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The Adaptive Web: Industry-Specific Trends in Website Evolution and Digital Marketing

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ABSTRACT
This paper presents a sector-specific analysis of website evolution, focusing on how technological advancements are shaping their roles in marketing across diverse industries. Examining websites from nine major sectors, including healthcare, finance, retail, and telecommunications, this study utilizes historical data from the Wayback Machine alongside the CW-Index framework to evaluate website competitiveness over nearly three decades. The analysis reveals how emerging technologies, such as artificial intelligence (AI), mobile optimization, and advanced SEO, are uniquely adopted and implemented according to each sector's goals and user demands. Key findings include a widespread increase in page size and load time, attributable to complex features such as high-resolution media and interactive tools. Despite this, improvements in mobile optimization and analytics integration are enabling websites to offer more personalized, data-driven experiences, which enhance customer engagement and loyalty. Notably, social media links and responsive design have become common, with sectors like healthcare and higher education showing high social media integration rates.This research contributes to digital marketing literature by highlighting how industry-specific strategies influence website design, functionality, and user interaction. By identifying these trends, the study underscores the strategic importance of websites as adaptable, user-centric marketing tools that align with sectoral innovation and consumer expectations. Insights from this study guide marketers and web developers in optimizing websites to meet evolving technological and competitive demands across sectors.

1. INTRODUCTION

The first website was created in August 1991 by Tim Berners-Lee at CERN, a European nuclear research agency, marking the dawn of the World Wide Web [1]. Since that initial site, the web has expanded exponentially, with a new website being launched approximately every three seconds [2]. By 2023, the number of websites has skyrocketed (Fig.1.) to an estimated 1 to 2 billion [2]. This rapid growth illustrates the increasing importance of websites in our digital ecosystem, not just as sources of information but as essential components of modern marketing strategies.

According to Citi's Digital Strategy team [4] digital disruption have seen digital disruption fundamentally erode value across many industries (music sales, video rentals, travel booking, and newspapers), resulted on average in a 44% share-shift from physical to digital business models over a 10-year period. Also, they defined a digital disruption tipping point around the year of 2012 (Fig. 2.).

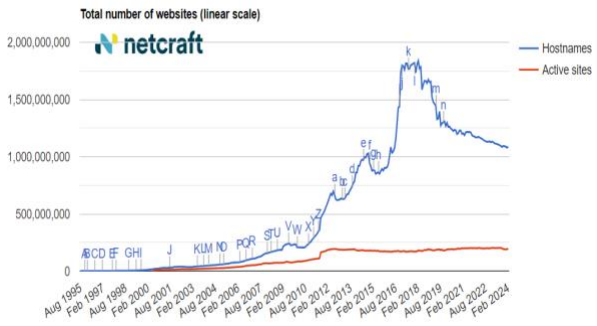

Figure 1. Number of websites [3]

The advent of the internet has transformed it into a vast digital marketplace where businesses and consumers interact on unprecedented levels, and this evolution reflects the broader digital transformation of the global marketplace. As this transformation unfolds, digital marketing emerges

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as a key strategy, leveraging the internet and various digital channels to facilitate communication and exchanges with customers [5].

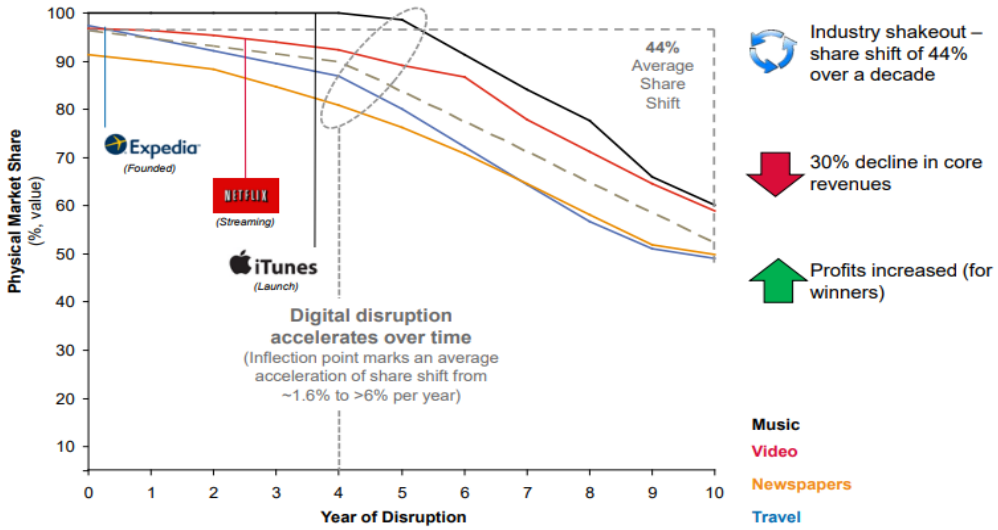


Figure 2. Digital disruption [4]

The proliferation of Web 2.0 technologies, such as social media, has created new opportunities to improve the user experience and enhance interaction between brands [6].

