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AGGREGATED INDICES IN QUALITY ASSESSMENT OF SELECTED GEOINFORMATION WEBSITES

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Summary

Map portals can facilitate the work of public administration units and improve access to information, although they have to present high material and technical quality. Not without significance are also measures supporting these websites. This paper aims to assess the quality of selected geoinformation websites. The study was carried out in the form of a quality audit with the use of selected web applications provided in a freeware, thin-client model. A comparative analysis was performed on three versions of the geoservice functioning for the Tomice municipality (accessed on 5th July 2023): 1) eMPZP website (https://www.tomice.pl/mpzp/), 2) municipal geoportal (http://www.mpzp.tomice.pl), and 3) municipal map portal (https://sip.gison.pl/tomice). The measurements were taken only once and in an ad hoc manner. The tests were performed in selected quality dimensions: responsiveness, performance, content and hyperlink quality, accessibility for people with disabilities, syntactic code correctness, search engine optimisation (SEO), and usage indicators, with special emphasis on overall quality. The conclusion was that each of the geoportals evaluated presents good quality. However, it would be wrong to compare them in absolute terms, as the quality of these services should be assessed through the lens of the different times in which they operate.

Keywords

quality • quality management • information management • quality assessment • aggregate measurement • quality improvement

1. Introduction

Entities that recognise the potential of web analytics are increasingly monitoring websites and internet applications, capturing user behaviour patterns, analysing the quality of services, and identifying areas that require optimisation. A mature analytics culture enables an effective use of data in the decision-making process [Röglinger et al. 2012]. The private sector uses web analytics significantly more frequently and at a higher level than public administration, including local governments. Furthermore, the private sector conducts audits much more often in order to improve the quality of their internet services [Alghenaim et al. 2023].

A map portal can help streamline the work of public administration units and improve access to information for residents and landowners. Municipal map portals make it possible to check the designation of land plots in the current local spatial development plans, as well as to study the conditions and directions of spatial development, together with the full content of resolutions of local plans. Furthermore, most geoportals offer thematic layers such as maps of flood risk, landslides and areas prone to mass movements, flooding, deposits, mining areas, protected areas, Natura 2000 sites, and natural monuments [Glanowska and Hanus 2016].

Regular quality audits of online services are justified in order to improve and maintain their quality. This can be somewhat different in the case of municipal map portals. Municipalities do not conduct audits of the map portals they provide to residents, as these applications are highly advanced and have specific characteristics, which include their functions, scope of functionalities, and purposes. The quality of such a service is standardised and adapted to the applicable international norms and standards, such as those set by the World Wide Web Consortium (W3C) or the Web Content Accessibility Guidelines (WCAG), without taking into account the standards of the geodata themselves. It can be argued that quality audits of such applications (on-site audits) are of less value than external audits that assess the environment of these services (off-site audits). This is largely due to the limited direct influence of municipalities on the quality of map applications. On the other hand, there are significant opportunities for influence beyond the service, in its functional environment. Therefore, there may be untapped potential for off-site optimisation that is worth exploring to enhance the visibility (presence) of online map services. As a result, this could have an impact on the visibility of all municipal services in search engine results. The aim of this study is to assess the quality of selected geoinformation websites. The study addresses the following research questions: 1) What information can a quality audit of map portals provide, and how can its results be used by municipal authorities?; and 2) Do all the quality attributes characteristic of online services apply to the evaluation of municipal map portals? The subsequent part of the study is structured as follows: the second section introduces topics related to the indicator-based assessment of online service quality, presents the typology of quality indicators, and characterises selected indicators. The third section outlines the methodological aspects of the research, including a description of the research model adopted and the analytical tools used. The fourth section presents the research findings and conclusions. The study concludes with a discussion and summary.

