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ORIGINAL ARTICLE

Visibility, Discoverability, Findability, Search Engine Optimization (SEO) and Academic SEO in Digital Repositories: A scoping review

Visibilidad, descubrimiento, encontrabilidad, SEO y SEO académico en repositorios digitales: una revisión de alcance

Visibilitat, descobriment, trobabilitat, SEO i SEO acadèmic en repositoris digitals: una revisió d'abast

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Abstract

Visibility plays a critical role in enhancing the impact of scientific research, yet it is often interpreted in diverse and overlapping ways. Related concepts – such as discoverability, findability, search engine optimization (SEO), and academic search engine optimization (ASEO) – are frequently used interchangeably, despite having distinct meanings. This study aims to clarify how these terms are conceptualized in the context of digital repositories and to identify the techniques proposed to op-

timize them. A theoretical framework was first developed to define and differentiate these concepts based on their usage in the broader web environment. This was followed by a scoping review, conducted in accordance with the SALSA framework, of 67 scholarly articles that address the use of these terms within the domain of repositories. The review analyses how the concepts are understood and applied, and catalogues the optimization strategies discussed. The results reveal a lack of clear conceptual distinctions among the terms, which are often used synonymously. The review does however identify 22 distinct optimization techniques aimed at improving the visibility of content stored in digital repositories.

Keywords

Visibility; discoverability, findability; SEO; Search Engine Optimization; ASEO, optimization; Academic Search Engine Optimization; repositories; digital repositories; institutional repositories; academic repositories.

Resumen

La visibilidad es un factor relevante para el impacto de la investigación científica, pero es entendida de distintas maneras, existiendo diferentes significados entre el propio término y conceptos similares como la capacidad de descubrimiento o descubribilidad, la encontrabilidad, el *search engine optimization* (SEO) y el *academic search engine optimization* (ASEO). El principal objetivo de este trabajo es determinar y clarificar cómo estos términos son abordados en el dominio de los repositorios digitales, y qué técnicas son propuestas para su optimización. Para ello, se elaboró un marco teórico que permite definir y comparar cada concepto en el ámbito general de la web. Luego, estos se analizaron en el contexto de los repositorios, para lo cual se realizó una *scoping review* siguiendo el *framework* SALSA, donde se examinó un total de 67 artículos. Con esta muestra documental, se determinó cómo estos términos son abordados conceptualmente y qué técnicas de optimización son propuestas para los repositorios digitales. Los hallazgos muestran que dichas propiedades son empleadas de manera indistinta, sin ofrecer una claridad conceptual entre cada término. Por otro lado, se identifican 22 técnicas propuestas de optimización que contribuyen a fortalecer la visibilidad de los contenidos almacenados en repositorios digitales.

Palabras clave

Visibilidad; descubrimiento, encontrabilidad, SEO; posicionamiento en buscadores; ASEO; optimización; posicionamiento académico; repositorios; repositorios digitales, repositorios institucionales; repositorios académicos.

Resum

La visibilitat és un factor rellevant per a l'impacte de la recerca científica, però s'entén de diferents maneres, existint diversos significats entre el propi terme i conceptes similars com la capacitat de descobriment, la trobabilitat, el SEO (optimització per a motors de cerca) i l'ASEO (optimització acadèmica per a motors de cerca). L'objectiu principal d'aquest treball és determinar i aclarir com s'aborden aquests termes en el domini dels repositoris digitals, i quines tècniques es proposen per a la seva optimització. Per a això, es va elaborar un marc teòric que permet definir i comparar cada concepte en l'àmbit general del web. Posteriorment, aquests conceptes es van analitzar en el context dels repositoris realitzant una revisió d'abast seguint el marc SALSA, on es van examinar un total de 67 articles. Amb aquesta mostra documental, es va determinar com s'aborden conceptualment aquests termes i quines tècniques d'optimització es proposen per als repositoris digitals. Els resultats mostren que aquestes propietats s'utilitzen de manera indistinta, sense oferir una claredat conceptual entre cada terme. D'altra banda, s'identifiquen 22 tècniques d'optimització proposades que contribueixen a enfortir la visibilitat dels continguts emmagatzemats en repositoris digitals.

