

SEO EVALUATION WITH AI AND CONVENTIONAL TOOLS: CASE STUDY OF HIGHER EDUCATION WEBSITES IN CROATIA

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ABSTRACT

This study evaluates the SEO performance of three Croatian higher education websites by comparing conventional SEO auditing tools with generative AI-based analysis. The research identifies key technical and on-page deficiencies such as missing meta descriptions, poor heading structures, and a lack of schema markup and XML sitemaps. While AI tools like ChatGPT and ClaudeAI offer valuable strategic and content-level suggestions, they fall short in technical precision compared to traditional tools like RankMath and SpeedTest Insights. The study also highlights the effectiveness of open-source and free SEO tools in low-resource environments. Results suggest that a hybrid approach, combining AI and conventional tools, provides the most comprehensive SEO evaluation. The paper concludes with suggestions for future research to explore long-term SEO improvements and broader institutional comparisons.

KEYWORDS: SEO, generative AI, higher education, Croatia, case study

1. INTRODUCTION

In today's digital landscape, the visibility and performance of a website significantly influence how effectively an institution communicates with its target audience. Although Search Engine Optimization (SEO) is often associated with commercial enterprises aiming to increase web traffic and conversions, it is equally important for public sector entities, including higher education institutions. University websites serve as the primary digital interface for prospective students, researchers, and partners. Therefore, ensuring that these websites are well-optimized, accessible, and aligned with modern SEO best practices is strategically important. As highlighted by [Maček & Novak, 2024], SEO encompasses various techniques aimed at improving digital presence and achieving higher rankings in organic search results, which is equally crucial for academic institutions as it is for businesses.

This paper presents an SEO homepage evaluation of three websites representing Croatian higher education institutions: the Faculty of Organization and Informatics (FOI), the Faculty of Electrical Engineering and Computing (FER), and the Department of Informatics at the University of Rijeka (FIDIT). The analysis was conducted using a combination of publicly available, free tools. The study utilized both conventional SEO tools and specialized AI, including generative AI tools. The main objective is to assess and compare these websites in terms of SEO performance, technical optimization, and adherence to web best practices, and to evaluate how well AI tools perform in comparison to conventional ones. By doing so, we aim to highlight common strengths and weaknesses in the current digital presence of academic institutions in Croatia and suggest pathways for improvement.

The rest of the paper is organized as follows: Section 2 presents related work; Section 3 outlines the methodology; Section 4 reports the results; Section 5 provides the discussion; and Section 6 concludes the paper.

2. RELATED WORK

Search Engine Optimization (SEO) is a set of practices aimed at improving a website's visibility in search engines like Google, which dominates the market [Alfiana et al., 2023; Vinutha & Prajwal, 2023]. The primary goal is to achieve high rankings for specific keywords to increase organic (non-paid) traffic.

The process begins when a search engine indexes web content, which is a prerequisite for appearing in search results [Google, 2019]. Complex algorithms then rank pages based on numerous factors [Sistrix, 2022]. According to [Camossi & Rodas, 2023], the most relevant factors include keyword selection, high-quality content, on-page elements (titles, URLs), link building, mobile responsiveness, technical optimization (e.g., site speed), and overall user experience.

Recent SEO trends emphasize user-centric optimization. Google's Core Web Vitals, metrics for loading speed, interactivity, and visual stability, and the focus on Expertise, Authoritativeness, and Trustworthiness (E-A-T) have become significant ranking signals [Google, 2019; McDonald, 2023]. The rise of voice search and Google's BERT algorithm, which enables better semantic understanding of queries, has also shifted strategies, contributing to the growth of featured snippets and "no-click" searches [McDonald, 2023; Sistrix, 2022].

SEO performance is measured using Key Performance Indicators (KPIs) such as organic traffic, keyword rankings, bounce rate, session duration, and conversions from organic traffic [Xinghai, 2023]. Various tools like Google Analytics, Ahrefs, and SEMrush are used for tracking these metrics [Firstpagesage, 2024].

The impact of SEO is well-documented beyond the commercial sector. For instance, a study at a private university in Sarajevo [Poturak et al., 2022]. found that improving search rankings led to increased site visitors, longer user engagement, and ultimately, higher student enrollment and annual revenue.