In the aftermath of the COVID-19 pandemic accelerates digital transformation [7] digital marketing strategies have undergone a major transformation, with the role of websites becoming even more prominent.

Digital marketing encompasses a wide array of tactics designed to optimize these interactions, including Search Engine Optimization (SEO), Search Engine Marketing (SEM), Pay-Per-Click (PPC) advertising, Social Media Marketing (SMM), Email Marketing, Affiliate Marketing, Content Marketing, and Native Advertising [8]. As such, websites have become not only repositories of information but also powerful marketing tools and communication channels, enabling businesses to engage with their audiences effectively and drive their marketing strategies forward.

By examining emerging trends and innovations of websites, this paper seeks to answer key questions, such as: What will be the future of websites? Will they continue to dominate as essential digital platforms?

This paper aims to provide insights by analyzing website trends over the past 29 years, assessing the likelihood and implications of their future development. Ultimately, it offers a nuanced understanding of the enduring significance of websites, focusing on their evolving role as powerful marketing tools.

2. MATERIALS AND METHODS

2.1. Dataset and preparation

2.2.1. Evaluation Aspect

The Wayback Machine, a digital archive of the World Wide Web managed by the Internet Archive, provides an invaluable resource for retrieving historical versions of websites [9]. By using the Wayback Machine's CDX Server API, researchers can access and analyse websites as they appeared in the past, enabling the study of web evolution across various metrics, such as page structure, performance, and SEO optimization.

For analysing global website trends the evaluation of website, I have chosen nine industrial sectors represent mainstream industries that are crucial to the global economy and modern society (Table. 1.). Tracking these companies provides insights into essential metrics. The selection of these sectors and brands provides a strong foundation for presenting global website trends for several reasons:

- Broad Industry Coverage: The chosen sectors span critical areas of the global economy, including technology, finance, healthcare, retail, and energy, among others. This diversity offers a comprehensive view of how different industries approach website design, optimization, and user experience.
- Global Influence: The brands selected are globally recognized, making their websites representative of trends at the forefront of digital strategy.
- Technology Adoption: Across sectors, these brands tend to adopt cutting-edge technologies like AI, cloud computing, and advanced analytics on their websites. By tracking their web presence, you can showcase how leading companies integrate the latest tools and practices.

- Variety of Website Needs: The difference in website needs across sectors stem from the specific functions, audiences, and goals each industry prioritizes.
- Innovation and Trends: These brands are typically early adopters of new design trends like, analysing their websites gives a window into future digital trends.
- Sector-Specific Insights: Each sector has its own website requirements and trends.

Table 1. Websites of ten brand in 9 sectors

Automotive	Energy	Fashion
audi.com	aramco.com	adidas.com
bmw.com	bp.com	gucci.com
ford.com	chevron.com	hm.com
gm.com	conocophillips.com	louisvuitton.com
honda.com	eni.com	nike.com
mercedes-benz.com	equinor.com	patagonia.com
nissan-global.com	exxonmobil.com	ralphlauren.com
tesla.com	petrochina.com	underarmour.com
toyota.com	shell.com	uniqlo.com
volkswagen.com	totalenergies.com	zara.com
Finance	**Healthcare**	**Higher Education**
americanexpress.com	abbott.com	berkeley.edu
bankofamerica.com	anthem.com	cam.ac.uk
citi.com	cigna.com	columbia.edu
goldmansachs.com	gsk.com	harvard.edu
jpmorganchase.com	jnj.com	mit.edu
mastercard.com	merck.com	ox.ac.uk
paypal.com	novartis.com	princeton.edu
schwab.com	pfizer.com	stanford.edu
visa.com	roche.com	uchicago.edu
wellsfargo.com	unitedhealthgroup.com	yale.edu
Retail	**Technology**	**Telecommunications**
alibaba.com	aws.amazon.com	att.com
amazon.com	adobe.com	bt.com
bestbuy.com	apple.com	chinamobileltd.com
costco.com	google.com	comcast.com
homedepot.com	ibm.com	orange.com
ikea.com	intel.com	telefonica.com
macys.com	meta.com	telekom.com
target.com	microsoft.com	t-mobile.com
walgreens.com	oracle.com	verizon.com
walmart.com	samsung.com	vodafone.com

