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Evaluating the Accessibility, Usability, and Security of Corporate Investor Relations Web Pages: A Case Study of the Turkish Stock Market



Merve Garip¹ & Serhat Peker¹

¹ İzmir Bakırçay University, Department of Management Information Systems, İzmir, Türkiye

Abstract

This study investigates the accessibility, usability, and security of investor relations (IR) web pages of 53 companies listed on the Istanbul Stock Exchange (BIST), focusing on both BIST-30, representing the most liquid and highly capitalized companies, and BIST-2022, companies that had their initial public offerings (IPOs) in 2022. Using automated testing tools, the analysis examines adherence to the WCAG 2.1 guidelines, mobile responsiveness, and security measures. The findings reveal that accessibility issues, particularly related to the robust and perceivable principles, are prevalent across the assessed web pages, with BIST-30 companies showing a higher rate of errors. While BIST-2022 companies generally performed better in usability, with faster loading times and fewer broken links, security assessments indicated low to medium risks across both categories. This study contributes to the limited literature on the quality assessment of corporate IR web pages and highlights the necessity for enhancements in accessibility, usability and security, providing valuable insights for web administrators and developers to improve the quality of IR web pages.

Keywords

Human Computer Interaction • Website Performance Evaluation • Automated Testing Tools • Corporate Websites • Investor Relations



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✉ Corresponding author: Serhat Peker serhat.peker@bakircay.edu.tr



Introduction

Websites have evolved into powerful universal communication tools, serving as platforms for information sharing, interaction, and engagement. In this digital age, it is crucial to recognize the importance of designing, usable, and secure. Accessibility ensures that individuals of all abilities and disabilities can access and navigate the website, regardless of their physical, sensory, or cognitive limitations (Sevilla, Herrera, Martínez, & Alcantud, 2007). Incorporating accessible design elements, like adding alternative text for images, using straightforward language, and enabling keyboard navigation, makes websites inclusive, allowing all users to fully engage with the online experience. Usability focuses on creating intuitive and user-friendly interfaces that enable seamless navigation and interaction (Kumar et al., 2023). By understanding user behaviors and preferences, designers can optimize the layout, structure, and functionality of websites, thereby enhancing user satisfaction and engagement. Usable websites are efficient, well-organized, and provide clear calls to action, enabling visitors to easily find the information they need and accomplish their goals. In today's digital landscape, where online threats and data breaches are common, ensuring website security is also crucial. This requires implementing strong security measures like encryption, secure authentication, and consistent software updates (Chatterjee, Gupta, & De, 2013; Sicari, Rizzardi, Grieco, & Coen-Porisini, 2015). By prioritizing security, websites protect user data, maintain trust, and safeguard sensitive information.

In today's competitive business landscape, corporate websites serve as powerful instruments for facilitating communication between companies and their stakeholders (Brennan & Merkl-Davies, 2018). Corporate websites also serve as the primary platform for disseminating Investor Relations (IR) information to a wide range of stakeholders, including current and potential investors (Halim, Basiruddin, & Ali, 2015). The purpose of Investor Relations (IR) is to attract and retain investors by effectively communicating the company's financial performance, strategic direction, and future prospects. By offering detailed financial reports, annual statements, investor presentations, and other relevant materials, companies demonstrate transparency and accountability, instilling confidence and trust among investors. The availability of IR information on corporate websites is crucial as it allows investors to make informed decisions about their investment choices. Moreover, it enables companies to showcase their strengths, competitive advantages, and growth strategies, attracting new investors and retaining existing ones. By prioritizing Investor Relations on their corporate websites, companies can establish strong investor relationships, enhance their market credibility, and foster long-term investment partnerships that contribute to their sustained success.

Recognizing the pivotal role of corporate websites in today's competitive business landscape, this research aims to assess the usability, accessibility, and security of investor relations web pages of companies listed on the Istanbul Stock Exchange in Turkey. Our comprehensive analysis covers 53 web pages, using automated testing tools to scrutinize various aspects such as adherence to accessibility guidelines, loading speed, broken links, and security measures. The results of these analyses offer valuable insights into the overall performance of corporations in their online presence for effective Investor Relations (IR) communication. This research offers a nuanced understanding of how these corporate websites facilitate communication with investors, contributing valuable insights to the limited literature available on the quality assessment of corporate IR web pages.

Related Work

Many studies have been undertaken to assess corporate websites. This section examines studies of corporate websites, and each study provides valuable insights into the distinct aspects of web quality

and accessibility. For instance, Fogli and Guida (2013) presented an innovative quality model for corporate websites, highlighting the essential concepts of ultimate quality, external quality, and internal quality. The emphasis on these three key dimensions provides a nuanced perspective on the overall quality of corporate websites, considering both user satisfaction and organizational objectives. While exploring the quality of other websites, Fogli and Guida (2015) introduced a viewpoint on website quality, emphasizing stakeholder relationships. The research aligns the concept of quality with stakeholder perspectives, distinguishing final quality for site owners from quality in use, basic quality, and internal quality for users, service managers, and designers.

Other studies have also delved into the analysis of business websites. Huang and Cappel (2012) evaluate and contrast the website usability of INC. 500 companies using 11 distinct measures of usability. The study aims to determine the extent to which companies follow selected website usability guidelines and to identify any differences between the Fortune 500 and INC. 500 companies in this regard. In the initial assessment, it is evident that Fortune 100 companies have enhanced the accessibility of their websites throughout the study period (Loiacono, Romano, & McCoy, 2009). In another study, Loiacono and McCoy (2004) investigated and compared the accessibility of websites in the federal government, nonprofit, and corporate sectors for people with disabilities. The study reveals that federal government websites are significantly more accessible than those of non-profits and corporations.

Examining web accessibility in the corporate context, Singh and Singh (2020) explore the web accessibility of corporate information disclosed by 100 major Indian companies listed on the BSE. Their objective was to identify the factors that impact the accessibility of this information. Their results reveal that larger, more established Indian firms with lower risk tend to have websites with better accessibility, around 55%, emphasizing the significance of web accessibility for effective corporate communication. Additionally, Leitner et al. (2016) aimed to study an exploratory case study across three industry sectors to examine organizations' motivations, consequences, and determinants regarding the implementation of Web accessibility standards, aiming to illuminate managerial rationales and support better decision-making in organizations. Consequently, only 12% of the assessed websites successfully met the accessibility criteria.

