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Ministry of Social Development and Family
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مدى mada
digital access for all
نفاذ رقمي للجميع

Arab Web Accessibility Study

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Preface

Welcome to the inaugural Arab Web Accessibility Study, an exploration into the state of web accessibility across the Arab region. This study brought to life by the team at Mada, the Assistive Technology Center Qatar, marks a significant stride towards our collective vision of a digitally inclusive society. Established in 2010, Mada has been at the forefront of advocating for the rights and digital inclusion of persons with disabilities (PWDs) in Qatar and beyond. As a Center of Excellence in digital access in Arabic, our efforts are dedicated to breaking down barriers and opening new avenues for technology to serve as a bridge to empowerment and equality.

The Arab Web Accessibility Study is the culmination of extensive research, collaboration, and a shared commitment to making the digital world accessible to all. It reflects Mada's foundational goal to foster a technologically advanced community that is attuned to the needs of PWDs, not just in Qatar but across the entire Arab region. By mapping out the current landscape of web accessibility, this study aims to highlight the progress made, identify the challenges that lie ahead, and offer actionable insights for a more inclusive digital future.

In these pages, you will find an examination of web accessibility practices across Arab countries, shedding light on the state of digital inclusivity. This research endeavors not only to understand where we stand today but also to pave the way for meaningful improvements in the accessibility of digital platforms. Through this work, Mada reinforces its commitment to ensuring that the digital realm is a space where everyone, regardless of their abilities, can participate fully and independently.

As we present the results from this project, we extend our gratitude to everyone who has contributed to this groundbreaking study. Together, we look forward to building a more inclusive digital world, one that truly embodies the principles of equality and accessibility for all.

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Executive Summary

Advancing Digital Inclusion: A Study on Web Accessibility Across the Arab World

Under the auspices of Mada, the Assistive Technology Center Qatar, this study delves into the state of web accessibility across the Arab world, and emerges as a pioneering document, underlining Mada's mission to advance digital inclusivity for persons with disabilities (PWDs). Since its inception in 2010, Mada has become a global beacon of excellence, dedicated to harnessing the power of ICT to foster a more inclusive society, particularly for the Arabic-speaking population.

The Arab Web Accessibility Study represents a pioneering effort focused on enhancing web accessibility within the Arab region, marking a significant milestone in efforts to foster digital inclusivity for individuals with disabilities. This comprehensive study, the first of its kind, meticulously evaluated the digital landscapes of all Arab countries, covering Algeria, Bahrain, Comoros, Djibouti, Egypt, Iraq, Jordan, Kuwait, Lebanon, Libya, Mauritania, Morocco, Oman, Palestine, Qatar, Saudi Arabia, Somalia, Sudan, Syria, Tunisia, the United Arab Emirates, and Yemen. By analyzing the homepage of 2,863 websites across various sectors, including government, education, healthcare, and commerce, the study provides an overview of the current state of web accessibility in the region.

Scope and Vision

This study, the first of its kind, encompasses an analysis of the homepage of 2,863 websites across all Arab countries. It aims to map out the accessibility landscape, offering a unique perspective on digital inclusivity and setting the stage for transformative change. The Arab Web Accessibility Study Q3 not only assesses compliance with the Web Content Accessibility Guidelines (WCAG) 2.2 but also provides accessibility pillar, and individual criteria-specific insights to enhance web accessibility.

Key Discoveries and Strategies for Advancement

- A nuanced understanding of web accessibility across the Arab region, revealing both achievements and areas in need of significant improvement.
- An urgent call for the adoption of WCAG 2.2 standards across digital platforms to bridge the accessibility gap.
- Strategic recommendations for stakeholders to implement robust training, regulatory frameworks, and monitoring mechanisms to ensure universal digital accessibility.

Commitment to a Digitally Inclusive Future

Mada's initiative in producing the Arab Web Accessibility Study underscores a steadfast commitment to creating a technologically advanced and inclusive community. This study not only serves as a starting point for current accessibility standards but also as a blueprint for future action. Through collaboration, innovation, and advocacy, Mada and its partners are dedicated to realizing a digital environment that is accessible to all, embodying our shared vision of inclusivity, independence, and participation for PWDs in the Arab region and beyond.

Conclusion

This study stands as a foundation in the journey towards digital equality in the Arab region. It offers a comprehensive evaluation of the present state of web accessibility, not only underscoring the prevailing barriers but also proposing feasible solutions through specific recommendations. The commitment to enhancing digital inclusivity is evident through the study's insights, which serve as a call to action for stakeholders across the region. As the first comprehensive study of its kind, this study paves the way for sustained efforts to ensure that the digital domain is accessible to everyone, fostering a more inclusive and equitable digital future for individuals with disabilities in the Arab region.

1. Introduction

Web accessibility is a vital part of the fast-evolving digital age, ensuring that everyone, including people with disabilities, has equal access to online resources. The Arab Web Accessibility Study, to be completed by the end of 2024, will analyze the web accessibility standards of the homepage of 5,000 websites through automated testing in the Arab region. Covering various sectors such as government, education, healthcare, and business, the study will provide a detailed view of digital inclusivity in the Arab world. The findings will highlight both achievements and areas needing improvement, offering a clear picture of the current state of web accessibility in the region. This data can help drive new initiatives and policies to enhance digital inclusivity.

The investigation is based on the Web Content Accessibility Guidelines (WCAG) 2.1, which set the standards for web content accessibility. The analysis will look at crucial aspects like site navigability, readability, compatibility with assistive technologies, and compliance with legal and ethical accessibility standards. The study aims to reveal the current state of web accessibility, pinpoint common challenges faced by people with disabilities and offer practical recommendations for improving digital inclusiveness in the region.

1.1. Significance of Web Accessibility Research

The research has value as it may provide valuable insights for stakeholders, web developers, and policy makers on the adoption of web accessibility practices. By doing so, it facilitates the establishment of a digital environment that is more inclusive, enabling the complete participation of all individuals in the digital society, irrespective of their cognitive or physical capabilities. This study endeavors to contribute to the ongoing efforts towards achieving digital equality in the Arab region.

Building on this, the transformative efforts in Qatar exemplify the region's commitment to inclusivity and digital accessibility [1]. The nation's dynamic policy framework and initiatives underscore a proactive stance towards ICT accessibility, aligning with international standards and conventions. Similarly, [2] presents the MARSAD tool developed by Mada Center, reflecting a meticulous approach to assessing and enhancing ICT accessibility within Qatar, further emphasizing the significance of such research in paving the way for inclusive digital advancements.

1.2. Sector-Specific Accessibility Developments

Considerable efforts have been made to enhance web accessibility in the Arab region, with particular emphasis on educational platforms, government websites, and e-commerce, among other sectors. Below are a few notable developments:

1. **Government Websites Accessibility**: Recent studies have evaluated the accessibility of Arabian e-government websites, using automated tools to assess compliance with the Web Content Accessibility Guidelines (WCAG) 2.0. The objective of these studies was to enhance the availability of government services online for all individuals, especially those with disabilities [3,4]. One research entailed a comparative analysis of both English and Arabic versions of e-government sites across the Arabian region to ascertain which version exhibited fewer accessibility issues, employing

tools that conform to the WCAG 2.0 criteria [3]. Similar studies have been conducted across the Middle East, revealing varied results in accessibility standards among governmental websites of different countries [4]. Expanding the examination to the wider Middle East, a separate study utilized both manual and automated methods to evaluate the web accessibility of 58 government websites from seventeen countries, integrating WCAG 2.0 and Section 508 standards to achieve a more detailed and effective evaluation. The outcomes identified a disparity, with nations such as the United Arab Emirates, Saudi Arabia, Bahrain, and Oman achieving high scores in manual assessments yet showing lesser performance in automated evaluations. This contrast underscores the nuanced challenges of adhering to web accessibility standards across the region.

2. **Educational Websites Accessibility**: Recent studies conducted on the accessibility of educational platforms have underscored significant challenges in ensuring equitable digital access for visually impaired users. In a research, the crucial role of web accessibility standards, such as those established by the W3C Web Accessibility Initiative (WAI), in ensuring digital inclusivity was highlighted [5]. Despite the availability of guidelines aimed at enhancing web accessibility for all users, including those relying on assistive technologies, findings revealed that university websites in Jordan and the Arab region exhibited significantly more accessibility errors compared to their UK counterparts—13 and 5 times more, respectively. This difference highlights the critical need for Arab educational institutions to prioritize and enhance online accessibility to enable equitable access to educational materials. [6] evaluated the accessibility of 33 Saudi university websites using AChecker and TAW tools against 38 WCAG criteria. The findings revealed significant issues, with AChecker identifying 11% known and 89% likely or potential problems, while TAW reported 26% problems and 74% warnings. The study emphasized the need for immediate action on known problems and highlighted that automated tools alone are insufficient, recommending further research involving disabled users for comprehensive assessment. In a study by [7], 41 higher education institution websites in Kuwait were assessed for WCAG 2.0 compliance using tools such as AChecker, Total Validator, WAVE, and HTML/CSS/ARIA. The results showed no websites fully conforming to WCAG 2.0 Level A, with 24% of pages having an error rate exceeding 35%. Most errors were in the perceivable criteria, indicating a lack of prioritization of accessibility in development. The study called for urgent redesign and repair of these websites and recommended enforcing policies, increasing awareness, training developers, and conducting routine reviews. The study by [8] developed two frameworks: one for comparing the performance of web accessibility evaluation tools and another for evaluating webpage accessibility. The study evaluated six Saudi university homepages and compared WAVE and SiteImprove tools, with SiteImprove outperforming WAVE. The first framework was found useful in selecting appropriate evaluation tools, while the second framework helped measure website accessibility and identified common accessibility issues. Taibah University's homepage was noted as the most accessible among those evaluated.

3. **E-commerce Web Accessibility:** Studies assessing the accessibility of Arabic e-commerce websites employed automated technologies to detect common accessibility concerns. These research initiatives highlight the need for improvements in navigation, readability, and input assistance to make e-commerce more accessible to people with disabilities. [9] investigated the accessibility of e-commerce websites in Saudi Arabia for disabled users by evaluating three popular

sites with five accessibility testing tools, finding common accessibility issues, and highlighting the need for improvements despite the potential offered by various supportive tools.

These efforts indicate a rising awareness and commitment to increasing web accessibility in the Arab region, while also emphasizing the need of continual improvements and the use of standardized accessibility rules across various sectors.

Mada's initiatives, such as the Tawasol Symbols and the Unified Arabic Braille, exemplify the critical role of localization in enhancing digital accessibility for the Arab region [10]. These projects not only cater to the specific needs of the local population but also align with sustainability goals, further reinforcing the importance of sector-specific developments in digital accessibility. Additionally, [11] highlights the overarching benefits of implementing digital accessibility policies, emphasizing how such frameworks can extend inclusivity and diversity across communities, thereby amplifying the impact of sector-specific accessibility advancements.

2. Web Accessibility Standards

To attain accessibility status, a website must typically adhere to established web accessibility standards and guidelines, which guarantee that its features and content are usable by individuals with diverse abilities. The World Wide Web Consortium (W3C) is responsible for developing the Web Content Accessibility Guidelines (WCAG), which are the most widely acknowledged standards.

Here are the key principles of WCAG 2.2 [12], known as the four pillars of accessibility, under which specific criteria (success criteria) fall:

1. **Perceivable:** i.e., individuals must be able to understand the information that is being presented.

