand for professionals with some experience. Additionally, the proportion of advertisements not specifying seniority has risen to 26.89%, up from around 13%, indicating a higher level of ambiguity regarding experience requirements in the current dataset.

Table 3. Distribution of job advertisements according to position seniority level.

Position Seniority Level	Number of Occurrences (%)
Senior	200 (9.24%)
Mid-level	537 (24.82%)
Entry-level	845 (39.05%)
Not mentioned	582 (26.89%)
Total	2,164

The distribution of job advertisements by seniority level in the expanded dataset reveals a notable shift in trends: entry-level positions now form the largest segment, which might indicate a significant increase in opportunities for newcomers to the QA field. In contrast, senior positions, which previously dominated the dataset, have decreased markedly to

just approximately 10% of the dataset, which might suggest a reduced demand for experienced QA professionals in Brazil. Mid-level positions are now prominently represented, accounting for almost 25% of the dataset.

We examined the frequency and listing order of soft skills in job advertisements to determine if companies in Brazil prioritize certain soft skills based on the seniority level of the position. We surmise that the listing order of skills in a job advertisement reflects the priority employers place on certain abilities. Our analysis focused on the top three soft skills, according to their order of appearance in the job advertisement. According to our results, when considering senior level positions, our analysis shows that *Planning* stands out as the skill most frequently listed in the first and second positions in job advertisements: it is listed first around 20% of the time and appears in second about 14% of the time. *Innovation* ranks as the second most prevalent skill listed first, appearing in approximately 19.5% of the job advertisements for senior professionals. *Communication (generic)* is listed first in 15% of the job advertisements for senior-level positions. Thus, *Planning*, *Innovation*, and *Communication (generic)* seem to be the most valued soft skills considering senior level professionals. Our results indicate that *Collaboration* is the forth most sought after soft skill for senior QA professionals, coming forth in the first listing position at 9.5%.

Communication (generic) is the soft skill most frequently listed in the second and third place in job advertisements (around 17.44% and 25.92% of the time, respectively). We believe that this suggests that communication skills are of key importance to senior QA professionals. *Planning* is the second most listed soft skill in second place (13.95%), it also ranks third in frequency when listed in the third position of importance within job advertisements (11.85%).

Based on the expanded dataset, the analysis reveals interesting shifts in the landscape of soft skills mentioned in job advertisements for mid-level professionals. Previously, a significant portion (35%) of job advertisements did not specify any soft skills. In the updated analysis, this figure has notably decreased to only 6%, indicating a possible increase in the recognition of the importance of soft skills for mid-level QA professionals.

Among the job advertisements that do mention soft skills, the rankings have shifted. Previously, *Collaboration* was the soft skill most cited in the first place in job advertisements for mid-level QA professionals (17.5%), followed by *Innovation* (12.5%) and *Communication (generic)* (7.5%). However, in the expanded dataset, *Innovation* emerges as the predominant soft skill, being listed first in 21.79% of the job advertisements, surpassing *Communication (generic)*, which is mentioned first in 16.57% of cases, and *Collaboration*, which appears first in 14.34% of the instances. This shift indicates a growing emphasis by employers on *Innovation* and skills related to communication, while *Collaboration*, although still critical, has seen a relative decrease in prioritization.

Communication (generic) is the most prevalent soft skill mentioned in the second place in job advertisements. It appears in 16.32% of the analyzed job advertisements for mid-level QA professionals, suggesting it is a highly sought-after soft skill for the positions these advertisements are intended for. *Collaboration* and *Planning* appear in approximately 13% and 10% of job advertisements, respectively. *Planning* and *Communication (generic)* appear with almost the same frequency (19.71% and 18.57%, respectively) in the third place in job advertisements for mid-level QA professionals.

As for entry-level professionals, *Innovation* is the soft skill most frequently listed first, appearing roughly 17.16% of the time. *Communication (generic)* is the second most frequently listed soft skill in first place: communication-related skills appear first in roughly 15% of job advertisements targeting entry-level QA professionals. This suggests communication is highly valued even among novice QA professionals. *Collaboration* and *Planning* are the first-listed skills in about 10% of job advertisements, indicating that these skills are also important but not as sought after as *Innovation* and communication-related skills. Based on the results from our analysis, it appears that a significant proportion (13.72%) of job advertisements for entry-level professionals do not explicitly mention any soft skill. This could suggest that employers might place more emphasis on hard or technical skills at this level of seniority; or it could simply be an oversight in the job advertisements.