2. Indicative assessment of website quality

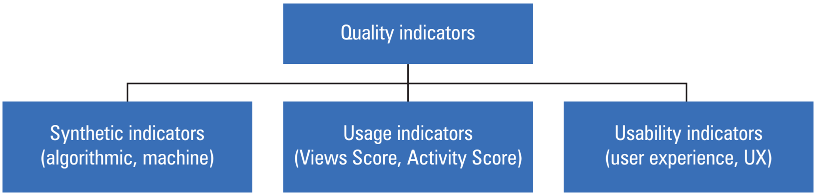
Quality is a concept that has different meanings depending on the context. In a general sense, the concept refers to the degree to which a given object, item, element, or service meets specified requirements, norms, standards, or expectations. Quality can be measured or evaluated based on various factors, depending on the field or context in which it is considered [Wolniak and Jonek-Kowalska 2021]. Quality management refers to a systematic approach to ensuring, maintaining, and improving the quality of products or services. It can involve quality control processes, certifications, quality standards and norms [Wolniak 2013]. In the context of human resource management, quality may refer to competencies, skills, efficiency, or professionalism, and may be measured on the basis of achievements, education, experience, or ratings from employee performance appraisals [Izvercian et al. 2014]. In the case of products or services, quality refers to the extent to which they meet specified standards, including technical standards, but also the requirements of customers and clients. Consequently, quality can be measured with various indicators such as reliability, durability, performance, usability, or customer satisfaction. Some of these indicators are relative and subjective in nature, while others take the form of aggregated measures resulting from algorithmic measurements [Moorthy and Bovik 2011]. In terms of websites and web applications, quality is expressed through a range of technical attributes, including responsiveness, performance, accessibility for people with disabilities, syntactic code correctness, content quality, including texts, degree of search engine optimisation, hyperlink quality, and many others [Król and Zdonek 2020].

2.1. Characteristics of selected quality indicators

Quality indicators are measures used to assess the quality of a given product, service, process, or activity. They allow a relatively objective assessment and monitoring of quality in decision-making, improvement, and comparison of results. Indicators of compliance with norms and standards are used to determine whether a product, service, or process conforms to specified norms, regulations, or standards. A synthetic, aggregated quality index, on the other hand, is a measure that combines different quality components into a single indicator representing overall quality. This measure allows for the simplification of quality assessment or the comparison of different objects in terms of quality in a more comprehensive and accessible way (benchmarking tests, competitive analysis).

Quality indicators for online services can be divided into three basic groups (Fig. 1). The first group consists of synthetic indicators. These exist only in the digital ecosystem and have no counterparts in the natural ecosystem. The collection of values for these indicators is automated, usually through testing applications (algorithmic measurement). These measurements can be initiated within a web browser window (in the thin client model). They can also be taken by computer programs installed on a hard drive or by browser components (called plug-ins). Synthetic indicators have different characteristics but most often take the form of aggregated scores, with values ranging from 0 to 100 or from 0 to 10 points/units.

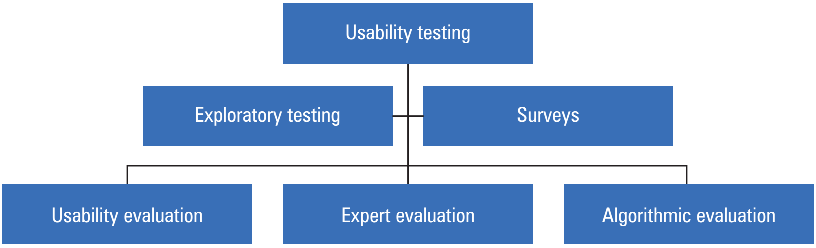
The second set consists of indicators, which can be referred to as Views Score or Activity Score. These metrics reflect the degree, to which a service is actually being used, both quantitatively and qualitatively. Examples are the bounce rate, the number of page views, or the number of users [Król 2018]. The values of these indicators can sometimes only be estimated, especially in the case of competitive analysis when there is no access to analytical tools. For instance, the estimation of usage indicators can be facilitated by the SimilarWeb application [Król and Halva 2017].



Source: Author's own study

Fig. 1. Division of quality indicators by source of measurement

Websites serve specific functions (such as providing information, facilitating contact, reservations, or payments) through different functionalities that can be more or less useful. Usability indicators are linked to user experience (UX), which encapsulates the 'user's feelings' when interacting with a particular product, system, or service. Consequently, user experience is a term widely used to refer to the emotional aspect of the 'perceived quality' of interactive products [Hassenzahl and Tractinsky 2006]. UX is a broader concept than usability, as it also includes aspects of user interaction with an organisation, its services and products, as well as thoughts, perceptions, and associated emotions [Knijnenburg et al. 2012]. Common methods used in usability research include checklists, and evaluation is often done through cognitive walkthroughs. These studies involve both users and experts. Testing applications and survey forms are also used (Fig. 2).