- **Text Alternatives**: Offer text alternatives for any material that is not in text form (e.g., images, videos).
- **Time-based Media**: Offer substitutes for time-based media (e.g., audio and video).
- **Adaptable**: Create content that can be presented in different ways without losing meaning (e.g., through assistive technologies or by user choice).
- **Distinguishable**: Separate the foreground and the background to make material easier to view and hear for users.

2. **Operable** i.e., the interface has to be user-friendly.

- **Keyboard Accessible**: Ensure that all features can be accessed with a keyboard.
- **Enough Time**: Ensure that users are given an adequate amount of time to read and interact with the material.

- **Seizures and Physical Reactions**: Create content in a manner that avoids triggering seizures or eliciting bodily responses.
- **Navigable**: Offer ways to assist users in navigating, finding material, and determining their location.

3. **Understandable** i.e., Users must be able to understand both the information and how the user interface works.

- **Readable**: Ensure that the textual information is both comprehensible and easy to understand.
- **Predictable**: Ensure that web pages have consistent and predictable appearance and functionality.
- **Input Assistance**: Assist users in preventing and rectifying mistakes.

4. **Robust** i.e., users must be able to access the content as technologies advance

- **Compatible**: Maximize compatibility with current and future user agents, including assistive technologies (e.g., screen readers).

3. Methodology

To map the landscape of web accessibility across the Arab region, this study embarked on the examination of websites spanning all Arab countries. The countries included in this study encompass Algeria, Bahrain, Comoros, Djibouti, Egypt, Iraq, Jordan, Kuwait, Lebanon, Libya, Mauritania, Morocco, Oman, Palestine, Qatar, Saudi Arabia, Somalia, Sudan, Syria, Tunisia, the United Arab Emirates, and Yemen. This expansive coverage ensures a comprehensive understanding of web accessibility practices across the Arab world, laying the groundwork for targeted improvements and the formulation of region-wide digital inclusivity strategies.

In the third quarter phase of our web accessibility analysis, we initially targeted 3,394 websites across the Arab region. However, after the data crawling and cleaning process, the final analysis was conducted on 2,863 of these websites. The reduction in the number of websites was due to various errors and security barriers encountered when attempting to execute our proprietary evaluation code. These challenges ranged from technical errors within the websites themselves to stringent security measures that prevented our assessment tools from running effectively. Despite these obstacles, the substantial sample size of 2,863 websites remains representative and sufficient for drawing meaningful insights into the state of web accessibility within the region. The data derived from these sites have been critical in identifying both the strengths and areas for improvement in web accessibility practices, providing a robust foundation for our comprehensive quarterly analysis.

4. Results

Our comprehensive analysis of 2,863 websites for web accessibility reveals a mixed landscape of compliance with WCAG success criteria, detailed in a complete table and a corresponding chart for a distilled visual summary.

4.1. Distribution of Websites by countries

Figure 1 displays the number of websites assessed from each Arab country in this study, with the Kingdom of Saudi Arabia (KSA) having the highest representation, followed by United Arab Emirates (UAE), Bahrain, Qatar, and Jordan. The study encompassed a diverse range from across the region, including countries, such as Djibouti and Somalia, illustrating the breadth of the web accessibility evaluation.

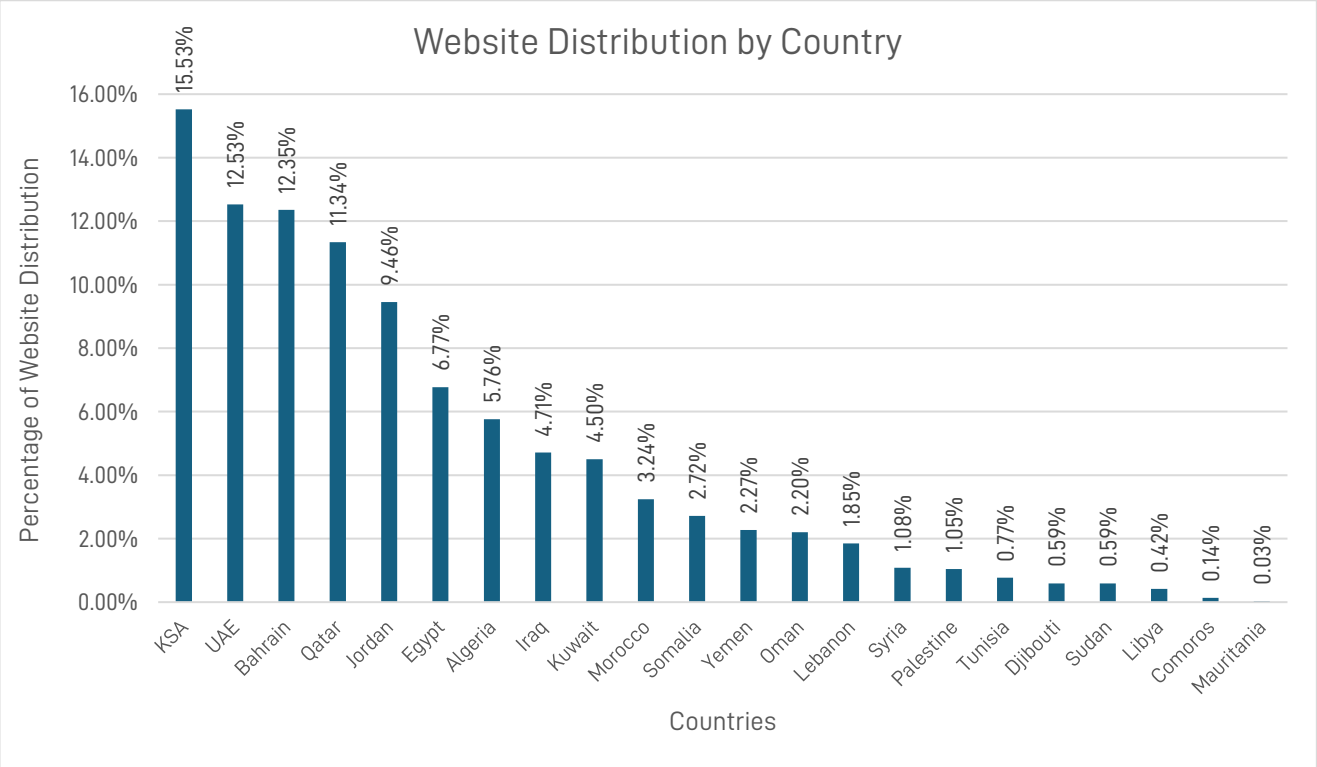

Figure 1: Website distribution by country.

4.2.Distribution of website by sector

Figure 2 illustrates the distribution of websites analyzed in this study, categorized by sector. It shows that most websites fall under the 'education' category, followed by 'government'. The 'others' category comprised 373 websites, representing a variety of sectors including but not limited to industry, sports, tourism, etc., while 'e-commerce' had the fewest, with only 28 sites evaluated.

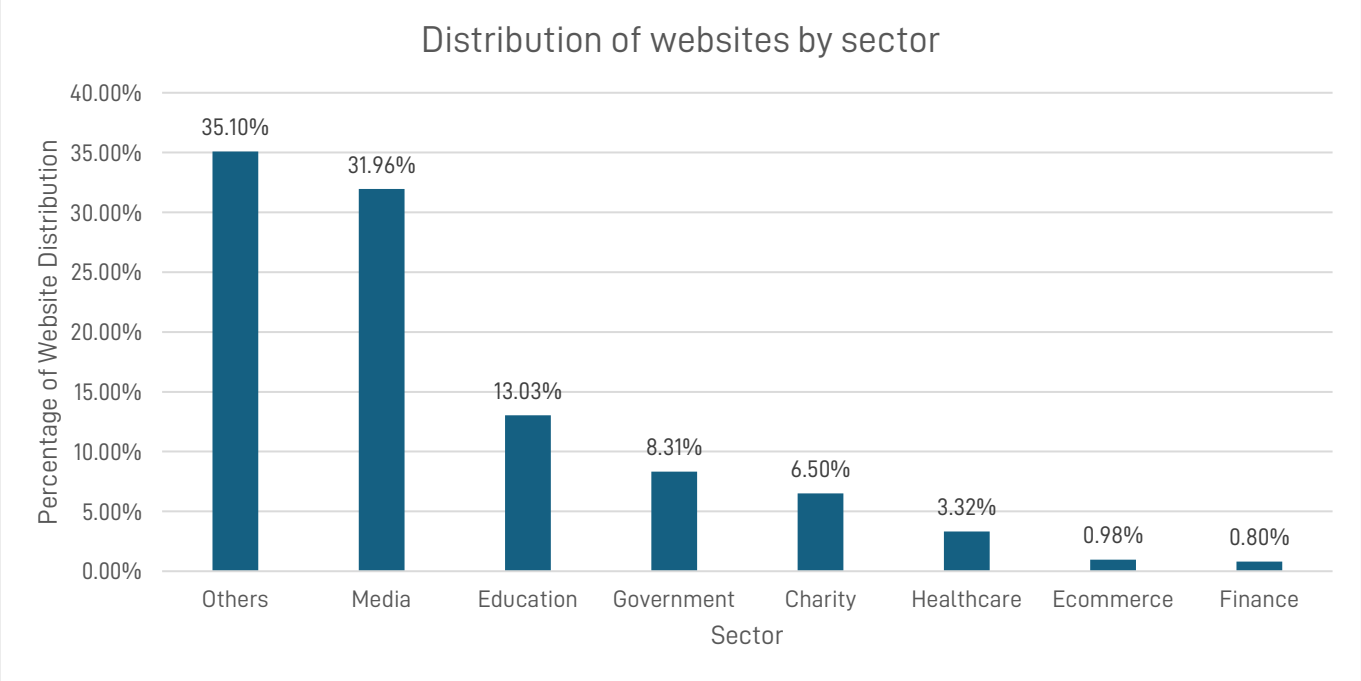

Figure 2: Website distribution by sector.

4.3.Comprehensive Accessibility Audit Overview

The accessibility audit results of 2,863 websites based on **automated testing of their home pages are in** Table 1 below. Precaution should be taken when interpreting the results as automated testing only assesses about 50% of the accessibility criteria. Extensive usability testing across multiple pages is required to understand the complete web accessibility status of the website.

The "Success" column shows the percentage of sites that successfully implemented each success criteria according to the automated testing, the "Fail" column shows the percentage of sites that failed, and the "N/A" (Not Applicable) column indicates the percentage of sites where the criteria were not applicable. For in-depth information on the terms used in the success criteria and their corresponding pillar of accessibility—Perceivable, Operable, Understandable, and Robust—please refer to the appendix. The appendix is structured into two informative sections: the first elaborates on the definitions and importance

of each success criterion (Appendix A), and the second maps these criteria to their respective pillars, providing an organized framework to understand the complex data (Appendix B).