Paraules clau

Visibilitat; descobriment; trobabilitat, SEO; posicionament en cercadors, ASEO; optimització, posicionament acadèmic; repositoris; repositoris digitals; repositoris institucionals; repositoris acadèmics.

1. Introduction

In the field of scientific research, increasing a publication's visibility is a highly desirable goal for various reasons. Essentially, the greater the visibility an academic article enjoys, the more likely it is to be read and cited (Egghe et al., 2013; Ivanović et al., 2013). Moreover, its enhanced visibility helps attract potential collaborators and can even boost a study's impact (Majhi et al., 2023). Yet, at the same time, visibility today has become a pressing need given the information overload with which scientific literature has to deal (Arnold et al., 2023; Landhuis, 2016). Each new publication generates more studies and fresh academic output, which in turn increases the demand for tools that can provide more efficient information retrieval (D'Aniello, 2024).

The research line aimed at enhancing the visibility of publications has employed a range of different terms to describe both this property: hence, *visibility*, *findability*, *discoverability*, and the process of improving the quality of website traffic: hence, *search engine optimization* (SEO) and, more specifically, in academic contexts, *academic search engine optimization* (ASEO). And while the origin of these terms lies firmly in the fields of marketing and website performance, respectively, they do differ in a number of respects.

This article undertakes a theoretical study of the various definitions associated with each of these terms in the wider domain of web services. It then performs a scoping review to examine the literature published between 2019 and 2024 dedicated to the concepts of visibility, findability, discoverability, search engine optimization, and academic search engine optimization as they relate to digital repositories. Our goal is to identify and clarify how these terms are addressed in the context of repositories and what techniques are advanced for their optimization.

2. Theoretical framework

This section provides a systematic analysis of the definitions coined for these terms in the literature as they relate to general web services. In so doing, we provide a framework for the identification of any similarities and differences in how these terms are employed.

The term 'web visibility' is typically used to refer to that quality which enables content to be seen and found among the hundreds of millions of resources on the internet, drawing user visits and increasing *online* traffic (Vállez & Lopezosa, 2024a). The term describes the ease with which a website can be located via multiple channels: including search engines, direct URL access, social media platforms, indexes, etc. (Lopezosa et al., 2019; Pedrosa & Morais, 2021; Vállez et al., 2023).

Various dimensions of web visibility have been examined, including, for example, the ranking of websites on search engine result pages (SERPs), as a reflection of their market reach (Caro et al., 2011). Critical factors, such as page authority, the number of outbound links, and similar metrics have also come under scrutiny (Gori & Witten, 2005; Lee & Park, 2012), most of which continue to be widely used with a high degree of reliability in digital marketing (Reyes-Lillo et al., 2023).

In academic publishing, the general understanding of the concept remains similar. Thus, some authors define visibility as a publication's capacity to be read or acknowledged by the broader scientific community (Martín, 2013), while others note that, while citations have traditionally been the primary measure of academic visibility, the use of alternative metrics and the integration of social media have introduced a more holistic approach to visibility (Bar-Ilan et al., 2012). Indeed, several studies show how social media can contribute to enhancing visibility (Araujo et al., 2018; Headley Johnson & Jones, 2023; Howoldt et al., 2023).

Building on this perspective, Majhi et al. (2023) observe that researchers and research institutions alike seek to increase the visibility of their work so as to both boost the academic impact of their publications and create more opportunities for collaboration. They also outline a number of strategies for optimizing academic visibility, including self-archiving, social media engagement, open access publishing, the use of repositories, and the application of SEO techniques.

More recently, Orduña Malea and Font Julián (2025) speak of research visibility in terms of an academic article's presence and accessibility, two factors that are critical for determining its reach and influence. The authors refer to science itself as a communicative object and emphasize the role of search engines and algorithms in enhancing this particular dimension. They also introduce a process that we return to in greater depth below: *academic search engine optimization*. The authors note that, in this field, there is still a dearth of robust research, despite the pressing need for standardization in reporting and measurement techniques.

We next turn to the concept of 'findability', a term defined by Morville (2005) as:

- The quality of being locatable or navigable.
- The degree to which a particular object is easy to discover or locate.
- The degree to which a system or environment supports navigation and retrieval

Findability is, as such, a property that can be measured at both the level of a specific object or web content and at that of the system.

