

Investigating the accessibility of popular mobile Android apps: a prevalence, category, and language study

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ABSTRACT

Accessibility in mobile applications is crucial for ensuring that all users, including those with disabilities, can effectively interact with technology. Despite advancements in smartphone integration, significant accessibility challenges remain. This study investigates the accessibility of popular mobile Android apps, examining the prevalence of accessibility issues, categorizing the types of errors, and evaluating the impact of language on accessibility. We evaluated eight widely used apps using the Accessibility Scanner tool and executed them across three languages: Portuguese, English, and Spanish. Results indicate that most accessibility issues are related to touch target size (1145) and contrast (594). Furthermore, the execution language affects accessibility, with Spanish presenting the highest number of errors (828). This study underscores the importance of integrating accessibility best practices in app development and suggests areas for future research to improve mobile app accessibility.

KEYWORDS

Mobile accessibility, Android app, Accessibility scanner

1 INTRODUCTION

According to the latest data from IBGE¹, in 2023, Brazil had 18.6 million Persons with Disabilities (PwDs), representing about 8.9% of the population. These numbers highlight the urgent need to ensure equal opportunities and access to available resources in society, such as education, employment, various physical spaces, and technology-mediated services.

Smartphones have become increasingly prevalent in Brazilian society. Data from TIC Domicílios 2021 confirms this importance, highlighting that 99% of Brazilians with Internet access use their smartphones to browse it. However, PwDs still face challenges when using these devices [3, 4]. They require additional resources and special modes to perceive and interact with applications, such as the TalkBack voice assistant on Android used by people with

¹<https://cod.ibge.gov.br/5Q9H3>

visual impairments (PvIs). For accessibility assistants to function properly, apps need to follow appropriate standards and contain alternative information, such as content description, which must comply with the context and users' access needs [2, 8].

Unfortunately, studies indicate that the mobile ecosystem faces numerous accessibility issues, even in open-source apps and those developed by big tech companies (e.g., Amazon) [1, 8]. Possible causes of these problems include the lack of knowledge or proper training of developers regarding accessibility guidelines (e.g., the ABNT NBR 17060:2022 Standard²), the absence of rigorous accessibility testing during development, and the prioritization of other app features over accessibility [1, 6, 9–11, 13]. Additionally, the lack of detailed and specific feedback from PwDs can contribute to the perpetuation of these issues [9].

In this context, the objective of this research is to analyze the current level of accessibility of popular applications in the Android ecosystem across various categories, including apps dealing with music and videos. Another goal is to evaluate them in different languages, such as Portuguese, English, and Spanish. In a previous study, we observed, by chance, that the number of accessibility issues in three apps changed when evaluated in different languages, suggesting that the execution language could affect PwDs' usage [8]. By analyzing applications in different categories and languages, this study aims to provide an initial overview of the current state of accessibility in Android apps, research that could be expanded to other app categories and operating systems.

2 METHODOLOGY

The main goal of this research was to analyze the accessibility level of popular Android apps in various languages. Three research questions were established:

- RQ1** - What is the accessibility level of popular mobile applications on Android?
- RQ2** - Which categories of accessibility errors are the most frequent?
- RQ3** - Does changing the execution language significantly affect app accessibility?

To answer these questions, we used an exploratory methodology based on accessibility inspection assisted by an accessibility checker. In this first phase of the study, we limited our analysis to 10 popular

²<https://www.abntcolecao.com.br/mpf/norma.aspx?ID=516652#>

apps on the Android operating system. Throughout the study, we sought data indicating the presence of accessibility issues in these apps. Another aspect involved statistically analyzing the difference in app accessibility when changing the smartphone's execution language between Portuguese, English, and Spanish.

2.1 Study Objects

To select the first ten apps to be evaluated, we chose to use a list of apps from another research project [5] unrelated to our own. This allowed us to start by analyzing popular apps without a selection bias from our research group. Additionally, the apps belong to five distinct categories. Table 1 shows the apps evaluated during the study, their category, and their number of downloads on the Play Store, which range from 50 million to 10 billion.

Application	Category	Downloads
ESPN	News	50 mi
The Weather Channel	News	100 mi
Linkedin	Social Media	1 bi
Pinterest	Social Media	1 bi
SoundCloud	Audio Streaming	100 mi
Spotify	Audio Streaming	1 bi
Twitch	Video Streaming	100 mi
YouTube	Video Streaming	10 bi
Shopee	E-Commerce	100 mi
Copang	E-Commerce	50 mi

Table 1: Apps evaluated in the research

2.2 Materials and Methods

We used the Accessibility Scanner tool to evaluate the apps. This Google tool assesses app interfaces during manual navigation and identifies accessibility issues. Designed for developers and designers, it offers improvement suggestions and generates detailed reports, identifying issues with contrast, font sizes, and button labels. The definitions of the identified accessibility errors are available on the tool's website³. For instance, Figure 1 highlights the accessibility errors detected with the help of the Accessibility Scanner. The tool visually identified the contrast errors and touch area size issues on the SoundCloud app's home screen.