Table 1: Accessibility audit results of 2863 websites

Success criteria	Success	Fail	N/A
accesskeys	2.37%	0.14%	97.49%
aria-allowed-attr	68.44%	6.56%	25.00%
aria-allowed-role	72.97%	9.74%	17.28%
aria-command-name	18.85%	1.75%	79.40%
aria-conditional-attr	75.00%	0%	25.00%
aria-deprecated-role	73.39%	0%	26.61%
aria-dialog-name	3.32%	3.49%	93.19%
aria-hidden-body	99.83%	0%	0.17%
aria-hidden-focus	62.19%	7.68%	30.13%
aria-input-field-name	1.43%	7.40%	91.17%
aria-meter-name	0%	0%	100%
aria-progressbar-name	0.14%	0.28%	99.58%
aria-prohibited-attr	71.30%	3.70%	25.00%
aria-required-attr	72.56%	0.84%	26.61%
aria-required-children	13.62%	10.93%	75.45%
aria-required-parent	16.52%	3.81%	79.68%
aria-roles	72.91%	0.49%	26.61%
aria-text	0.00%	0.03%	99.97%
aria-toggle-field-name	3.04%	1.33%	95.64%
aria-tooltip-name	0.17%	0.03%	99.79%
aria-treeitem-name	0.03%	0%	99.97%
aria-valid-attr-value	71.79%	3.25%	24.97%
aria-valid-attr	74.83%	0.21%	24.97%
button-name	37.29%	22.63%	40.08%
bypass	2.97%	0%	97.03%
color-contrast	30.27%	68.65%	1.08%
definition-list	0.70%	0.56%	98.74%
dlitem	1.08%	0.10%	98.81%
document-title	98.92%	1.05%	0.03%
duplicate-id-aria	8.80%	0%	91.20%
form-field-multiple-labels	0.77%	0%	99.23%
frame-title	20.46%	17.32%	62.22%
heading-order	39.21%	55.73%	5.06%
html-has-lang	86.10%	13.86%	0.03%
html-lang-valid	86.52%	0.28%	13.20%
html-xml-lang-mismatch	2.83%	0.03%	97.14%

Success criteria	Success	Fail	N/A
image-alt	51.82%	45.53%	2.65%
image-redundant-alt	87.85%	9.50%	2.65%
input-button-name	17.25%	1.64%	81.11%
input-image-alt	0.45%	0.59%	98.95%
label	45.36%	9.46%	45.18%
link-in-text-block	31.53%	7.33%	61.14%
link-name	17.46%	80.13%	2.41%
list	77.83%	14.21%	7.96%
listitem	81.60%	10.79%	7.61%
meta-refresh	0%	1.33%	98.67%
meta-viewport	73.64%	22.17%	4.19%
object-alt	0.03%	0.35%	99.62%
select-name	2.27%	6.11%	91.62%
skip-link	7.75%	1.75%	90.50%
tabindex	50.52%	2.97%	46.51%
table-duplicate-name	11.94%	0.00%	88.06%
target-size	59.81%	38.09%	2.09%
td-headers-attr	11.28%	0.00%	88.72%
th-has-data-cells	1.12%	0.00%	98.88%
valid-lang	15.05%	0.21%	84.74%
video-caption	12.95%	0.00%	87.05%
empty-heading	17.77%	0%	82.23%
identical-links-same-purpose	69.48%	0%	30.52%
landmark-one-main	48.32%	0%	51.68%
label-content-name-mismatch	15.71%	5.66%	78.63%
table-fake-caption	5.27%	0.84%	93.89%
td-has-header	1.99%	1.68%	96.33%

Figure 3 presents an analysis of various accessibility criteria, detailing their effectiveness in meeting success standards. The table categorizes each criterion into three outcomes: Success, Fail, and Not Applicable (NA). Percentages are provided for each outcome, highlighting the performance of different accessibility attributes. This data is essential for understanding areas of strength and improvement within accessibility practices, aiding in the identification of effective strategies and potential gaps in compliance.

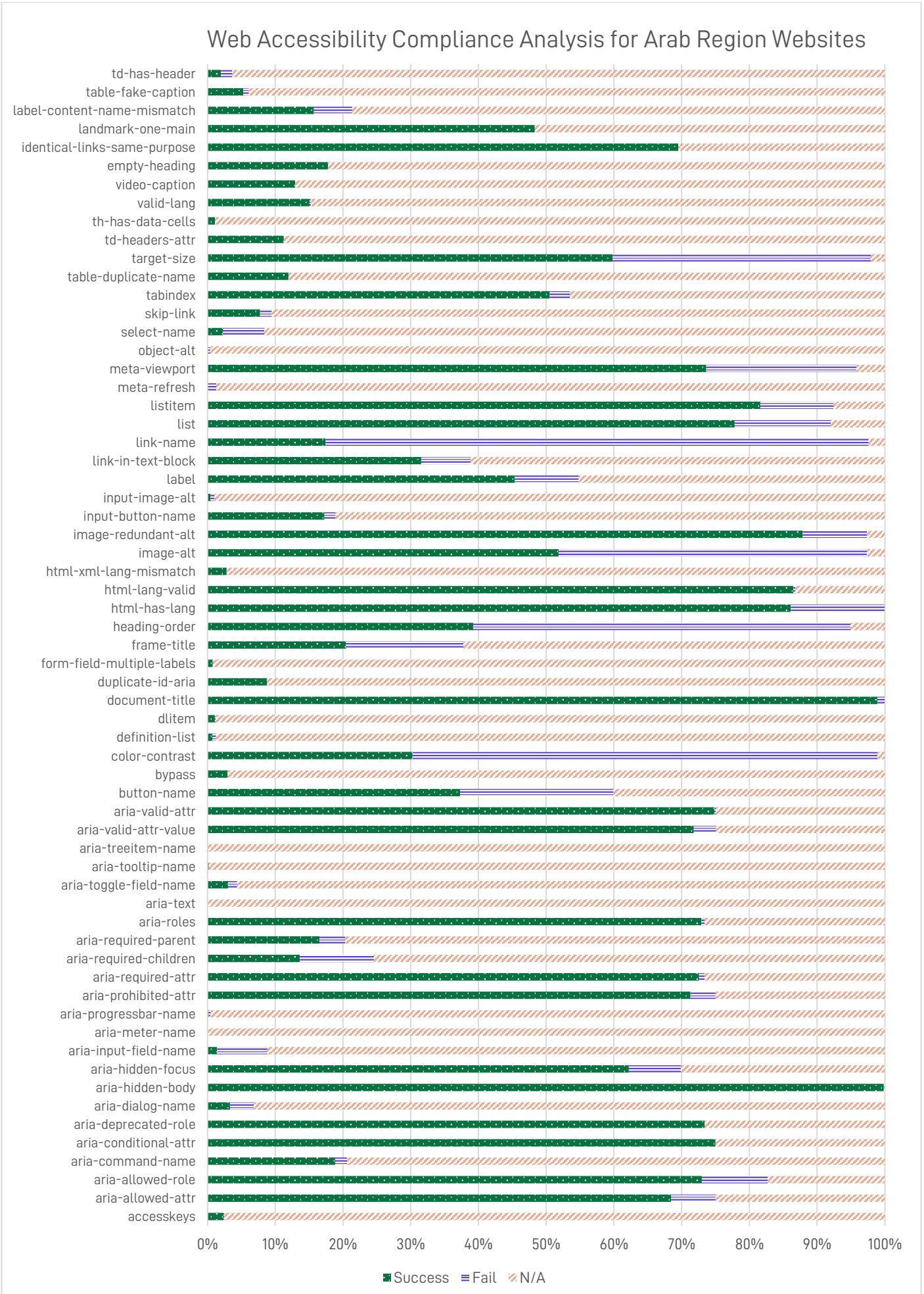
Web Accessibility Compliance Analysis for Arab Region Websites
td-has-header
table-fake-caption
label-content-name-mismatch
landmark-one-main
identical-links-same-purpose
empty-heading
video-caption
valid-lang
th-has-data-cells
td-headers-attr
target-size
table-duplicate-name
tabindex
skip-link
select-name
object-alt
meta-viewport
meta-refresh
listitem
list
link-name
link-in-text-block
label
input-image-alt
input-button-name
image-redundant-alt
image-alt
html-xml-lang-mismatch
html-lang-valid
html-has-lang
heading-order
frame-title
form-field-multiple-labels
duplicate-id-aria
document-title
dlitem
definition-list
color-contrast
bypass
button-name
aria-valid-attr
aria-valid-attr-value
aria-treeitem-name
aria-tooltip-name
aria-toggle-field-name
aria-text
aria-roles
aria-required-parent
aria-required-children
aria-required-attr
aria-prohibited-attr
aria-progressbar-name
aria-meter-name
aria-input-field-name
aria-hidden-focus
aria-hidden-body
aria-dialog-name
aria-deprecated-role
aria-conditional-attr
aria-command-name
aria-allowed-role
aria-allowed-attr
accesskeys
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Success
Fail
N/A

Figure 3: Web accessibility compliance analysis overview for Arab region websites (Above).

4.4.Accessibility Performance Highlights

Some highlights and key points from the analysis:

1. **High Success Rates based on automated testing:**

    - **aria-hidden-body** had a 99.83% success rate, indicating that all audited sites correctly implemented this feature according to the automatic testing.
    - **document-title** is almost used correctly on most websites, with a 98.92% success rate.
    - **html-has-lang and html-lang-valid** had a high success rate of 86.10 % and 86.52%, indicating that most audited websites specify a default language for their content.
    - **Image-redundant-alt** also had a high success rate of 87.85%, indicating a high level of compliance with the standard, ensuring that redundant or decorative images do not interfere with the experience of screen reader users.

2. **Low Success Rates:**

link-name had a notably high failure rate at 80.13%, indicating that a considerable proportion of the links evaluated did not meet the necessary standards. This indicates a substantial issue with link naming practices, which can severely impact the usability and accessibility of the content for users with visual impairments or other disabilities.

3. **Accessibility Issues Requiring Immediate Attention:**

    - The **bypass** criterion had a success rate of 2.97%, and the rest of it was deemed "NA" indicating this criterion was not measurable for most websites using the automatic testing process.
    - **color-contrast** had a failure rate of 68.65%. This indicates a substantial issue with color contrast across the content, potentially impacting the readability and usability for a sizable number of users. Adequate color contrast is crucial for readability and accessibility, particularly for users with visual impairments or color blindness.

4. **Criteria with Moderate Success:**

Criteria such as **aria-prohibited-attr, aria-conditional-attr, aria-deprecated-role, aria-required-attr, aria-roles, aria-valid-attr-value, aria-valid-attr, list, and meta-viewport** have success rates above 70%, indicating a moderate level of implementation across the websites.

4.5.Accessibility Pillars Criteria Evaluation Summary

Figure 4 demonstrates the accessibility of each of the pillars of accessibility, highlighting success, failure, and non-applicable rates for each category. For "Perceivable" (ensuring content is accessible to the senses), 21.68% succeeded, 9.88% failed, and 68.44% were not applicable. For "Robust" (ensuring content is compatible with various technologies), 44.86% succeeded, 4.52% failed, and 50.62% were not applicable. For "Operable" (ensuring users can interact with all controls), 37.76 % succeeded, 18.04 % failed, and 44.20% were not applicable. For "Understandable" (ensuring content is easy to comprehend), 38.25% succeeded, 2.88% failed, and 58.87% were not applicable. For "Best Practice" (following optimal accessibility standards), 28.51% succeeded, 6.95% failed, and 64.55% were not applicable.

