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Accessibility of banking websites in Central and Eastern European countries in relation to cost management

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Abstract

Purpose – This study evaluates the accessibility of websites for publicly listed commercial banks in Central and Eastern European (CEE) countries, with a specific focus on the relationship between website accessibility and bank cost management indicators.

Design/methodology/approach – We analyzed the websites of 26 publicly listed banks across nine CEE countries using the web accessibility evaluation tool (WAVE), a widely recognized tool for assessing website accessibility. We supplemented the analysis with cost management data, including general and administrative expenses and the cost-to-income (C/I) ratio, sourced from the Equity RT database and annual bank reports where necessary.

Findings – The study reveals significant disparities in website accessibility among publicly listed banks in the CEE region. Larger banks tend to have better website accessibility for individuals with disabilities. However, we found no significant relationship between cost management indicators, such as general and administrative expenses or the C/I ratio, and the number of accessibility errors reported by WAVE at national and individual bank levels.

Research limitations/implications – The study is limited to publicly listed banks in Central and Eastern Europe, which may not represent the broader banking sector in the region. Moreover, as the sole assessment tool, WAVE may not capture all dimensions of web accessibility.

Practical implications – The findings suggest that while larger banks may invest more in web accessibility, cost management practices do not directly influence website accessibility improvements. This could inform future strategies for banks aiming to enhance their digital inclusivity.

Originality/value – This research provides new insights into the relationship between bank size, cost management practices and web accessibility in the CEE region, contributing to the limited literature on digital inclusivity in the banking sector.

Keywords Web accessibility, Accessible banking, Retail banking, Banking services, Financial inclusion, Disability, Central and Eastern Europe, European regulations

Paper type Research paper

Introduction

Website accessibility refers to ensuring that websites are usable by as many people as possible, including those with disabilities. This concept is critical as it guarantees inclusivity and equal access to digital content. The impact of banking websites' accessibility on improving financial inclusion levels requires special attention. Financial inclusion ensures free access to and use of

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affordable financial products and services for all people and businesses that meet their needs. In the empirical literature, financial inclusiveness is crucial as it supports banking stability (Han & Melecky, 2013; Anton & Afloarei Nucu, 2024) and promotes economic well-being (Feghali, Mora, & Nassif, 2021). Moreover, enforcing laws and regulations such as the Americans with Disabilities Act (ADA) in the United States and the European Accessibility Act (EAA) in the European Union underscore the importance of web accessibility. Furthermore, the United Nations Convention on the Rights of Persons with Disabilities (CRPD), ratified by 174 countries, emphasizes the global commitment to ensuring equal access to information and communication technologies, including the Internet, for disabled people.

In Central and Eastern Europe, banking websites' accessibility is particularly significant. Central and Eastern European banks constitute a perfect laboratory for accessibility research as they are mostly foreign-owned and, therefore, focus on development through the high-quality standards of their shareholders. Moreover, banks in this region may be under pressure to fulfill all the necessary clients' needs to gain positive feedback from the market and increase their share in the sector. The financial sector is pivotal to the economy. Thus, it is essential to ensure that all users can access online banking services regardless of abilities. This is not only a matter of legal compliance but also aligns with the Sustainable Development Goals (SDG), particularly Goal 10, which aims to reduce inequality within and among countries. Furthermore, the European Union's Directive 2019/882, known as the European Accessibility Act, mandates that key products and services, including banking, must be accessible to people with disabilities.

We aimed to evaluate the accessibility of banking websites in Central and Eastern European countries, considering cost management indicators. Ensuring that banking websites are accessible is a legal and ethical obligation and a strategic advantage that can enhance customer satisfaction and loyalty. The article contributes to the existing literature in several ways. First, we analyzed how banking websites adhere to accessibility standards, with reference to the Web Content Accessibility Guidelines (WCAG) and the European standard EN 301 549, developed by the European Telecommunications Standards Institute (ETSI). These standards provide a technical foundation for evaluating accessibility compliance in alignment with the European Accessibility Act (EAA). Research on the accessibility of banking systems remains scarce, particularly for Central and Eastern European banks. Second, we accounted for the cost management measures and their links to the evaluation results of banking websites' accessibility. Third, we sought to understand the balance between regulatory compliance, inclusivity and economic efficiency. The rest of the article is structured as follows. The next section will provide the associated literature review. Then, we will develop the data and methodology, present the results and underline limitations and recommendations. Finally, we will present conclusions.

Literature review

Research areas regarding accessibility issues

Over the past decades, numerous studies have explored various aspects of web accessibility, from technical standards to user experience. In a systematic review, Nuñez, Moquillaza, and Paz (2019) used a predefined protocol to identify 343 studies, out of which they selected 20 for detailed analysis. Their research provides evidence that the most frequently used techniques for web accessibility evaluation are automatic tools (Acosta-Vargas, Luján-Mora, & Salvador-Ullauri, 2016; Acosta-Vargas, Acosta, & Luján-Mora, 2019; Vila, González, & Darcy, 2018; Gharbi, Bouraoui, & Bellamine Ben Saoud, 2018; Song *et al.*, 2018; Valizadeh-Haghi & Rahmatizadeh, 2018), expert evaluation (Baazeem & Al-Khalifa, 2015; Brajnik, Vigo, Yesilada, & Harper, 2016) and user tests (Calvo, Seyedarabi, & Savva, 2016; Mendoza-González, Zaphiris, & Loizides, 2018; Coughlan & Lister, 2018). Noteworthy, automated accessibility testing tools can detect a significant portion of accessibility issues but do not cover all aspects of the Web Content Accessibility Guidelines (WCAG). Studies have shown