During the app analysis process, two evaluators, each with distinct devices, executed the evaluation protocol. One used a Galaxy S22 Ultra and the other a Galaxy A03. Table 2 identifies the smartphone used and their Android versions.

2.3 Procedure

We defined a list of activities to be performed according to the app category to ensure navigation consistency. To address RQ3, the two evaluators changed the smartphones' language settings before executing the activities. The evaluation protocol was then repeated. The same evaluator checked accessibility across different language executions using the Accessibility Scanner. This tool evaluated all

³<https://support.google.com/accessibility/android/faq/6376582?hl=pt-BR>

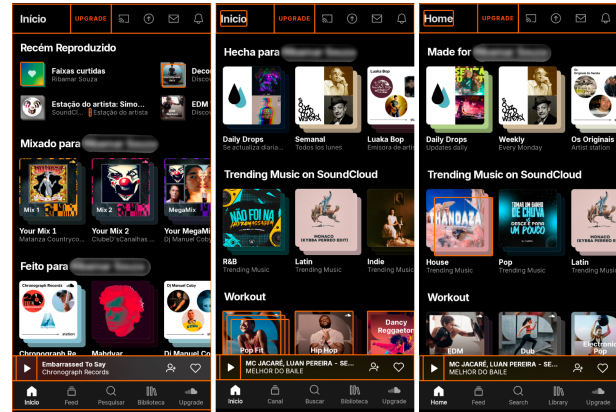


Figure 1: Accessibility evaluation of SoundCloud app

interactions through screen captures, enabling the identification of accessibility errors in multiple languages during navigation.

Table 3 shows all the activities performed. We had some issues with two apps. The Coupang app only had the Korean language available, making it impossible to change the language execution. The Shopee app did not allow changing the language to English or Spanish. The Coupang app was excluded from the result analysis, and we only checked the Portuguese version of the Shopee app.

3 RESULTS

3.1 RQ1 - What is the accessibility level of popular mobile applications on Android?

Table 4 displays the number of accessibility errors we found in each application. The ESPN app had the highest number of errors (536), with the English test (201) showing the most errors. The SoundCloud app exhibited the lowest total error rate (131) across all tested languages. Despite having test results only in Portuguese, the Shopee app reported 405 accessibility errors, a figure higher than most other apps when considering all their executions.

Table 5 presents the average number of errors per screen for the applications. We emphasize that the number of screens evaluated was the same across all three runs for each application when the language was modified. The SoundCloud app, in English, has the lowest average (5.57 errors per screen) among all applications. Conversely, The Weather Channel app, in the Portuguese evaluation, has the highest average of errors (34.5).

3.2 RQ2 - Which categories of accessibility errors are the most frequent?

Figure 2 categorizes the errors identified during all application tests in Portuguese. The 'Touch Target' category had the highest number of total errors (437), followed by 'Contrast' (274). On the other hand, the 'Clickable Items' category recorded the fewest issues (4). All applications in the 'News', 'Social Media', and 'Video Streaming' categories exhibited more 'Touch Target' errors, while the Shopee and SoundCloud applications showed more 'Contrast' errors. Lastly, Spotify had more 'Text Size' errors.

Smartphone	Android	Evaluated Apps
Galaxy A03	14	Shopee, The Weather Channel, Spotify, SoundCloud, ESPN e Copang
Galaxy S22 Ultra	13	Linkedin, Twitch, YouTube e Pinterest

Table 2: Materials used in the research

Category	Tasks
NEWS	T1 - Navigate the homepage T2 - Use the search bar to look up a keyword and access a news article T3 - View game statistics (ESPN)
SOCIAL MEDIA	T1 - Use the search bar to find a specific post T2 - Comment on a post ; T3 - Create a new post
E-COMMERCE	T1 - Explore the homepage T2 - Use the search bar to find a specific product T3 - Check product reviews; T4 - Add an item to the shopping cart T5 - View the shopping cart content
STREAMING	T1 - Use the search bar to find a specific video or song T2 - Access the content discovery screen ; T3 - Add a video or song to a playlist T4 - Follow a content creator or artist