In the entry-level job advertisements analyzed, *Communication (generic)* is by far the most prevalent soft skill mentioned in the second place in job advertisements. It is listed in second in nearly 29% of the analyzed job advertisements for entry-level QA professionals. *Planning* and *Collaboration* are also frequently listed second in job advertisements, appearing approximately 14.90% and 10.22% of the time, respectively. *Curiosity* follows closely, being listed in second in about 6% of the job advertisements for entry-level professionals. *Communication (generic)* and *Planning* are both the most frequently mentioned soft skills in third place, appearing in about 17% of the entry-level job advertisements. Similarly, *Innovation* and *Collaboration* are also both often listed in third place on the list of most sought-after soft skills: they appear in approximately 11% of the entry-level job advertisements in the third place on the list.

In comparison to our previous analysis (Lancetti et al., 2023), there is a noticeable decrease in job advertisements that do not mention any soft skills, especially among mid-level positions. This might be indicative of a broader recognition of the importance of these skills in the professional growth and effectiveness of QA personnel.

Key insights for RQ$_3$: For senior roles, *Planning* and *Innovation* are highly prized, reflecting the need for strategic and creative capabilities at higher levels of responsibility. Mid-level positions emphasize *Innovation*, indicating a shift towards innovative skill sets at this career stage. Notably, for entry-level positions, *Innovation* and *Communication (generic)* stand out as the most valued soft skills. Across all levels, communication-related skills consistently appear as a key soft skill (as discussed in Section 6.2). These findings underscore a job market where innovative thinking, planning skills, and effective communication are essential for QA professionals across all seniority levels.

6.5 RQ_4: Soft Skill Expectations Based on Organization Size

Table 4 illustrates the distribution of job advertisements stratified by company (and recruitment agency) size. In our analysis, 982 distinct companies and recruitment agencies posted job advertisements for QA professionals in Brazil. As shown in Table 4, large companies accounted for the majority of these postings, contributing 1,099 advertisements. Medium-sized companies were also significant contributors with 418 postings. Micro companies posted 351 advertisements, and small companies posted the fewest, with a total of 296 job advertisements tailored to QA professionals.

Table 5 shows an overview of the top five most sought-after soft skills based on the size of the hiring organization. The Sankey diagram shown in Figure 3 illustrates the data summarized in Table 5, providing an overview of the demand for various soft skills across different company sizes. The width of each flow line corresponds to the number of occurrences, thereby indicating the relative importance of each soft skill within specific company sizes. This visualization aids in identifying which soft skills are most valued by companies of varying sizes.

Table 4. Distribution of job advertisements by company size.

Company Size	Number of Job Advertisements
Large	1,099
Medium	418
Small	296
Micro	351

Communication-related skills are the most valued soft skill in large organizations, with 613 occurrences. This is followed by *Planning* (469), *Innovation* (422), and *Collaboration* (336). Written communication skills also appears significant, listed 172 times, indicating a comprehensive emphasis on communication skills alongside strategic and innovative capabilities.

In medium-sized organizations, communication-relation skills rank highest with 252 instances. *Planning* (171) and *Innovation* (170) follow closely, indicating a balanced focus on strategic thinking and an innovative mindset. *Collaboration* and *Communication (written)* also hold significant importance, with 142 and 97 occurrences respectively, highlighting the crucial roles of effective collaboration and communication.

For small companies, *Communication (generic)* tops the list with 149 mentions, indicating its universal importance across company sizes. This is followed by *Planning* (111) and *Collaboration* (105), with *Innovation* (65) and *Communication (written)* (47) also featuring prominently, highlighting the importance of interdependent work, an innovative mindset, strategic execution, and effective communication skills.

In micro-sized companies, *Communication (generic)* remains the most sough-after soft skill with 189 mentions. *Planning* (145) and *Collaboration* (117) are also highly valued, reflecting a need for organizational skills and being able to work in a collaborative fashion. *Innovation* (104) and *Creativity* (48) round out the list, emphasizing an inclination towards innovative and creative approaches to problem-solving within smaller, potentially more agile environments.