that these tools can identify approximately 20–57% of accessibility issues (Deque report, 2021; Spillers, 2022), while manual review is approximately 80% (UsableNet, 2021). This is because automated tools may not fully assess dynamic components, complex forms or contextual dependencies, which are crucial for a comprehensive accessibility evaluation. Therefore, relying solely on automated tools may provide a partial view of a website's accessibility. Moreover, the study identifies the primary domains where scholars have conducted web accessibility assessments, with the most frequent being (1) education (Acosta-Vargas *et al.*, 2016; Gharbi *et al.*, 2018; Mendoza-González *et al.*, 2018; Coughlan & Lister, 2018), (2) government (Brajnik *et al.*, 2016; Calvo *et al.*, 2016), (3) health (Acosta-Vargas *et al.*, 2019; Valizadeh-Haghi & Rahmatizadeh, 2018) and (4) entertainment (Calvo *et al.*, 2016; Vila *et al.*, 2018). The literature devoted to the accessibility evaluation of banking systems is scarce, highlighting a gap in the literature we aimed to fill.

Accessibility of banking websites

In terms of banks, authors mostly investigate websites' accessibility but also consider their functionality, reliability and usability (Miranda, Cortés, & Barriuso, 2006; Nouman, 2012; Kaur & Dani, 2013; Lorca, De Andrés, & Martínez, 2016; Martínez, De Andrés, & García, 2014; Nazar, Sarfraz, & Shoaib, 2017; Oyefolahan, Sule, Adepoju, & Babakano, 2019; Pham, Wentz, Nguyen, & Pham, 2021; Wentz *et al.*, 2019; Fatima, Bawany, & Bukhari, 2020; Alhadreti, 2023). In parallel, scholars increasingly pay attention to the accessibility of banks' mobile applications (Wentz, Pham, & Tressler, 2017; Alayed, 2023; Borowska-Beszta, Smieszek, & Borowska-Beszta, 2023).

The methodology of studies is based on automated evaluation (Kaur & Dani, 2013; Lorca *et al.*, 2016; Martínez *et al.*, 2014; Nazar *et al.*, 2017; Oyefolahan *et al.*, 2019), manual validation (Miranda *et al.*, 2006; Wentz *et al.*, 2019; Pham *et al.*, 2021; Alayed, 2023) or the compilation of these both approaches (Alhadreti, 2023). Furthermore, Wentz *et al.* (2017) provided survey results and Fatima *et al.* (2020) relied on questionnaires showing users' perspectives. Moreover, Borowska-Beszta *et al.* (2023) used a descriptive case study method based on analytical induction.

For accessibility assessment, scholars use automated evaluations tools such as Achecker (Nazar *et al.*, 2017; Oyefolahan *et al.*, 2019; Fatima *et al.*, 2020), Atenea (Lorca *et al.*, 2016; Martínez *et al.*, 2014), TAW (Kaur & Dani, 2013; Martínez *et al.*, 2014; Alhadreti, 2023), Wave (Oyefolahan *et al.*, 2019; Fatima *et al.*, 2020) or WCGA (Wentz *et al.*, 2019; Pham *et al.*, 2021). Less commonly, total validator (Alhadreti, 2023), Markup Validation Service (Nazar *et al.*, 2017) and the validation of HTML and CSS (Nazar *et al.*, 2017; Alhadreti, 2023). Moreover, Nazar *et al.* (2017) employed W3C, Valet tool or Eval Access and Martínez *et al.* (2014) used Hera or HiSoftware Cynthia Says. There are also other tools that researchers apply even more rarely, for instance, MAUVE++, (Alhadreti, 2023), AW (Fatima *et al.*, 2020), WAI (Miranda *et al.*, 2006) or European Internet Inclusion Initiative (EIII) Tool (Oyefolahan *et al.*, 2019). While automated tools play an essential role in initial assessments, they have inherent limitations. They typically verify only around 30% of WCAG criteria, with the remaining 70% requiring manual human evaluation. This challenge is particularly relevant in banking platforms, where dynamic content and transactional systems often necessitate nuanced human interpretation to identify genuine accessibility barriers.

Bank samples vary between articles, but most constitute a one-country study. More specifically, authors examine such countries as India (Kaur & Dani, 2013), Nigeria (Oyefolahan *et al.*, 2019), Pakistan (Nouman, 2012; Nazar *et al.*, 2017; Fatima *et al.*, 2020), Saudi Arabia (Alayed, 2023; Alhadreti, 2023), Spain (Miranda *et al.*, 2006; Lorca *et al.*, 2016) and USA (Wentz *et al.*, 2017, 2019; Pham *et al.*, 2021). Only Borowska-Beszta *et al.* (2023) explored Poland, and Martínez *et al.* (2014) analyzed 11 European countries excluding Poland. Practical considerations such as data availability, regulatory differences and resource constraints often drive the dominance of single-country studies. However, this focus may limit

the findings' generalizability, as accessibility standards and implementation challenges can vary significantly between countries. Authors do not always clearly outline the selection process of banks from these countries. For example, Martínez *et al.* (2014) analyzed 49 European banks whose shares were included in the Dow Jones EURO STOXX TMI Banks Index, and Pham *et al.* (2021) focused on the 18 largest national banks regarding the number of branches. The other authors simply indicate the number of banks considered for the analysis purposes, which fluctuates between 10 banks (Oyefolahan *et al.*, 2019; Fatima *et al.*, 2020), through 15 banks (Nazar *et al.*, 2017), 32 banks (Alhadreti, 2023), 48 banks (Kaur & Dani, 2013), 73 banks (Lorca *et al.*, 2016), 98 banks (Miranda *et al.*, 2006) and finally 100 banks (Wentz *et al.*, 2019).