The web accessibility practices of 311 Dow Jones Sustainability World Index-listed firms were evaluated through a content analysis of adherence to World Wide Web Consortium (W3C) guidelines by Conte et al. (2022). This study identifies variations in corporate accessibility practices for disabled users, offering insights to enhance alignment with sustainability objectives. Advancing in the investigation of web accessibility, Gonçalves et al. (2013) assessed web accessibility among the top 250 Forbes enterprises, revealing significant shortcomings and emphasizing the ethical responsibilities of leaders. It reveals a significant need for improvement in web accessibility levels among the Forbes 250 largest enterprises, indicating widespread errors and low compliance with established standards.

Embarking on an in-depth analysis, Ashbaugh et al. (1999) investigated the practice of Internet Financial Reporting (IFR) among firms, assessing the extent to which they utilize the internet to enhance the relevance of their financial reporting. The study examines firms' IFR practices, finding substantial variation in quality and timeliness, with 70% of the sampled firms engaging in IFR, and discusses implications for stakeholders. Xiao et al. (2004) examined the factors that impact the voluntary adoption of Internet-based financial reporting by Chinese listed companies, along with the extent of their disclosures. The results, derived from an analysis of the top 300 listed Chinese companies, indicate that choices in Internet-based disclosure are influenced by particular attributes of their environment.

The field studies of web accessibility in the literature are mentioned sequentially. Numerous studies investigate website accessibility across different sectors, with a particular focus on industries such as tourism, e-commerce, airline, banking, and fintech. Domínguez Vila et al. (2018) evaluated the accessibility of 210 official national tourism organization websites globally, utilizing a website accessibility evaluation tool to identify patterns and rankings, intending to provide an indicator for inclusive organizational practices in online accessibility for individuals with disabilities in the realm of accessible tourism. Gonçalves et al. (2018) evaluated Portuguese e-commerce websites for accessibility and usability, revealing issues through automated tools, manual checks, heuristic evaluations, and user tests, and proposed seven recommendations for improvement. Agrawal et al. (2019) analyzed the quality of Indian airline websites in terms of accessibility, usability, and readability, emphasizing their adherence to web accessibility guidelines, identification of usability issues, and assessment of mobile friendliness. Additionally, Fatima et al. (2020) assessed the usability, accessibility, and vulnerability of Pakistani and International Banking Websites, employing manual evaluations, automated tools, and user perspectives, with a focus on identifying issues and comparing the performance of these websites. Lastly, Nour (2022) focuses on 32 Saudi FinTech websites and reveals notable accessibility and usability issues, emphasizing the urgent need for improvements to better serve people with disabilities in accessing crucial services like banking and healthcare.

Table 1 summarizes previous studies assessing corporate web pages in various domains worldwide in terms of different dimensions such as accessibility and usability in chronological order.

Table 1

A summary of previous research work

Article	Year	Sector	Dimensions	Sample	Tools and techniques Used
Gonçalves et al. (2018)	2018	E-commerce	Accessibility and Usability	Portuguese e-commerce websites	SortSite and manual assessments, heuristic evaluation for usability
Agrawal et al. (2019)	2019	Airline	Accessibility, Usability, and Readability	Home pages of 9 websites of airlines based in India	TAW, Pingdom, Websitepulse, WAVE, Webpagefx, Google mobile-friendly test
Fatima et al. (2020)	2020	Banking	Accessibility and Usability	Homepage on 10 bank websites in Pakistan, Canada, Australia, United States of America, and United Kingdom	Heuristic evaluation of usability Wave, TAW, AChecker
Nour (2022)	2022	Fintech	Accessibility and Usability	The Arabic version of the 32 Saudi FinTech websites' homepages	MAUVE++, WAVE
Başgömez et al. (2023)	2023	Technology and Informatics	Usability	Websites of 24 Turkish companies in the BIST Technology and Informatics index	GTmetrix, gray relational analysis,

As shown in **Table 1**, there are several studies conducted in various sectors, including technology, fintech, e-commerce, banking, tourism, and airline, assessing dimensions such as accessibility and usability. These studies used tools like MAUVE++, WAVE, SortSite, and manual assessments, among others, to evaluate website performance. While these studies have contributed to the understanding of website accessibility and usability, a noticeable gap exists in the assessment of accessibility, usability, and security specifically for corporate investor relations web pages. Our study addresses this gap by conducting a comprehensive

evaluation of investor relations web pages in the context of the Turkish stock market, considering accessibility with WCAG 2.1 standards, usability, and security.

Methodology

Data

This study focuses on conducting an assessment of investor relations web pages associated with companies listed on the BIST-30, which represents the performance of the 30 most liquid and highly capitalized companies traded in the Istanbul stock market and the companies with initial public offerings (IPOs) in the Istanbul Stock Exchange (ISE) during the year 2022. The data were collected between March 28 and April 1, 2023. It was thoroughly processed, tabulated, and visualized by April 27, 2023. Throughout the article, we used "BIST-30" to refer to the first group of companies and "BIST-2022" for the second group.

In this study, we initially identified 68 investor relations (IR) web pages associated with companies listed on the BIST-30, which represents the most liquid and highly capitalized companies on the Istanbul Stock Exchange, and companies that had their initial public offerings (IPOs) in 2022. However, 53 of these web pages were included in the final analysis based on the following criteria:

- **Inclusion Criteria:**

- Web pages that are explicitly dedicated to investor relations and provide financial reports, presentations, investor announcements, and other related content.

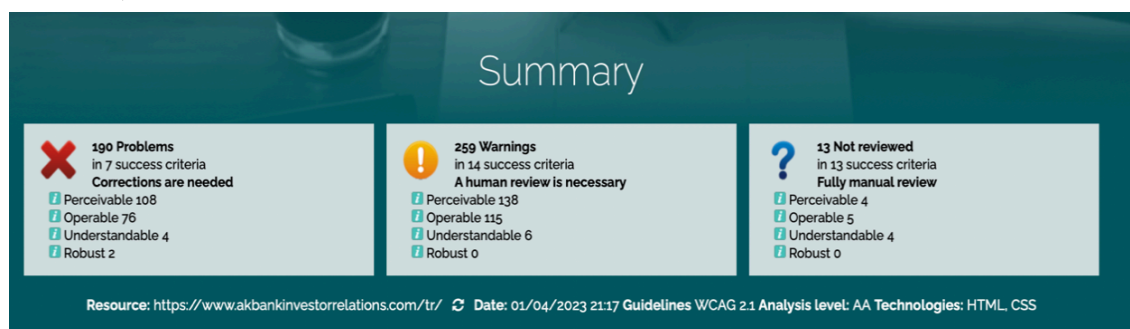
- **Exclusion Criteria:**

- Two company web pages were excluded because they presented financial statements, reports, and investor-related content directly on their corporate websites instead of having a dedicated IR page.
- Thirteen companies were excluded because they do not maintain a dedicated IR web page, meaning their investor relations information is either absent or merged within general corporate sections without a clear structure.