3. METHODOLOGY

This study analyzes the homepage websites of three faculties: the Faculty of Organization and Informatics (FOI) at the University of Zagreb, the Faculty of Electrical Engineering and Computing (FER) at the University of Zagreb, and the Department of Informatics (FIDIT) at the University of Rijeka. These institutions were selected to represent Croatia's diverse technical universities, all with a shared focus on informatics, where web visibility is crucial. Their similar structures allowed for direct benchmarking of SEO practices, and their public websites ensured that the analysis could be reproduced.

This study exclusively used free tools such as Rank Math SEO Analyzer, PageSpeed Insights, and Generative AI (ChatGPT, ClaudeAI, DeepSeek) to ensure the methodology is both reproducible and accessible. By avoiding commercial platforms, we demonstrate that web audits can be achieved without financial barriers, offering a cost-effective proof of concept for under-resourced institutions. This approach provides practical, scalable recommendations for organizations with limited budgets.

The case study was designed as follows: First, conventional tools were used to gather as much information as possible regarding SEO, as well as performance and security. Only then were AI tools employed, with the goal of determining what information they can provide, whether it is accurate, and if they can replace conventional tools.

The research questions of this study are:

- What are the strengths and limitations of generative AI tools in SEO analysis compared to conventional auditing methods?
- What are the most critical technical and on-page SEO deficiencies across the evaluated institutional websites?
- What actionable improvements would most significantly enhance the websites' search visibility and usability?
- Additionally by using only free tools we want to answer the question: To what extent can open-source and freely available tools provide actionable insights into institutional SEO and web page optimization?

4. RESULTS

4.1. RANKMATH SEO ANALYZER

Rank Math SEO Analyzer (<https://rankmath.com/tools/seo-analyzer/>) offers a simple interface that analyzes a web page with 26 different elements divided into Basic SEO, Advanced SEO, Performance and Security. In Table 1 13 of the 26 elements are presented. It calculates an overall score based on the result.

A comparative SEO analysis of the three faculties reveals several shared and some specific weaknesses. Common issues include the absence of XML sitemaps and improper use of meta descriptions, these are entirely missing on the FER and FOI websites, while FIDIT's meta description is excessively long. All sites also lack image alt text, which negatively impacts accessibility. In terms of structure, only FOI uses the H1 tag correctly; FER and FIDIT misuse it by placing multiple H1 tags on a single page. On the technical side, FIDIT is the only faculty

using Schema.org structured data. In contrast, FER is the only one entirely lacking a robots.txt file and canonical tags, both of which are present on the FOI and FIDIT websites.

Table 1. Summary of results by RankMath SEO Analyzer

SEO Aspect	FIDIT	FOI	FER
Meta Description	Present but too long	Missing	Missing
H1 Tags	Too many (4)	Appropriate (1)	Too many (10)
Alt Attributes	1 missing	16 missing	18 missing
Canonical Tag	Present	Present	Missing
Schema.org Data	Present	Missing	Missing
CSS/JS Minification	CSS partially minified, JS minified	Not fully minified	Not fully minified
Number of Requests	Moderate (52)	Moderate (40)	High (55)
Response Time	Good (<0.8 s)	Slower (1.22 s)	Good (<0.8 s)
OpenGraph Tags	Partially missing	Partially missing	Present
Title Length	Good	Good	Good
Internal/External Links Ratio	Good 102 internal 31 external	Good 115 interna 18 external	Good 346 internal 12 external

Source: Authors

In terms of performance, FER and FIDIT have acceptable server speeds, while FOI's is noticeably slower. All three websites suffer from incomplete CSS and JavaScript optimization, with FER generating the highest number of HTTP requests. Among them, only FER utilizes OpenGraph tags for social media sharing. Link distribution is generally well-balanced; however, FER emphasizes internal linking, whereas FIDIT relies more heavily on external links.

In summary, FIDIT performs well in structured data implementation but needs to address issues with meta descriptions and heading usage. FOI should prioritize improving its technical performance and adding OpenGraph support. FER requires more extensive improvements, particularly in metadata, crawlability, and content structure. Resolving these issues would enhance the search visibility and accessibility of all three sites.

4.2. SPEEDTEST INSIGHTS

Although the Rank Math SEO Analyzer provided useful data, its performance insights were limited. Therefore, SpeedTest Insights (<https://pagespeed.web.dev/>) was used for a more detailed desktop analysis. This tool evaluated performance, accessibility, best practices, and SEO. The performance results are summarized in Table 2, while the other metrics largely aligned with Rank Math's findings.