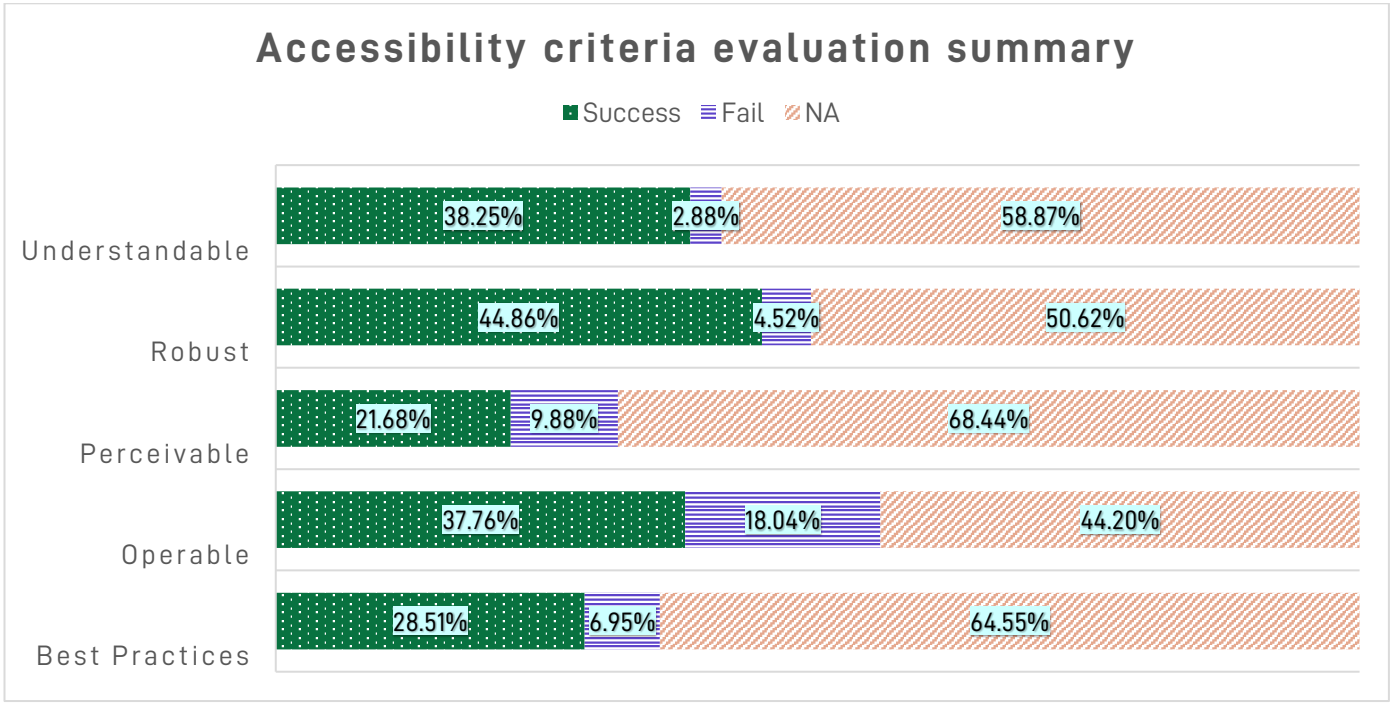

Figure 4: Accessibility Pillars Success Evaluation Criteria

4.6.Perceivable Criterion Performance

Figure 5 below gives an overview of how well websites are meeting success criteria based on automated testing under the principle of "Perceivable," one of the four pillars of accessibility according to the Web Content Accessibility Guidelines (WCAG) on average. The "Perceivable" principle emphasizes the need for information and user interface components to be presentable to users in ways they can perceive.

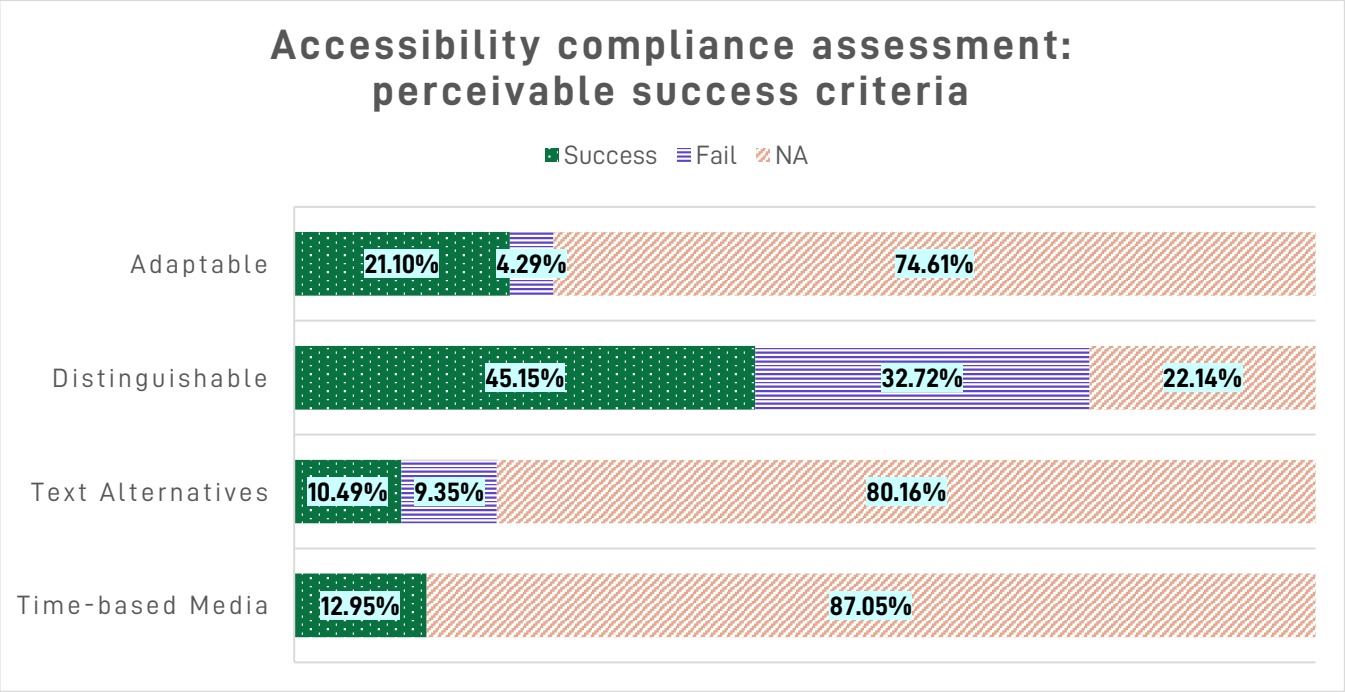

Figure 5: Perceivable success criteria compliance assessment analysis results overview.

1. **Text Alternatives (Average: 10.49% Success, 9.35% Fail, 80.16 % N/A):**

This success criterion focuses on providing text alternatives for any non-text content. The data suggests that 10.49% of the sites have provided text alternatives for non-text content, while 9.35 % have failed to do so. A significant 80.16% of the criteria were marked as not applicable. Figure 5 demonstrates the varied success rates in meeting perceivable success criteria for text alternatives. Figure 6 shows the breakdown of the success criteria for text alternatives.

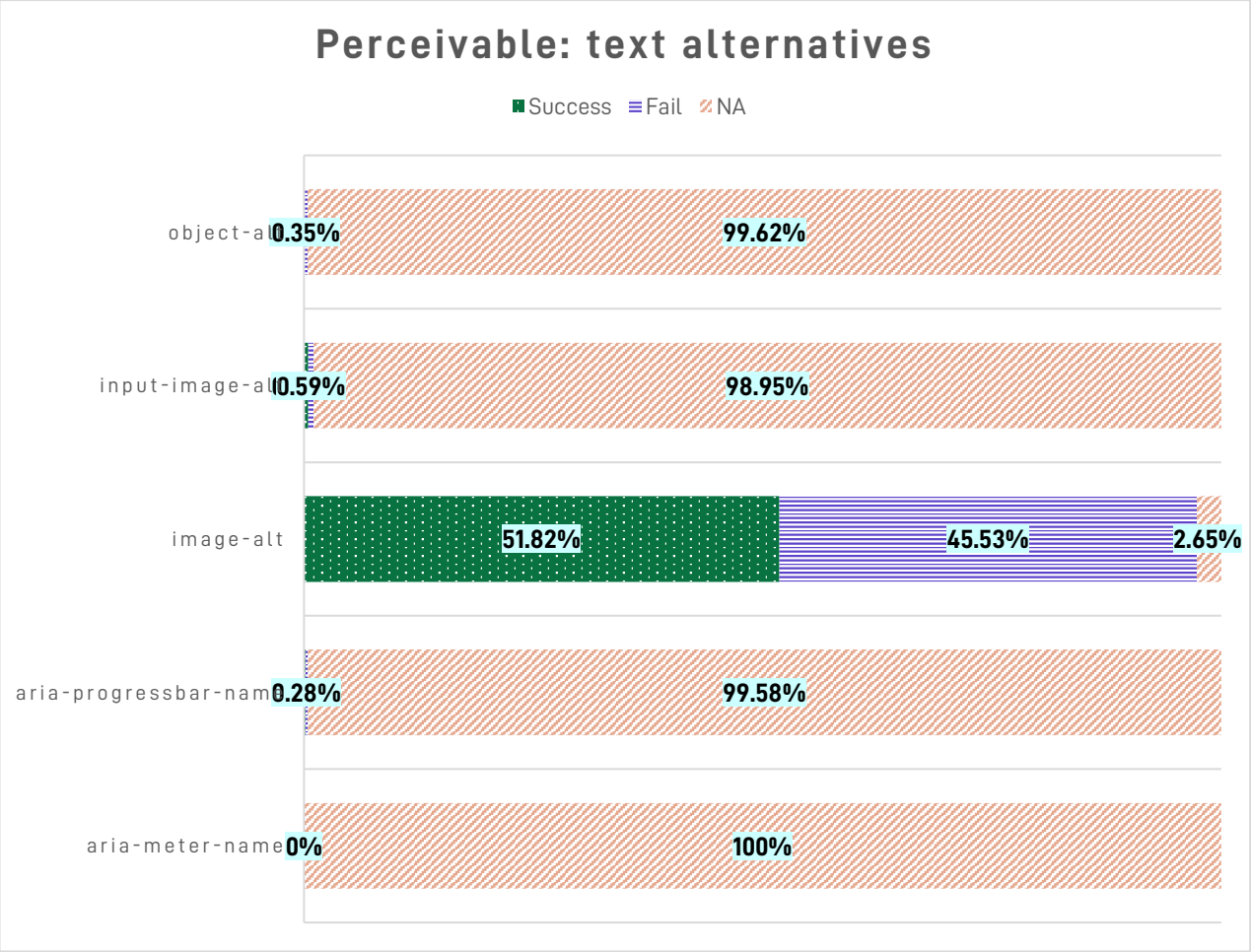

Figure 6: Text Alternatives success criteria compliance assessment analysis results overview.

2. Adaptable (Average: 21.10 % Success, 4.29 % Fail, 74.61 % N/A):

Being adaptable means that content can be presented in different ways without losing information or structure, such as through assistive technologies. Only 21.10 % of the website homepages successfully met this criterion based on automated testing on average, with a small failure rate of 4.29%, and 74.61% being not applicable. Figure 7 demonstrates the varied success rates in meeting adaptable success criteria.