Findability is concerned with the ease with which users can locate information or items on a website or within a system, as such it is closely linked with the efficiency and effectiveness of search and information retrieval systems. Thus, findability is defined as an inherently interdisciplinary concept, where design, engineering, and marketing practices converge, given that it involves elements such as information organization, information-seeking behaviour, interaction design, branding, search engine positioning, and web standards, to name just a few of its components (Jacob & Loehrlein, 2009).

However, there is an additional characteristic: findability describes the property that enables users to find content or items they assume to exist. This contrasts with our third concept – that of, 'discoverability' – which describes the property that enables users to find new content or functionality of which they were previously unaware. Put simply, a user was not actively searching for an item, rather they just happened upon it or discovered it (NNgroup, 2020).

This distinction is made even clearer by Cortinovis et al. (2019), who stress that discoverability places the emphasis on content or objects that are not already known to the user and that the concept is more closely associated with exploratory searches. In recognizing this conceptual difference, Makri et al. (2019) argue that digital environments are primarily optimized for findability, rather than discoverability.

The concept of discoverability has also been adopted in the field of interaction design by Donald Norman (2013), where he defines it as the ability to determine what actions are possible and how to perform them when interacting with an object – in other words, discovering how it can be used.

More recently, Mackamul et al. (2024) elaborate on the conceptual difference, noting that discoverability concerns either intentional or serendipitous encounters with new functionalities of which the user was previously unaware, while findability assumes that the user is already conscious of the existence of a system or feature and that they set out with the intention of locating it. These two elements are addressed differently in design but are both essential to ensuring an efficient, effective, and satisfying user experience (Creager & Gillan, 2016).

In a context perhaps more closely related to web visibility, Somerville et al. (2021) define discoverability as the degree to which scholars can locate the content needed to advance their research and other creative activity. They stress that discoverability is not limited to technical search engine optimization methods, and that the location, placement, and context of published material are all vital to definitions of discoverability.

Despite these distinctions, the term discoverability is often used interchangeably with findability to refer to the ease with which content or an item can be found using a search engine, database, or information system (Bullock et al., 2019; Interaction Design Foundation [IxDF], 2024; Yi et al., 2022).

Finally, at a more practical level, 'search engine optimization' (SEO) has been defined as the techniques employed to ensure that a website is optimized in accordance with search engine requirements (O'Neill & Curran, 2011). In short, it is understood as all those techniques that improve the presence and visibility of a website on SERPs (Serrano-Cobos, 2016) and incorporates such methods as keyword selection, search engine indexing, and on-page and off-page optimization (Veglis & Giomelakis, 2021).

On-page optimization includes the management of the technical aspects of a website, such as loading speed, structured data markup, responsive design, and user experience. It also involves the strategic use of keywords to enhance the description of website content (Vállez & Lopezosa, 2024a). Off-page optimization, on the other hand, includes all actions made away from the website to promote its visibility. Here, link building is especially relevant and involves obtaining inbound links or backlinks from other websites (Lopezosa et al., 2021).

Vállez and Lopezosa (2024b) propose a series of SEO-based actions specifically targeting library websites. They include, most notably:

- Evaluating the SEO performance of a library's digital service.
- Identifying keywords that could drive more traffic.
- Comparing results with those of similar institutions.
- Identifying and resolving technical SEO problems.
- Reviewing existing content for SEO-focused optimization.
- Auditing and managing backlinks.

The same set of techniques applied to the ambit of academic communication is known as 'academic search engine optimization' (ASEO) and is considered a new area of expertise and study for information professionals (Codina & Lopezosa, 2020). At heart, the goal of ASEO is to improve the ranking of research output and to help authors achieve a better ranking for their publications across various search engines (Schilhan et al., 2021). This involves writing titles, abstracts, and keywords adopting an SEO-oriented approach, as well as using enriched metadata and other technical elements.

Alcaraz-Martínez (2025) describes ASEO as a set of practices aimed at enhancing the visibility and impact of an author's or an institution's academic output. The author highlights multiple techniques that can potentially contribute to this goal, including technical optimization related to search engine crawling and indexing and dissemination strategies in the social media and other platforms to expand an author's reach.