Table 5. Top five most sought after soft skills according to organization size.

Soft Skill	Number of Occurrences
Large	
Communication (generic)	613
Planning	469
Innovation	422
Collaboration	336
Communication (written)	172
Medium	
Communication (generic)	252
Planning	171
Innovation	170
Collaboration	142
Communication (written)	97
Small	
Communication (generic)	149
Planning	111
Collaboration	105
Innovation	65
Communication (written)	47
Micro	
Communication (generic)	189
Planning	145
Collaboration	117
Innovation	104
Creativity	48

Key insights for RQ_4: The analysis of the data across all company sizes reveals a uniform demand for the four soft skills highlighted in Section 6.2, namely, *Communication (generic)*, *Planning*, *Innovation*, and *Collaboration*. While written communication skills are deemed significant across most organizational sizes, they are less emphasized in micro organizations. Notably, *Creativity* is predominantly valued only within micro companies. Consequently, this analysis suggests that the size of an organization does not significantly affect the primary (four) soft skills demanded from QA professionals.

6.6 Threats to Validity

In the previous version of our study (Lancetti et al., 2023), we acknowledged a potential threat to the external validity of our study, which was based on a sample of 253 job advertisements. We hypothesized that while a larger sample might alter the frequency distributions of identified soft skills, the essential list of skills would likely remain consistent. This hypothesis has been confirmed by our expanded analysis, which now includes over 2,000 job advertisements. Our initial conjecture is borne out by the results: the expanded dataset yielded 32 of the 34 soft skills identified in the

smaller sample, thus reinforcing the robustness of our findings concerning the prevalence of these skills in the QA job market.

We did not aim to create a balanced sample of job advertisements based on specific positions. We acknowledge that some positions may appear more frequently than others, and therefore, our focus was a position-agnostic view of the most valued soft skills for QA professionals within the context of Brazilian companies. Additionally, our analysis is centered on a specific period and does not track the evolution of soft skills in these advertisements over time. It is also worth mentioning that the findings of our study are specific to Brazil and cannot be generalized to other countries.

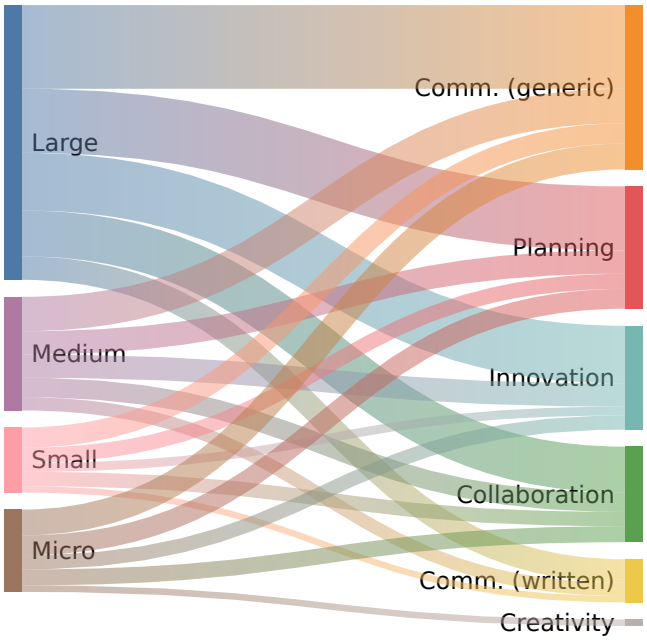

Figure 3. Distribution of soft skills demand by company size.

We opted for a broad categorization of QA professionals because it facilitates easier generalization, a factor that is particularly beneficial in research, especially during its initial stages. Such a categorization also streamlines communication by allowing us to present results without delving into excessively specific details for each category or QA role. However, we acknowledge the primary drawback of this approach: overgeneralization, which could result in the inaccurate representation of certain categories or QA roles. Moreover, we did not group skills into higher skills and subskills: amalgamating subskills into their respective higher skills (for instance, listening can be viewed as a subskill of communication, a *one-way* process) would yield a more generalized perspective on employer expectations for QA professionals.