Table 2. Summary of results by SpeedTest Insights

Largest Contentful Paint (LCP)	1.1 s	1.7 s	1.2 s
Interaction to Next Paint (INP)	48 ms	17 ms	16 ms
Cumulative Layout Shift (CLS)	0.04	0	0.08
First Contentful Paint (FCP)	0.7 s	1.4 s	0.9 s
Time to First Byte (TTFB)	0.3 s	1.0 s	0.5 s
First Contentful Paint (detailed)	0.8 s	0.9 s	1.0 s
Largest Contentful Paint (detailed)	3.6 s	3.0 s	1.8 s
Total Blocking Time (TBT)	270 ms	60 ms	0 ms
Cumulative Layout Shift (detailed)	0	1	123
Speed Index	4.0 s	2.1 s	1.4 s

Source: Authors

PageTest Insights showed that all three sites met Core Web Vitals benchmarks, but with notable differences. FER had the fastest Largest Contentful Paint (1.2 s) and best responsiveness (INP 16 ms), FOI demonstrated perfect layout stability (CLS 0), and FIDIT excelled in initial loading speed with the fastest time to first byte (0.3 s) and first contentful paint (0.7 s)

Among the three websites, FER achieved the highest overall performance score (85), excelling in speed, responsiveness, and minimal Total Blocking Time. FOI followed with a solid score (79), perfect adherence to best practices (100), and strong layout stability. Despite a lower performance score (60), FIDIT stood out in accessibility (96) and SEO (100), reflecting a strong focus on inclusivity and well-structured metadata. In contrast, FOI and FER showed weaknesses in accessibility due to missing alt text and incomplete metadata.

Further technical analysis reinforced these patterns. FER demonstrated the fastest Speed Index (1.4 s) and the shortest content load time (1.8 s), while FOI performed moderately across key metrics. FIDIT lagged in speed-related indicators, with a Total Blocking Time of 270 ms and the slowest Speed Index (4.0 s), highlighting the need for optimization. In summary, FER leads in speed and responsiveness, FOI excels in layout stability and coding practices, and FIDIT stands out in accessibility and SEO, each showing distinct strengths and areas for targeted improvement.

4.3. AIOSEO

AIOSEO (<https://aioseo.com/seo-analyzer/>) is an AI tool specialized for SEO. It has a similar interface as the previous two tools. This tool generates a report divided into the same four categories as RankMath SEO Analyzer (i.e., Basic SEO, Advanced SEO, Performance and Security). The tool analyzes 22 elements. All of the elements that the tool reports are also in the RankMath SEO Analyzer. The results are similar but not identical. For example this tool mentioned 411 internal and 8 external links for FER, 121 internal and 20 external links for FOI, and 117 internal links and 18 external links for FIDIT.

The overall score in this tool is: 44 for FER, 68 for FOI and 64 for FIDIT. These differences come from the fact that there is a difference in the number of elements checked but also how the specific element is treated. For example the case of AIOSEO OpenGraph Meta is present but some Open Graph meta tags are missing and this is flagged as critical while the RankMath SEO Analyzer only checks if the meta tags have been found. This show also that AIOSEO does do some deeper analysis but overall, at least in the free version, it is not much better than RankMath SEO Analyzer.

4.4. GENERATIVE AI TOOLS

This study evaluated the SEO analysis capabilities of three generative AI tools: ChatGPT v4 (<https://chatgpt.com/>), ClaudeAI Sonnet 4 (<https://claude.ai/new>), and DeepSeek v3 (<https://chat.deepseek.com/>). To mimic the simplicity of conventional SEO tools, we used a deliberately basic prompt: “Can you do SEO analysis for the following web pages: <https://www.foi.unizg.hr/>, <https://www.fer.unizg.hr/>, and <https://www.inf.uniri.hr/?>” This approach was intended to assess the tools’ baseline performance, an issue further examined in the Discussion section.

All three tools successfully queried the web pages and generated reports. ChatGPT provided textual summaries highlighting the strengths and weaknesses of each site. It identified issues related to metadata, heading structures (H1, H2), image alt attributes, and Core Web Vitals. The final summary noted that each institutional site had unique strengths but also shared common weaknesses. For instance, FOI offered strong clarity but had poor metadata; FER conveyed authority but lacked meta descriptions and image optimization; and FIDIT featured a good structure but required improvements in meta tags and schema markup.