As we have seen, while the terms are closely related, they are also conceptually distinct. Table 1 seeks to capture these characteristics.:

Table 1. Comparison of the concepts of visibility, findability, discoverability, SEO and ASEO

Concept	Brief definition	Focus	Differences
Visibility	The property of being visible and locatable on the web.	Searchability and discoverability.	A broader concept than the others, combining various techniques to increase visits and web traffic.
Findability	The property of being easily located by users within a website or system.	Content that the user already knows exists	A more specific concept than visibility, assuming that the user is searching for something in particular.
Discoverability	The property of a resource to be discovered serendipitously, without implementing an active search.	Content that the user is unaware of or does not know exists.	A more specific concept than visibility, addressing the capacity to uncover content on a website or in a system, requiring proactive design for exploration.
SEO	The set of strategies and techniques primarily aimed at improving website visibility, particularly in search engine results.	Strategic and technical procedures to optimize search engine ranking (on-page/off-page).	SEO practices can enhance both findability and discoverability, but the main focus is on making content more accessible via search engines.
ASEO	The set of strategies and techniques used to improve the visibility of academic publications.	Strategic and technical procedures for positioning academic content, including optimization of titles, abstracts and keywords.	Typically discussed in terms of article-level techniques, though potentially extendable to search systems as well.

Source: Authors' own

This evident terminological confusion is an issue that has also been addressed by Mackamul et al. (2024). The authors point out that the use of these concepts is ambiguous, which creates various problems, including inconsistent definitions, overlapping terminology, a lack of consensus in their application, and difficulties in consolidating research and appraisals, which are ultimately at odds with each other. Conceptual clarity is not only essential at a theoretical level, it also impacts specific applications in the domain of visual interface design (Creager & Gillan, 2016).

The above concepts are also increasingly being employed in the context of digital repositories, that is, infrastructure designed to store, preserve, and disseminate the scholarly output of an institution or discipline (Abadal, 2013), as well as to maximize its usage and impact (Gargouri et al., 2010). Moreover, thanks to their metadata capabilities and the latter's integration with persistent identifiers, repositories can even serve as metrics sources in their own right (Reyes-Lillo & Pastor Ramon, 2024). Thus, in addition to improving their web quality so as to enhance user experience (Morales-Vargas et al., 2020), these systems require the optimization of the aforementioned properties to increase the visibility of the content they host (Morales-Vargas & Codina, 2019).

As we have shown, there is a clear need to carefully delimit existing definitions of the concepts of visibility, findability, discoverability, search engine optimization, and academic search engine optimization. While apparently similar, each refers to distinct elements – albeit that the literature continues at times to use them interchangeably. It is our contention that it is vital that we establish their unique characteristics, particularly as they relate to digital repositories, and identify the techniques used to optimize each of their properties.

3. Methodology

To address these objectives, we conducted a scoping review in adherence with the SALSA framework (Grant & Booth, 2009). This type of review, also known as a mapping review or exploratory systematic review, provides a systematic summary of available evidence that can be used for multiple purposes, including: (1) identifying the extent, range, and nature of a particular research activity; (2) detecting research gaps and op-

portunities; (3) clarifying key concepts and definitions within a scientific field; and (4) summarizing the main research findings in a particular area of knowledge (Codina et al., 2021).

The SALSA framework provides the structure for conducting the review and comprises four stages: search, appraisal, synthesis, and analysis. In this study, the search phase involved identifying publications that address the concepts of *visibility*, *findability*, *discoverability*, *SEO*, or *ASEO* as they relate to institutional or digital repositories. To this end, a search query was designed combining these five conceptual keywords using the Boolean operator OR and pairing them with the terms *institutional repositories* or *digital repositories* using the AND operator, but also linked with the OR operator. This search string was applied across four major multidisciplinary academic databases: Web of Science (WoS), Scopus, OpenAlex, and Google Scholar. The first two platforms are widely recognized for their use in conducting scientific literature searches (Chadegani et al., 2013), while OpenAlex and Google Scholar provide broader inclusion criteria, offering a balance between selectivity of content and coverage rates (Culbert et al., 2024; Visser et al., 2021).

