Global Knowledge, Memory and Communication

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Get found: global metrics for assessing the position of geoportals in the online ecosystem

Karol Król

Department of Land Management and Landscape Architecture, University of Agriculture in Krakow, Krakow, Poland

Received 1 July 2024
Revised 5 November 2024
12 February 2025
Accepted 7 April 2025

Abstract

Purpose – Geoportals are specific websites whose quality is most often assessed based on design techniques, potential uses, and usability. However, their position within the online ecosystem and their ability to reach users have not been studied as extensively. This presents a research gap worth exploring. This paper aims to assess the quality of selected geoportals in terms of their position within the online ecosystem.

Design/methodology/approach – The author tested geoportals for the territory of Poland with proprietary domains and subdomains with algorithmic tools. They measured such global quality metrics as Open PageRank, Moz Domain Authority, Page Authority, Trust Flow and Citation Flow. The results were validated and juxtaposed with results for geoportals of selected European Union member states.

Findings – The study revealed that publishers of (geo)information portals use unfriendly URL addresses, which are of little to no value to crawlers. The highest global metric values were identified for a geoportal with dynamic content and many users.

Originality/value – The position of a (geo)information portal in the online ecosystem is a synergistic outcome of the qualities of all thematic geoportals. It is recommended that thematic geoportals provided as part of a main geoportal have their own subdomains. Subdomains can potentially become satellites of the main portal, improving its position in the online ecosystem.

Keywords Quality metrics, Online ecosystem, Geoinformation, Geoportal, Backlinks, Quality assessment

Paper type Research paper

1. Introduction

Geoportals are considered innovative platforms for spatial data collection, analysis, management, visualisation and dissemination. Web-based geoportals provide gateways to visualise and disseminate thematic databases, information from various sources and metadata for geographic data and services (Reddy, 2022). Such websites are used in multiple fields, including agriculture, disaster management and early warning, land and water management, urban planning, air quality and energy (Vahidnia and Vahidi, 2021). The

Funding: Co-financed by the Minister of Science under the "Regional Initiative of Excellence" programme. Agreement No. RID/SP/0039/2024/01. Subsidised amount PLN 6,187,000.00. Project period 2024–2027.

Global Knowledge, Memory and Communication
Vol. 74 No. 11, 2025
pp. 163-177
Emerald Publishing Limited
2514-9342
DOI 10.1108/GKMC-06-2024-0332

quality of geoportals, their usability and reliability are determined primarily by the quality of data provided. The quality, in turn, depends on how the data are acquired, processed and presented (Goodchild, 2013). Inaccurate or imprecise (geo)data or (geo)information can drive wrong decisions, especially in crisis management or spatial planning (Michalik and Zwirowicz-Rutkowska, 2023). Geoportal quality assessment often involves verification against International Organization for Standardization (ISO) principles, Open Geospatial Consortium (OGC) standards, Infrastructure for Spatial Information in the European Community (INSPIRE) requirements and World Wide Web Consortium (W3C) standards, including the Web Content Accessibility Guidelines (WCAG) (Senaratne *et al.*, 2017). Such research is of tremendous value because maladjustment of a geoportal to geospatial standards prevents cross-platform data exchange and system interoperability (including compatibility with WebGIS). Still, analyses of usability attributes related to performance or responsiveness are just as relevant because these factors affect user comfort (Unrau and Kray, 2019). Data presentation is also pertinent, including accessibility for people with disabilities and ergonomics and design (Gkonos *et al.*, 2019). Poor user interfaces hinder any effective use of geoportals (Menegon *et al.*, 2023), while lacking mobile-friendliness optimisation and insufficient performance hurt user experience (Król and Sroka, 2023). Therefore, geoportal quality is assessed regarding user experience on the one hand (He *et al.*, 2012) and functionality embodied in the data and services it provides on the other hand (Dareshiri *et al.*, 2019). At the same time, portal providers develop application programming interfaces (APIs) and processes for handling big data (Vahidnia and Vahidi, 2021). Many analyses focus on data security and geoportal user security (Reddy, 2022) or the time and financial costs of developing geoportals (Iosifescu-Enescu *et al.*, 2017).

Geoportal quality is also analysed in terms of usability for public administration, spatial planning and management, decision-making, education, navigation and tourism (Król and Sroka, 2023). Researchers focus much less on investigating the position of geoportals in the global online ecosystem and their potential to reach the user, that is, the potential to get found or rank high on search engine results pages. This offers a research gap worth filling in. Such analyses are possible thanks to global quality metrics, which provide information about websites' position in the online ecosystem. The paper aims to assess the quality of selected geoportals in terms of their position in the online ecosystem. The three research questions combine theory and practice:

RQ1. How to interpret the results of measurements of global quality metrics, and how to improve the geoportal's position in the online ecosystem using these results?