Studies' timeline is onefold. It means that this research type aims at a specific period, namely between April and May 2004 (Miranda *et al.*, 2006), December 2015 and February 2016 (Wentz *et al.*, 2017), December 2016 and January 2017 (Wentz *et al.*, 2019) or from February 2022 to July 2022 (Borowska-Beszta *et al.*, 2023). Some researchers focus also on one month, such as January 2009 (Lorca *et al.*, 2016; Martínez *et al.*, 2014).

A limited number of studies include bank-level data in websites' accessibility evaluation. Alhadreti (2023) employs net Income and total assets, whereas Pham *et al.* (2021) use the number of branches, number of closing branches, total deposits and ROEA. The studies of Lorca *et al.* (2016) and Martínez *et al.* (2014) contain the broadest scope of bank-level variables. Lorca *et al.* (2016) focus on performance measured by operating income to total equity, income before tax to total equity, net income to total equity and bank size reflected by total assets and equity funds. Martínez *et al.* (2014) employ the same bank performance measures. However, the authors additionally quantify bank size as the number of employees and include CSR commitment proxied by DJSI status as well as by FTSE4 Good status.

Regarding banking websites' accessibility, research findings are quite conclusive. Authors provide evidence of a low level of conformance with Web Content Accessibility Guidelines (WCAG) (Kaur & Dani, 2013; Fatima *et al.*, 2020; Alayed, 2023; Alhadreti, 2023). More specifically, Kaur and Dani (2013) show that only 12 out of 48 websites conform to the minimum requirements of WCAG 1.0, and none of the websites fulfill the criteria applicable to WCAG 2.0. These results indicate that the accessibility of banking websites is not very satisfactory for their users. Further, Fatima *et al.* (2020) claim that most of the banking websites under the study do not adhere to usability principles. Similarly, these websites do not follow WCAG 2.0. Finally, Alhadreti (2023) and Alayed (2023) demonstrate that the banking websites under evaluation do not conform fully to WCAG 2.1, thus reducing the customers' ability to use the websites fully. Moreover, in terms of WCAG implementation, Lorca *et al.* (2016) show that smaller banks are more prone to meet these specific requirements, allowing them to receive some benefits in market competition. According to the European Accessibility Act, which mandates the accessibility of digital services, including retail banking services, all banking websites and mobile applications must meet the relevant accessibility standards. This directive applies to financial institutions across the European Union, requiring them to adapt their online platforms to accessibility requirements so that people with various disabilities can use banking services equally and fully. Implementing this directive is still ongoing in many EU countries, and banks are adjusting their platforms to meet the new requirements, so these regulations represent a significant step towards greater digital inclusion. In this context, WCAG 2.2, which introduces new accessibility criteria, may become crucial for the banking sector. Although WCAG 2.2 is not yet widely applied in this industry, its guidelines, such as new provisions for interface interactions and accommodations for people with different disabilities, constitute an important aspect that requires consideration in future research on the accessibility of banking websites and applications. Adhering to these standards in the future will be essential for compliance with regulations, enhancing user satisfaction and promoting the social inclusion of users of digital banking services. Noteworthy, scholars based many earlier studies primarily on WCAG 2.0 or 2.1, which may represent a limitation in the context of current requirements.

Many authors postulate a need for an enhanced adoption of website accessibility criteria. As noted by Nazar *et al.* (2017) and Oyefolahan *et al.* (2019), most banking websites are not completely accessible to disabled people, leading to their discrimination. Indeed, it constitutes a strong reason for the substantial improvements of these websites in inclusion, security and privacy. Wentz *et al.* (2017, 2019) also see this issue as a priority. Contrary to those studies, Borowska-Beszta *et al.* (2023) examine banking mobile applications and confirm their partial adaption to the needs of people with disabilities, underlying that some of them exert functionalities dedicated to disabled people.

Some studies also consider specific features of banks and their relation to website accessibility levels. One of the most common issues is an ownership structure. Kaur and Dani (2013) differentiate between public and private sector banks, Miranda *et al.* (2006) classify banks as private or savings and Alhadreti (2023) distinguishes between local and foreign banks. None of them has proven any association between the owner type and the number of accessibility issues detected. Authors also pay attention to the bank size. However, this control variable does not affect the accessibility level fulfillment either (Martínez *et al.*, 2014; Alhadreti, 2023). Less commonly used bank characteristics with no influence on the accessibility assessment of banking websites are profitability level (Alhadreti, 2023), operational factors and CSR commitment (Martínez *et al.*, 2014). Moreover, Pham *et al.* (2021) consider the trend of branch closing and its inevitable impact on the need to improve the online accessibility of banking services.