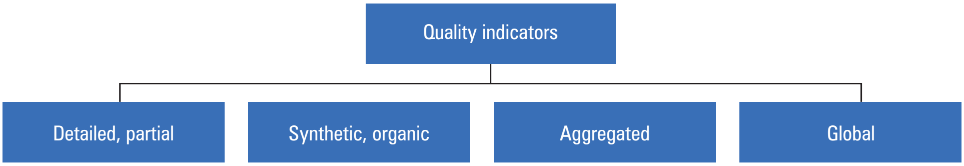


Source: Author's own study

Fig. 2. Types of usability testing

An aggregated quality indicator is a measure that combines and aggregates different quality indicators to provide a comprehensive view of quality in a given context. This approach organises and presents quality-related data, enabling comparisons and evaluations of overall quality based on different components. In the context of assessing the quality of online services, quality indicators can be divided into detailed (partial), synthetic and organic, aggregated, and global indicators (Fig. 3).

There are quality indicators that can be assigned to several categories. For example, the Open PageRank indicator is a global, aggregated indicator (an offsite type indicator). The Open PageRank measures the estimated quality of a website, representing its 'domain capital' or online 'brand strength'. The value of the indicator is expressed on a scale from 0 to 10 points. A higher value indicates greater popularity of the website.



Source: Author's own study

Fig. 3. Types of quality indicators

Detailed indicators are often associated with individual measurements of specific quality attributes. An example of such an indicator is the Text to HTML Ratio (THR). THR is a metric used to assess the ratio of text to HTML code within a webpage. Excessive HTML code compared to text could signal search engine algorithms that the page may not have enough content for users. Organic indicator values are expressed within the digital ecosystem in units such as seconds. Time-based units are used, for instance, to express the values of indicators from the Core Web Vitals group.

3. Materials and methods

Synthetic scores appeal to the recipient's imagination in a unique way. They present the scale of intensity of a phenomenon in an accessible and understandable way. They are presented in the form of numbers, letters, or graphics, which improves their perceptual accessibility. Synthetic scores in automated evaluations of websites and web applications often serve as a summary of a test, a kind of final grade [Król and Zdonek 2020]. Based on such scores, it's possible to create rankings of evaluated objects or perform comparative analysis [Stepchenkova et al. 2010].

The research was conducted in the form of a quality audit using selected web applications delivered in a freeware, thin client model. This means that the use of the testing applications is free of charge and does not require any installation on the auditor's device. The infrastructure required to run the application is provided by its publisher. Measurements were taken only once and in an ad hoc manner. The research was carried out in June 2023, in both mobile and desktop modes if the testing tool allowed. It was assumed that mobile mode tests would be particularly significant due to the dynamic growth in the number of users browsing the web via mobile devices.

The quality of online services is most often divided into three main categories: content quality, usability, and technical quality [Rocha 2012]. The main quality attributes have been studied by [McLean and Wilson 2019, Król and Zdonek 2020]. Responsiveness, performance, content and hyperlink quality, accessibility for people with disabilities, syntactic code correctness, search engine optimisation (SEO), usage indicators, and global quality were verified, with a particular focus on overall quality (Table 1).

Table 1. Scope of the quality audit

No.	Testing tool	Quality attribute	Quality indicator	Type of indicator (measurement unit)	Measurement scale
1.	Mobile-Friendly Test (Bulk Testing Tool)	responsiveness	Mobile-Friendly, Tap Targets Too Close, Use Legible Font Sizes	detailed, usage	0–1
2.	GTmetrix	performance	Performance	aggregated, synthetic	0–100
3.	GTmetrix	performance	Structure	aggregated, synthetic	0–100
4.	GiftOfSpeed	performance	Speed Score	aggregated, synthetic	0–100
5.	GiftOfSpeed	performance	Time to Interactive Fully Loaded	organic	> 0
6.	Siteliner	Text to HTML Ratio	THR	detailed, synthetic	0–100
7.	Ahresf Broken Link Checker	internal hyperlinks	Link rot	detailed, organic	> 0
8.	WAVE	accesability	Number of errors according to CAG	detalied, organic	> 0
9.	HTML The W3C Markup Validation Service	syntactic correctness of the code	Number of errors according to W3C	detalied, organic	> 0
10.	Website Grader	SEO	SEO Score	aggregated, synthetic	0–30
11.	OpenPageRank by DomCop	global quality	OpenPageRank	global, aggregated, synthetic	0–10
12.	SimilarWeb	usage indicators	Total Visits Bounce Rate Pages per Visit	global, usage	> 0
13.	Website Grader	overall quality	overall quality	aggregated	0–100