As pointed out by Galster et al. (2022), job advertisements might be written by human resource departments, which might reuse templates without changing them to match the specific soft skill requirements of the advertised position. Consequently, soft skills in these job advertisements may not always accurately reflect the needs of the position, and essential skills could potentially be omitted from these job advertisements. Furthermore, those responsible for drafting these job advertisements might have different interpretations of what constitutes a soft skill. We tried to mitigate this by following an extraction process that included both manual (i.e., two researchers went over the job advertisements and discussed the results from the automated analysis to ensure a more accurate understanding and extraction of the relevant soft skills) and automated steps.

7 Discussion

As discussed in Section 7.1, some of our findings are not surprising (e.g., communication being the most sought-after soft skill) in the sense that they align with previous research. Nevertheless, we believe that our findings contribute to understanding what soft skills QA professionals must prioritize in order to maximize their employability prospects throughout their careers. Specifically, we believe that our study presents empirical evidence pertinent to Brazilian QA professionals, contributing with insights into what soft skills are valued by Brazilian companies. Additionally, we believe that understanding what are the most sought-after soft skills in the software industry can help those tasked with curriculum design and professional development. Our findings can guide curriculum creators to integrate soft skills training into their course objectives. We surmise that the most effective approach to teaching soft skills is to weave them into the curriculum. However, determining which of the soft skills identified in our study should be incorporated into software engineering curricula, and to what extent, is a subject that requires further exploration in future research.

QA professionals and software developers have distinct roles and responsibilities. However, our findings highlight certain skills that are fundamental to both: communication, planning, and collaboration skills. We believe that oral communication is key for both roles. For instance, while developers discuss and collaborate on design and problem-solving, QA professionals communicate identified issues and feedback. Written communication is equally vital; QA professionals often create documentation such as test plans, test cases, and bug reports, while developers document their code and produce technical guides.

Planning skills are important because QA professionals often play a critical role in managing timelines and resources for testing phases. In this context, effective planning helps ensure that testing is conducted efficiently and within the established timelines, which is crucial for the timely release of products. Additionally, planning skills are vital for devising test strategies that cover various aspects of the software to be tested: this entails deciding on the types of tests to be performed and the resources required. In terms of collaboration, both developers and QA professionals must work together closely, especially during the debugging process.

7.1 Comparative Analysis with Related Work

As mentioned in Section 4, Kassab et al. (2021) analyzed job advertisements to identify the most sought-after skills for the software testing role in the United States. According to their results, 70% of the job advertisements ask for at least one soft skill. Our analysis aligns with these findings: Brazilian companies seem to value soft skills similarly to North Amer-

ican companies. Specifically, we found that only 8.96% of the job advertisements we analyzed do not mention any soft skills. Moreover, similar to our results, Kassab et al. found that communication skills are the most frequently listed in job advertisements, appearing around 41% of the time in job advertisements. Problem-solving and collaboration skills are also highly valued by North American companies: *workplace thinking* skills (which includes problem solving) and *teamwork and collaboration* skills appear in roughly 23% and 19% of the job advertisements, respectively. As discussed in Sections 6.2, 6.4, and 6.5, communication and collaboration skills are highly valued across all company sizes and QA professionals at every career stage should focus on improving their communication and collaboration skills.

Interestingly, according to our analysis, problem-solving is no longer among the most sought-after soft skills. In our previous analysis (Lancetti et al., 2023), problem solving skills were heavily emphasized by large and micro organizations. Considering the expanded dataset, problem-solving skills are no longer emphasized as prominently across organizations of varying sizes. This shift suggests a potential change in the skillset priorities within the QA field or perhaps a broader distribution of critical soft skills that now overshadows the emphasis on problem-solving.

Our findings also align with the results from Matturro (2013) (Section 4), which highlight the importance of oral/written communication for QA professionals. This suggests that software companies in both Brazil and Uruguay tend to place a high emphasis on communication skills. In Matturro's study, most job advertisements focus on the importance of oral/written communication in English. As for our study, most job advertisements refer to general communication skills without further elaborating on what that entails. Additionally, we found that *Communication (generic)* consistently emerges as the most critical soft skill across all company sizes, reinforcing the idea that effective communication is paramount in the QA profession regardless of organizational scale.