RQ2. How is geoportal quality defined in the context of its position in the global online ecosystem?

RQ3. What is the potential of geoportals for getting found in the online ecosystem and reaching users?

The tangible contribution of the article is 1) the determination of the position of selected geoportals in the online ecosystem; 2) results of the assessment of geoportal quality with global quality metrics; and 3) recommendations for improving geoportal's position in the online ecosystem.

The structure of the article is as follows: Section two presents global quality metrics and characterises some of them. Section three provides the methodology, lists the investigated geoportals and test tools and describes how the results were verified. Section four offers the results, including values of global quality metrics and outcomes of result validation. The next section contains observations and discusses the results. The final section covers conclusions, practical implications and further research.

2. Background

2.1 What are global quality metrics?

The online ecosystem encompasses diverse technologies, platforms, services, types of content and users who coexist, cooperate and interact (Cormode and Krishnamurthy, 2008). Elements of the ecosystem have strictly defined and yet dynamic relationships. Because of this, researchers pay particular attention to interactions between users and components of the ecosystem. The components are assessed considering design techniques and usability, also with quality metrics.

Quality assessment involves assigning values or using satisfaction scores based on specific criteria. Its objective is to understand how much a given phenomenon, product, service, process or activity conforms to specific standards, expectations or targets (Batini *et al.*, 2009). A quality metric is a measure or criterion for describing, comparing and evaluating a phenomenon, product, service, process or activity (Pipino *et al.*, 2002). Quality metrics are used in decision-making to drive improvements or compare results against benchmarks. Therefore, it is critical to define metrics consistent with the objectives and nature of the phenomenon, product, service, process or activity to be evaluated. The same applies to components of the online ecosystem.

Quality metrics used to describe components of the online ecosystem can be classified as detailed (indicators), including artificial (they describe phenomena found only in the online ecosystem and are expressed with units without analogues in the natural ecosystem) and organic (they have analogues in the natural ecosystem, such as operation duration in seconds), and aggregate indices, emerging as a combination of multiple detailed indicators. Quality metrics can also be divided depending on the data source, such as algorithmic (performance-based) and use metrics (user-based). In the former case, the data source is digital recommendations from users, usually backlinks. The latter come from user activity monitoring. User-based metrics can represent how often and in what ways users use the website. In both cases, the metric values provide insight into the quality of the website and its place in the online ecosystem. Quality metrics describe on-site and off-site website quality. The other kind, called global quality metrics, quantifies the intensity of relationships between different websites.

2.2 Characteristics of selected global quality metrics

Values of global quality metrics help estimate the position of a geoportal in the online ecosystem compared to other geoportals or websites. They also provide means to assess the potential of "getting found" by users based on such parameters as the backlink volume. The number of backlinks is a form of initial capital, which defines the geoportal's position in the online ecosystem and the starting point for its development (Giannakoulopoulos *et al.*, 2019). Global quality metrics can be used to assess the capital of a website, which affects the online ecosystem as a single entity (that is, the domain and website, including content and technology). Moreover, global quality metrics can monitor the results of efforts made to optimise the website for search engines, for example (Semrush, 2023). Note, however, that values of the global metrics are estimated from databases, which are a fragment of online resources. Therefore, any identified "global potential" or "position in the online ecosystem" should be considered a simplification because the results of measurements and global quality metrics are computed on a finite database.

2.2.1 Open PageRank and Moz Domain Authority. Until recently, Google PageRank was the most popular global quality metric (Brin and Page, 1998). Google PageRank is a Google algorithm for ranking websites (Khan and Mahmood, 2018). Google's PageRank method was developed to evaluate the importance of web pages using their link structure

(Gleich, 2015). In simple terms, the global quality of a website was reflected in the number of hyperlinks directing to it from other high-quality websites. In this case, the links are (digital) recommendations. Consequently, numerous high-quality digital recommendations bear witness to the high quality of the recommended portal (Brin and Page, 1998). Google PageRank was discontinued in 2016, leaving a gap filled in by Open PageRank (OPR).