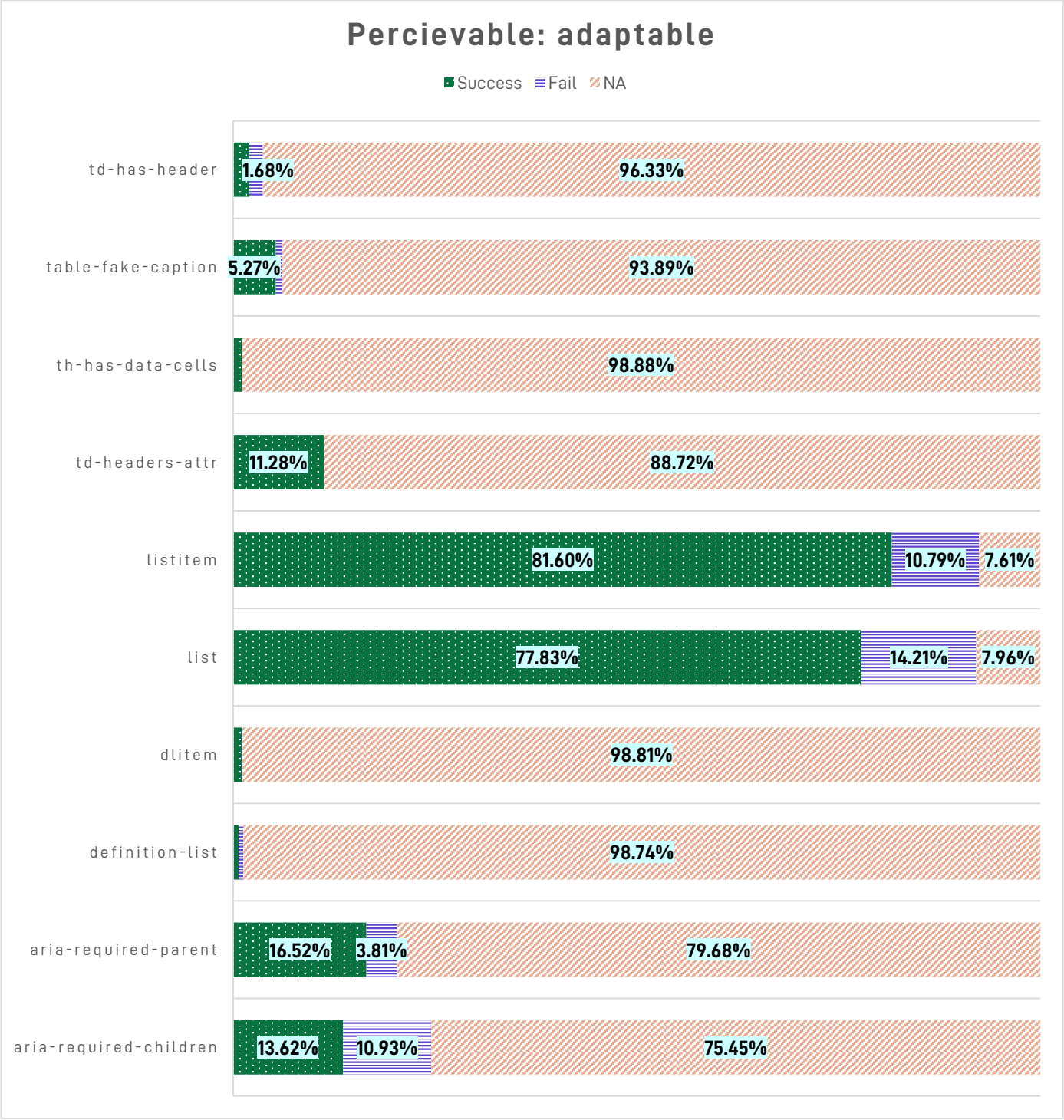

Figure 7: Adaptable success criteria compliance assessment analysis results overview.

3. Distinguishable (Average: 45.15 % Success, 32.72 % Fail, 22.14 % N/A):

This success criterion is crucial for making it easier for users to see and hear content, including separating foreground from background. On average about 45.15 % of the website homepages successfully met this criterion based on automated testing, with a failure rate of 32.72 %, and 22.14% being not applicable (N/A). Figure 8 demonstrates the varied success rates in meeting success criteria for distinguishable.

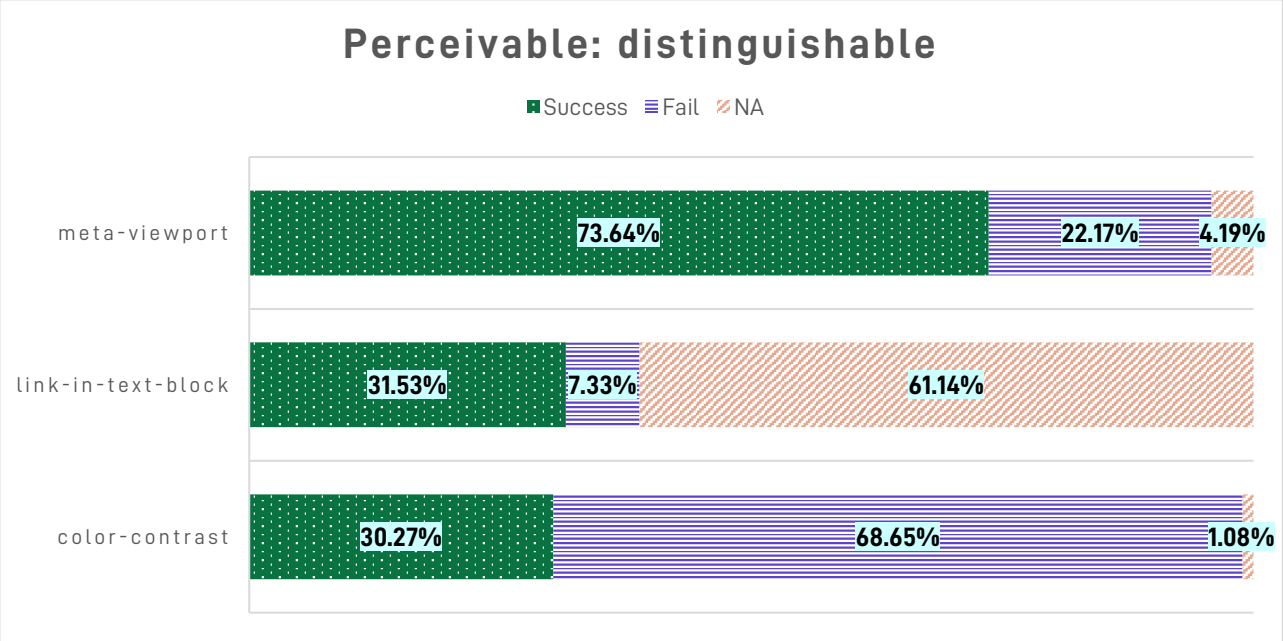

Figure 8: Distinguishable success criteria compliance assessment analysis results overview.

4.7.Operable Criterion Performance

Figure 9 below gives an overview of how well website homepages are meeting certain success criteria based on automated testing under the principle of " Operable" one of the four pillars of accessibility according to the Web Content Accessibility Guidelines (WCAG). The "Operable" principle emphasizes that users must be able to operate the interface (the interface cannot require interaction that a user cannot perform).

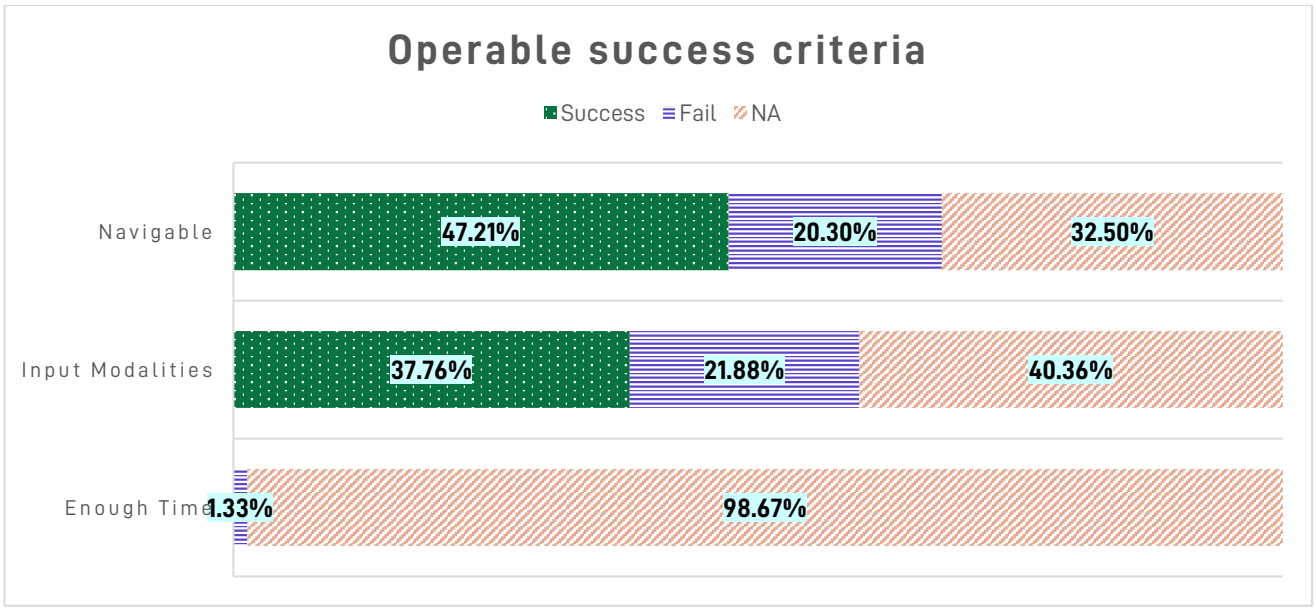

Figure 9: Operable success criteria analysis results overview.

1. Navigable (Average: 47.21 % Success, 20.30 % Fail, 32.50 % N/A):

"Navigable" assesses whether users can navigate and find content. Based on the automated testing employed, the 47.21 % success rate shows that less than half of the website homepages have adequately provided navigational mechanisms. A failure rate of 20.30 % indicates that nearly a quarter of the websites have issues that could hinder navigation for users, particularly those using screen readers or other assistive technologies. 32.50 % were rated as N/A. Figure 10 demonstrates the varied success rates in meeting operable success criteria for navigable.

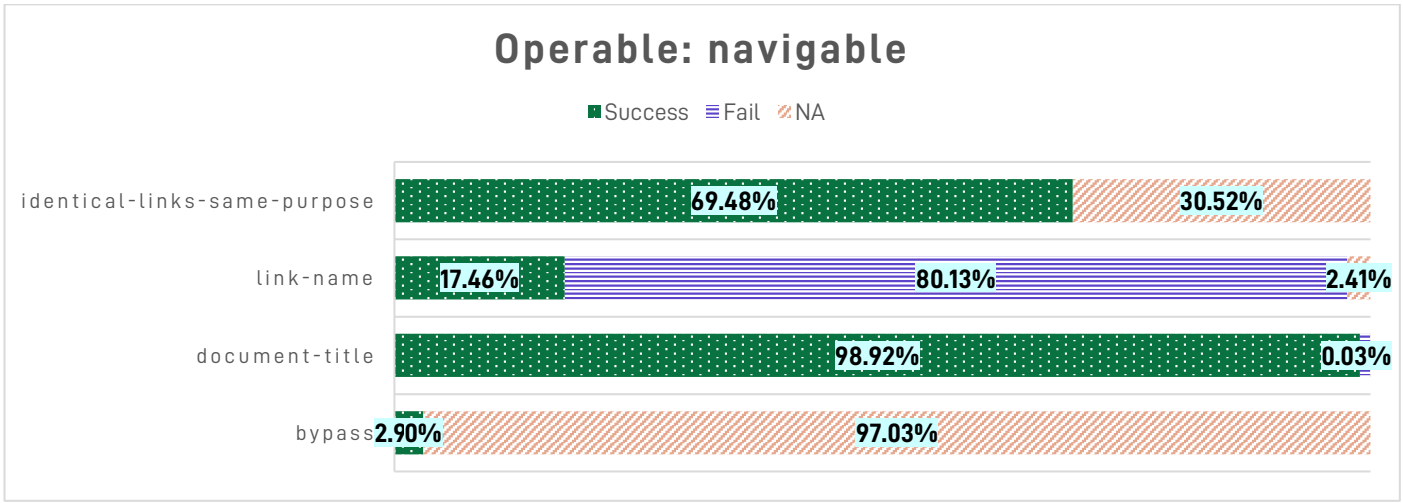

Figure 10: Navigable success criteria compliance assessment analysis results overview.