As discussed in Section 6.3, we found that there is a strongest association between *Communication (general)* and *Communication (written)*, which in a way corroborates the findings of Matturro and indicates that employers place a premium on QA professionals with robust written and oral communication abilities.

8 Concluding Remarks

We analyzed 2,164 job advertisements related to QA positions in order to identify the soft skills that are most frequently listed by software companies in Brazil. To the best of our knowledge, before this expanded version, only our initial study (Lancetti et al., 2023) had investigated the soft skills sought by employers in Brazil for QA professionals. The results from our analysis support previous studies on soft skills for QA/testing professionals, thus we believe that the insights derived from our results add to the body of knowledge to bolster the empirical evidence for soft skills.

Our findings reveal that approximately 91% of these job advertisements highlight the necessity of soft skills, with communication-related skills, planning, innovation, collaboration, and written communication being the most emphasized. Notably, the demand for these skills is consistent across different company sizes, which suggests a broad consensus regarding their importance for QA professionals.

Our results also indicate that that while soft skills such as communication and planning are sought after across all seniority levels, the emphasis on innovation increases with the complexity of roles, particularly in mid- to senior-level positions. This reflects a nuanced understanding within the industry that, although foundational skills such as communication are essential at all levels, the ability to innovate becomes crucial as professionals advance in their careers. Additionally, our research has identified significant gaps in the recognition of diversity-related skills, which are seldom mentioned despite Brazil's diverse workforce. This finding suggests potential areas for future development within human resources practices aimed at enhancing the inclusivity of QA teams.

We believe our research underscores the critical importance of soft skills in the QA profession within Brazil and provides insights for educational institutions and corporate training programs. By focusing on the identified key soft skills, these entities can better prepare QA professionals to meet the evolving demands of the software industry. As the landscape of software development continues to advance, the integration of soft skill training plays a pivotal role in developing professionals who can navigate the complexities of modern QA environments effectively. The insights garnered from our expanded dataset contribute to a deeper understanding of the labor market and serve as a foundational resource for strategic decisions in educational and professional development realms within Brazil. These conclusions pave the way for future research that could explore the implications of these trends globally, potentially offering a comparative perspective on the evolution of soft skill demands in the QA sector worldwide.

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References

Acuna, S., Juristo, N., and Moreno, A. (2006). Emphasizing human capabilities in software development. *IEEE Software*, 23(2):94–101.

Akoglu, H. (2018). User's Guide to Correlation Coefficients. *Turkish Journal of Emergency Medicine*, 18(3):91–93.

Ardelt, M. (2000). Still stable after all these years? personality stability theory revisited. *Social Psychology Quarterly*, 63(4):392–405.

Balcar, J. (2016). Is it better to invest in hard or soft skills? *The Economic and Labour Relations Review*, 27(4):453–470.

Bass, B. M. and Riggio, R. E. (2005). *Transformational Leadership*. Psychology Press, 2nd edition.

Bourque, P., Fairley, R. E., and Society, I. C. (2014). *Guide to the Software Engineering Body of Knowledge (SWEBOK(R)): Version 3.0*. IEEE, 3rd edition.

Buhrer, H. K. (2003). Software development: What it is, what it should be, and how to get there. *ACM SIGSOFT Software Engineering Notes*, 28(2):5.

Burbekova, S. (2021). Soft skills as the most in-demand skills of future it specialists. In *IEEE International Conference on Smart Information Systems and Technologies (SIST)*, pages 1–5.

Calazans, A. T. S., Paldes, R. A., Masson, E. T. S., Brito, I. S., Rezende, K. F., Braosi, E., and Pereira, N. (2017). Software requirements analyst profile: A descriptive study of brazil and mexico. In *IEEE 25th International Requirements Engineering Conference (RE)*, pages 204–212.

Charette, R. N. (2005). Why software fails]. *IEEE Spectrum*, 42(9):42–49.

Daneva, M., Wang, C., and Hoener, P. (2017). What the job market wants from requirements engineers? an empirical analysis of online job ads from the netherlands. In *ACM/IEEE International Symposium on Empirical Software Engineering and Measurement (ESEM)*, pages 448–453.

Drennan, R. D. (1996). *Statistics for Archaeologists: A Commonsense Approach*, chapter Relating a Measurement Variable to Another Measurement Variable, pages 203–226. Springer.