OPR is a global quality metric devised as an alternative to Google PageRank. The OPR initiative was created to bring back Page Rank metrics so that different domains could be easily compared. The value of OPR ranges from 0 to 10. It is estimated from open-source data provided by Common Crawl and Common Search. Another global quality metric is Moz Domain Authority (DA).

Moz DA is a metric by Moz that shows the "domain rank potential" in the Google search engine. In simple terms, the value of Moz DA depends on the frequency of the website in Google search results. It depends on the popularity of the website, among others. The higher the popularity, the more often it is searched and the higher the Moz DA value. In addition, Moz DA depends on the usefulness of the website; the more useful it is, the more frequently it is searched. Therefore, Moz DA can be used to estimate the potential of the website to rank high in search results.

DA is an aggregate index, which means its value is estimated from many factors, including backlinks. Moz DA is based on machine learning algorithms, so its value changes over time in the range from 1 to 100. Note that improving the result from 20 to 30 is easier than improving from 70 to 80. Moz DA should be used in comparative tests. Its value shows the competitive relationship between Google results of a website compared to websites of similar type or from the same industry. This means DA is a relative value, so there is no "poor" or "good" result in absolute terms. Still, results can be "poor" or "good" in the context of a set of similar websites or websites in the same industry (Moz, 2024a).

2.2.2 Page Authority and Authority Score. Page Authority (PA) is a score developed by Moz that predicts how well a specific page will rank on a search engine results page (SERP). PA is calculated the same way as DA but at the level of individual pages. PA scores range from one to 100, with higher scores corresponding to a greater ability to rank. The value of PA is represented on a 100-point logarithmic scale. This is why increasing the result from 20 to 30 is easier than from 70 to 80. Like DA, PA is a holistic score and is difficult to influence directly. It is an aggregate of metrics that have an impact on the score (Moz, 2024b).

Authority Score is based on several indicators that reflect the trustworthiness and authority of the website. It is estimated with such measures as link power, which is the quality and quantity of backlinks, and organic traffic, the estimated monthly average of organic search traffic. The score is measured on a scale from 0 to 100, with the latter being the strongest. The final score is measured relative to the most authoritative domains. If a domain's score shows an upward trend, it may be a sign that the site is actively working to improve its online presence and reputation. It may also be a sign of inefficient search engine optimisation (SEO) on the competition's side (Semrush, 2023).

2.2.3 Trust Flow and Citation Flow. Trust Flow determines the "trustworthiness of a website" and "trust in the website" based on backlink quality analysis. Consequently, Trust Flow is a measure of the global authority of the website. The authority stems from the quality of online recommendations. It is proportionate to the number of recommendations from other reputable (high-authority) websites. In simple terms, the value of Trust Flow depends on the number of backlinks from other valuable websites that exhibit high Trust Flow. The value of Citation Flow is estimated from the backlink volume. Citation Flow value much higher than Trust Flow might mean that the website has many backlinks but the algorithm

evaluates them as being of lower quality (Jones, 2017). Trust Flow and Citation Flow range from 0 to 100.

3. Materials and methods

The study assumed the perspective of a third-party auditor and is presented as a quality audit report. The quality was tested with selected metrics and test tools. The author used algorithmic tests to investigate geoportals for Poland (Table 1) selected with subject matter and technical criteria (the so-called domain criterion). The first criterion is that a geoportal must provide full geodata in the national spatial information infrastructure framework. The other criterion requires that the geoportal is available under its own domain or subdomain (a part of a larger domain). Domain owners can create subdomains to offer URLs of pages that are easy to recall within a higher-level domain. Subdomains are generally used to separate various parts of a website.

OPR, MoZ DA, PA, Trust Flow and Citation Flow were selected to assess the position of the geoportals in the online ecosystem for several critical reasons. OPR and MoZ DA analyse website visibility and authority in the SEO context, which is essential for understanding the impact and value of geoportals as tools for public administration and commercial organisations. Considering the unique character of geoportals, these metrics offer a cross-sectional assessment of their position in the global online ecosystem. A high value of PA suggests a significant probability of high search engine results page ranks. Values of Trust Flow and Citation Flow are calculated from the quantity and quality of links to the geoportal, reflecting the "trust of other websites" (Reyes-Lillo *et al.*, 2023). SEO researchers and practitioners have appreciated all the selected metrics, which further supports their use in the employed research design.

Values of global quality metrics, including OPR, Moz DA, PA, Trust Flow and Citation Flow, were obtained with selected free-to-use test tools (Table 2). The test tool selection was made based on other studies. Experiments by Reyes-Lillo *et al.* (2023) confirmed that such SEO platforms as Moz DA Checker and Ahref Website Authority Checker provide reliable information on the quality of websites and their positions in the online ecosystem. This is why they are employed here.