In summary, there is a growing need to overcome existing difficulties regarding banking websites' accessibility. Hitherto, the research found that banks lack guidelines and principles in this field, which restricts high user satisfaction. Furthermore, there is an urgent need for further research into the economic factors influencing the implementation of accessibility, particularly in terms of the costs and benefits for banks. While there is substantial research on the technical aspects of accessibility, research has paid less attention to the financial implications of these implementations.

The key gap in the existing literature is the lack of studies exploring the costs involved in making banking websites accessible and the long-term financial benefits that might arise from such investments, such as increased customer satisfaction and broader market reach. Understanding the economic trade-offs between the costs of implementing accessibility features and the potential returns on investment is crucial for banks to make informed decisions in this area. Moreover, there is a need to assess how banks can effectively manage resources to ensure that accessibility initiatives are both financially sustainable and compliant with relevant regulations.

Sample and methodology

Data collection

We focused on publicly listed commercial banks in Central and Eastern European countries. We used the EquityRT database to gather data on the cost efficiency of those banks. According to the study criteria set, the database included 28 banks. However, we excluded two banks due to technical errors encountered during the website accessibility measurement. Consequently, the final sample consisted of 26 publicly listed banks from nine Central and Eastern European countries, all of them being EU members: Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Lithuania, Poland, Romania and Slovenia.

Sample characteristics

Figure 1 shows the distinction between the 26 banks analyzed in each of the nine countries.

In line with Figure 1, Polish banks dominated our sample. There were nine banks from Poland, which constitutes 35% of the total number of analyzed banks. Then, Bulgaria, Croatia and Romania are represented by three banks each. This means that banks from every of these

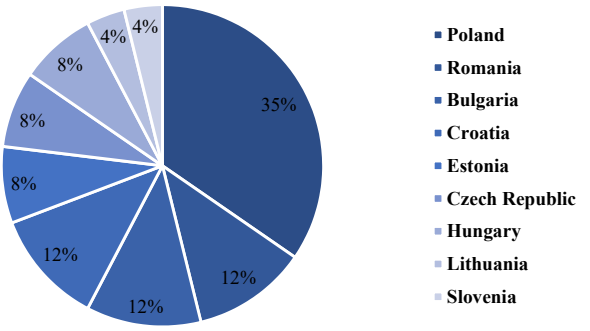

Figure 1. The share of banks by countries in a total sample. Source: Own elaboration

countries account for 12% of the total sample. Consequently, the Czech Republic, Estonia and Hungary were represented by two banks each. In turn, it corresponded to 8% of all analyzed banks. Finally, Lithuania and Slovenia had only one bank each, constituting 4% of the total sample. Considering the varying numbers of banks in countries, we decided to check the size of those banking sectors measured by the sum of total assets. Figure 2 represents it graphically.

Figure 2 shows that the sum of bank assets was the largest in Romania and then in Poland. Following these countries, there were the Czech Republic and Slovenia. The rest of the countries were below the average size of analyzed banks by countries, which equaled 23,557 mln euro. The smallest countries in terms of total sum of banking assets are Romania, Croatia, Bulgaria, Lithuania and Estonia. Interestingly, the sum of banking assets by countries does not overlap with the specific number of analyzed banks.

Web accessibility evaluation procedures

In evaluating web accessibility for banking websites in Central and Eastern European countries, we employed a comprehensive approach using the Web Accessibility Evaluation (WAVE) tool. We chose it based on the systematic analysis by Acosta-Vargas *et al.* (2019), which compared various automated accessibility evaluation tools, including WAVE, AccessMonitor, Tenon, TAW and Web Accessibility Checker. The comparison criteria included the license cost, the nature and form of the result presentation and the tools' usability, with WAVE scoring the highest on a scale from 1 to 100.

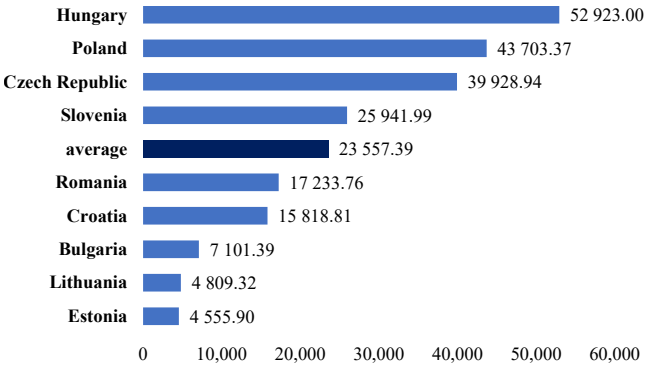

Figure 2. Total assets of banks by countries (mln euro). Source: Own elaboration

We evaluated the accessibility of banking websites listed on the stock exchanges in Central and Eastern European countries in April 2024. We used the Conformance review method, as highlighted by Kaur and Dani (2013), who employed an analytical approach based on standards and guidelines, incorporating computer-aided testing with accessibility tools.

The WAVE tool provides a detailed analysis of web accessibility issues, categorized into various metrics. For our study, we used the following WAVE metrics:

(1) ***Wave errors:*** counts the critical accessibility errors that need to be addressed.

(2) ***Wave contrast errors:*** identifies issues related to insufficient color contrast.

(3) ***Wave alerts:*** highlights potential accessibility issues that may require human review.

(4) ***Wave features:*** indicates features that enhance accessibility.