A detailed list of companies and their analyzed IR web pages can be found in the Appendix.

Tools and techniques

For accessibility testing, the TAW tool was employed. The TAW is one of the most frequently used automated testing tools for website evaluation and has been widely used in academic research (Macakoğlu & Peker, 2022). This tool evaluates investor relations websites based on the WCAG 2.1 standards, providing an online accessibility analysis and generating a comprehensive report for a specific URL (TAWdis, 2001). The generated TAW report encompassed an overview of the issues and warnings, as well as a detailed breakdown of the perceivable, operable, understandable, and robust aspects, as illustrated in [Figure 1](#). The generated reports were used to identify accessibility shortcomings and categorize them based on WCAG conformance levels (A, AA, AAA). The data collection process using TAW was conducted manually, with each web page being individually tested by entering its URL the tool.

Figure 1*Taw's interface*

Usability testing was conducted using Pingdom and GTmetrix, both of which are commonly used in performance evaluation studies. Pingdom was employed to analyze website load speed and optimize performance, evaluating key usability aspects such as page size, number of requests, and load time (Pingdom, 2005). This tool is widely used in research, such as Akgül (2021), who applied it to assess the usability of state and private university websites. GTmetrix is an online tool that evaluates website speed and performance by measuring metrics such as fully loaded time, first contentful paint, speed index, and total blocking time (GTmetrix, 2009). The tool was applied manually by inputting each website URL, following a methodology similar to that of Csontos and Heckl (2021), who assessed usability across various domains.

For security evaluation, the Sucuri tool was used. This tool scans for viruses, checks the blacklisting status, identifies website errors, assesses the risk level of the website, and examines the TLS and server configurations (Sucuri, 2007). It is widely employed in security assessments, as demonstrated by Macakoğlu et al. (2022) in their study on website domain scanning. The security assessment was carried out by inputting each URL into Sucuri. The Dead Link Checker tool (Dead Link Checker, 2013.) was used to identify broken links, which can have adverse effects on user experience and SEO. Each website was manually checked using this tool, which analyzed and reported any dead or broken links. This tool has also been widely employed in academic research, such as Gopinath et al. (2016), who used it to examine broken links on Sri Lankan government websites.

Furthermore, the Google Mobile-Friendly tool has been widely used to evaluate mobile responsiveness. (Mobile-Friendly Test, 2014). This online tool evaluates how well a website performs on mobile devices by assessing key mobile usability factors, such as text readability, ease of navigation, and the responsiveness of images and other elements when viewed on smaller screens. The tool provides a straightforward "pass" or "fail" result, indicating whether the site is optimized for mobile use. Studies such as Al-Sakran and Alsudairi (2021) have used this tool to evaluate mobile e-government websites. Each web page was tested manually by entering its URL the tool, and the results were recorded. Lastly, all evaluations were conducted manually, with URLs being individually entered into the respective tools. The data collection process lasted five days, and all results were systematically recorded for further analysis.

Results

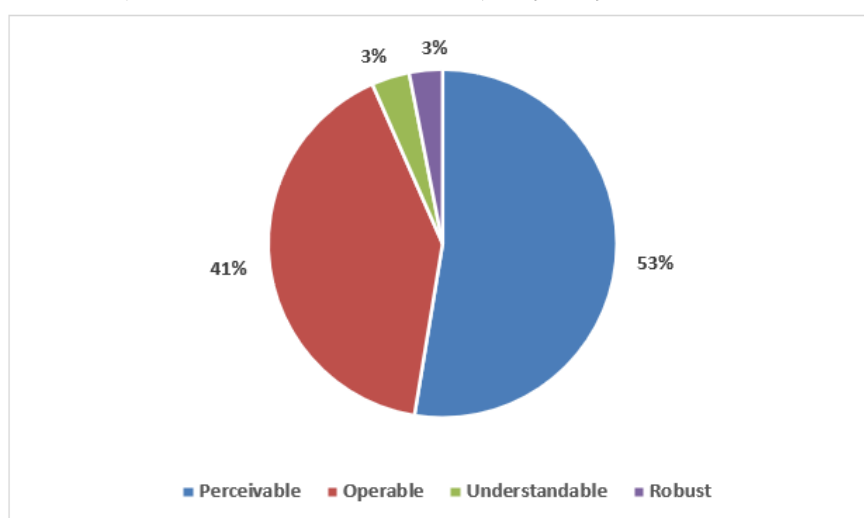
Accessibility analysis

Accessible web pages play a crucial role in providing content that is easily accessible to all individuals. The WCAG 2.1 guidelines specifically emphasize the importance of web content accessibility for people with disabilities (Web Content Accessibility Guidelines (WCAG) 2.1, 2018). In this study, a total of 51 web pages

belonging to companies listed on the BIST-30 firms and BIST-2022 firms indices in Turkey were evaluated using the TAW accessibility tool.

Three web pages were excluded from the analysis due to analysis errors, resulting in a final sample size of 51 web pages. This exclusion was specifically due to errors encountered during the evaluation process with the TAW accessibility tool, which failed to properly load the results for these pages. The principles of accessibility—namely, perceivable, operable, understandable, and robust, which are essential for ensuring that web content can be accessed and used by everyone—are illustrated in Figure 2.

Figure 2
Accessibility error distribution based on the four principles



In the "Perceivable" category, the recorded accessibility error rate was 53%. This suggests a notable presence of challenges in making system elements or content perceivable to users. These challenges may arise from various factors, including insufficient provision of alternative text for images, absence of captions for videos, or inadequate color contrast for text.

Within the "Operable" category, the accessibility error rate was recorded at 41%. This indicates notable challenges in providing the system's functionality and operability for all users. These challenges may stem from various issues, including difficulties with navigation, limitations in keyboard-only controls, or inconsistencies in the provision of clear and cohesive interactive elements.