While ChatGPT’s report was informative, it included only a small fraction of the information gathered by conventional tools. However, it introduced a valuable new element not found in traditional analyses: content improvement suggestions. These included: FOI – The homepage is too generic and should incorporate relevant keywords such as "study programs," "research," and "ICT education Varaždin" to improve SEO. FIDIT – The homepage should feature key terms like "digital technologies," "informatics," and "research" in visible headings and paragraphs. FER – The homepage contains a significant amount of dynamic content, which may impact SEO.

The second GAI tool, DeepSeek, provided a report similar to ChatGPT’s. Again, there were comments about titles, metadata, links, and content suggestions. It also included information about speed (e.g., TTFB), which aligned with the data reported by SpeedTest Insights. One improvement suggestion that ChatGPT did not offer was to enable compression and optimize CSS and JavaScript to enhance loading speed. DeepSeek offered simple statements for each

site: FER has the strongest SEO foundation but needs improvement in mobile optimization, FOI lags in meta descriptions and speed, and FIDIT requires a complete redesign and technical upgrade. As with ChatGPT, DeepSeek provided useful basic information and some helpful advice on content improvements. However, many valuable insights, easily obtainable with conventional tools, were missing.

Third GAI tool CloudeAI provided the most detailed report from all three tools. It divided the report in three parts: positive and negative aspects and SEO recommendations. While it did provide suggestions about titles, metadata and links it also gave suggestions about: content hierarchy, readability, mobile responsiveness, use of structured data (schema markup), and the inclusion of clear calls to action. It provided some scores (e.g. content quality, loading speed) and gave an overall conclusion noting the following key recommendations: *Technical Optimization* - Adding meta descriptions, schema markup, sitemap; *Content Structure* - Improved H1-H6 hierarchy, shorter paragraphs; *Local SEO* - Google My Business, addresses, contact information; *Mobile Optimization* - Responsive design, loading speed and *Call-to-Action* - Clearer calls to action for prospective students.

5. DISCUSSION

This study aimed to evaluate the SEO performance of three Croatian higher education institutional websites using both conventional and AI-based tools. The research was guided by five key questions, each of which is addressed below in light of the collected data and comparative analysis.

5.1. TECHNICAL AND ON-PAGE SEO DEFICIENCIES

The second research question: “*What are the most critical technical and on-page SEO deficiencies?*”, was addressed through analysis using tools such as RankMath, SpeedTest Insights, and AIOSEO. The evaluation revealed several recurring issues across the websites. Both FER and FOI completely lacked meta descriptions, while FIDIT’s meta description was excessively long, potentially reducing click-through rates. Heading structures were also problematic, with FER and FIDIT using multiple H1 tags per page, which can confuse search engines about the content hierarchy. All three websites had numerous images missing alt attributes, undermining both accessibility and image-based SEO. Furthermore, none of the sites included XML sitemaps, and only FIDIT implemented structured data via Schema.org, which limits their eligibility for enhanced search result features. FOI, in particular, struggled with technical performance, showing the slowest server response time and the highest Total Blocking Time (TBT), making its mobile usability especially poor. Collectively, these deficiencies point to a general lack of technical SEO hygiene, with key weaknesses in areas that affect how websites are crawled, indexed, and displayed in search results.

5.2. ACTIONABLE IMPROVEMENTS FOR VISIBILITY AND USABILITY

To address the third research question: “*What actionable improvements would most significantly enhance the websites’ search visibility and usability?*”, the analysis identified several practical steps based on the tool-based evaluations. Implementing schema markup for elements such as courses, events, and organizational information would help improve visibility in search results through rich snippets. Additionally, the creation and submission of XML sitemaps, along with optimized robots.txt files, would facilitate better indexing and crawling by

search engines. Technical enhancements like minifying CSS and JavaScript files and enabling compression, especially on the FOI and FER websites, are crucial for improving page speed and meeting Core Web Vitals standards. Although FER currently performs best in mobile responsiveness, all three sites could benefit from design adjustments to ensure faster loading and a more adaptive layout. Finally, improving the placement of calls-to-action and enhancing navigation, through clearer headings, a more logical internal link structure, and engaging interactive elements, would boost usability, particularly for prospective students. These improvements are largely feasible with modest technical effort, especially when using freely available SEO tools to guide the process.