Table 1. Characteristics of the geoportals selected for algorithmic tests

Acronym	URL	Function
w1	https://polska.geoportal2.pl	Provision of map resources and (geo)datasets at the central, district and municipal level
w1b	https://geoportal2.pl	
w2	https://mapy.geoportal.gov.pl	National Geoportal of GUGiK*. Provision of spatial data from the State Geodetic and Cartographic Inventory
w2b	www.geoportal.gov.pl	
w3	https://wms.zgkikm.wroc.pl	Portal of the Board of Geodesy, Cartography, and City Cadastre in Wrocław
w3b	https://zgkikm.wroc.pl	
w4	https://polska.e-mapa.net	GEO-SYSTEM (e-mapa). Open Spatial Data Geoportal
w4b	https://e-mapa.net	
w5	https://drogi.gddkia.gov.pl	Map service of GDDKiA**. Road data map
w5b	https://gddkia.gov.pl	

Note(s): w1…wn – geoportal; w1b … w1n – main portal, (geo)information portal, landing page, higher-level address above the tested subdomain; *Head Office of Geodesy and Cartography; **General Directorate for National Roads and Motorways; accessed: 20.02.2024
Source(s): Authors' own work

Table 2. Test tools and global quality metrics used in the study

Item	Global quality metric	Measuring tool
1	Open PageRank (OPR)	A DomCop tool for comparing websites
2	Ahref Domain Rating (ADR)	Ahref Website Authority Checker
3	Moz Domain Authority (Moz DA)	Moz Domain Authority Checker
4	Authority Score (ZAS) Domain Authority (ZDA) Page Authority (PZA)	Zadro Web SEO Auditor
5	Domain Authority Score	SEO Review Tools, Website Authority Checker
6	Trust Flow Citation Flow	Majestic SEO Backlink Checker
7	Total Valuable Backlinks	BacklinkWatch Backlink Checker

Note(s): URLs of the tools: 1. www.domcop.com/openpagerank/; 2. https://ahrefs.com/pl/website-authority-checker/; 3. https://moz.com/domain-analysis/; 4. https://zadroweb.com/seo-auditor/; 5. www.seoreviewtools.com/website-authority-checker/; 6. https://pl.majestic.com/; 7. www.backlinkwatch.com/; accessed: 20.02.2024
Source(s): Authors' own work

When measuring the values of the global quality metrics, the author recorded the backlink volumes reported by the test applications. In addition, the author tested the geoportals of selected European Union (EU) member states to facilitate a better understanding of the results for the Polish geoportals. They are listed and profiled in a table available in the repository (Repo 1, 2025).

The geoportals are provided mainly under a subdomain or a URL representing the location of the application on the server. Therefore, the results must be validated to ensure they pertain to the subdomain and related application, not the main domain and website. The validation involved a comparison of metric values for subdomains and URLs of geoportals with results for their respective main domains. Hence, the results for the geoportals were juxtaposed with those for (geo)information portals that are "gateways" for the thematic geoportals. The websites vary in how they present content, but make up complete (geo)information platforms. The platforms are usually central points of access to geoinformation resources and services.

4. Results

OPR values are comparable for all the tested geoportals and range from 3.1 to 3.5 out of 10 (Table 3). Values from 2.1 to 4.0 (21–40 units) are typical of local portals in need of optimisation with a modest potential of positioning on the first SERPs for searches with competitive keywords, both generic and long-tail.

A slightly higher OPR was identified for w2 (National Geoportal of GUGiK). Its OPR is nearly 4.2 units. Valued of 4.1–6.0 (41–60 units) are typical of websites with usually large backlink volumes, relatively many users, solid online ecosystem position and significant potential but lack optimisation and/or positioning.