The accessibility error rate of 3% in the "Understandable" category indicates that the system generally excels in terms of user comprehension and understanding. However, there may still exist areas that warrant improvement, such as the provision of clear instructions, error messages, or the avoidance of jargon or complex language. Similarly, the "Robust" category also demonstrated a commendable accessibility error rate of 3%, signifying the system's compatibility and adaptability across various platforms and technologies.

Figure 3 illustrates the distribution of accessibility errors based on basic principles, with the results separately presented to two BIST categories. The accessibility error rates for the BIST-2022 companies demonstrate noteworthy differences.

Figure 3*Distribution of errors according to principles by website page type*

In the "Perceivable" category, BIST-2022 companies exhibit a lower error rate of 30.40%, signifying relatively fewer challenges compared to BIST-30 companies. Similarly, in the "Operable" category, BIST-2022 shows a moderate error rate of 43.40%, suggesting moderate difficulties in ensuring system functionality and operability, which is lower than the error rate of BIST-30 companies. Notably, the "Understandable" category in BIST-2022 presents a relatively stronger performance with an error rate of 33.18%. Lastly, the "Robust" category of BIST-2022 companies showcases the lowest error rate of 26.84%.

The analysis reveals that a significant majority of the accessibility errors in the "Perceivable" category were found on web pages belonging to companies listed on BIST-30. Likewise, the "Understandable" category also exhibited a substantial concentration of errors originating from BIST-30 company web pages, surpassing two-thirds of the total errors. Moreover, it is noteworthy that the BIST-30 companies consistently demonstrated the highest number of errors across all evaluated principles.

Table 2 presents an overview of the rate of accessibility errors by success criteria. The Web Content Accessibility Guidelines (WCAG) define three conformance levels to assess website accessibility: Level A, Level AA, and Level AAA. Level A establishes the fundamental accessibility criteria, ensuring that the key needs of individuals with impairments are met. If a webpage does not meet the Level A criteria, it may lack essential functionality, such as alternative text for images or keyboard navigation, making it difficult for users with disabilities to access the content. Level AAA, on the other hand, represents the highest level of accessibility, designed to provide maximum usability for all users, particularly those with impairments. However, achieving full compliance at this level is a challenging task and is often regarded as an ideal goal rather than a mandatory requirement for all web content.

Table 2*Distribution of the success criterion errors*

Success Criteria	Level	BIST Category					
		Overall		BIST-30 (n=24)		BIST-2022 (n=27)	
		%	Total	%	Avg	%	Avg
1.1.1 - Non-text Content	A	84.31	2284	87.5	77.04	81.48	16.11
1.3.1 - Information and Relationships	A	90.19	767	87.5	14.37	92.59	15.62
2.1.3 - Keyboard (No Exception)	AAA	9.80	37	12.5	1.37	7.41	0.14
2.4.2 - Page Titled	A	3.92	2	0	0	7.41	0.07
2.4.4 - Link Purpose (In Context)	A	86.27	1249	87.5	31.95	85.19	17.85
2.4.9 - Link Purpose (Link Only)	AAA	76.47	600	79.16	16	74.07	8
2.4.10 - Section Headings	AAA	80.39	528	79.16	5.91	81.48	14.29
3.1.1 - Language of the Page	A	35.29	18	45.83	0.45	25.93	0.25
3.2.2 - On Input	A	33.33	22	33.33	0.45	33.33	0.40
3.3.2 - Labels or Instructions	A	52.94	145	62.5	4.83	44.44	1.07
4.1.2 - Name, Role, Value	A	60.78	179	75	5.5	48.15	1.74

The analysis of the BIST-30 and BIST-2022 companies, based on the data provided in [Table 2](#), highlights key similarities and differences in their adherence to accessibility standards. The results indicate that the highest number of errors were found at Conformance Level A, indicating that many investor relation web pages do not meet basic accessibility requirements. The most common issues at Level A were related to Non-Text Content (1.1.1), Information and Relationships (1.3.1), and Link Purpose (2.4.4). Additionally, some errors were identified at Level AAA, particularly in the Link Purpose (2.4.9) and Section Headings (2.4.10). These findings suggest that while some accessibility measures are in place, further improvements are necessary, especially in addressing Level A errors to ensure a more inclusive user experience.

Both BIST-30 companies and BIST-2022 companies encounter challenges in meeting the accessibility requirements for non-text content (criterion 1.1.1) and information and relationships (criterion 1.3.1). The relatively high error percentages in these areas indicate a significant proportion of non-compliant web pages within both groups, highlighting the need for substantial improvements in ensuring accessibility. The high error percentages suggest a significant number of non-compliant web pages in both groups. Additionally, keyboard accessibility without exceptions (criterion 2.1.3) is relatively better although there is room for improvement. The error percentages indicate the need for enhancing accessibility in terms of non-text content and information structures.

In terms of specific criteria, BIST-30 companies demonstrate better compliance with page titles (criterion 2.4.2), while BIST-2022 companies achieve perfect compliance in this regard. However, both categories struggle with providing clear and meaningful link purposes within the context (criterion 2.4.4), indicating a need for improvement. The comparison also highlights challenges in fulfilling link purposes when links are presented in isolation (criterion 2.4.9). BIST-30 companies and BIST-2022 companies exhibit relatively high error percentages, suggesting the necessity to enhance link accessibility.

Broken link analysis

[Table 3](#) presents the results of the broken link analysis for both BIST-30 and BIST-2022 companies separately. The analysis was conducted using the Deadlink Checker tool. However, this tool has the limitation

of checking a maximum of 2000 pages per website. As a result, for websites exceeding this limit, only the first 2000 pages were analyzed. Table 3 provides an overview of the average number of URLs checked per website, along with the minimum, average, and maximum number of broken links identified.

Table 3

Number of broken links

BIST Category	Average of URLs checked	Broken Links		
		Min.	Avg.	Max.
BIST-30	1577.07	0	270	2000
BIST-2022	1095.76	0	52.51	2000

For the BIST-30 companies, an average of 1577.07 URLs were evaluated, revealing a heterogeneous distribution of broken links. The range indicates that some web pages within this category had a significant number of broken links, while others had none. In the case of BIST-2022, an average of 1095.76 URLs were checked. Overall, the table demonstrates that both BIST-30 companies and BIST-2022 companies had varying degrees of broken links, with BIST-30 companies showing a wider range in the number of broken links. The results highlight the importance of regularly checking and maintaining the integrity of links on web pages to ensure seamless user experience and to avoid issues such as broken navigation and inaccessible content.