(5) ***Wave structural elements:*** evaluates the structural elements of the web pages, such as headings and landmarks.

(6) ***Wave ARIA:*** assesses the implementation of Accessible Rich Internet Applications (ARIA) attributes.

We conducted the accessibility analysis on the home pages and main navigation pages of the banking websites. We assessed each page using the WAVE tool, recorded the results and analyzed them to identify common accessibility issues and improvement areas.

However, we acknowledge a key methodological limitation regarding automated testing. While tools like WAVE are valuable for providing initial insights into accessibility issues, their results require expert human interpretation to verify whether flagged issues constitute actual barriers. Automated tools like WAVE also face technical limitations when analyzing certain web technologies commonly used in banking platforms, such as dynamic or transactional systems. These limitations may result in undetected issues that significantly affect these platforms' accessibility. While our study focuses on the outputs of WAVE, future research should consider integrating manual reviews to address these gaps and provide a more holistic understanding of accessibility performance.

Cost management indicators

From the perspective of cost management by banks, we could argue that the amount of money spent on website adaptation to accessibility standards is included in the income statement, namely under the position of general and administrative expenses. This category comprises many other expenses, but the limitation of the EquityRT database did not allow us to gather data only on one specific cost category devoted to the IT expenses, and with high probability, IT expenses are the expenses for accessibility adaptation processes. For this reason, we had to use the general and administrative expenses as a whole to analyze the link between the bank spending level and the website accessibility evaluation. However, we complemented this measure by using the cost-to-income (C/I) ratio. This is a common indicator that many authors use in the banking literature to control how efficiently a bank operates by reflecting management cost decisions (Pasiouras & Kosmidou, 2007; Goddard, Liu, Molyneux, & Wilson, 2013; Trujillo-Ponce, 2013). Consequently, the research found that this ratio reduces bank profitability (Dietrich & Wanzenried, 2014; Davis, Karim, & Noel, 2022). We assumed that higher values of this ratio should ensure better website accessibility levels in banks as more money could be spent on website development.

Results

WAVE evaluation

Table 1 presents the results of the accessibility evaluation of the banking websites in Central and Eastern European countries based on the WAVE metrics. The obtained measures indicated a significant variance in accessibility issues across the evaluated websites.

Table 1. Descriptive statistics of errors detected by WAVE for analyzed banks

Wave metrics	Sum	Average	Min	Max
Wave errors	383	14	2	98
Wave contrast errors	359	13	0	69
Wave alerts	1,349	50	5	254
Wave features	674	25	4	88
Wave structural elements	1,607	60	14	127
Wave ARIA	2,571	95	0	441

Source(s): Own elaboration

The wave errors metric, with a sum of 383, revealed that, on average, each website had 14 errors. This suggests a moderate level of critical accessibility issues, with individual websites showing a range from 2 to 98 errors. This variation indicates that while some websites are close to being error-free, others require substantial improvements. The most common errors (Table 2) included missing alternative text (109 instances), empty links (88 instances), empty buttons (57 instances), linked images, missing alternative text (34 instances) and missing form labels (32 instances). The Wave contrast errors metric highlights challenges with color contrast, which is crucial for users with visual impairments. The total count of 359 contrast errors averaged out to 13 per website. Some websites exhibited no contrast issues, while others had up to 69, demonstrating inconsistent adherence to color contrast standards across the websites.

In terms of wave alerts, there was a high total of 1,349 alerts, averaging 50 per website. These alerts point to potential accessibility issues that may need further human review. The number of alerts per website varied widely, from 5 to 254, indicating a broad spectrum of potential accessibility challenges that need to be addressed. The most common alerts (Table 3) included redundant title text (506 instances), justified text (238 instances), redundant link (190 instances), noscript element (61) and possible heading (57).

The evaluation also considered wave features, with a sum of 674 features identified, averaging 25 per website. These features, which enhance accessibility, varied significantly between websites, ranging from 4 to 88. This suggests that while some websites are incorporating numerous accessibility-enhancing features, others have room to integrate more. The most common features (Table 4) included linked images with alternative text (173), null or empty alternative text (154) and alternative text (124).

We also assessed wave structural elements with a total of 1,607 elements, averaging 60 per website. These elements are critical for navigation and accessibility. The range of structural elements per website varied from 14 to 127, indicating varying levels of complexity and

Table 2. A list of the most common errors detected by WAVE for analyzed banks

Errors	No. of errors
Missing alternative text	109
Empty link	88
Empty button	57
Linked image missing alternative text	34
Missing form label	32
Other	62

Source(s): Own elaboration

Table 3. A list of the most common alerts detected by WAVE for analyzed banks

Alerts	No. of alerts
Redundant title text	506
Justified text	238
Redundant link	190
Noscript element	61
Possible heading	57
Broken same-page link	44
Other	246

Source(s): Own elaboration

Table 4. A list of the most common features detected by WAVE for analyzed banks

Features	No. of features
Linked image with alternative text	173
Null or empty alternative text	154
Alternative text	124
Language	100
Form label	68
Other	55

Source(s): Own elaboration

thoroughness in the structuring of web content. The most common structural features (Table 5) identified include an unordered list (846), heading level 3 (229) and heading level 2 (215).