Table 3: Tasks performed in each app category

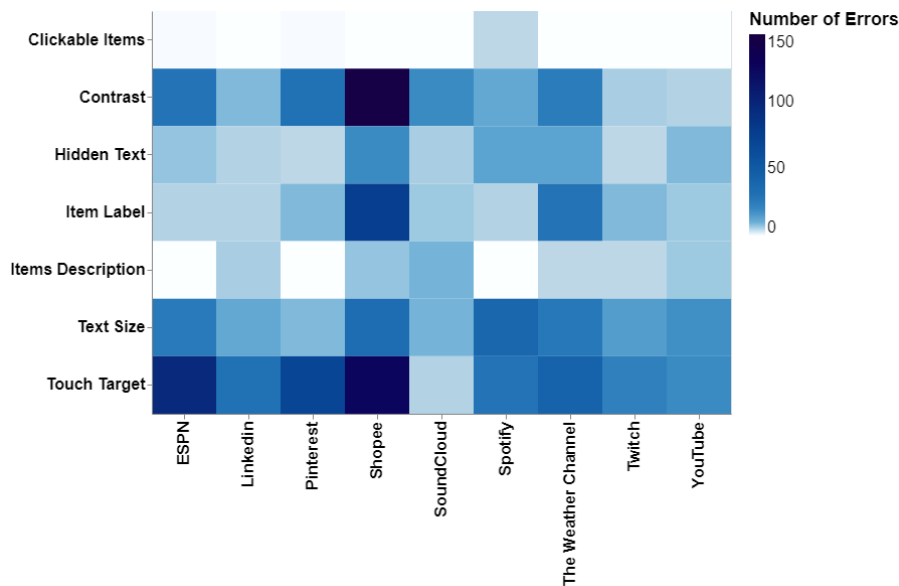


Figure 2: Heatmap of Accessibility Errors by Categories

3.3 RQ3 - Does changing the execution language significantly affect app accessibility?

To answer, we applied the T-Student test by pairing the evaluation results two by two. In all combinations, the differences in the number of errors were not significant ($p < 0.05$). For English-Spanish, the $t - value$ was 0.12934 and the $p - value$ was 0.898929. For Portuguese-Spanish, the $t - value$ was 0.50475 and the $p - value$

was 0.621584. And finally, for English-Portuguese, the $t - value$ was 0.34592 and the $p - value$ was 0.734544. In summary, the results suggest that for these eight apps and the evaluated languages, there are **no significant differences** in the number of accessibility errors when changing the execution language.

	PT-BR	ING	ESP	TOTAL
SoundCloud	48	39	44	131
Spotify	96	144	168	408
ESPN	161	201	174	536
The Weather Channel	138	123	135	396
Linkedin	59	54	54	167
Pinterest	119	127	132	378
Twitch	52	61	68	181
YouTube	55	50	53	158
Shopee	405	-	-	405
TOTAL	1133	799	828	

Table 4: Accessibility errors

	PT-BR	ING	ESP
SoundCloud	6,85	5,57	6,28
Spotify	8	12	14
ESPN	20,12	25,12	21,75
The Weather Channel	34,5	30,75	33,75
Linkedin	11,8	10,8	10,8
Pinterest	23,8	25,4	26,4
Twitch	13	15,25	17
YouTube	11	10	10,6
Shopee	45	-	-

Table 5: Accessibility errors per screen

4 FINAL CONSIDERATIONS

This work presents an initial analysis of the accessibility levels of applications with a large number of users, using the inspection method with the Accessibility Scanner. Our analysis identified a significant number of errors. In some apps, the number of errors exceeded twenty per screen. These errors can make usage extremely difficult for PwDs. Additionally, the results of Shopee's execution caught our attention because it had 45 accessibility errors per screen. A member of the research group who is blind confided in us that this application is almost impossible to use without assistance from another person. Although applications belonging to the "News" category have fewer tasks to be performed during testing, we can observe that these are some of the applications with the highest number of total errors and the highest error rate per screen.

The results highlighted in this research are similar to those of studies [7, 8, 12] that evaluated different mobile applications with the Accessibility Scanner. These studies reported the most accessibility errors in Touch Target and Contrast. However, elements with label problems, which were a determining factor in another study [12], presented the lowest number of errors in this study. It is important to note that Touch Target area and Contrast errors can hinder usability even for people without disabilities.

Overall, the findings indicate a need for heightened awareness and adoption of accessible practices. Using tools such as the Accessibility Scanner can effectively mitigate a wide range of the

accessibility issues we find. Moreover, adhering to the interface design and development standards outlined by the Android operating system guidelines is imperative during the app development cycle.

4.1 Threats to Validity and Limitations

A threat to the validity of our research refers to a still small set of apps that may not reflect the accessibility situation of the most popular apps in the Android ecosystem. However, even with the small set, it already reflects the state of applications accessed by billions of users. Another threat to validity lies in the evaluators who performed the assessments who may not have adequately followed the protocol. To mitigate this threat, we conducted the tests rigorously and transparently, adhering to the guidelines specified in Table 3. We manually evaluated the applications using the Accessibility Scanner to capture screens, ensuring result reliability and minimizing the potential for evaluator bias during data collection. This approach enhances the study's integrity and objectivity. We divided the applications as detailed in Table 2. Each evaluator tested the assigned applications in all 3 languages, ensuring consistent execution of tests across different application languages.

In our study, we did not observe significant differences in the number of accessibility errors when changing the runtime language. However, as seen in Tables 4 and 5, the English runtime had fewer accessibility errors in 7 applications. This finding contrasts with previous research [8]. It is important to note that an accessibility analysis involving PwDs could still reveal differences, as the Accessibility Scanner may not accurately assess message descriptions or detect other accessibility issues such as navigation confusion.

4.2 Future Direction

For future work, expanding the scope of this research could involve several directions. First, increasing the number of apps evaluated to encompass a broader range of categories and user bases. Additionally, incorporating new evaluation methods that include the use of accessibility assistants like the Android TalkBack or the iOS Voice Over (i.e., the use of manual navigation assessments).

ACKNOWLEDGMENTS

This research was partially funded by CAPES and CNPQ (under grant number 314425/2021-7).

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