The higher OPR value for w2 can be caused by its role. The portal is the central node of spatial information infrastructure in Poland. It means it is "privileged" in the Polish online ecosystem (Polish-speaking Internet) as a primary geoinformation portal. Another contributing factor is that its provider is the Head Office of Geodesy and Cartography (GUGiK), a public authority. Its responsibilities include supervising the implementation of the state geodesic and cartographic policy, keeping the central geodesic and cartographic inventory, creating and maintaining a geoportal of spatial information infrastructure, licensing geodesy and cartography professionals and cooperating with self-governments and associations of surveyors and cartographers. This means that GUGiK's geoportal (w2) can

Table 3. Results of global quality metrics for Polish geoportals

Test application	Quality metric	Website w1	w2	w3	w4	w5
1	OPR	3.12	4.19	3.12	3.52	3.43
2	ADR	60	75	28	71	74
3	Moz DA	35	55	N/D	38	55
4	ZAS	47	IE	F/C	47	45
	ZDA	35	IE	F/C	38	55
	ZPA	32	IE	F/C	42	45
5	PA	59	76	F/C	74	81
	DA	48	62	34	48	45
6	Trust Flow	12	29	16	8	42
	Citation Flow	10	29	10	37	40

Note(s): IE – internal error; F/C – failed to connect; N/D – no data; test date: 15.02.2024
Source(s): Authors' own work

have more backlinks on other websites, especially governmental (.gov domain) and educational (.edu) ones. The large number of backlinks drives the higher value of global quality metrics and better potential to rank high on SERP.

Ahref Domain Rating (ADR) values vary from 60 to 75 units, with 28 for w3 as an outlier. It is the only tested website that is of local reach. Its provider is the Board of Geodesy, Cartography, and City Cadastre in Wrocław, which is a local government institution. The research shows that the website may exhibit a lower potential to rank high on SERP for searches with competitive generic and long-tail keywords. The other portals are provided by nationwide institutions and attract users from the entire Poland, which is reflected in ADR. Three reached scores from 61 to 80, meaning a relatively significant potential for high SERP positioning.

Moz DA scores are slightly lower. The metric did not exceed 55 out of 100 units. It means that the tested portals exhibit good quality, usually with many backlinks, according to Moz DA. They have relatively numerous audiences, solid online ecosystem positions and high potential. Still, their future growth depends on optimisation and/or positioning.

The Trust Flow and Citation Flow metrics assumed values from several to below twenty units for w1, w3 and w4, with Citation Flow slightly higher. This means that the tested geoportals have a relatively small number of online recommendations, which are in addition sourced from websites of modest reputation, according to the test algorithm and under the employed research design. The results are comparable, reflecting a similar quality of the geoportals, particularly w1, w3 and w4. Geoportal w5 scored a little higher, which may be due to its profile. The portal receives and publishes notifications of road incidents in real-time but also offers EV charging station maps, road information maps and road construction maps. This means that its content is very dynamic and targets a broad audience: individuals and enterprises, such as drivers, carriers, or mass media like radio stations. The other geoportals provide more static content/(geo)data that users download less often. As a result, geoportal w5 can be visited and cited (referenced) more often, also with its URL, compared to the other websites. Its functionality and frequency of use can drive its high global metrics. Note the consistency of results for w5, which confirms its solid position in the online ecosystem.

4.1 Backlink volume analysis

Ahref Website Authority Checker identified the largest number of backlinks for w2 and w4. The first is a governmental project, and the other is a commercial enterprise. The difference

in backlink volumes between them is significant and amounts to 2.2 M backlinks. The same test application revealed that backlinks to geoportal w4 are found on merely 146 unique URLs (Repo 2, 2025). The results are consistent with the outcomes of "Moz Linking Root Domains" and "External links to page" tests (SEO Review Tools). Note that although w4 has a relatively large volume of backlinks compared to the other portals, its OPR and ADR values are not higher (3.52 and 71, respectively). In comparison, w2's backlinks were found on 2.3 K unique URLs, and it had higher OPR and ADR (4.19 and 75, respectively).

The relatively large volume of backlinks to w4 (compared to the other portals) should yield higher global metrics than for the others, but it does not. Note, however, that high values of global quality metrics are driven not only by the volume of backlinks but also their quality, i.e. the quality of websites where the backlinks occur. Therefore, many backlinks to w4 can possibly be posted on websites of mediocre quality (according to the test algorithms and under the employed research design).

The in-depth analysis revealed that w3b has 47 valuable links, according to BacklinkWatch. A manual verification of the report revealed that the result was overestimated. There are fewer such backlinks, not more than 37. Backlinks on such spam websites as "$iteprice" should be removed from the report. Geoportal w3 had even fewer backlinks, only 10. In comparison, geoportal w5 and portal w5b had 172 and 1164 valuable backlinks, respectively (according to BacklinkWatch). Geoportal w3 and portal w3b have relatively few backlinks (under the employed research design), which may result in zero TF and CF values.