The wave ARIA metric, which recorded the highest sum at 2,571, had an average of 95 instances per website. Accessible rich internet applications (ARIA) attributes are essential for making dynamic and interactive content accessible. The wide range, from 0 to 441 ARIA attributes per website, highlighted different levels of ARIA implementation. Some websites fully embraced ARIA to enhance accessibility, while others have yet to implement these critical attributes. The most common ARIA instances (Table 6) included ARIA2 (851), ARIA tabindex (558) and ARIA label (466).

The accessibility evaluation of banking websites in Central and Eastern European countries revealed notable similarities and differences (Figure 3). Several countries exhibited moderate

Table 5. A list of the most common structural features detected by WAVE for analyzed banks

Structural features	No. of structural features
Unordered list	846
Heading level 3	229
Heading level 2	215
Navigation	70
Heading level 4	60
Other	174

Source(s): Own elaboration

Table 6. A list of the most common ARIA instances detected by WAVE for analyzed banks

ARIA	No. of ARIA
ARIA2	851
ARIA tabindex	558
ARIA label	466
ARIA hidden	377
Other	319

Source(s): Own elaboration

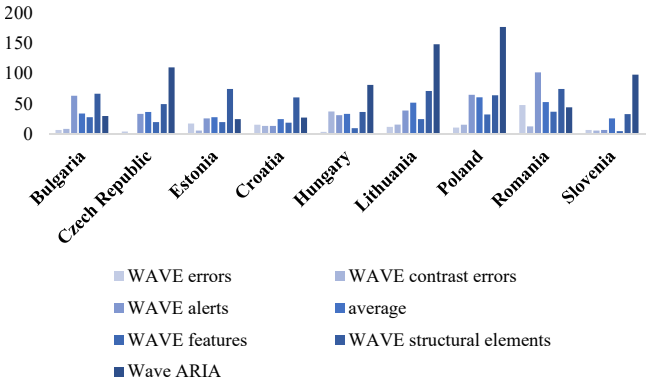

Figure 3. The results of accessibility evaluation of the banking websites by countries. Source: Own elaboration

levels of WAVE errors and alerts. For instance, Bulgaria, the Czech Republic, Estonia, Croatia and Slovenia had WAVE errors ranging from 5 to 18 and alerts between 7 and 63. These countries generally maintained an average error count per website between 25 and 37, indicating a consistent pattern of accessibility challenges. We observed significant disparities in specific metrics across the countries. Romania stands out with the highest number of WAVE errors (48) and alerts (102), indicating more severe accessibility issues. Poland also reported high average errors per website (61) and the highest ARIA instances (176), suggesting both substantial issues and extensive use of dynamic content accessibility features. Conversely, Hungary showed the lowest WAVE errors (4) but faced challenges with many contrast errors (38). Lithuania and Romania had the highest average errors per website, at 52 and 53, respectively, reflecting broader issues.

In summary, the evaluation results underscored the disparities in accessibility compliance among banking websites in Central and Eastern Europe. While some websites demonstrated commendable adherence to accessibility standards, others exhibited significant deficiencies, particularly in critical error counts and ARIA implementation. These findings highlight the necessity for targeted improvements to enhance web accessibility across the banking sector, fostering a more inclusive digital environment for all users. However, we must acknowledge the limitations of relying solely on automated testing tools like WAVE, which can only provide partial insight into accessibility compliance. Automated tools are particularly limited in evaluating dynamic or transactional content, which is prevalent in banking platforms. Overall, while many countries showed moderate levels of accessibility issues, significant variations in specific metrics highlight the need for targeted improvements in some regions to enhance web accessibility consistently across the sector. These findings emphasize the foundational role of the Web Content Accessibility Guidelines (WCAG) as a benchmark for defining digital

accessibility requirements, underscoring their importance in guiding banks toward creating accessible digital platforms.

The relation between bank cost-effectiveness and websites accessibility

The last part of our analysis related to links between bank cost efficiency and their website accessibility assessment. In the beginning, we followed studies by Alhadreti (2023) and Martínez *et al.* (2014), accounting for the bank size and its link to the WAVE evaluation results.

As part of the study, we divided the analyzed group of banks into two categories based on their total assets: banks with above-average total assets and banks with below-average total assets. An analysis of accessibility metrics using the Wave tool for both groups of banks (Table 7) showed that in five out of six metrics, larger banks had a lower average number of accessibility issues. This indicates that, overall, the websites of larger banks are better adapted to the needs of people with disabilities.

However, in the area of contrast errors, smaller banks demonstrate better adaptation of their websites. This suggests that smaller banks have achieved better results in this specific metric, possibly indicating greater attention to visual aspects and content readability on their websites.

The scatter plot (Figure 4) illustrates the relationship between the total assets of the analyzed banks (*x*-axis) and the average number of accessibility errors (*y*-axis). Each point on the plot represents an individual bank. Among the smaller banks, there appeared to be a positive link between total assets and the average number of accessibility errors. This indicates that, within this group, banks with larger total assets tend to have more accessibility errors on their websites. The largest banks, those with the highest total assets, generally exhibit an average number of errors. This suggests that while these banks may have more resources, they do not necessarily have the fewest errors but rather have a moderate level of accessibility compliance.