Mobile-friendly analysis

Mobile-friendly analysis conducted using the Google Mobile-Friendly tool enabled a comprehensive examination of 52 web pages to evaluate their mobile responsiveness. Figure 4 illustrates the results of this evaluation, indicating the rate of web pages that successfully passed the mobile-friendly standards. Only 10% of all BIST company web pages failed.

Figure 4

Result of the mobile-friendly test

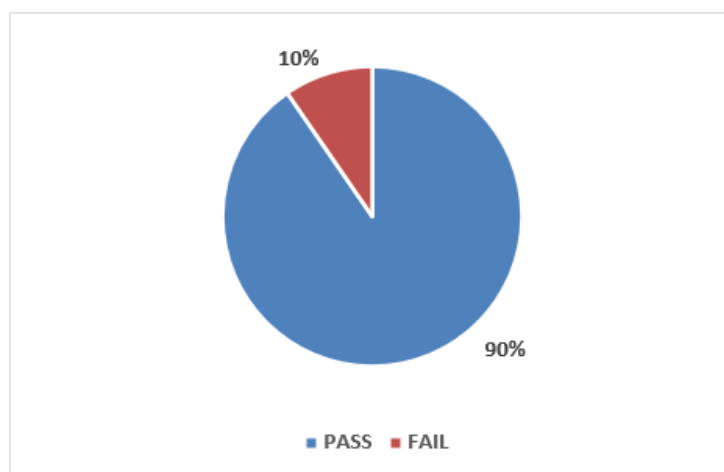


Table 4 demonstrates that company IR web pages failed or passed the mobile-friendly evaluation. 88% of the web pages successfully passed the mobile-friendliness evaluation, indicating a significant proportion of compliant web pages in terms of mobile design within the BIST-30 category. Conversely, 12% of the web pages in this category did not meet the requirements for mobile friendliness, indicating areas that need improvement.

Table 4*Mobile-friendly results by the BIST category*

BIST Category	Pass	Fail
BIST-30 (n=25)	22 (%88)	3 (12%)
BIST-2022 (n=27)	25 (%92.59)	2 (7.41%)

In the BIST-2022 category, 92.59% of the web pages achieved a pass result, denoting a slightly higher percentage of mobile-friendly web pages compared to BIST-30 companies. A mere 7.40% of the web pages failed to fulfill the mobile-friendliness criteria. The findings underscore the overall positive outcomes in both BIST categories, as a substantial majority of the web pages in these categories are mobile-friendly. Nonetheless, there is still a small subset of web pages in each category that necessitates enhancements to ensure optimal mobile compatibility.

Usability analysis

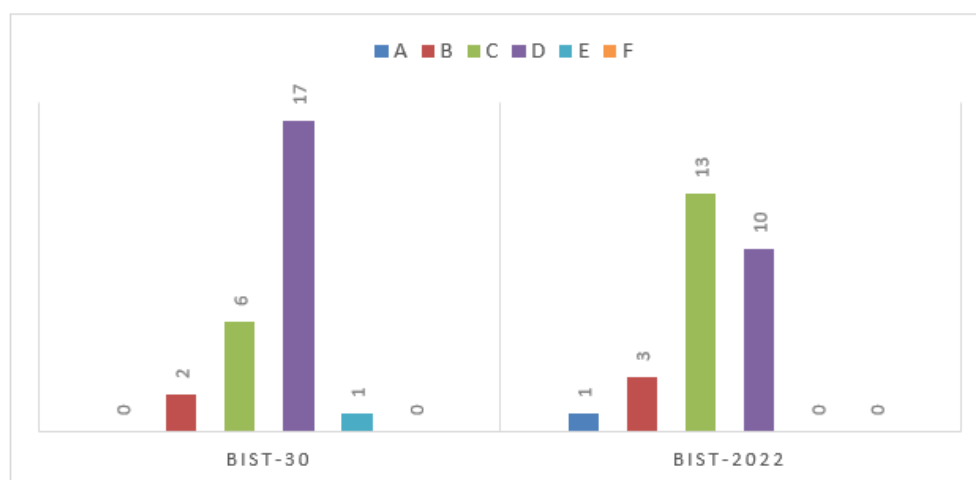
In the analysis of 53 web pages, page sizes and loading times were evaluated using Pingdom and GTmetrix. Pingdom's grading system assigns scores from A (excellent) to F (very bad), based on factors such as page load time, number of requests, and overall optimization. [Table 5](#) presents an overview of the performance grade distribution based on the Pingdom scores.

Table 5*Overview of the Pingdom grades*

Pingdom Grade (A-F)	Number of websites
A (excellent)	1 (2%)
B (good)	5 (9%)
C (average)	19 (36%)
D (below average)	27 (51%)
E (bad)	1 (2%)
F (very bad)	0 (0%)

The results indicate that most web pages fall within the “Average” (C) and “Below Average” (D) categories, highlighting opportunities for optimization. A considerable 51% of the web pages received a “D” grade, indicating performance below the average while the F category excluded any web pages. This shows that a significant portion of the web pages examined need improvements in their performance metrics.

[Figure 5](#) illustrates a detailed breakdown of the performance grades, shown as percentages, for both the BIST-30 and BIST-2022 companies.

Figure 5*Percentage of performance grades by BIST categories*

For BIST-30 companies, it is noteworthy that no web pages were categorized under the F grade. Instead, most web pages gravitated toward the higher end of the performance spectrum, particularly in the D and C grades. For BIST-2022 companies, a similar pattern was observed, with no web pages having received an F grade. All web pages managed to avoid the lowest performance grade, and most of them obtained performance grades ranging from A to D. This figure indicates that web pages in both BIST categories tended to achieve better performance scores, highlighting a notable proficiency in web performance among the assessed web pages. In conclusion, it is discerned that the webpages of BIST-30 companies are predominantly categorized within Grade D, whereas those of BIST-2022 exhibit a preponderance in Grade C.

The website performance analysis for the BIST-30 and BIST-2022 companies, as summarized in [Table 6](#), examines key GTmetrix performance metrics to assess loading efficiency and responsiveness. The evaluated metrics include:

- **Fully Loaded Time (s):** The total time required for a web page to load completely.
- **First Contentful Paint (FCP) (s):** The time it takes for the first visible element to appear on the screen.
- **Speed Index (s):** A measure of how quickly the content is visually displayed during loading.
- **Total Blocking Time (TBT) (ms):** The amount of time a webpage remains unresponsive due to background processes.