2. Enough Time (Average: 0% Success, 1.33 % Fail, 98.67 % N/A):

"Enough Time" evaluates whether users have enough time to read and use the content on the homepage. According to the automated testing results only 1.33 % of the website homepage successfully met this criterion. The 98.67% N/A rate suggests that the automated testing was unable to measure this criterion on most websites. Figure 11 demonstrates the success rate in meeting success criteria for enough time based on meta-refresh.

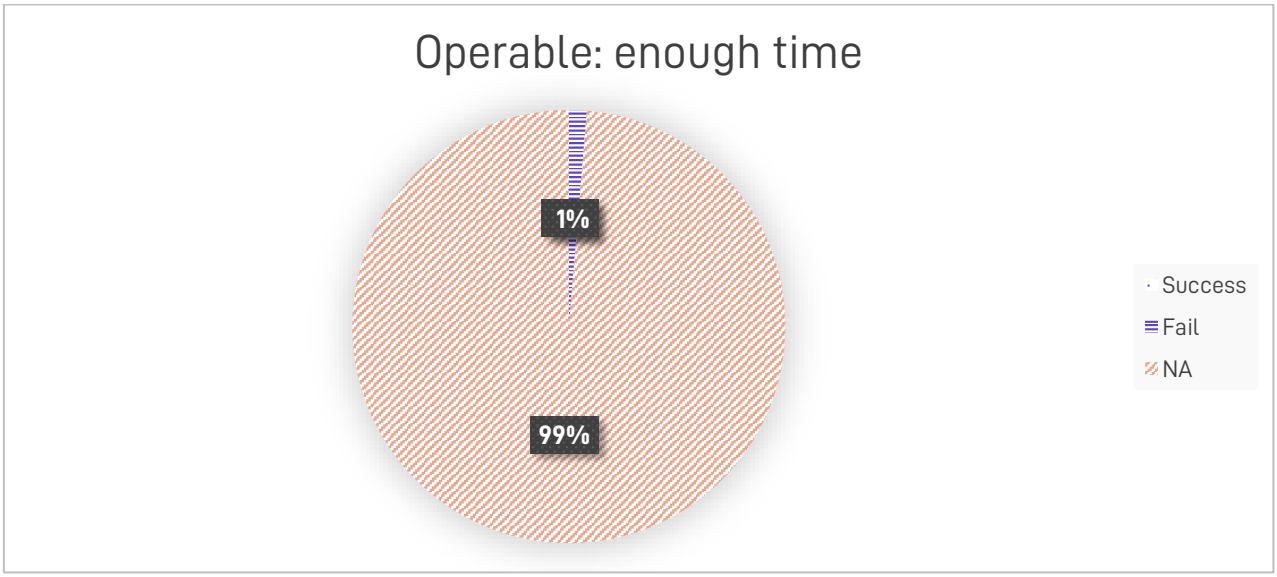

Figure 11: Enough Time Success Criteria Compliance Assessment Results Overview

3. Input Modalities (Average: 37.76% Success, 21.88% Fail, 40.36% N/A):

"Input Modalities" refers to providing users with various options to input data beyond traditional keyboard interfaces. The success rate based on automated testing of the website homepages was found to be 37.76%. This criterion was not applicable on 40.36% of the website homepages. Figure 12 demonstrates the varied success rates in meeting operable success criteria for input modalities.

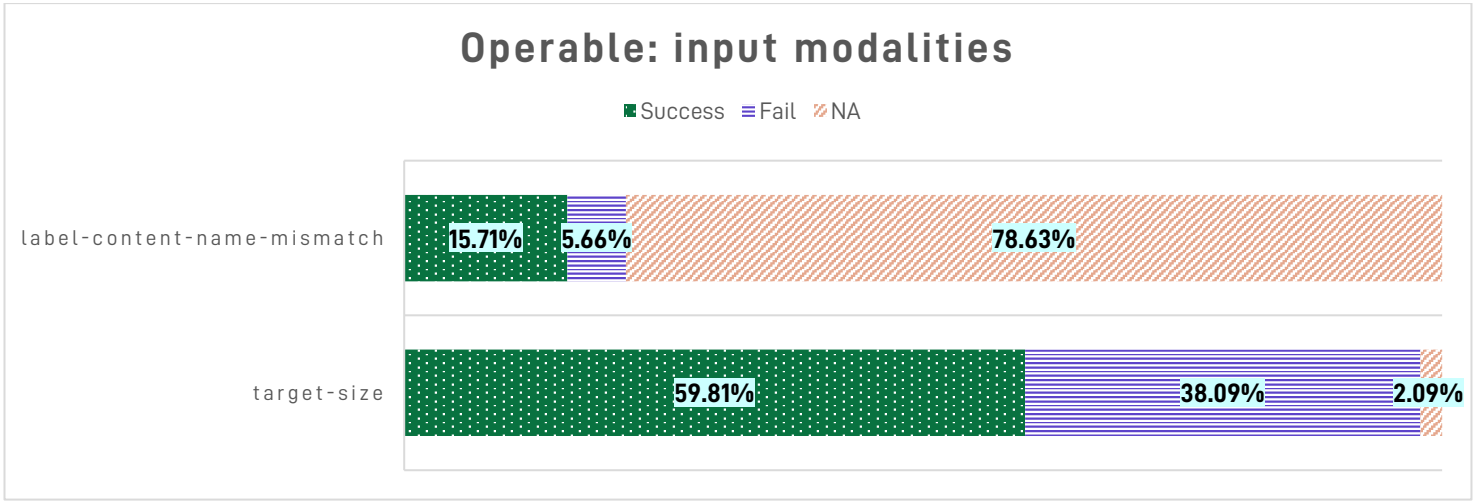

Figure 12 Input Modalities Success Criteria Compliance Assessment Results Overview

4.8.Understandable Criterion Performance

Figure 13 provided below offers a comprehensive snapshot of the performance of homepages of websites against specific success criteria pertaining to the "Understandable" criterion, a fundamental component of accessibility outlined in the Web Content Accessibility Guidelines (WCAG). The "Understandable" criterion emphasizes the importance of content being presented in a clear and coherent manner, ensuring that users can easily comprehend the information provided. This criterion is essential for facilitating access to web content for individuals with diverse cognitive abilities and language proficiencies. By adhering to the "Understandable" criterion, websites enhance their usability and inclusivity, thereby ensuring that information is readily understandable by all users, regardless of their background or abilities.

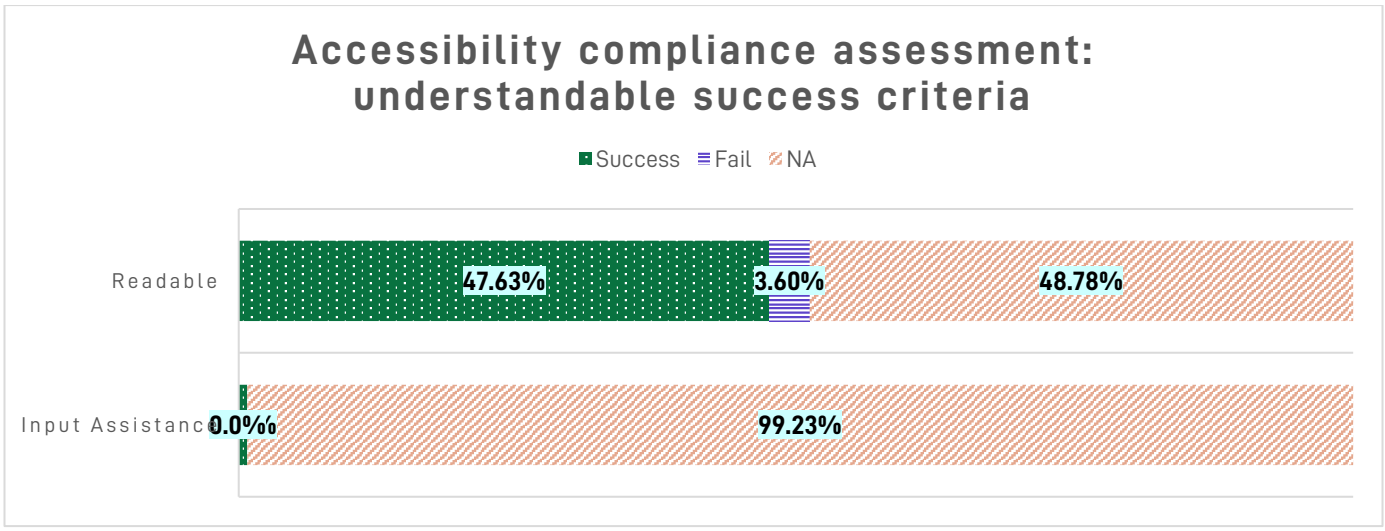

Figure 13 Understandable success criteria analysis results overview.

Understandable (Average: 38.25 % Success, 2.88 % Fail, 58.87 % N/A):

Figure 4 above indicates that only 38.25% of website homepages have successfully met the understandable criteria according to automated testing, indicating that there is room for improvement. A 2.88% failure rate suggests that a small fraction of website homepages exhibit unclear or confusing content, hindering user comprehension. Addressing these issues could significantly enhance the overall accessibility and usability of web content. Figure 14 and Figure 15 demonstrate the varied success rates in meeting understandable success criteria based on automated testing for readable, and input assistance, respectively.