Table 7. Bank size and accessibility metrics by WAVE

Size	Wave errors	Wave contrast errors	Wave alerts	Wave features	Wave structural elements	Wave ARIA
Above average total assets	5	69	21	9	51	71
Below average total assets	17	13	53	27	64	109

Source(s): Own elaboration

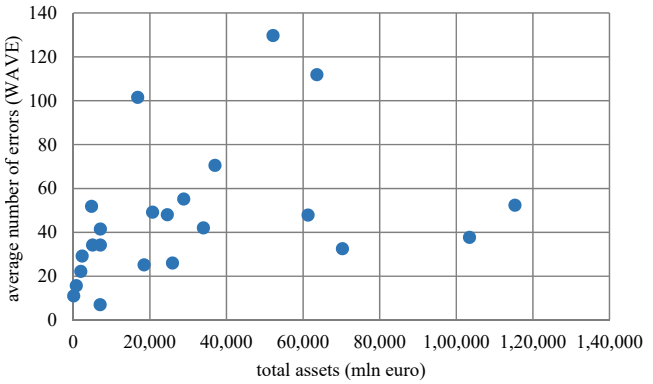

Figure 4. Scatter plot of banks' total assets and average number of errors. Source: Own elaboration

In the next step, we focused on general and administrative expenses and the C/I ratio as we believe they do have a high potential to determine the banking websites' accessibility level. We grouped the average values of general and administrative expenses and the C/I ratio by country, along with the average number of errors displayed by banks in these given countries. Figures 5 and 6 represent it, respectively.

Figures 5 and 6 show that there is no clearly stated link between cost management measured by general and administrative expenses or C/I ratio and the average number of errors by countries. Thus, the amount of bank expenses is not reflected in the websites' accessibility compliance in given countries. Similarly, the C/I ratio does not determine the level of banking websites adaption for the needs of disabled people. Consequently, WAVE statistics do not seem to be affected by bank cost management throughout countries.

Considering that there is no evident association between the bank cost management and the average number of errors calculated for each country, we checked the same relationship for individual banks. Figures 7 and 8 represent this attitude.

As Figure 7 indicates, the lower the general and administrative expenses, the lower the average number of errors by banks. In general, it is not in line with the assumption that higher

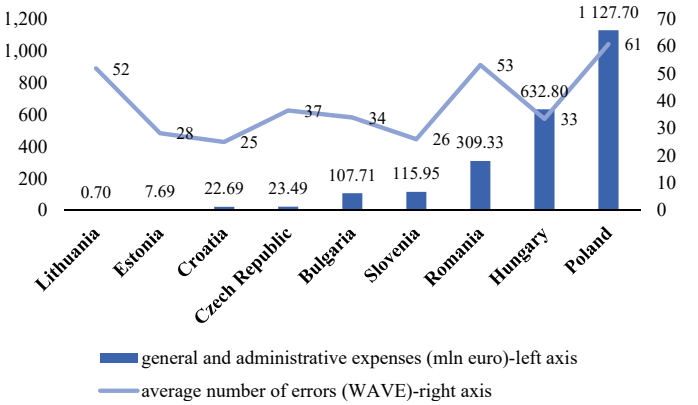

Figure 5. General and administrative expenses and average number of errors by countries. Source: Own elaboration

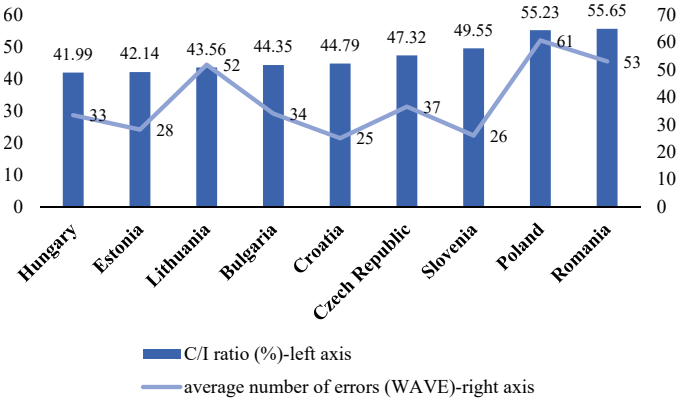

Figure 6. C/I ratio and average number of errors by countries. Source: Own elaboration

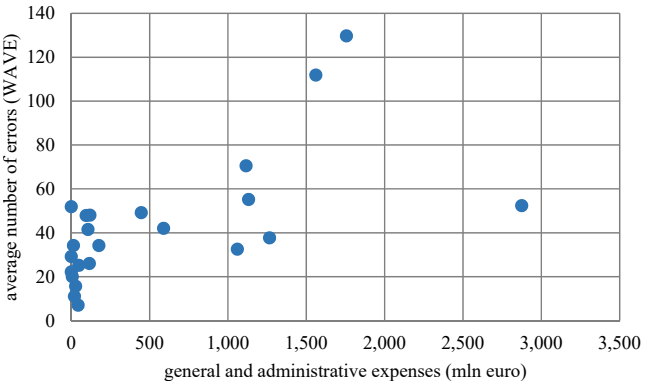

Figure 7. Scatter plot of general and administrative expenses and average number of errors by banks. Source: Own elaboration

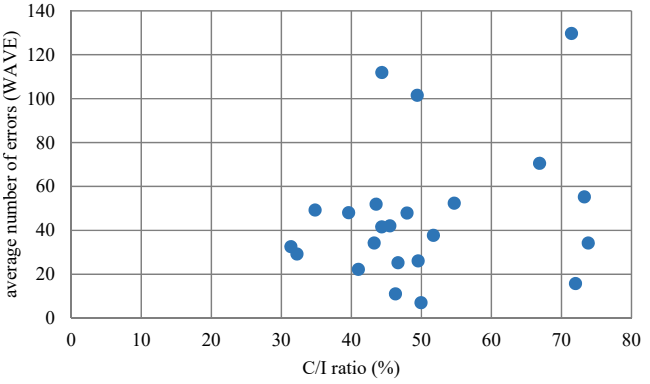

Figure 8. Scatter plot of the C/I ratio and average number of errors by banks. Source: Own elaboration

spending in this category cost relates to better banking websites' accessibility. Moreover, Figure 8 does not confirm that banks that displayed higher C/I ratios were the banks with some IT investments reflected in the accessibility area improvement. We did not observe any trend in the C/I ratio level or the average number of errors by banks.