Each metric is presented with its minimum, mean, and maximum values to provide a comprehensive performance comparison between the two groups.

Table 6*Quality performance summary of websites by BIST categories*

Performance Metrics	BIST categories	
	BIST-30 (n=26)	BIST-2022 (n=27)
<i>Fully loaded time (s)</i>		
Min	0.57	0.3
Mean	2.73	1.21
Max	8.13	2.77

Performance Metrics	BIST categories	
	BIST-30 (n=26)	BIST-2022 (n=27)
<i>First contentful point (s)</i>		
Min	1.1	0.60
Mean	3.15	1.71
Max	12.9	3.9
<i>Speed index (s)</i>		
Min	1.4	0.86
Mean	4.55	2.44
Max	13.6	5.2
<i>Total blocking time (ms)</i>		
Min	0	0
Mean	110.21	33.66
Max	781	228

An analysis of the fully loaded time metric reveals that the BIST-30 companies exhibit a wider range, varying from 0.57 s to 8.13 s, with an average of 2.73 s. In contrast, the BIST-2022 companies demonstrated a more limited range, spanning from 0.3 seconds to 2.77 seconds, with an average of 1.21 seconds. For the first contentful paint metric, BIST-30 companies show a broader range from 1.1 s to 12.9 s, averaging 3.15 s. Conversely, the BIST-2022 companies have a narrower range, from 0.60 to 3.9 seconds, with an average of 1.71 seconds. The speed index metric follows a similar trend, with BIST-30 companies showing higher values and a broader range from 1.4 seconds to 13.6 seconds, with an average of 4.55 seconds, compared to BIST-2022 companies, which have a smaller range from 0.86 seconds to 5.2 seconds and an average of 2.44 seconds.

The total blocking time, measured in milliseconds, highlights a significant difference between the two categories. BIST-30 companies exhibited higher values, ranging from 0 ms to 781 ms, with an average of 110.21 ms. In contrast, BIST-2022 companies show lower values, ranging from 0 ms to 228 ms, with an average of 33.66 ms. A thorough examination of the results reveals that the BIST-30 companies consistently display higher values across various performance metrics compared to the BIST-2022 companies. This discrepancy is particularly evident in the fully loaded time, first contentful paint, and speed index metrics, where BIST-30 companies demonstrate both wider ranges and higher average values.

GTmetrix also reports the total page size in megabytes (MB), which directly impacts the loading speed and overall performance. Table 7 presents a detailed distribution of the total page sizes for websites categorized under BIST-30 and BIST-2022. The data are classified into different size ranges (MB) to provide insights into how page weight affects display efficiency and user experience.

Table 7

Distributions of the total sizes of websites

Total page size (MB)	Number of websites	
	BIST-30 (n=26)	BIST-2022 (n=27)
0-1.4 (very good)	4 (%15)	12 (44%)
1.5-2.4 (good)	8 (%31)	11 (41%)
2.5-3.4 (average)	3 (%11,5)	3 (11%)
3.5-4.4 (bad)	3 (%11,5)	0 (0%)

Total page size (MB)	Number of websites	
	BIST-30 (n=26)	BIST-2022 (n=27)
4.5 and above (very bad)	8 (31%)	1 (4%)

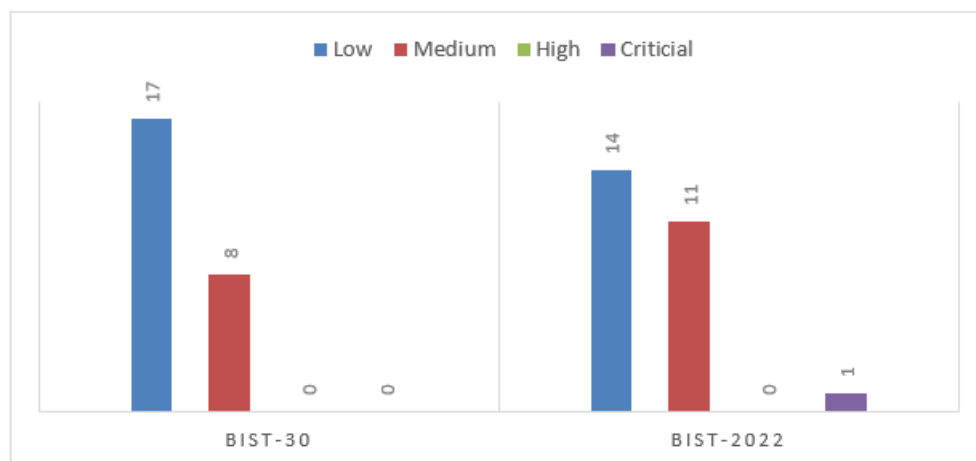
For the "4.5 and above (very bad)" range, BIST-30 companies encompass 31% with 8 web pages, while BIST-2022 holds 4% with 1 web page. This analysis provides insights into the distribution of web pages across different total page size categories, revealing performance variations within the BIST-30 and BIST-2022 categories.

Security analysis

In the security analysis, the evaluation focused on assessing the risk levels of the web pages using the Sucuri tool. The risk levels were categorized as low, medium, high, and critical, providing a comprehensive understanding of the security posture of the analyzed web pages. Sucuri examines various security vulnerabilities, including malware presence, blacklist status, security anomalies, outdated software, SQL injection vulnerabilities, and cross-site scripting (XSS) risks. This detailed analysis helps identify potential threats that could compromise the integrity and safety of the websites.

Figure 6 presents an overview of the security risk levels across the BIST-30 and BIST-2022 web pages. In the "Low" risk category, there are 17 instances for BIST-30 companies and 14 for BIST-2022 companies, totaling 31. In the "Medium" risk category, BIST-30 companies have 8 instances, while BIST-2022 companies have 11, resulting in a combined 19.

Figure 6
Percentage of risk levels of the sites by BIST type



Notably, neither BIST-30 nor BIST-2022 companies have web pages classified under the "High" risk category. In the "Critical" risk category, BIST-30 companies show no instances, whereas BIST-2022 has 1, resulting in a cumulative 1.

Additionally, Table 8 highlights the distribution of the web server technologies used by these companies.