The search was conducted on 5 October 2024. For all four databases, this search was limited to publications appearing between 2019 and 2024. Our scoping review included documents – encompassing articles, books, book chapters, and conference papers – written in both English and Spanish.

A summary of the search phase and the results obtained are shown in Table 2:

Table 2. Search queries

Platform	Search query	Results
Scopus	(TITLE-ABS-KEY (visibility) OR TITLE-ABS-KEY (findability) OR TITLE-ABS-KEY (discoverability) OR TITLE-ABS-KEY (SEO) OR TITLE-ABS-KEY ("Search Engine Optimization") OR TITLE-ABS-KEY (ASEO) OR TITLE-ABS-KEY ("Academic Search Engine Optimization") AND TITLE-ABS-KEY ("Institutional Repositories") OR TITLE-ABS-KEY ("Digital Repositories")) AND PUBYEAR > 2018	117
WoS	(TS=(visibility) OR TS=(findability) OR TS=(discoverability) OR TS=(SEO) OR TS=("Search Engine Optimization") OR TS=(ASEO) OR TS=("Academic Search Engine Optimization")) AND TS=("Institutional repositories") OR TS=("Digital Repositories") Publication date: 2019-01-01 to 2024-10-05	64
OpenAlex	Title and Abstract include: (Visibility OR findability OR discoverability OR SEO OR "Search Engine Optimization" OR ASEO OR "Academic Search Engine Optimization") AND ("Institutional Repositories" OR "Digital Repositories") Year is within range: 2019-2024	449
Google Scholar	allintitle: (Visibility OR findability OR discoverability OR SEO OR "Search Engine Optimization" OR ASEO OR "Academic Search Engine Optimization") AND ("Institutional Repositories" OR "Digital Repositories") Year: 2019-2024 Citations: Not included	14
TOTAL		644

Source: Authors' own

The results were exported in CSV format, yielding a sample of 644 records for further analysis.

For the appraisal phase, a prior data processing step was conducted to standardize the records exported from the different sources. Specifically, given the differences in the way in which the four databases export data, we needed to harmonize certain key fields for the unambiguous identification of records, including the digital object identifier (DOI) (Xu et al., 2019). To this end, DOI strings were standardized by removing the initial part of the URL in those instances where it was included.

The results were then cleaned by eliminating any duplicate records. To do so, duplicate records were identified across the whole exported sample, with the DOI being considered the primary matching criterion. For records without a DOI, the title, publication year, author name, and journal title (Vieira & Leta, 2024) were analysed to determine duplication. A total of 135 duplicate records were identified, reducing the overall sample to 509 articles.

A content analysis of the titles and abstracts of the 509 articles was then performed, and those considered relevant to the research topic were selected. In making this selection, the articles were tagged for thematic relevance based on the following inclusion criteria:

- Contributes to the definition of concepts (18 documents).
- Contributes optimization guidelines (42 documents).
- Both contributes to the definition of concepts and contributes optimization guidelines (7 documents).

Conversely, we excluded all those articles that lacked thematic relevance, fell outside the scope of the study in terms of document type or language, or which were duplicates not previously identified in the automated process described above. These discarded articles were tagged as follows:

- Not thematically relevant.
- Document type falls outside the scope of study
- Language falls outside the scope of study.
- Duplicate document (not previously identified).

Thus, we were left with a total of 67 articles making up our final sample, having excluded 442 articles on the grounds that they did not contribute substantially to our research objectives.

For the synthesis and analysis stages, this categorization was maintained, distinguishing between articles that contribute to the definition of concepts and those that describe techniques for optimizing visibility, findability, discoverability, SEO, and ASEO. To carry out the last stage, we employed a thematic analysis approach (Mak & Thomas, 2022).

4. Results

This section presents our main findings in the form of a narrative synthesis of the articles making up our final sample. The analysis is structured into two parts. The first, entitled *Conceptualization*, describes how this corpus addresses the concepts of digital repositories, visibility, findability, discoverability, SEO, and ASEO. The second, entitled *Optimization Techniques*, outlines how these documents propose optimizing the aforementioned properties as they relate to digital repositories.