In conducting my research, I have selected the most relevant criteria from the CW-Index evaluation framework [10] for analysing the competitiveness of websites. This comprehensive framework was designed to assess various dimensions of website performance, including factors such as user experience, technological functionality, and accessibility, all of which contribute to a website's overall competitive advantage. The CW-Index has been applied across numerous sectors [11-15]. In alignment with the CW-Index framework, I have identified the following key criteria as the most relevant for evaluating website competitiveness in my research:

- Page Size and Load Time: Measuring the size of the page in kilobytes and its loading performance.
- Meta Tags and Header Tags (H1, H2, H3): Assessing the SEO readiness of the site over time.

- Mobile Optimization: Checking if the website was mobile-friendly or responsive design.
- Presence of Analytics: Detecting embedded analytics tools like Google Analytics or Tag Manager.
- Social Media Links and Menu Links: Identifying external social media connections and internal site navigation links
- Augmented Reality (AR) Features: Evaluating the presence of AR technologies.
- Content size: Total number of words, characters and images on the page. Total number of links (both internal and external) embedded within the page content.

Utilizing Python programming, which is specifically tailored for data analysis, I developed an algorithm for automating and analysing historical web data in this project, leveraging the Wayback Machine's API to retrieve archived versions of websites across different sectors. The use of Python enabled efficient, scalable, and reproducible analysis of multiple metrics from these websites, including page performance, structure, and SEO readiness.

2.2.1. Key Tasks Performed Using Python

1. Automated Data Retrieval:

Python's requests library was used to interface with the Wayback Machine's CDX Server API, fetching historical snapshots of websites. A retry mechanism with exponential backoff was implemented to handle failed retrievals, ensuring robustness.

2. Website Analysis:

For each archived website version, Python extracted various metrics such as page size, load time, meta tags, header tags (H1, H2, H3), and the presence of social media links or menu links using libraries like BeautifulSoup for HTML parsing. The script also checked if the website was mobile optimized and embedded analytics tools like Google Analytics.

3. Error Handling and Logging:

Python was used to manage errors during data retrieval, tracking instances where a URL could not be fetched or archived snapshots were unavailable. This was logged and counted to generate detailed statistics on failed attempts.

4. Data Aggregation:

Python's Pandas library enabled the organization of data into structured DataFrames, making it easy to analyse results across multiple years and sectors. This allowed for streamlined data manipulation, averaging metrics over time, and generating sector-level insights.

5. Visualization:

Using Matplotlib and Seaborn, Python generated graphs that illustrated trends in website performance and optimization across sectors.

6. Execution Time Monitoring:

Python measured the total execution time of the analysis, tracking how long the process took for large-scale website analysis across multiple years and sectors.

2.2.2. Key information about the dataset

- Research date: 19th of September 2024.
- Scraping time: 13,5 hours
- Analysed years: from 1996 – 2024
- Total row of dataset: 2340 rows

The graph shows that earlier years have fewer websites, while the number of websites stabilizes in the more recent years. This suggests either fewer archived websites from earlier periods or incomplete data for those years. In later years, the website count becomes more consistent (Fig. 3.).

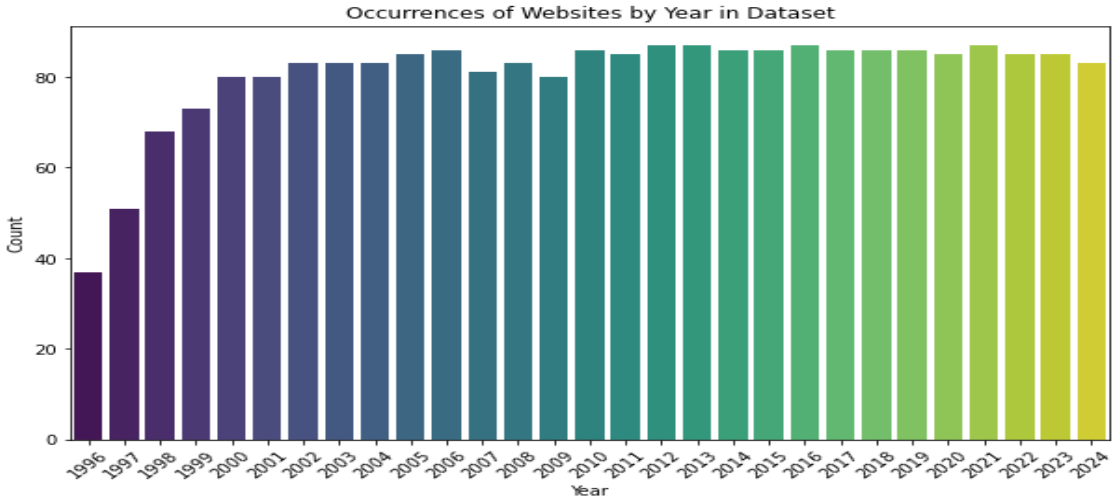


Figure 3. Occurrences of websites by year in dataset

For some reason, the automatic website analysis bot was unable to read Tesla's website, which led to the exclusion of this brand from the analysis.