Table 8
Distribution of the web servers

Type of web server	Number of websites
Apache	5 (9%)

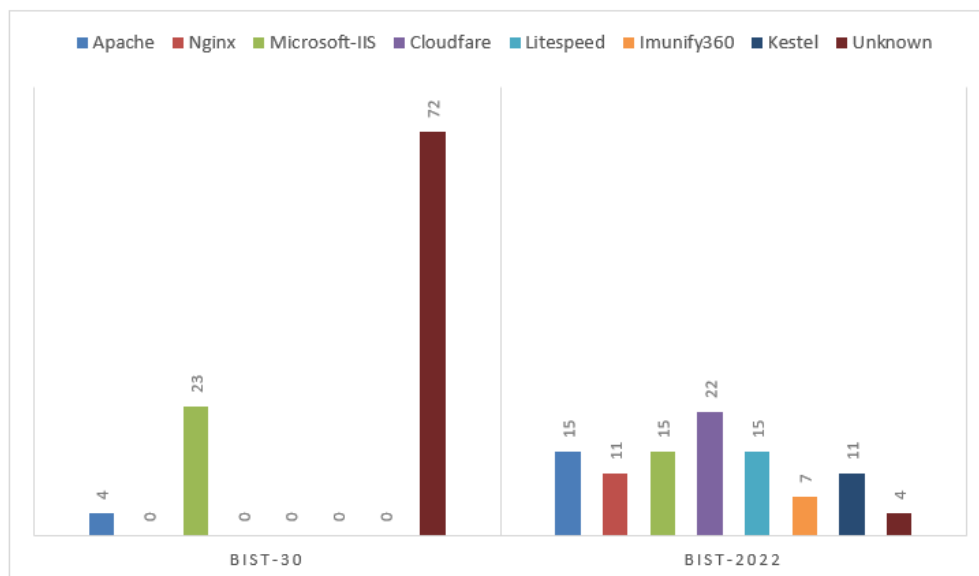
Type of web server	Number of websites
Nginx	3 (6%)
Microsoft-IIS	10 (19%)
Cloudflare	6 (11%)
Linseed	4 (8%)
Imunify360	2 (4%)
Kestrel	1 (2%)
Unknown	22 (41%)

The results indicate a diverse selection of web servers, although a significant portion (41%) is categorized as "unknown." This classification arises from instances where server details are either not publicly disclosed by the company or cannot be retrieved due to security configurations or privacy settings. Among the identified web servers, Microsoft-IIS was the most prevalent, constituting 19% of the total, followed by Cloudflare (11%), Apache (9%), Litespeed (8%), Nginx (6%), Imunify360 (4%), and Kestrel (2%).

The percentage of web servers by BIST type is given in Figure 7. For BIST-30 companies, Unknown is the dominant choice, constituting 72% of the total, while Apache is present at 4%. In contrast, BIST-2022 displays a more diverse selection, with Cloudflare leading at 22%, followed closely by Microsoft-IIS (15%), Litespeed (15%), Apache (15%), and Nginx (11%).

Figure 7

Percentage of web servers by BIST type



This analysis shows the nuanced distribution of web server technologies across the two BIST categories, indicating distinct preferences in server infrastructure. In the final stage of the security analysis, the examination focused on the use of TLS (SSL) encryption on web pages. The findings indicated that among the 54 web pages scrutinized, only 1 does not implement SSL encryption on BIST-2022 companies.

Discussion and Conclusion

This study examined the accessibility, usability, and security of investor relation web pages of corporate companies in Turkey by employing automated testing tools. A total of 53 web pages were subjected to analysis, and the assessment encompassed the utilization of online automated testing tools, namely TAW for the identification of accessibility errors, Deadlink Checker for the evaluation of broken links, and Google Mobile-Friendly Test for the assessment of mobile responsiveness. The study followed the WCAG 2.1 guideline, and the findings were subject to distinct analysis, systematically documented, and followed by subsequently analyzing the results.

The results of the study highlighted a significant number of accessibility problems, indicating that the most frequently violated standards were related to robust and perceivable principles. Additionally, both groups encountered challenges related to non-text content, indicating the need for improvement in adhering to accessibility guidelines. When comparing BIST categories, BIST-30 company web pages exhibited a higher rate of accessibility errors. Fixing these errors for each page type is crucial to improving the accessibility of web pages, providing a more user-friendly digital environment to individuals with disabilities. The analysis of broken links showed that the BIST-2022 company web pages had better performance in this regard. However, nearly each site contains at least one broken link. Mobile-friendliness assessments indicated positive results for both categories, with BIST-2022 companies demonstrating a slight advantage.

In terms of usability, BIST-2022 companies emerged as the leader, consistently displaying faster loading times and smaller page sizes. These metrics contribute to an enhanced user experience, positively influencing factors such as user engagement and satisfaction. The security evaluation for both BIST-30 and BIST-2022 companies indicated low to medium risks, with no web pages raising alarms in the "High" risk category. Additionally, web server types varied, with unknown or unspecified web server being the most used in the BIST categories. Except for one web page in the BIST-2022 group, all web pages implemented SSL encryption, demonstrating a strong commitment to secure communication. In summary, BIST-2022 companies demonstrated superior performance in accessibility, usability, and security compared to BIST-30. Nevertheless, both BIST-30 and BIST-2022 companies have specific areas that require attention and improvement for overall enhancement.

The study's significance is based on recognizing company web pages as crucial information sources for stakeholders and researchers, filling a notable research gap by evaluating BIST-30 and BIST-2022 company web pages. Similarly, the outcomes have practical implications for equitable access to information on investor relation pages, providing valuable guidance with raising public awareness. The findings reveal the frequency of errors, indicating insufficient compliance to WCAG 2.1 standards for site administrators and developers.

Despite the comprehensive analysis conducted in this study, certain limitations should be acknowledged. First, the study focused solely on automated testing tools to evaluate accessibility, usability, and security, which, while effective for identifying technical issues, may not fully capture user experience and subjective usability aspects. Future research could complement automated analyses with user-based evaluations, incorporating real user feedback and usability testing to gain deeper insights. Second, this study utilized data corresponding to the year 2022, providing a snapshot of the accessibility, usability, and security of investor relations web pages at that time. Given that corporate web pages are subject to change over time due to evolving technologies and company strategies, this study could be repeated periodically (e.g., yearly) in the future. By applying the same methodology to data from different years, researchers can assess

changes in website performance and identify trends in accessibility, usability, and security enhancements. Lastly, expanding the scope to include a broader range of companies or comparing results across different global stock markets could provide a more comprehensive understanding of IR web page quality.