4.1. Conceptualization

4.1.1 Digital repositories

Based on our corpus, digital repositories can be defined as technological platforms designed to capture, store, preserve, and disseminate widely the intellectual output of an institution or discipline. Their primary purpose is to provide open access to academic publications and other digital documents, thereby increasing the visibility and global impact of the knowledge produced (Ntim & Fombad, 2021; Tapfuma & Hoskins, 2021).

These technological systems enable the efficient management of digital materials and ensure the long-term preservation of scientific output. By offering cost-free access to institutional or disciplinary research online, digital repositories ensure that academic results are accessible to a global audience, thus enhancing their discoverability and use (Tapfuma & Hoskins, 2022).

From a functional standpoint, digital repositories serve as infrastructure that support the acquisition, storage, and showcasing of digital content. By using enriched, extensible metadata, established technical standards, and, often, open-source technologies, these systems optimize the management of digital assets, ensuring their long-term preservation and sustainable access (MacGregor, 2023).

Regardless of the platform or software used, all repositories generally share a similar infrastructure. This includes relational databases for managing metadata, software to retrieve and display these metadata via user interfaces, digital object and metadata storage systems, along with tools for managing user accounts and authorizations, uploading of digital objects and metadata, and the creation or configuration of collections (Farnel, 2023).

Digital repositories are not only storage spaces, they also promote academic communication and institutional positioning. By operating under open licenses, such as Creative Commons, and facilitating the green route to open access, they contribute to the dissemination of research and enhance institutional visibility in both regional and global rankings (Adam & Kiran, 2021).

Thus, digital repositories have been consolidated as basic tools for the preservation and dissemination of intellectual output, enabling open access to theses, dissertations, scientific articles, technical reports, and other academic documents. Their creation represents a significant step towards a greater democratization of knowledge, the strengthening of scientific communication, and the dissemination of academic content (Nurdin & Mukhlis, 2019; Nneka & Kaosisochukwu, 2021; Baro & Nwabueze-Echedom, 2023).

As such, repositories are closely linked to enhancing the visibility of the content they store. Their technological infrastructure is designed with this purpose very much in mind. Indeed, several elements integrated into these systems strengthen this property: that is, metadata, navigable knowledge organization, use of persistent identifiers, search tools – for searching, faceting, and relevance ranking – multilingual functionality, interoperability protocols, and data export and exchange tools (Farnel, 2023; Zavalina & Burke, 2023).

This direct relationship with visibility makes it all the more important to clarify the different terms associated with this concept as they relate to the work of digital repositories.

4.1.2. Visibility

'Visibility' is one of the most frequently discussed concepts in relation to digital repositories, although its exact conceptualization varies. Broadly speaking, it describes the degree to which stored works can be considered accessible, detectable, and used by end users. Its significance lies in maximizing the use and impact of an institution's scientific output through global access (Nneka & Kaosisochukwu, 2021).

From a more technical standpoint, visibility is associated with the ease of locating a repository and its content, encompassing as such the concepts of visibility and findability (Hwang et al., 2020). Other authors associate visibility with the number of external links pointing to an institutional repository from different domains, a metric that can be assessed using tools such as MajesticSEO (Ridwan, 2023).

Digital repositories play a critical role in enhancing the visibility of scientific articles by facilitating the creation, storage, retrieval, and transfer of knowledge. This process is critical for user satisfaction and the effective dissemination of academic output (Ntim & Fombad, 2021; Nyakurerwa, 2021). More specifically, visibility is directly linked to the chances of an article being read and, hence, cited, thereby reinforcing the relevance of stored content and its impact within the scholarly community (Baro & Nwabueze-Echedom, 2023).

Additionally, the concept is closely tied to strategies for content promotion, indexing, and dissemination, which extend access beyond the academic community (Nurdin & Mukhlis, 2019). In this sense, visibility involves more than the mere diffusion of information; it includes the ability to attract diverse audiences and transcend disciplinary boundaries, offering benefits such as increased citation rates, improved institutional rankings, international collaboration, and broader public engagement (Val Hyginus et al., 2023).

Adriaanse and Rensleigh (2022) discuss the notion of *e-visibility* as it impacts research authors and identify three core elements: the online presence of their research, the discoverability of researchers via academic networks and communication platforms, and the accessibility of their output across multiple digital environments, all of which promotes increased downloads and citations of their work.