4.2 Result validation

The validation revealed that the results for geoportals differ from the results for their main domains. The only exception is the test with Moz Linking Root Domains (Repo 3, 2025). It records the same number of backlinks for geoportals and main URLs. This means that Moz Linking Root Domains shows results for the main domain even if a subdomain is selected for tests. The same applies to values of Moz DA (Repo 4, 2025), which are identical for subdomains and main domains. It is hard to determine beyond any doubt how SEO Review Tools count backlinks. In some cases, they offer relatively large numbers (several to over 10 m). Hence, caution is advised when interpreting them.

Moreover, the validation revealed that Ahref Domain Rating, Moz DA, Zadro DA and PA show the global quality of the main domain even if a subdomain is selected as the test object. It means indirectly that the position in the online ecosystem synergistically emerges from the quality of all websites (and all assets) provided on a portal (its main domain). Therefore, portal quality can be evaluated as the quality of a single, large and complex object, but one can also assess the quality of its individual components. In practice, this state of affairs offers more possibilities for improving brand visibility online, but may also require greater SEO effort.

4.3 Measurement of global metrics for European geoportals

Acquiring OPR values for European geoportals was impossible under the employed research design. It is because they are provided under URLs that are access paths containing domain addresses and catalogues with map application components. Measurements with Ahref Website Authority Checker (ADR) demonstrated that this test application collects data for the main domain (Repo 5, 2025). The results confirm that the tests evaluate the position of the main domain in the online ecosystem. Its results are made up of results for all assets under the address and under related subdomains.

Regardless of their country, main portals ("landing pages") reached similar OPR values, around 4 units. The French g5b, Spanish g6b and Polish w2b portals scored slightly higher than the others. The lowest value was identified for the Portuguese portal (g7b). An in-depth analysis revealed that this geoportal (g7b) offers content only in Portuguese, which is not the case for the other websites. It may be detrimental to its position in the online ecosystem. The German, Czech, Slovak, Italian and Spanish geoportals automatically run English versions for international users. The only exception is the French (geo)information portal (g5b), which offers no English language version.

5. Discussion

5.1 Global quality metrics in studies on web asset quality

Global quality metrics are used to assess the quality of various websites, web applications and web assets. For example, Yates and Dixon (2015) used PageRank to assess the quality of scientific literature. They assumed that the quality of a scientific publication depends on the volume of citations defined as inbound links and their quality (citation importance) defined as citations in high-quality journals or articles (that also have high volumes of inbound links). One of the foundations of the present study, similar to the work by Yates and Dixon (2015), is the assumption that the quality of geoportals is defined by the number of backlinks that are a type of recommendation. Combined with other attributes, the number influences the value of the global quality metric, in this case OPR.

Jing and Baluja (2008) used PageRank in their mechanism to identify the consistency of search results with user expectations regarding graphic files. They pointed out that search engines often rely solely on the text clues of the pages in which the images are embedded to rank images, regularly completely ignoring the content of the images as a ranking signal. Their research confirmed that the geoportal's position in the online ecosystem should be reinforced with valuable content, which can be published on the home page that is the gateway to the map (graphic) section. Results to date have confirmed the dependency between website authority combined with the volume and quality of backlinks and its position in the online ecosystem. Khan and Mahmood (2018) demonstrated that websites are ordinarily optimised through backlinks, whereas individual webpages are optimised through specific keywords, which builds their position in the online ecosystem. Their results corroborate the present study, confirming the need for backlink building.

Katumba and Coetzee (2017) emphasised that geoportals are often known only in geoinformation communities, and they present technological challenges for indexing by web search engines. The present study offers similar conclusions, confirming the need to improve geoportal visibility in the online ecosystem. The article evaluates the extent of geoportal backlink assets and geoportals searchability potential, whereas Katumba and Coetzee (2017) focused on content and metadata optimisation to improve geoportal visibility on the search engine results page. The two perspectives are complementary and use different strategies to enhance geoportal visibility.

Berberich *et al.* (2005) analysed the online link structure to measure website authority. They noticed that users are particularly interested in high-authority websites. They used link volume and web dynamics as website quality predictors and devised the T-Rank Light and T-Rank global metrics that take into consideration web freshness (time of link creation and frequency of updates). Reyes-Lillo *et al.* (2023) also showed that DA is key to its search engine results page position. They verified the reliability of DA measurement with leading SEO expert platforms: Moz DA, Semrush Authority Score and Ahrefs Domain Rating. According to their studies, the platforms can be considered reliable sources of insight. These

results corroborate the applicability of quality metrics provided by the Moz and Ahrefs test tools to test geoportal quality.