Source: Author's own study

A comparative analysis of three versions of the geoservice for the municipality of Tomice was carried out (accessed on 5th July 2023): 1) Geo1 – the eMPZP website that was used until 2019 (https://www.tomice.pl/mpzp/), 2) Geo2 – the municipal geoportal (http://www.mpzp.tomice.pl/), used until 2022, and 3) Geo3 – the current municipal map portal (https://sip.gison.pl/tomice). Each of these applications has been built differently, and their development techniques show the evolution in the presentation of geospatial information online.

4. Results

Each of the evaluated map applications has a different online address structure. The address of the Geo1 application is a path to files located in the 'mpzp' directory on the municipal server at 'tomice.pl'. The address of the Geo2 is a subdomain, while the Geo3 is a path within the subdomain. As a result, the possibilities for performing an automated audit vary, namely by testing applications that run in a web browser window. The greatest difficulties were encountered in cases where the Internet address of the service points to a directory on the server, as is the case with the Geo1 and Geo3 services.

In the case of the Geo2 and Geo3 applications, the way the information is displayed is adapted to the screen of the device on which it is viewed. The Geo1 application is non-responsive due to its architecture. It was built based on raster files and JavaScript. Raster geodata is displayed in a floating frame window (iframe). The whole composition follows the principles of the Web 1.0 era, which has significantly defined the usability of the application. As a result, the lack of responsiveness and limited functionality may have determined the replacement of the app with a geoportal.

The highest performance, measured by synthetic indicators like Performance, Structure (GTmetrix), Speed Score (GiftOfSpeed), and organic indicators like Time to Interactive and Fully Loaded (GiftOfSpeed), was observed in the case of the Geo1 service, while the lowest was observed in the case of the Geo3 service. The differences in measurements are relatively large. For instance, the Geo1 application is fully loaded within a web browser window in 2.37 seconds, while the Geo3 application takes 20.04 seconds. This is significantly correlated with the number of components comprising each application and the volume of these components (Table 2).

Table 2. Quality audit results in terms of responsiveness and performance

No.	Testing tool	Quality indicator	Measurement results		
			Geo1	Geo2	Geo3
1.	Mobile-Friendly Test (Bulk Testing Tool)	Mobile-Friendly Tap Targets Too Close Use Legible Font Sizes	0 1 0	1 0 1	1 0 1
2.	GTmetrix*	Performance Structure	98 93	68 70	38 48

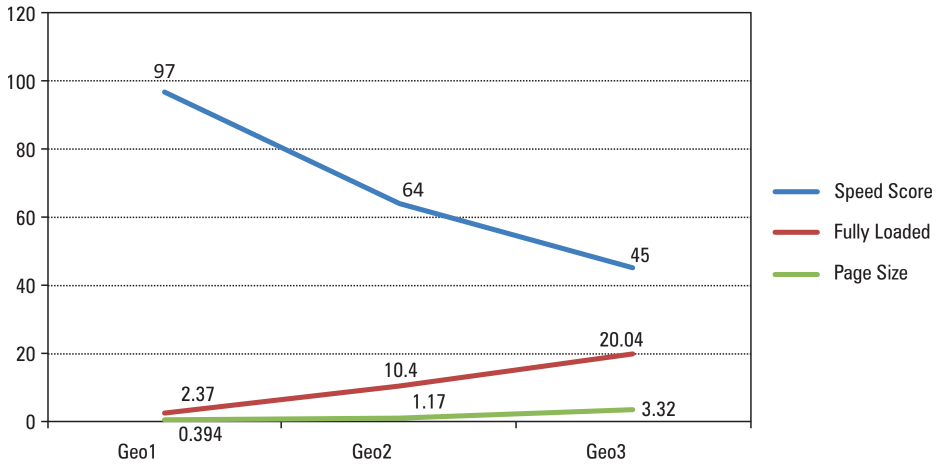
Table 2. cont.