Overall, there appears to be a consensus that visibility in digital repositories contributes to enhancing the global reputation and positioning of academic institutions. By making scientific production internationally accessible, repositories reinforce their public value and consolidate their impact within the research community (Asadi et al., 2019).

4.1.3. Discoverability

Another frequently cited term in the context of digital repositories is 'discoverability'. This concept refers to the ease with which digital resources can be located both by users and by machines (MacGregor, 2023). In an environment where the volume of information grows exponentially, ensuring that materials can be discovered is a key challenge for libraries, archives, repositories, and digital information platforms.

Initially, discoverability was assessed primarily through indexing in academic search engines such as Google Scholar. However, over time, new strategies have emerged to enhance this property, including the use of semantic markup standards like Schema.org and the indexing of digital resources in specialized aggregators (Dong & Tay, 2023). These approaches have broadened the reach of information by facilitating access across multiple platforms and search engines, and by promoting the exchange of data.

The development of discovery services has, moreover, played a fundamental role in optimizing discoverability (Thompson & Hoover, 2023). These tools have transformed how users interact with large volumes of data, enabling them to locate the most relevant content with greater precision within vast digital ecosystems.

From a technical standpoint, and reinforcing the above arguments, this property depends not only on the online presence of resources, but also on the correct implementation of metadata, appropriate levels of description, and effective exposure to search engines. This not only supports information retrieval but also promotes the dissemination and reuse of materials created within academic institutions and beyond, by means of metadata optimization and content syndication strategies in specialized networks (Woolcott & Shiri, 2023).

In this context, metadata play a crucial role in enhancing discoverability, as they enable the structuring and description of information in ways that make it more easily identifiable and retrievable across digital environments (Mosha & Ngulube, 2023). Throu-

gh the efficient use of metadata and advanced indexing strategies, organizations can maximize the visibility and accessibility of their resources in an increasingly interconnected information landscape.

4.1.4. Findability

'Findability', in contrast, is not as frequently referenced, except when discussed in relation to the FAIR principles – a set of recommendations for ensuring research data are findable, accessible, interoperable, and reusable. Here, it is defined as the property that enables information to be easily located by means of search functions (Nieva de la Hidalga et al., 2022; Nosé et al., 2024). However, more often than not, the terms visibility and findability are used interchangeably (Hwang et al., 2020).

4.1.5. SEO and ASEO

Finally, 'search engine optimization' (SEO) is defined as a series of systematically employed processes aimed at improving both the volume and quality of search engine traffic to a specific site using the search engine's working mechanism or algorithm (Formanek, 2021). SEO seeks to optimize the structure and content of a website to achieve higher rankings in search engine results, with the primary goal of increasing the website's position in web search outcomes. However, in relation to repositories, references to SEO are not very frequent; rather, they tend to be scattered and often of uncertain origin (French & Fagan, 2019). Generally, SEO is used to describe techniques aimed at optimizing the visibility of digital repositories (Hwang et al., 2020; Dong & Tay, 2023).

We should stress, furthermore, that in our sample of records, no references were found to 'academic search engine optimization' (ASEO) in relation to digital repositories. Although ASEO is an accepted term within the academic community (Beel et al., 2010), there is an obvious gap in the literature regarding the way in which ASEO techniques might contribute to optimizing visibility in repositories.

4.2. Optimization techniques

This section is based on the part of the sample that includes articles proposing optimization techniques. Table 3 lists 22 techniques mentioned in those documents, along with a brief description of each.

Table 3. Main optimization techniques for digital repositories as identified in the scientific literature.