Patel *et al.* (2021) demonstrated that the number of views and unique visitors testify to the high quality of a website. Importantly, high levels of user activity stimulate the growth of organic backlinks. Patel *et al.*'s (2021) results can be adopted to improve the geoportal's position in the global online ecosystem. Still, the primary focus should be on the main portal through which map assets are accessed. The metrics used in the present study have also been found in a publication by Mavridis and Symeonidis (2015). These scholars conducted experiments, the results of which correspond with those presented here. They concluded that the backlink structure is critical for the website's position in the online ecosystem. The present study and the one by Mavridis and Symeonidis (2015) concern the search engine ecosystem. Their primary interest is the search engine results page position of a website, but this article investigates the potential of geoportals to be found online and contribute to the branding of the owner. Therefore, the present study concerns a highly specialised part of the online ecosystem, which is growing more important and is founded on geoinformation. Roumeliotis and Tselikas (2023) analysed the SEO impact of the following quality attributes: Title Tag, SEO-Friendly URL, Alternative Tags and Image Optimization, Heading Tags, Responsive and Mobile-Friendly Design, Webpage Speed and Loading Time and Off-Page SEO Techniques. Similarly to the present study, they emphasised the importance of DA for assessing website quality. This study analyses aggregate metrics and how they affect the position of the geoportal in the online ecosystem, whereas the contribution by Roumeliotis and Tselikas (2023) uses machine learning algorithms to dynamically evaluate the performance of SEO. The analysed research focuses on assessing website quality, process automation, website optimisation and the position of websites in the online ecosystem. Traditional studies employ static measurements of selected quality indicators, evaluation of link structure and the impact of a range of factors on search engine results page visibility. Recent publications use algorithmic methods for dynamic SEO analysis. Still, apparently, for an SEO strategy to be effective, it has to involve classical analytical methods, new algorithm-based tools and automated measurements.

5.2 Geoportals and conversion

Geoportals have specific purposes. The degree to which they fulfil it is the conversion rate. Quality geoportals enjoy a greater potential to "get found online" and reach a higher conversion rate. The question is, what benefits providers of geoportals achieve and what user actions can be considered conversion, i.e. meet the expectation of geoportal providers (also in terms of business). For "typical" e-commerce websites, conversion means "turning a visitor into a buyer" (Moorhouse *et al.*, 2018). Obviously, geoportals—especially public ones—usually do not have "typical" e-commerce functions (basket). Instead, they provide information, education and (geo)data. Why, then, improve the online position of central, regional, or local government geoportals and what benefits can it yield for their providers?

A commercial geoportal provider responsible for developing and maintaining the spatial data platform may secure income from premium subscriptions, advertising, business partnerships, or paid services, such as advanced tools for spatial data analysis or personalised thematic reports (Jiang *et al.*, 2020). In this case, conversion can be defined as a purchase of a paid land report or plot report. Geoportals provided by public administration are slightly different. Their purpose is not to sell subscriptions or thematic reports but to provide public (geo)information. Governmental geoportals show, for example, thematic maps, demographic data, or public infrastructure information. An improved position of a public geoportal in the online ecosystem—defined here as a better SERP position and more backlinks—makes it

easier for citizens to access (geo)information quickly. Moreover, geoportals can be communication tools or channels for public authorities to effectively share information on planned projects, infrastructure changes or other relevant public matters. Therefore, the availability of spatial data can affect public participation in decision-making, especially at the level of local or regional government (Michalik and Zwirowicz-Rutkowska, 2023). Importantly, geoportals can improve the transparency of public administration activities. Availability of (geo)data and insights into public projects build public trust. Higher SERP positions of these geoportals are achieved thanks to their high quality and large backlink volume, which increases their potential to "get found", impact and conversion rate.

6. Summary

The study sheds new light on building geoportal and geoinformation website positions in the online ecosystem and identifies the need to revise the current passive approach to geoportal management on the web. Insight into the role and place of geoportals in the online ecosystem helps better utilise any potential for conversion and build their image and brand. Moreover, the results show a new approach to investigating the quality of geoinformation websites. This approach does not include geodata quality in the assessment of geoportal quality. The high quality of a geoportal in the study is tantamount to its position in the online ecosystem, expressed as performance-based quality metrics. The study defines a high-quality geoportal as a geoportal with many high-quality backlinks (answer to research question Q2).