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Author Details

Merve Garip

¹ İzmir Bakırçay University, Department of Management Information Systems, İzmir, Türkiye

 0009-0007-6441-8288

Serhat Peker

¹ İzmir Bakırçay University, Department of Management Information Systems, İzmir, Türkiye

 0000-0002-6876-3982  serhat.peker@bakircay.edu.tr

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Appendix

See Table 9.

Table 9

List of companies and their IR web pages analyzed

Company	Type	IR Web page URL
Akbank	BIST-30	https://www.akbankinvestorrelations.com/tr/
Aksa Enerji	BIST-30	https://www.aksainvestorrelations.com/tr/
Alarko	BIST-30	https://www.alarko.com.tr/tr/yatirimci-iliskileri/
Arçelik	BIST-30	https://www.arcelikglobal.com/tr/sirket/yatirimci-iliskileri/yatirimci-iliskileri/
Aselsan	BIST-30	https://www.aselsan.com/tr/yatirimci-iliskileri
Bim	BIST-30	https://www.bim.com.tr/Categories/105/yatirimci-iliskileri.aspx
Emlak Konut	BIST-30	https://www.emlakkonut.com.tr/tr-tr/yatirimci-iliskileri
Erdemir	BIST-30	https://www.erdemir.com.tr/yatirimci-iliskileri/
Ford	BIST-30	https://www.fordotosan.com.tr/tr/yatirimcilar/yatirimci-iliskileri-anasayfasi
Garanti BBVA	BIST-30	https://www.garantibbva.com.tr/yatirimci-iliskileri
Gübretaş	BIST-30	https://www.gubretas.com.tr/yatirimci-iliskileri/
Hektaş	BIST-30	https://hektas.com.tr/yatirimci-iliskileri
İş Bankası	BIST-30	https://www.isbank.com.tr/bankamizi-taniyin/yatirimci-iliskileri
Koç Holding	BIST-30	https://www.koc.com.tr/yatirimci-iliskileri
Odaş Enerji	BIST-30	https://www.odasenerji.com.tr/tr/yatirimci-iliskileri/
Petkim	BIST-30	https://www.petkim.com.tr/yatirimci-iliskileri
Pegasus	BIST-30	https://www.pegasusyatirimciiliskileri.com/tr
Sabancı Holding	BIST-30	https://yatirimciiliskileri.sabanci.com/tr/
Sasa Polyester Sanayi	BIST-30	https://www.sasa.com.tr/yatirimci-iliskileri
Şişecam	BIST-30	https://www.sisecam.com.tr/tr/Sayfalar/Inverstor%20Relations/Investor-Relations.aspx
Tav Havalimanları	BIST-30	https://ir.tav.aero/tr-TR/

Company	Type	IR Web page URL
Turkcell	BIST-30	https://m.turkcell.com.tr/tr/hakimizda/yatirimci-iliskileri
Türk Hava Yolları	BIST-30	https://investor.turkishairlines.com/tr
Tekfen Holding	BIST-30	https://www.tekfen.com.tr/yatirimci-iliskileri-birimi-4-15
Tofaş	BIST-30	https://www.tofas.com.tr/YatirimciIliskileri/GenelBakis#
Tüpraş	BIST-30	https://www.tupras.com.tr/genel-bakis
Tera Yatırım	BIST-2022	https://www.terayatirim.com/kurumsal/yatirimci-iliskileri
Özsu Balık	BIST-2022	https://www.ozsubalik.com.tr/yatirimci/kategori/yatirimci-iliskileri
Sanica Isı	BIST-2022	https://www.sanicaisi.com.tr/yatirimci-iliskileri/
Hidropar	BIST-2022	https://www.hktm.com.tr/yatirimci-iliskileri
Aztek Teknoloji	BIST-2022	https://www.aztekteknoloji.com/yatirimci/
Barem Ambalaj	BIST-2022	https://www.baremambalaj.com/yatirimci-iliskileri.aspx
Obase Bilgisayar	BIST-2022	https://obase.com/yatirimci-iliskileri-ana-sayfa/?lang=tr
Koroplast	BIST-2022	https://www.koroplast.com.tr/yatirimci-iliskileri
Kiler Holding	BIST-2022	https://www.kilerholding.com.tr/yatirimci-liskileri.php
Rubenis Tekstil	BIST-2022	https://www.rubenis.com/yatirimci-iliskileri/
Kocaer Çelik	BIST-2022	https://www.kocaersteel.com/tr/investor-relations
Europen Endüstri	BIST-2022	https://yatirimciiliskileri.europen.com.tr
Sun Tekstil	BIST-2022	https://www.suntekstil.com.tr/yatirimci-iliskileri
Kımpur	BIST-2022	https://kimpur.com.tr/yatirimci-iliskileri/
BMS Tel	BIST-2022	https://www.bmstel.com.tr/yatirimci-iliskileri/
Consus Enerji	BIST-2022	https://consusenerji.com.tr/yatirimci-iliskileri/
Smart Güneş	BIST-2022	https://www.smartsolar.com.tr/yatirimci-iliskileri.html
Gür-Sel Turizm	BIST-2022	https://www.gurseltur.com.tr/yatirimci-iliskileri
Gezinomi	BIST-2022	https://www.gezinomi.com/yatirimci-iliskileri



Company	Type	IR Web page URL
Koleksiyon Mobilya	BIST-2022	https://koleksiyon.com.tr/yatirimci-iliskileri/
Hitit Bilgisayar	BIST-2022	https://hitit.com/tr/yatirimci-iliskileri
InvestCo Holding	BIST-2022	https://investco.com.tr/tr/yatirimciiliskileri
DAP Gayrimenkul	BIST-2022	https://dapgayrimenkulgelistirme.com.tr/yatirimci-iliskileri/
Hun Yenilebilir	BIST-2022	https://www.hunyenilenebilirenerji.com/yatirimci-iliskileri
PanelSan	BIST-2022	https://www.panelsan.com/tr/page/35/yatirimci-iliskileri
Oncosem	BIST-2022	https://oncosem.com/yatirimci-iliskileri/
SDT	BIST-2022	https://www.sdt.com.tr/tr/yatirimci-iliskileri