To sum up, it is not possible to point towards any dependence between cost management measures, and the average number of errors for both categories, country level and individual bank bank-level means that there is no clear statement describing the level of bank expenses and meeting the accessibility requirements. In other words, the cost management policy does not seem to be linked to the accessibility of banking websites in Central and Eastern European countries, as quantified by WAVE indicators.

These findings may stem from several factors. One possible explanation is the inherent limitations of the WAVE tool, which, while effective for identifying certain accessibility issues, does not capture the full range of accessibility barriers, particularly those requiring nuanced human judgment. Moreover, many banks in Central and Eastern Europe are likely in the process of adapting to the recently introduced WCAG 2.2 guidelines. As a result, neither the financial expenditures allocated to accessibility improvements nor the measured accessibility performance fully reflect the outcomes of these ongoing efforts.

Study limitations and recommendations

Banks should ensure that their websites comply with the latest Web Content Accessibility Guidelines (WCAG 2.2) to make their digital services more accessible to all users, including those with disabilities. It is crucial to raise awareness among web designers regarding accessibility requirements, equipping them to create inclusive and user-friendly websites. Policymakers should not only introduce regulations concerning web accessibility but also consider mechanisms for enforcing these regulations. This could involve setting up monitoring systems and imposing penalties for non-compliance to ensure that accessibility standards are met. Furthermore, greater involvement of people with disabilities in the testing of bank websites is essential. Their feedback can provide valuable insights into the practical usability of these websites and highlight areas needing improvement.

We limited this study to publicly traded banks in nine selected countries of Central and Eastern Europe, so the findings may not be representative of banks in other regions or those that are not publicly traded. The assessment of website accessibility was conducted using the WAVE tool. While effective, there are many other tools available, many of which are paid services. Future studies could benefit from combining automated evaluations with expert reviews and user testing to provide a more comprehensive analysis of web accessibility issues. Moreover, for technical evaluations, it would be valuable to conduct usability studies involving people with disabilities to better understand their experiences and challenges when navigating bank websites.

We based the analysis concerning cost management indicators solely on data from 2023. Perhaps we could observe more significant relationships if we analyzed data from multiple years. The authors plan to repeat this study in two to three years to determine whether there has been an improvement in the accessibility of bank websites and to assess the associated costs over time.

Conclusions

Website accessibility constitutes one of the most important concepts in terms of equality and inclusivity for all people using digital services. It is crucial not only from the perspective of societal goals but also the economy as a whole, in particular for the financial sector. Although the awareness regarding disability increases in many institutions, there exist some requirements that have to be met to fulfill the special needs of disabled people. They regard both technical standards and user experience. In the last few years, scholars have paid more and more attention to the accessibility of banking websites and their functionality, reliability and usability. One of the most significant documents determining whether banks provide digital services in a way convenient for disabled people is the Web Content Accessibility Guidelines (WCAG 2.2).

Using the WAVE tool, we have evaluated the website accessibility of 26 publicly listed commercial banks from nine Central and Eastern European countries. We show that most banks suffer from severe accessibility errors. However, there is a significant variance in accessibility issues across the evaluated websites. Moreover, at the country level, we also observed the disparities in accessibility compliance among Central and Eastern European banking websites. Further, considering the bank cost management, there is no clearly stated link between the general and administrative expenses or the C/I ratio and the average number of errors by countries and banks. This indicates no direct impact of the bank expenses policy and its spending on accessibility activities to ensure compliance with requirements arising from disability issues. Ultimately, it is worth noting that the accessibility errors detected using the WAVE tool show areas for potential improvement. Thus, on the one hand, our study underlines the growing need for banks to adapt their banking websites to the needs of disabled people, creating a more inclusive digital environment for all digital users. On the other hand, it shows the essential direction of changes for Central and Eastern European banks.

Our findings are crucial for bank managers and policymakers. The policy implications of banking website accessibility are vital for financial inclusion, regulatory compliance and equal access to essential services. As financial services move online, inaccessible websites can pose major challenges for people with disabilities. Policies regulating accessibility, such as adherence to the Web Content Accessibility Guidelines (WCAG 2.2), aim to ensure that all users have equal access to banking websites. Noncompliance erodes public trust and alienates a sizable part of potential customers. Furthermore, accessible banking websites encourage financial literacy and independence, hence increasing social and economic participation. Policymakers and bank managers should not only cooperate to create and implement accessibility guidelines but also establish regular audits and enforceable benchmarks to ensure continuous improvement. By prioritizing accessibility in the digital financial sector, they can foster trust, enhance user satisfaction and build a truly inclusive financial system that benefits everyone.

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