There were no missing data in the dataset. However potential outliers were identified in several variables. To assess the presence of outliers, both histograms and boxplots were employed.

Additionally, the normality of the data was tested using the Shapiro-Wilk and Kolmogorov-Smirnov tests. The results of these tests provide strong evidence against normality for all metrics, given the extremely low p-values. Since both tests strongly indicate non-normality, outlier detection was performed using the Interquartile Range (IQR) method. Two approaches were considered: removing outliers for each year using the 1.5IQR rule and removing outliers using the 3*IQR rule. After examining the histograms and boxplots, the 3*IQR rule was chosen as the final method for outlier removal, as it provided a more balanced approach in reducing the influence of extreme values without excessively trimming the dataset.

After careful consideration in my examination of outliner removals, I have decided not to include the following metrics in my analysis: H1 Count, H2 Count, H3 Count, and Menu Links Count. These metrics do not contribute meaningful insights to my research and instead negatively impact the quality of my final dataset.

2.2. Analysis technique

The results from each sector are averaged for each year, enabling cross-sector comparisons of web development trends. Metrics are visualized over time, highlighting differences in website performance, SEO practices, mobile readiness. Additionally, failures in retrieving archived URLs are tracked, providing insight into the archival completeness for specific domains and years.

In this study, the Wayback Machine serves as a crucial tool to understand historical web patterns and developments, helping researchers and industry professionals assess how the web has evolved in response to technological advancements, regulatory shifts, and changing user expectations.

To check the correlation between the numeric columns in dataset, I used Python's Pandas corr() function calculates the pairwise correlation between the selected columns. By default, it uses Pearson's correlation. The correlation matrix will show how strongly the metrics are related to each other.

Non-numeric (categorical) columns provide qualitative information and need special methods for analysis. To analyse the adoption of a specific feature over time across different categories, I followed these steps:

1. Grouped the data by category and time period: I calculated the mean for the relevant column (e.g., the feature adoption column) for each category over time. Since the column was binary (0 = not adopted, 1 = adopted), the mean represented the proportion of entities in each category that had adopted the feature.
2. Plotted the trend: I created a line plot to visualize the trend of feature adoption over time for each category, making it easy to compare the adoption rates across different categories.

3. RESULTS

This section presents the correlation matrix results, highlighting the relationships among key metrics. (Fig.4.)

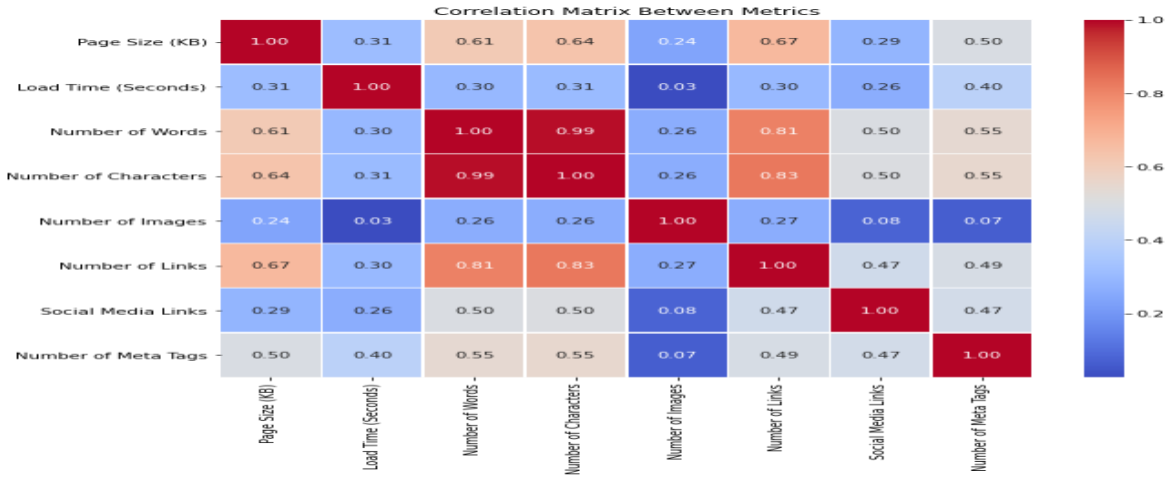


Figure 4. Average page size and average load time over years by sectors

1. Page Size (KB)

Number of Words (0.61), Number of Characters (0.64) and Number of Links (0.67) show moderate correlations with Page Size. Larger web pages often include more content, both in terms of text and hyperlinks.