5.3. AI TOOLS vs. CONVENTIONAL SEO TOOLS

The first research question: “*What are the strengths and limitations of generative AI tools in SEO analysis compared to conventional auditing methods?*”, highlighted both the promise and limitations of generative AI in SEO audits. While tools like ChatGPT, ClaudeAI, and DeepSeek produced meaningful insights regarding content structure, readability, and keyword use, they lacked the granularity and precision of conventional analyzers like RankMath or SpeedTest Insights. For example, ClaudeAI provided the most comprehensive AI-based evaluation, with both scoring and actionable recommendations across multiple dimensions (e.g., content quality, local SEO, technical optimization). ChatGPT and DeepSeek were stronger in qualitative assessments, especially in suggesting how to better align page content with user intent. However, AI tools missed crucial technical elements (e.g., sitemap presence, server response time, blocking time), which are core to SEO performance measurement.

Thus, while AI can support high-level SEO diagnostics and strategic content advice, conventional tools remain indispensable for granular technical auditing. There is the possibility to write more detailed prompts to the GAI tools but there are some issues. One issue that was encountered was that the GAI tool did not respond with real data but rather started making conclusions based on general information rather than querying the live web page. Another issue is that unless very specific information is requested (e.g. specific performance metric) GAI will return some performance data but necessarily the most important one. Third is that some metrics the GAI will not provide even if asked and would say the data is not available or point to use some external tools and web pages.

5.4. THE ROLE OF OPEN-SOURCE AND FREE TOOLS

The final research question: “*To what extent can open-source and freely available tools provide actionable insights?*”, demonstrated the practicality of using non-commercial SEO tools in academic and institutional contexts. Tools like RankMath, AIOSEO, and SpeedTest Insights yielded robust, actionable data across multiple domains (technical SEO, content structure, accessibility). Even with limitations in free versions, they enabled a comprehensive overview without the need for premium software. This underscores that institutions, especially in resource-constrained environments, can improve their web presence using free tools, provided they invest time in interpretation and implementation.

While performing this study one can see that useful information was obtained and that each of the three institutional websites exhibited a mix of strengths and weaknesses: FER - Strongest in performance and technical speed but lacking in metadata and schema markup; FOI - Good in best practices and layout stability but weak in speed and structured data; and FIDIT - Leading in accessibility and structured content but needs improvement in speed and H-tag structuring.

Integrating AI tools alongside conventional audits provides a well-rounded evaluation framework, especially when free or open-source tools are the primary resource. However, deeper technical issues still require conventional solutions, underlining the importance of hybrid methodologies in SEO evaluation.

Future research could explore longitudinal impacts of these optimizations on user engagement metrics. Comparative studies across multiple Croatian institutions or EU institutions may also contextualize these findings within broader regional trends.

6. CONCLUSION

This study provided a comparative SEO analysis of three Croatian higher education institutional websites using a combination of conventional and AI-based tools. The findings revealed several recurring technical and on-page SEO deficiencies, including missing meta descriptions, improper heading structures, lack of schema markup, and suboptimal performance metrics. While each institution exhibited distinct strengths, FER in technical speed, FOI in layout stability, and FIDIT in accessibility, the overall SEO hygiene remains inadequate for optimal online visibility.

Generative AI tools demonstrated promising capabilities in high-level content evaluation and strategic guidance, but they currently lack the precision and data access necessary for detailed technical audits. Conventional tools remain indispensable for diagnosing and resolving core performance issues, particularly in areas such as server responsiveness, Core Web Vitals, and structured data implementation.

The effective use of open-source and freely available SEO tools suggests that resource constraints need not be a barrier to meaningful optimization. However, the successful application of these tools depends heavily on human interpretation and consistent implementation.

A hybrid methodology that combines AI-driven strategic insights with the technical depth of traditional SEO tools emerges as the most balanced approach. Future research could extend this analysis by tracking changes in web performance post-implementation or by expanding the sample size to include a wider range of academic institutions within Croatia or the EU. Such studies could further illuminate the role of SEO in enhancing institutional digital presence and accessibility in higher education.

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