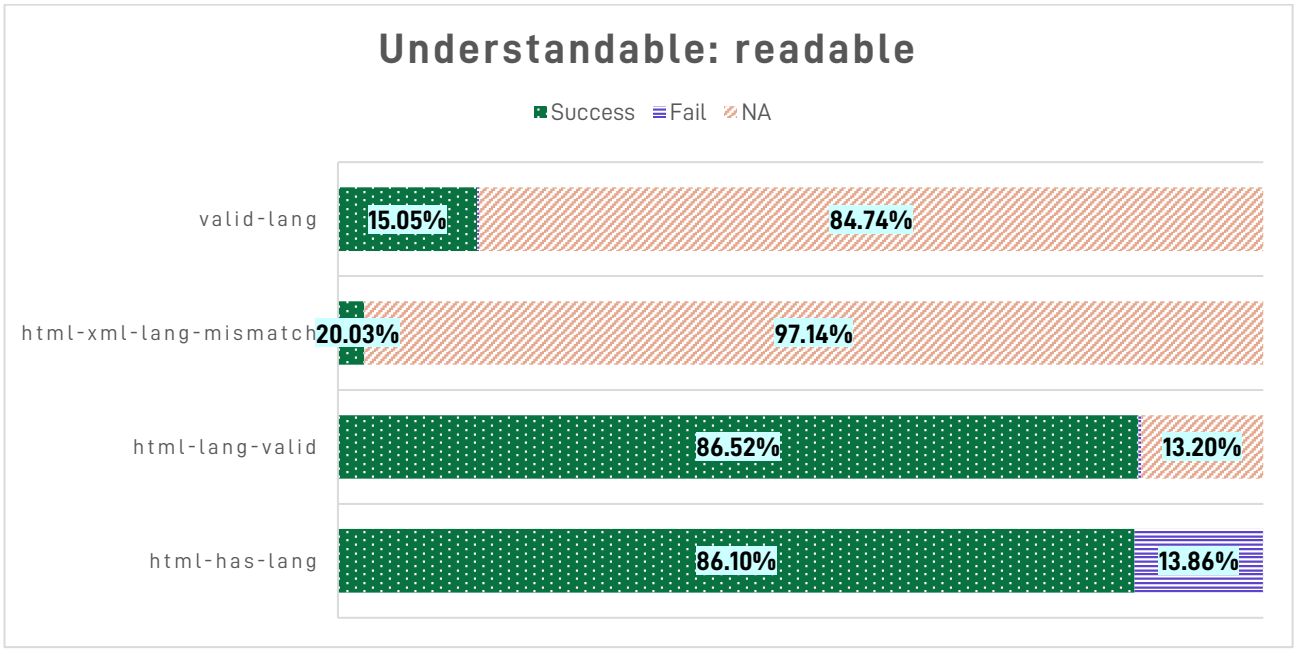

Figure 14: Readable Success Criteria Compliance Assessment Results Overview

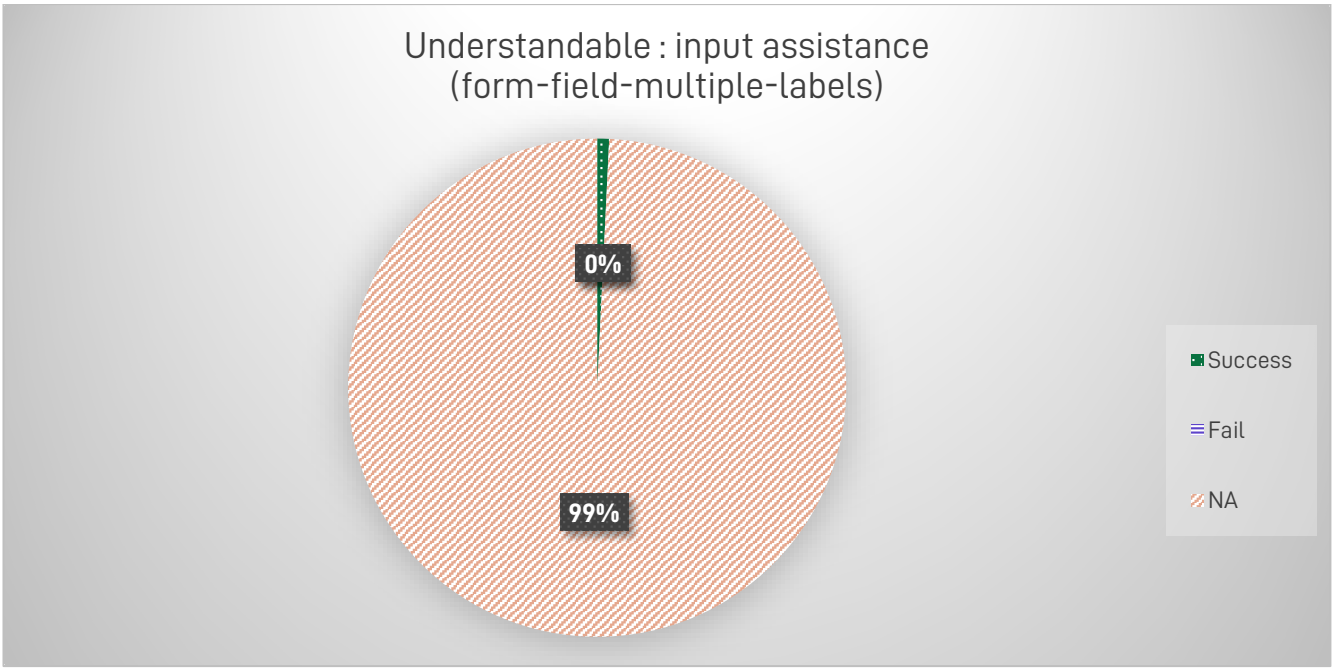

Figure 15: Input Assistance Success Criteria Compliance Assessment Results Overview

4.9.Robust Criterion Performance

Figure 16 below gives an overview of how well website homepages are meeting certain success criteria under the principle of "Robust," one of the four pillars of accessibility according to the Web Content Accessibility Guidelines (WCAG). The "Robust" principle of the Web Content Accessibility Guidelines (WCAG) highlights the need for content to be robust enough that it can be reliably interpreted by a wide variety of user agents, including assistive technologies. This principle ensures that content can be accessed by different technologies now and in the future.

Robust (Average: 44.86 % Success, 4.52 % Fail, 50.62 % N/A):

Figure 16 indicates that 44.86 % of websites on average have met the criteria according to automated testing for robustness, ensuring that content can be accessed by current and future assistive technologies. A 4.52 % failure rate means that a small percentage of the websites have features that are not compatible with assistive technologies, potentially due to the use of outdated or non-standard web practices. A significant 50.62% marked as N/A suggests that most of the content did not pertain to elements or features that are evaluated for robustness, or there may be a lack of awareness of how to implement robustness in web content. Figure 17 demonstrates the varied success rates in meeting robust success criteria for compatible.

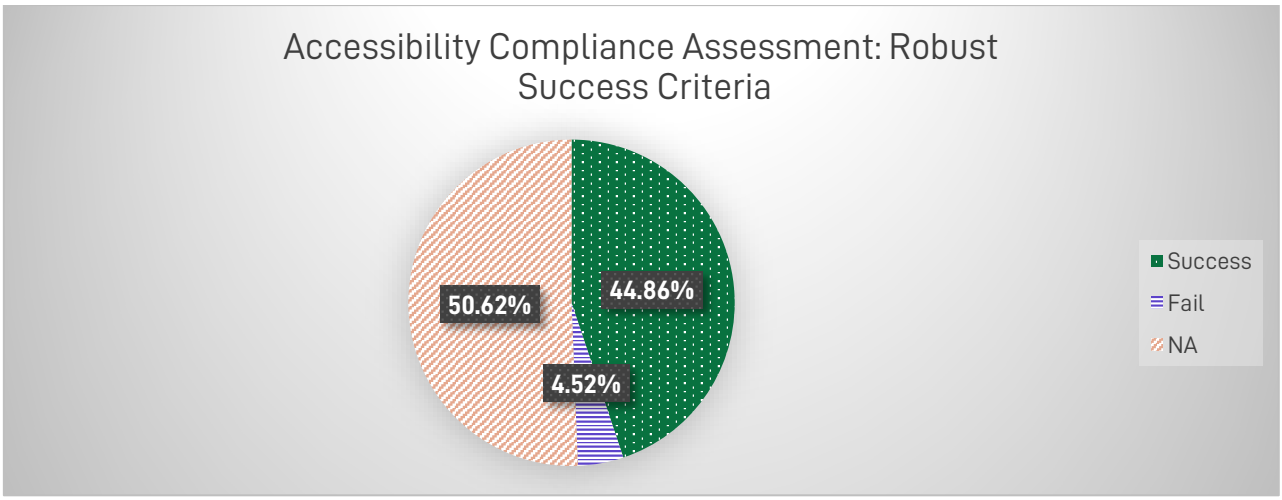

Figure 16: Robust success criteria analysis results overview.

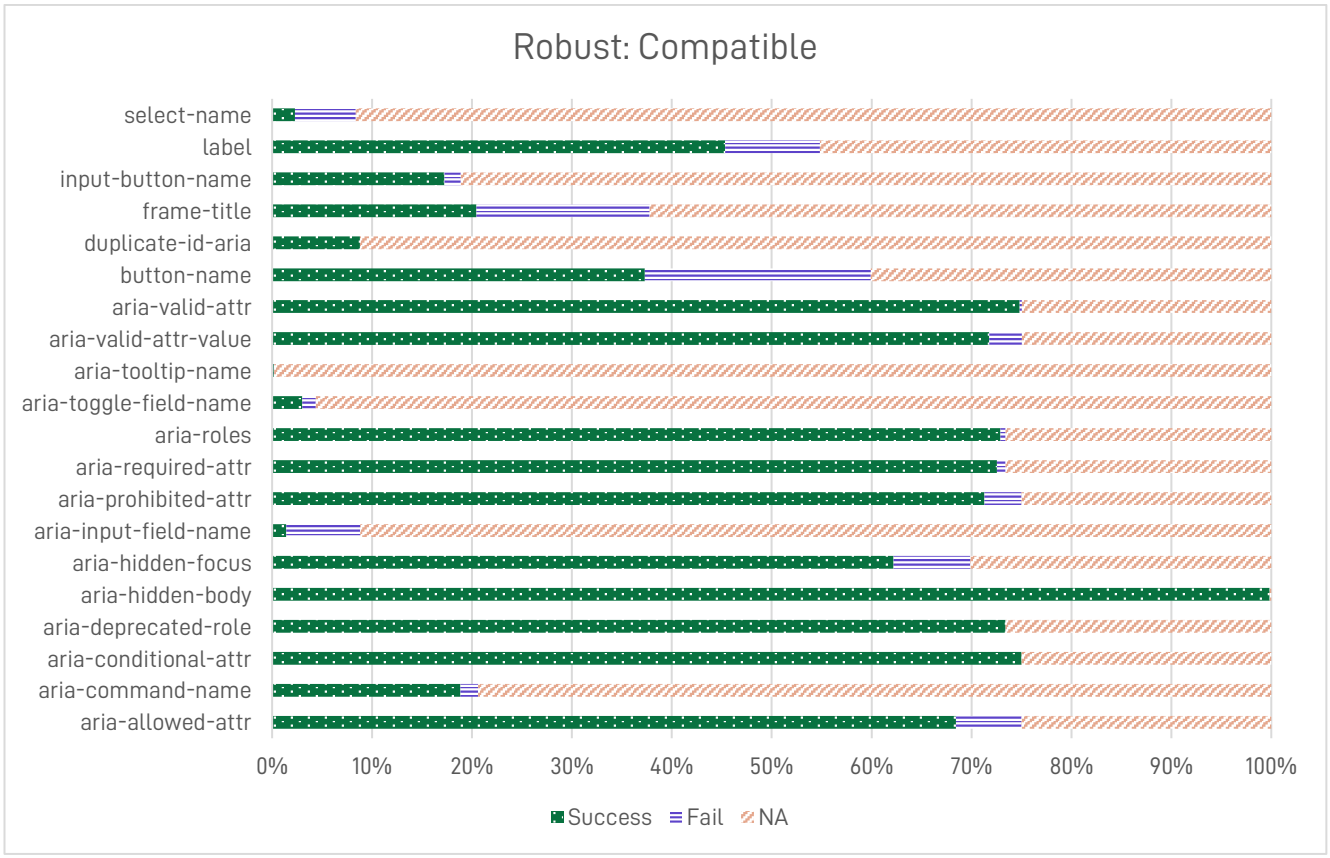

Figure 17: Compatible Success Criteria Compliance Assessment Results Overview

5. Conclusion

The analysis of the homepage of 2,863 websites in the Arab region reveals the current state of digital accessibility. While there are successes, overall compliance with WCAG standards varies widely. Automated testing helps identify some accessibility issues but can only find about 30-50% of barriers, often missing specific user experiences. Therefore, manual and usability testing, involving real users with disabilities and experts, is essential for a thorough evaluation.