2. Load Time (Seconds)

Low correlations with most factors indicate that page load time does not depend heavily on a single variable like page size or number of images. However, Number of Meta Tags (0.40) shows some moderate relationship, meaning pages with more meta tags might affect load time due to additional processing required for SEO or data collection.

3. Number of Words

Strong correlation with Number of Characters (0.99). As expected, more words lead to more characters, reinforcing the fact that text-heavy pages tend to increase both measures.

Number of Links (0.81). A high correlation suggests that content-rich websites tend to include more links, which can indicate informational depth or interconnected content.

4. Number of Images

Weak correlations across most variables: The number of images does not strongly impact the page size, load time, or other characteristics like words or links, which may indicate efficient image compression techniques are in use, or that images don't dominate the page's structure.

5. Number of Links

High correlation with Number of Words (0.81) and Number of Characters (0.83) shows that more verbose or content-heavy websites also tend to have more hyperlinks, possibly linking related content or external resources.

6. Social Media Links

Moderate correlations with Number of Words (0.50) and Number of Meta Tags (0.47) This suggests that content-rich pages tend to include more social media integration, likely for content sharing or engagement purposes.

7. Number of Meta Tags

Shows moderate correlation with Page Size (0.50) and Number of Words (0.55), suggesting that more meta tags are present in larger or more content-heavy pages, which could be optimized for SEO and data analytics purposes.

Short Summary

Text-heavy pages (Number of Words and Number of Characters) show strong correlations with Page Size, Number of Links, and even Meta Tags. Images do not appear to have a strong impact on load times, page sizes, or other characteristics, suggesting good optimization practices. Social Media Links tend to increase alongside other content-related metrics, reflecting that content-heavy websites also focus on engagement and social sharing.

4. DISCUSSION

The analysis of archived websites from 9 different sectors across the years 1996 - 2024, yielded several important insights:

1. Page Size and Load Time:

The average page size and load time have generally increased across sectors over time. This can be attributed to the growing complexity of modern web pages, including the use of high-resolution images, embedded videos, and interactive features (Fig. 5.). Automotive, Fashion and Retail sectors had the largest growth in page size and Higher Education had the lowest. Despite larger page sizes, advances in web technology and faster internet speeds helped mitigate load times.