Fareri, S., Melluso, N., Chiarello, F., and Fantoni, G. (2021). SkillNER: Mining and mapping soft skills from any text. *Expert Systems with Applications*, 184:115544.

Feldman, S. (2005). Quality assurance: Much more than testing: Good qa is not only about technology, but also methods and approaches. *Queue*, 3(1):26–29.

Florea, R. and Stray, V. (2019). The skills that employers look for in software testers. *Software Quality Journal*, 27(4):1449– 1479.

Galster, M., Mitrovic, A., Malinen, S., and Holland, J. (2022). What soft skills does the software industry *really* want? an exploratory study of software positions in new zealand. In *Proceedings of the 16th ACM/IEEE International Symposium on Empirical Software Engineering and Measurement (ESEM)*, pages 272–282. ACM.

Grant, A. (2023). *Hidden Potential: The Science of Achieving Greater Things*. Viking.

Hendarman, A. F. and Tjakraatmadja, J. H. (2012). Relationship among soft skills, hard skills, and innovativeness of knowledge workers in the knowledge economy era. *Procedia - Social and Behavioral Sciences*, 52:35–44.

Herrmann, A. (2013). Requirements engineering in practice: There is no requirements engineer position. In *Requirements Engineering: Foundation for Software Quality*, pages 347–361. Springer.

IEEE Std 730-2002 (2014). IEEE Standard for Software Quality Assurance Processes. *IEEE Std 730-2014 (Revision of IEEE Std 730-2002)*, pages 1–138.

Kassab, M., Laplante, P., Defranco, J., Neto, V. V. G., and Destefanis, G. (2021). Exploring the profiles of software testing jobs in the united states. *IEEE Access*, 9:68905–68916.

Lancetti, W., Endo, A. T., Ferrari, F. C., and Durelli, V. (2023). Ticket to Ride: A Journey Through the Most In-Demand Soft Skills for QA Professionals in Brazil. In *Proceedings of the XXII Brazilian Symposium on Software Quality*, SBQS '23, page 128–137. ACM.

Matturro, G. (2013). Soft skills in software engineering: A study of its demand by software companies in uruguay. In *6th International Workshop on Cooperative and Human Aspects of Software Engineering (CHASE)*, pages 133–136. IEEE.

Myers, G. J., Sandler, C., and Badgett, T. (2011). *The Art of Software Testing*. Wiley.

Orsted, M. (2000). Software development engineer in microsoft. a subjective view of soft skills required. In *Proceedings of the International Conference on Software Engineering*, pages 539–540.

Parnas, D. (2011). Software engineering - missing in action: A personal perspective. *Computer*, 44(10):54–58.

Rabelo, D., Lopes, A., Mendes, W., de Souza, C., Gama, K., Monteiro, D., and Pinto, G. (2022). The role of non-technical skills in the software development market. In *Proceedings of the XXXVI Brazilian Symposium on Software Engineering*, pages 31–40. ACM.

Sadowski, C., Storey, M.-A., and Feldt, R. (2019). *A Software Development Productivity Framework*, pages 39–47. Apress.

Treude, C. and Filho, F. F. (2019). *How Team Awareness Influences Perceptions of Developer Productivity*, pages 169–178. Apress.

Wagner, S. and Murphy-Hill, E. (2019). *Factors That Influence Productivity: A Checklist*, pages 69–84. Apress.

Wang, C., Cui, P., Daneva, M., and Kassab, M. (2018). Understanding what industry wants from requirements engineers: An exploration of re jobs in canada. In *Proceedings of the 12th ACM/IEEE International Symposium on Empirical Software Engineering and Measurement (ESEM)*. ACM.

Wang, C., Tang, Y., Liang, P., Daneva, M., and van Sinderen, M. (2020). What industry wants from requirements engineers in china? an exploratory and comparative study on re job ads. In *Proceedings of the 14th ACM/IEEE International Symposium on Empirical Software Engineering and Measurement (ESEM)*. ACM.

Wohlin, C., Runeson, P., Höst, M., Ohlsson, M. C., Regnell, B., and Wesslén, A. (2012). *Experimentation in Software Engineering*. Springer.