The study shows that thematic geoportals under a subdomain can rank higher on SERP than their gateway portals. Thanks to a subdomain, crawlers identify thematic geoportals as unique and autonomous components of the online ecosystem. Subdomains facilitate "online distribution" of geoportals by referring to a specific service instead of a platform with multiple services. It may be important for partner websites, which may aim to link to specific services under specific subdomains, not gateway portals.

The relationship between the number and quality of backlinks is critical for assessing the position of geoportals in the online ecosystem. Backlinks can be considered an indicator of trust in and authority of a website. Their number and quality significantly affect the search engine results page rank. The number of backlinks matters, but their quality is even more important. It is defined as the quality of referring domains (websites) where the links are located. The high quality of the referring domain on a similar topic ensures a strong recommendation. This should be the underpinning of the strategy for establishing the geoportal's position in the online ecosystem.

Both geoportals and their gateway (geo)information portals exhibit the substantial untapped potential to rank high on results pages (answer to research question Q3). A geoportal's position in the online ecosystem depends mostly on organic activity, which is a natural increase in backlinks. The position also depends on the content of the thematic geoportal's gateway. All this and many other factors contribute to the high quality of the geoportal, which stimulates its online expansion.

Geoportal quality is defined in the study as the quality of its link profile (answer to research question Q1). Geoportals that supplement the provision of spatial data and spatial services with information, education and social functions have a better potential for organic backlink volume growth. The spatial range and scope of services provided for that range are important as well. Portals that cover smaller areas, such as municipalities, regions, or cities, have inherently smaller potential for organic expansion of the backlink profile.

The results of the analysis of global indicators determine the position of geoportals in the global online ecosystem. Moreover, they help better understand how geoportals are evaluated (seen, perceived) by search engine algorithms, which affects their search engine

results page visibility (rank). In a broader context, the results can help conclude which geoportals are globally critical for ensuring access to spatial information and which need to be search-engine optimised to improve or increase their online presence.

6.1 Practical implications

The potential of geoportals for getting found can be considered on the macroscale and microscale levels. On the micro level, as seen by a single user or through a single query, the potential depends on the keywords used to find the geoportal. Geoportals are usually applications with specific names and brands, which helps with finding them. On the macro level, the potential means the frequency and position of the geoportal on SERP for specific keywords. The Geoportal optimisation strategy should aim for it to be listed as often as possible to as many keywords as possible. The geoportal should publish content saturated with brand-specific keywords to achieve it. However, being map applications, geoportals are not based on text. Their primary function is to provide spatial data (geodata) and relevant services. This means that positioning should be ensured by the parent gateway portal for thematic geoportals.

The study revealed that publishers of (geo)information websites that are gateways to geoportals use unfriendly URL addresses. These URLs are extensive and hard to remember, and their SEO value is negligible. These addresses are not included in databases used to estimate global quality metrics. As a result, the website's potential for a high SERP position and strong position in the online ecosystem is degraded. Therefore, it is recommended that thematic geoportals provided as part of a main geoportal have their own subdomains. The subdomains should be used for internal and external linking. Subdomains can potentially become satellites of the main portal and improve its position in the online ecosystem.

Geoportal editors can improve the number of high-quality backlinks with several strategies focusing on links from quality websites on similar topics. One strategy is to design a main page or landing page and share unique analyses, reports or spatial data. This may encourage other similar websites to refer users to these resources (links), especially when the content or data are not available elsewhere. Furthermore, it is beneficial or even necessary to partner with other organisations, such as universities, research institutions and geoinformation/geoinformatics companies, which may result in exchanging valuable backlinks. Presence in specialist media also increases the chance of backlinks from authoritative geoinformation sources. Note furthermore that the dynamic increase in geoinformation use and demand for (Web)GIS experts drive the need for (Web)GIS training materials, courses and tutorials. Such resources can generate backlinks from valuable referring domains in the industry. All these efforts can reinforce the link-building potential, improving the geoportal's authority perceived by users and crawlers. This may lead to improving its "valuation" and position in the online ecosystem.

6.2 Further research

The study identified an analytical problem of whether there is a difference between governmental and commercial geoportals regarding their position in the online ecosystem and the potential for ranking high on results pages. The difference may stem from a different (business) model of the services. Commercial geoportals need to bring profits. Hence, one could presume that their providers focus more on building their online position through sponsored links or paid advertising, for example. Public administration geoportals follow a slightly different model as they provide services free of charge. Analysis of these two perspectives can offer new information about the position of geoportals in the online ecosystem.

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Corresponding author
Karol Król can be contacted at: k.krol@onet.com.pl