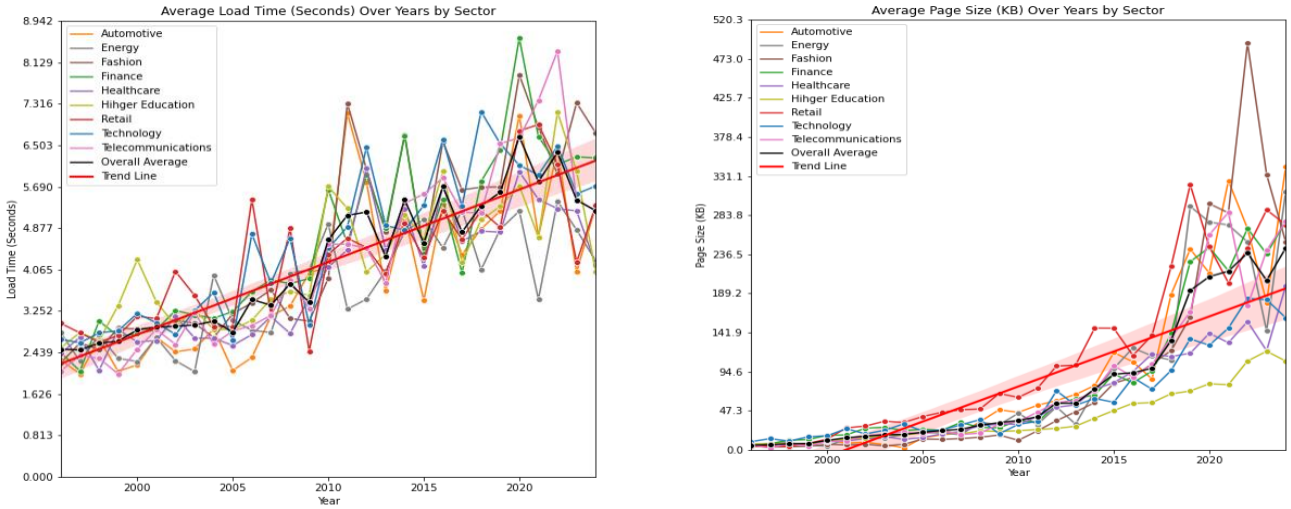


Figure 5. Average Page Size and Average Load Time over Years by Sectors

2. Responsive Design Adoption Over Time:

The analysis revealed a consistent increase in the adoption of responsive design across all sectors from earlier years to more recent times (Fig. 6). Technology, Healthcare and Higher Education sectors showed the fastest adoption rates, with nearly all websites in these sectors becoming responsive by the most recent year analysed. In contrast, sectors such as Automotive and Finance exhibited slower adoption, with some institutions still lacking responsive design features in recent years.

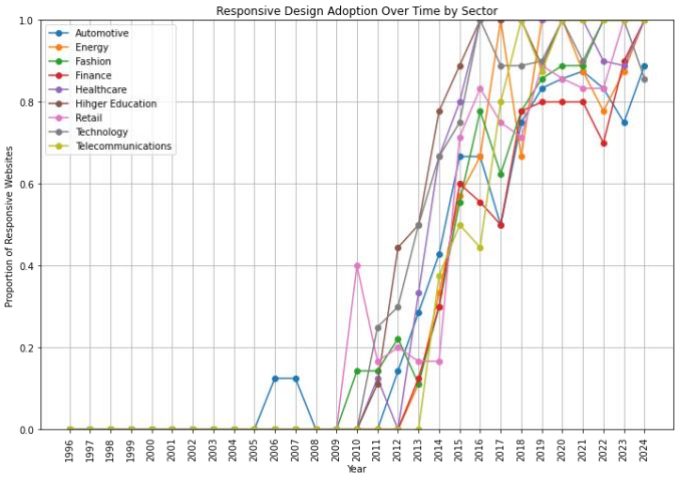
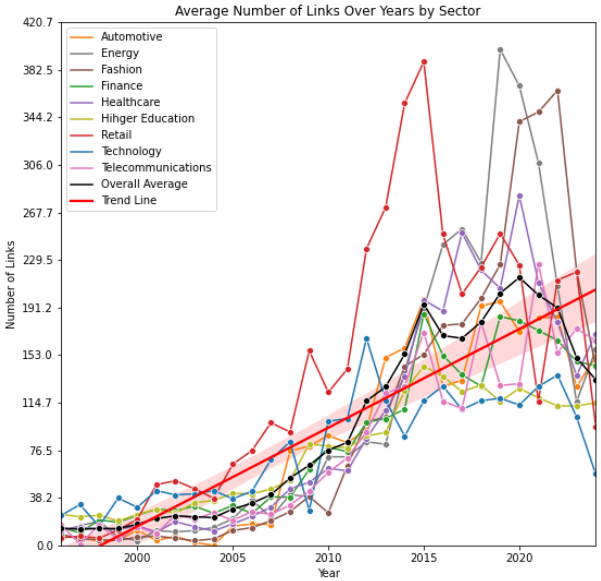


Figure 6. Responsive Design Adoption over Years by Sectors

3. Number of Character, Word, Links and Images:

Websites in the Healthcare and Retail sectors consistently had the highest number of links, characters, word and images, which may reflect the complexity and depth of their offerings, such as e-commerce product listings or detailed documentation (Fig. 7.). By contrast, sectors such as Technology, Fashion and Higher Education maintained a more minimalistic approach, with fewer images, characters, word and links.