No.	Testing tool	Quality indicator	Measurement results		
			Geo1	Geo2	Geo3
3.	GiftOfSpeed**	Speed Score Time to Interactive Fully Loaded	97 1.95s 2.37s	64 9.45s 10.4s	45 19.45s 20.04s
4.	Overall Information	Requests Page Size	49 394 KB	48 1.17 MB	123 3.32 MB

* Test Server Location: Vancouver, Canada; Chrome (Desktop), Lighthouse
** Test From: USA (New York); device: mobile
Geo1 – https://www.tomice.pl/mpzp/
Geo2 – http://www.mpzp.tomice.pl
Geo3 – https://sip.gison.pl/tomice

Source: Author's own study

The increase in the number and size of components of the web service (component files) is accompanied by a decrease in performance as indicated by the Fully Loaded indicator (Fig. 4). The loading time of the Geo3 application is indeed longer than the rendering time of the other services. However, this service provides more extensive information and features that are missing from the other services. These include tools to improve content accessibility for people with disabilities according to WCAG, access to cadastral and registration data (addresses, streets), road and monument records, land use classifications, as well as a range of thematic layers related to natural conditions, nature conservation, and tourism.



Source: Author's own study

Fig. 4. Relationship between performance and size of a map application

The value of the THR (Text to HTML Ratio) indicator is relatively low, but this is typical for geoportals. The specificity of these services lies in the fact that content is conveyed through images, such as polygons, points, and lines, which are displayed on a map base and thematic layers. Text and raster graphics are not the primary form of content communication here, hence the low THR values (Table 3). The nature of the studied services also explains why there are no broken hyperlinks in these services. Maps are generated in real-time (tile maps) and according to user preferences. Such displayed content is not connected by typical hyperlinks (HTML tag – <a href="#">), so no broken links were detected. However, it should be noted that there is a need to conduct an audit of external (incoming) links.

The number of syntax errors found in the code is low, with the highest number detected in the Geo1 application. The number of errors related to accessibility for people with disabilities is also low (according to the adopted research model), but only the Geo3 application is equipped with toolbars that allow the adjustment of content display to the individual needs of the recipient.

Table 3. Quality audit results in terms of content, code syntax correctness, degree of search engine optimisation (SEO), and usage rates

No.	Testing tool	Quality indicator	Measurement result		
			Geo1	Geo2	Geo3
1.	Siteliner	THR	n/d	0%	3%
2.	Ahresf Broken Link Checker	link rot	0	0	0
3.	WAVE	Number of errors according to WCAG	1	1	n/d
4.	HTML The W3C Markup Validation Service	Number of errors according to W3C	11	1	0
5.	Website Grader	SEO Score	n/d	25	25
6.	OpenPageRank	OpenPageRank	n/d	1.69	n/d
7.	SimilarWeb	Total Visits Bounce Rate Pages per Visit	n/d	57 n/d 2.14	n/d
8.	Website Grader	overall quality	n/d	56	74

Source: Author's own study

Due to the specificity of the studied geoinformation services and the resulting configuration of the internet addresses, difficulties were encountered in obtaining OpenPageRank values and usage indicators (according to SimilarWeb). These challenges were most frequently observed in the case of the Geo1 application.

5. Discussion

Publishers of geoinformation services are typically interested in increasing the visibility and traffic of their websites. Increased visibility in search engines allows reaching a wider audience and increases the educational side of information pressure. Even though information pressure describes a negative phenomenon and refers to the excessive exposure of individuals to a large amount of information that requires analysis and assimilation, in this case, it has a positive meaning. The recipient receives a systematic spatial information system, which enables him to select the presented information [Wadowska et al. 2023]. Furthermore, the greater popularity of a service means that it has a wider reach and can attract the attention of a larger number of people who use geoinformation services.

Geoinformation services often provide information about locations, routes, places, objects, and more. Increasing the accessibility of such services is beneficial for local communities, residents, tourists, and entrepreneurs who use this information for navigation and decision-making, including investment decisions. Moreover, increased traffic to a geoinformation service can help collect more data and information on users' interests and activities [Król 2018]. This, in turn, can help improve the quality of the service and better understand the needs of local communities.