High success rates in some criteria show progress in making content accessible and robust for users with disabilities. However, there are significant areas of non-compliance, especially with distinguishable elements critical for visually impaired users and navigable structures for assistive technologies. In summary, while there have been improvements in online accessibility, much work remains. This study urges web developers, content creators, and stakeholders in the Arab region to address the identified gaps, ensuring web content is operable, distinguishable, and robust. Continuous efforts are necessary to achieve a fully inclusive digital environment for all users.

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Appendix A

Glossary of Web Accessibility Terms

This appendix serves as a glossary, offering explanations for terms associated with web accessibility. Each term corresponds to specific success criteria within WCAG, aimed at ensuring websites are navigable and comprehensible for all users, including those using assistive technologies.

1. **accesskeys**: Ensures that keyboard shortcuts (access keys) are properly assigned and do not conflict with assistive technologies.

2. **aria-allowed-attr**: Checks if ARIA (Accessible Rich Internet Applications) attributes used are allowed for that element.

3. **aria-allowed-role**: Verifies that elements have appropriate ARIA role attributes according to their semantics.

4. **aria-command-name**: Ensures that ARIA command roles (such as **button**, **link**, etc.) have appropriate names for assistive technologies.

5. **aria-dialog-name**: Checks that dialogs (pop-ups) are properly labeled with names via ARIA attributes.

6. **aria-hidden-body**: Ensures that the **aria-hidden** attribute is not incorrectly applied to the body element, which can hide the entire document from screen readers.

7. **aria-hidden-focus**: Ensures that elements with **aria-hidden** are not focusable, as this can lead to confusion for screen reader users.

8. **aria-input-field-name**: Checks that ARIA input fields have accessible names.

9. **aria-meter-name**: Ensures that ARIA meter elements have properly defined names.

10. **aria-progressbar-name**: Verifies that progress bars have accessible names through ARIA.

11. **aria-required-attr**: Checks if elements with ARIA roles have all required ARIA attributes.

12. **aria-required-children**: Ensures that elements with ARIA roles contain required child roles.

13. **aria-required-parent**: Verifies that elements with ARIA roles are contained within required parent roles.
14. **aria-roles**: Checks for the correct use of ARIA roles on elements.
15. **aria-text**: Ensures that elements with ARIA roles have text content that is readable by assistive technologies.
16. **aria-toggle-field-name**: Checks that toggle fields like checkboxes or switches have accessible names.
17. **aria-tooltip-name**: Ensures that tooltips have an accessible name through ARIA.
18. **aria-treeitem-name**: Verifies that treeitem elements have accessible names.
19. **aria-valid-attr-value**: Checks that ARIA attributes have valid values.
20. **aria-valid-attr**: Ensures that ARIA attributes used are valid and appropriate for the element.
21. **button-name**: Ensures that buttons have discernible text or labels for screen readers.
22. **bypass**: Checks for mechanisms to bypass blocks of content that are repeated on multiple pages (like a "skip to main content" link).
23. **color-contrast**: Ensures that text and images of text have sufficient contrast ratio against the background.
24. **definition-list**: Verifies correct usage of definition lists (**<dl>**, **<dt>**, and **<dd>** tags).
25. **dlitem**: Ensures that **<dt>** and **<dd>** elements are inside a **<dl>**.
26. **document-title**: Checks that the document has a non-empty title element to aid navigation and identification of the site.
27. **duplicate-id-active**: Ensures that active elements do not have duplicate **id** attributes.
28. **duplicate-id-aria**: Checks for duplicate **id** attributes on elements with ARIA attributes.
29. **form-field-multiple-labels**: Verifies that form fields do not have multiple labels, which can be confusing for screen readers.
30. **frame-title**: Ensures that frames and iframes have titles for descriptive identification.
31. **heading-order**: Checks that headings (**<h1>**, **<h2>**, etc.) are in a sequentially descending order.

32. **html-has-lang**: Ensures that the HTML document has a language attribute to aid in text pronunciation by screen readers.
33. **html-lang-valid**: Verifies that the **lang** attribute on the **<html>** tag has a valid language value.
34. **html-xml-lang-mismatch**: Checks for discrepancies between **lang** and **xml:lang** attributes if both are used.
35. **image-alt**: Ensures that **<img>** elements have **alt** text to describe the image content to screen readers.
36. **image-redundant-alt**: Verifies that image alternative texts are not redundant or unnecessary.
37. **input-button-name**: Checks that input buttons (**<input type="button">**) have descriptive names.
38. **input-image-alt**: Ensures that image input elements (**<input type="image">**) have alternative text.
39. **label**: Verifies that form elements have associated label elements that are correctly implemented.
40. **link-in-text-block**: Checks that links within blocks of text are discernible and not ambiguous.
41. **link-name**: Ensures that links have discernible text to convey their purpose.
42. **list**: Verifies correct use of list elements (**<ul>**, **<ol>**, **<li>**).
43. **listitem**: Checks that list items (**<li>**) are properly placed within **<ul>** or **<ol>** parent elements.
44. **meta-refresh**: Ensures there are no automatic meta refreshes, which can be disorienting.
45. **meta-viewport**: Checks that the viewport allows user scaling, aiding accessibility for users with visual impairments.
46. **object-alt**: Ensures that embedded objects have alternative text.
47. **select-name**: Checks that select elements have proper names to identify their purpose.
48. **skip-link**: Verifies the presence of a mechanism to skip to the main content.
49. **tabindex**: Ensures that elements with a tabindex follow logical sequence and do not trap keyboard navigation.
50. **table-duplicate-name**: Checks for tables with duplicate names or captions.
51. **td-headers-attr**: Verifies that data cells are associated with their headers correctly in complex tables.
52. **th-has-data-cells**: Ensures that table header cells (<th>) are properly associated with corresponding data cells in a table.

53. **valid-lang:** Checks that the language assigned to the lang attribute is valid according to the Internet Assigned Numbers Authority (IANA) language subtag registry.

54. **video-caption:** Ensures that videos embedded on the website have captions for users who are deaf or hard of hearing.

55. **focusable-controls:** Ensures that interactive controls are focusable and accessible via keyboard, important for users who cannot use a mouse.

56. **interactive-element-affordance**: Verifies that interactive elements are easily identifiable and suggests their functionality to users.

57. **logical-tab-order:** Checks that the tab order of the page follows a logical sequence, which is critical for keyboard navigation.

58. **visual-order-follows-dom:** Ensures that the visual order of elements on the screen corresponds to their order in the Document Object Model (DOM), which affects users of screen readers and those who navigate by keyboard.

59. **focus-traps:** Verifies that there are no traps on the website that capture focus and prevent keyboard users from navigating away from an element or group of elements.

60. **managed-focus**: Checks that when new content is displayed on the page, focus is managed appropriately to direct users to the new content.

61. **use-landmarks:** Ensures that ARIA landmarks are used to identify regions of the page (like navigation, main content, search, etc.), which aids in screen reader navigation.

62. **offscreen-content-hidden:** Checks that content meant to be offscreen (and not visible to sighted users) is also hidden from assistive technologies.

63. **custom-controls-labels:** Verifies that custom controls have proper labels, making them accessible to assistive technologies.

64. **custom-controls-roles:** Ensures that custom controls have the correct ARIA role so that they are announced properly by screen readers.

65. **empty-heading:** Ensures that heading elements are not empty as this can be confusing for screen reader users.

66. **identical-links-same-purpose:** Checks that links with the same href have the same purpose, as users might not understand if the same link leads to different destinations.

67. **landmark-one-main:** Verifies that there is at least one main landmark (<main> or role="main") on the page, which helps in navigation.

68. **target-size:** Checks that interactive elements are of a minimum size, making them easier to interact with for users with limited dexterity.

69. **label-content-name-mismatch:** Ensures that visible label text matches the accessible name (e.g., aria-label or aria-labelledby), which can confuse users if there is a mismatch.

70. **table-fake-caption:** Verifies that tables do not use fake captions (like regular text styled as a caption), which can mislead users relying on proper table structure for understanding content.

71. **td-has-header**: Ensures that each table data cell has an associated header to help users understand the context of the data.

These criteria are essential for determining the accessibility of a website, ensuring that it can be used effectively by people with disabilities, such as visual, auditory, motor, and cognitive impairments. Following these guidelines not only improves the experience for users with disabilities but also enhances the overall usability of the web for all users.

Appendix B

Categorization of Success Criteria Under Accessibility Pillars

This list below outlines each success criterion evaluated in our study, categorized under the corresponding pillar of the Web Content Accessibility Guidelines (WCAG), and defined by the specific guideline it supports.

Success criteria	**Accessibility Pillar**	
accesskeys	Best Practice	NA
aria-allowed-attr	Robust	Compatible
aria-allowed-role	Best Practice	NA
aria-command-name	Robust	Compatible
aria-dialog-name	Best Practice	NA
aria-hidden-body	Robust	Compatible
aria-hidden-focus	Robust	Compatible
aria-input-field-name	Robust	Compatible
aria-meter-name	Perceivable	Text Alternatives
aria-progressbar-name	Perceivable	Text Alternatives
aria-required-attr	Robust	Compatible
aria-required-children	Perceivable	Adaptable
aria-required-parent	Perceivable	Adaptable
aria-roles	Robust	Compatible
aria-text	Best Practice	NA
aria-toggle-field-name	Robust	Compatible
aria-tooltip-name	Robust	Compatible
aria-treeitem-name	Best Practice	NA
aria-valid-attr-value	Robust	Compatible

aria-valid-attr	Robust	Compatible
button-name	Robust	Compatible
bypass	Operable	Navigable
color-contrast	Perceivable	Distinguishable
definition-list	Perceivable	Adaptable
dlitem	Perceivable	Adaptable
document-title	Operable	Navigable
duplicate-id-active	Robust	Compatible
duplicate-id-aria	Robust	Compatible
form-field-multiple-labels	Understandable	Input Assistance
frame-title	Robust	Compatible
heading-order	Best Practice	NA
html-has-lang	Understandable	Readable
html-lang-valid	Understandable	Readable
html-xml-lang-mismatch	Understandable	Readable
image-alt	Perceivable	Text Alternatives
image-redundant-alt	Best Practice	NA
input-button-name	Robust	Compatible
input-image-alt	Perceivable/Robust	Text Alternatives/Compatible
label	Robust	Compatible
link-in-text-block	Perceivable	Distinguishable
link-name	Operable/Robust	Navigable/Compatible
list	Perceivable	Adaptable

listitem	Perceivable	Adaptable
meta-refresh	Operable	Enough Time
meta-viewport	Perceivable	Distinguishable
object-alt	Perceivable	Text Alternatives
select-name	Robust	Compatible
skip-link	Best Practice	NA
tabindex	Best Practice	NA
table-duplicate-name	Best Practice	NA
td-headers-attr	Perceivable	Adaptable
th-has-data-cells	Perceivable	Adaptable
valid-lang	Understandable	Readable
video-caption	Perceivable	Time-based Media
empty-heading	Best Practice	NA
identical-links-same-purpose	Operable	Navigable
landmark-one-main	Best Practice	NA
target-size	Operable	Input Modalities
label-content-name-mismatch	Operable	Input Modalities
table-fake-caption	Perceivable	Adaptable
td-has-header	Perceivable	Adaptable