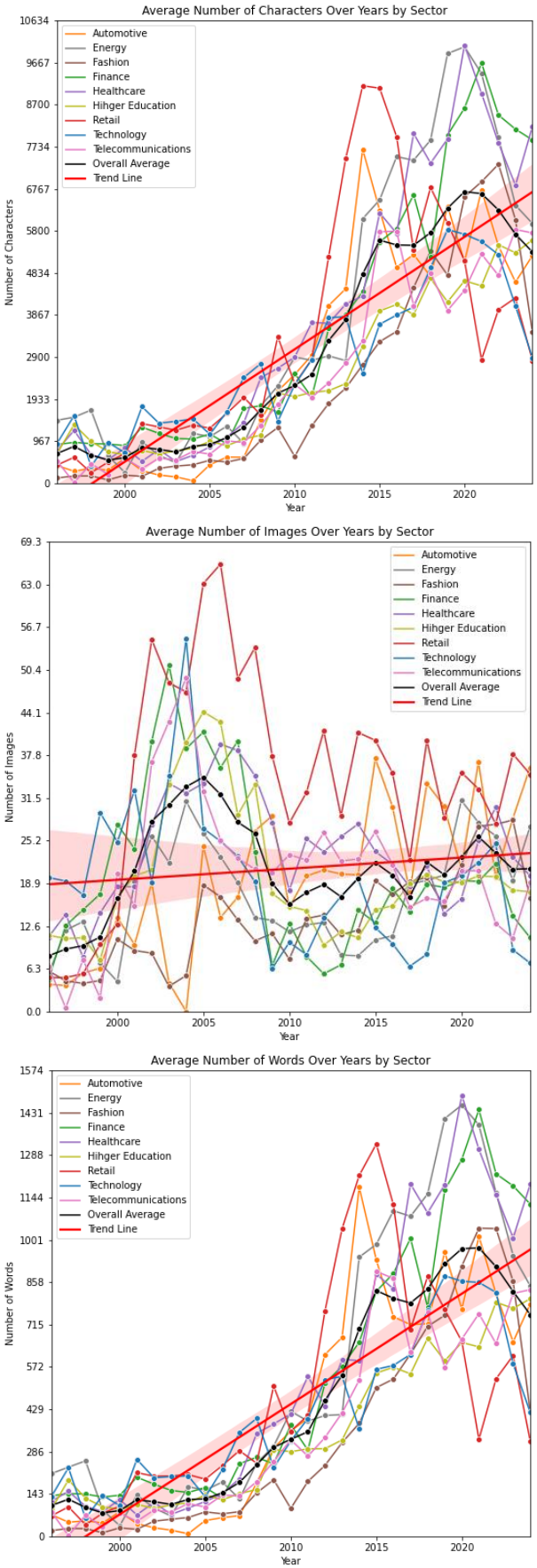


Figure 7. Number of Character, Word, Links over Years by Sectors

4. Social Media Integration:

The integration of social media links also varied by sector (Fig. 8.). Energy, Higher Education and Healthcare sectors, unsurprisingly, had the highest proportion of social media links, leveraging these platforms for customer engagement and brand promotion. Other sectors, such as Technology, Retail and Telecommunications, were less integrated with social media.

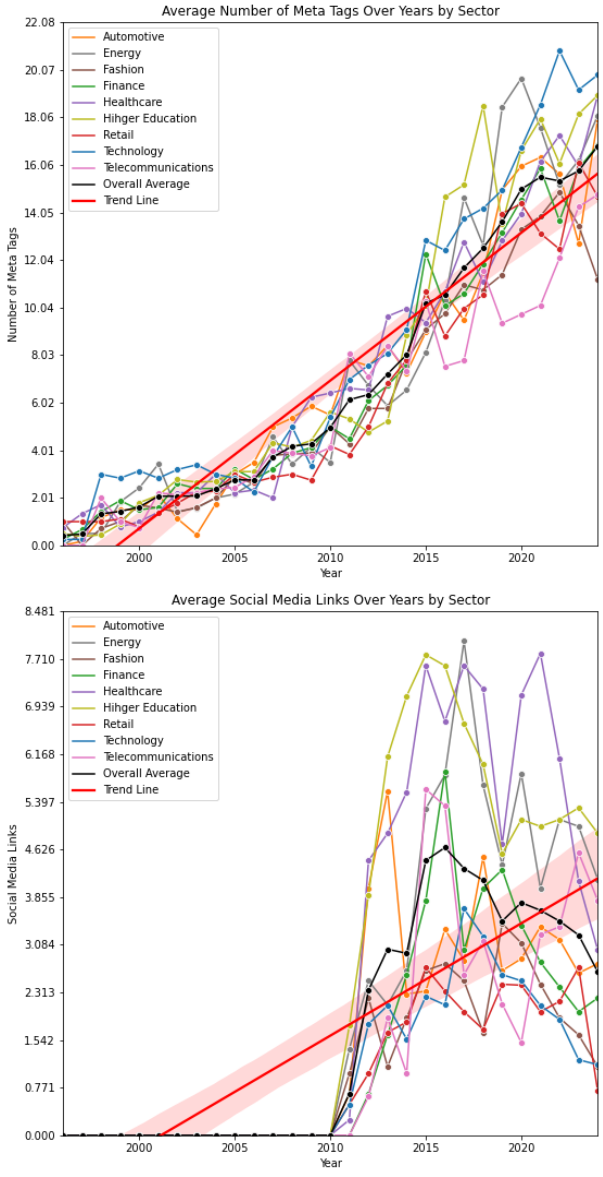


Figure 8. Social Media Integration and Meta Tags over Years by Sectors

5. Meta Tags and Analytics (SEO):

The integration of meta tags also varied by sector. Energy, Higher Education and Technology sectors had the highest meta tags numbers (Fig. 8.). Use of Google Analytics and Tag Manager became widespread across all sectors. Adoption in the Higher Education sector increased over time, as universities sought to improve user engagement through analytics (Fig. 9.).