The question of optimising websites for search engines (SEO) is often taken into account when creating geoinformation services. However, there are many different ways in which SEO techniques can be applied in geoinformation and geoinformatics services. The main goal of SEO is to increase the visibility of a website in search results, and thus the number of users acquired through this way [Giannakoulopoulos et al. 2019]. Limitations in the application of SEO techniques often arise from the technical nature of the service itself (design constraints). A geoinformation service is typically a platform, web application, or website that provides information related to geolocation, maps, geographic data, routes, or points of interest (POIs). It can be a map portal, a navigation application, or an information service with spatial data. The primary goal of a geoinformation service is to provide information related to location and space. On the other hand, geoinformatics services employ advanced IT techniques and tools for analysing, modelling, or visualising geographic data. An example could be a service for spatial analysis, forecasting natural hazards, or creating three-dimensional terrain visualisations. The main purpose of a geoinformatics service is to utilise geoinformatics techniques and tools for more advanced analysis and presentation of geographic data [Li et al. 2013, Li et al. 2018]. As a result, SEO efforts focus on building visibility through an increased number of online recommendations and offsite SEO [Kloostra 2015]. It's also important to consider the selection and use of appropriate keywords that align with geoinformation-related topics. Geoinformation services are often based on geographic data such as geographic coordinates, polygons, points, or lines. Optimising this data and providing it through search engine-friendly formats, together with descriptions and tags, can help to improve indexing by search engines. Furthermore, due to the growing popularity of mobile devices, it is equally important to optimise geoinformation services for responsiveness and fast loading on mobile devices [Green and Pearson 2011].

6. Conclusions

Leaving aside the issues of assessing the quality of geodata and digital spatial representation, which were not the subject of the study, a quality audit of the map portal can provide various information that may be useful for municipal authorities. The conducted tests primarily provide information regarding technical aspects, including performance and usability, but also indirectly indicate critical areas that can be optimised. This allows municipal authorities to take corrective action. Additionally, the audit results can provide municipal authorities with insights into the preferences and needs of their residents regarding the use of the geoportal. With this information, municipal authorities can implement improvements or new features that better meet user expectations.

The results of the quality audit could even lead to the replacement of the current service with a new version if the current one does not meet quality standards and optimisation is difficult or impossible. At this moment, three map services coexist online, indexed in search results, presenting local spatial development plans of the Tomice municipality. This situation might lead to confusion and questions: Which one is the latest?; Which application is valid?; Do they all present up-to-date content? That is why it is advisable to organise these resources, for instance, by automatically redirecting users from outdated services to their current versions.

Each of the evaluated geoservices is of good quality, but it would be wrong to compare them in absolute terms, as the quality of these services should be assessed through the lens of the different times in which they operate. Geo1 was developed in the XHTML 1.0 Transitional specification, and its design and project techniques conform to the requirements of this specification, which is characteristic of the Web 1.0 era [Król 2020]. On the other hand, Geo2 and Geo3 are built using modern technologies that take into account responsiveness, high interactivity, and the need for content personalisation. These services have been developed using contemporary solutions, varying in scope and configurations.

Not all quality attributes that are relevant to general websites are equally applicable to the evaluation of municipal map portals. This is especially true for attributes such as text quality (measured by indicators such as THR or perceptual accessibility) and internal hyperlink quality (due to technical constraints). When assessing the quality of geoportals, indicators related to the quality of geoinformation, performance, usability (subjective assessment of perceived user experience), and global quality indicators come to the fore.

The direct optimisation of a map portal may go beyond the technical and organisational capabilities of the municipality. However, the situation is different for the geoportal environment (offsite). SEO audits of geoservices can stimulate actions to improve visibility in Search Engine Results Pages (SERPs). Improving offsite SEO aspects can contribute to increased visibility in search engines, which can attract a larger user base. Building the ecosystem around a geoinformation service can increase organic traffic, i.e. the number of users who find the service through search engines. Increased organic traffic can have a positive impact on popularity and usability. Furthermore, conducting SEO audits makes it possible to define starting points and monitor the results of the actions taken. Regular audits enable tracking progress in optimization and adapting the SEO strategy more effectively. Data analysis and result monitoring are essential for the continuous improvement of the geoinformation service and for achieving better outcomes, especially in the area of offsite SEO.

Limitations and further research

The research has confirmed the hypothesis. The indicator-based quality analysis reflects the degree of 'existing quality' at the place and time of measurement. It is a challenge to carry out optimisation activities based on this analysis alone, as such efforts are geoinformatic by nature, mainly involving programming aspects (modifying source code, geodata, back-end). At the same time, there is considerable potential in building a 'geoportal environment,' over which municipal authorities (service publishers) can exert a significant influence, for instance, by expanding the network of inbound hyperlinks. Therefore, more attention should be paid in the future to research in the area of offsite SEO, which would provide a better understanding of the position of geoportals within the global digital ecosystem.

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