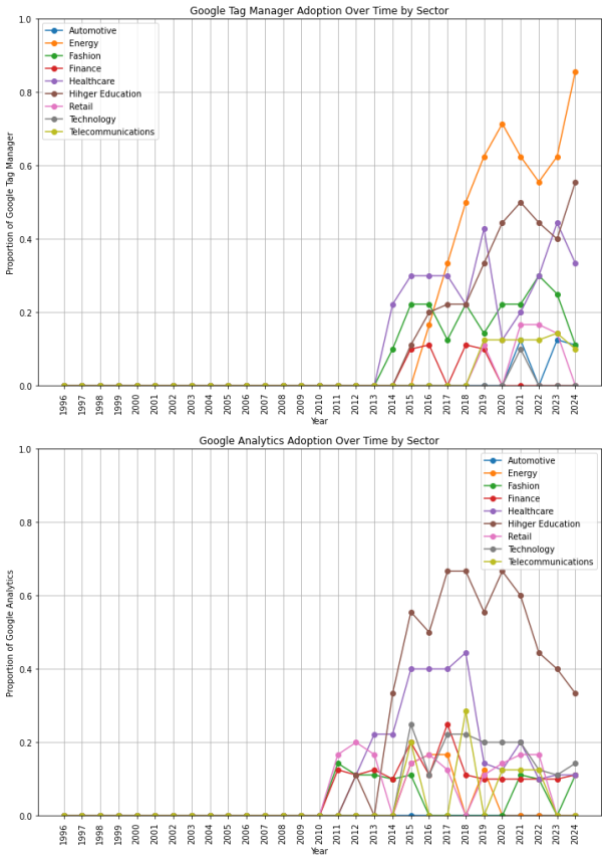


Figure 9. Analytics Tools over Years by Sectors

5. Conclusion

Python's versatility and extensive library ecosystem made it the ideal choice for automating the complex process of retrieving and analysing historical web data. The combination of API integration, HTML parsing, data analysis, and visualization allowed for comprehensive insights into how websites have evolved across different sectors and time periods. The analysis of archived websites from 9 different sectors across the years 1996 - 2024 yielded several important insights:

1. Increase in Page Size and Load Time:

Page sizes have increased significantly across all sectors from 1996 to 2024. This reflects the growing complexity of websites, with more multimedia content, interactive features, and enhanced visuals.

2. Mobile Optimization:

Mobile optimization became more common from 2015 onwards, as the mobile web grew. The graph clearly illustrates the impact of digital disruption on mobile optimization. By 2024, nearly all websites were mobile-optimized.

3. Meta Tags and Analytics tool:

Number of meta tags increased over time, reflecting improved attention to SEO and accessibility. Use of web analytics tools, especially Google Analytics and Tag Manager, became widespread across all sectors.

4. Social Media Links:

The number of social media links integrated into websites increased steadily over the years, reflecting the growing importance of social media for brand engagement.

5. Augmented Reality (AR) Presence:

Despite the increasing potential of Augmented Reality (AR) technology, its integration into websites remains minimal over time. The presence of AR on websites has not seen widespread adoption or significant usage during the observed period.

Final Conclusion

This historical analysis has demonstrated that website development trends across various sectors closely align with advancements in web technologies, particularly in areas such as mobile optimization, search engine optimization (SEO), and user engagement strategies, including analytics and social media integration. The shift toward larger, more interactive, and mobile-optimized websites, alongside increased emphasis on data analytics, underscores the pervasive digital transformation occurring across industries. While alternative digital platforms may emerge, websites remain integral as powerful marketing tools, continuously evolving to meet the demands of modern business and consumer needs.

Conflict of Interest

No conflict of interest is declared by tehe authors. In addition, no financial support was received.

Author Contributions

Study Design, GL; Data Collection, GL; Data Interpretation,GL; Manuscript Preparation, GL; Literature Search, GL. Author has read and agreed to the published version of the manuscript.

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