Optimization technique	Description	Author/Sources
Indexing or depositing repository content in multiple aggregators or external sources	Adding content to aggregators or external channels that serve as sources of traffic for the repository can enhance the visibility of publications, thus they become an additional channel of dissemination. This functions as an off-page SEO strategy.	MacGregor, 2019; Murillo González & Saavedra, 2022; Pradhan & Maharana, 2022; Dong & Tay, 2023; Herr et al., 2023; Eze et al., 2024
Metadata optimization	The quality of metadata is crucial for effective information retrieval, in terms not only of their consistency but also their compliance with standards. Adoption is recommended of standardized schemas as is combining the use of Dublin Core with formats like Highwire Press, JSON, XML, and others required by scholarly publishing.	Ahcene & Nabil, 2019; Hwang et al., 2020; Johnston & Russell, 2020; Pramudyo & Hendrawan, 2020; Nieva de la Hidalga et al., 2022; Dong & Tay, 2023; Herr et al., 2023; Kodua-Ntim, 2023; Lake & Nicholson, 2023; Osman et al., 2023; Piedboeuf et al., 2023; Riley, 2023; Nel et al., 2024; Nosé et al., 2024; Zoldoske, 2024
Use of persistent identifiers	Assigning persistent identifiers, such as DOI or Handle, to repository items ensures unique identification and traceability when sharing and circulating academic content. Integrating other identifiers for authors and their affiliations is also recommended.	Ahcene & Nabil, 2019; French & Fagan, 2019; Valles et al., 2020; Carter-Templeton et al., 2021; Khan et al., 2021; Herr et al., 2023; Kodua-Ntim, 2023; Majhi et al., 2023; Msoffe & Buhomoli, 2023; Eze et al., 2024

Use of interoperability protocols	Enabling and optimizing interoperability protocols such as OAI-PMH, ResourceSync, or tools that allow system integration like APIs. This allows external sources to harvest data from the repository, promoting its visibility and encouraging access through other channels. This is key to generating cooperation and collaboration among the various infrastructures that make up a scientific communication ecosystem.	Ahcene & Nabil, 2019; Khan et al., 2021; Courtot et al., 2022; Murillo González & Saavedra, 2022; Dong & Tay, 2023; Kodua-Ntim, 2023; Kumar et al, 2023; Neatrour & Hebron, 2023; Piedboeuf et al., 2023
Incorporating and displaying usage metrics: views, downloads, and altmetrics	Incorporating metrics and displaying them at the user level provides indicators for the publications with respect to the item, and aligns with the principles of the San Francisco Declaration on Research Assessment (DORA). Displaying statistics of views, usage, and alternative metrics is also recommended.	Valles et al., 2020; Dong & Tay, 2023
Integration of linked open data technologies in repositories	Integrating linked open data technologies such as RDF, Schema.org, JSON-LD, ontologies and others. The linked data generated enhance visibility and access to digital bibliographic material by creating explicit connections between related content from different digital collections.	Jin & Sandberg, 2018; Gonzalez-Toral et al., 2019; Neatrour & Hebron, 2023; Weise et al., 2023
Integration of controlled vocabularies in the repository to enhance metadata consistency	The use of controlled vocabularies to normalize keywords or authority terms produces more precise and consistent metadata. This leads to more effective search and navigation experiences, thereby optimizing the findability and discoverability of repository resources.	Chipangila et al., 2021; Lake & Nicholson, 2023; Thompson & Hoover, 2023; Chipangila et al., 2024
Optimizing web analytics measurements within the repository	Accurate measurement of digital repository traffic and usage aids in better management. Thus, employing and standardizing web analytics tools contributes to evaluating and enhancing repository performance and visibility.	Arlitsch et al., 2020; Valles et al., 2020; Dong & Tay, 2023; Thompson & Hoover, 2023
Optimizing the repository's user interface	Improving the user interface helps optimize the visibility of the digital repository by optimizing usability and information architecture, making the repository more user-friendly and responsive. Additionally, optimizing CSS and JavaScript files to improve loading times and avoiding unnecessary rules or variables so as to streamline the code are recommended.	Fernández-Luna et al., 2019; MacGregor, 2019; MacGregor, 2020; Gonzales et al., 2021
SEO optimization of the repository	Ensuring that content is well-structured and properly tagged allows for internal navigation and indexing by external search engines, with good ranking results. This includes adding meta-tags in HTML, using sitemaps and OpenGraph, and adopting HTTPS, among others.	MacGregor, 2019; Hwang et al., 2020; Formanek, 2021; Herr et al., 2023; Kodua-Ntim, 2023; Msoffe & Buhomoli, 2023; Neatrour & Hebron, 2023
SEO optimization of items	Using descriptive titles, keywords, and abstracts for articles ensures proper indexing and favours content retrieval in user search experiences.	Majhi et al., 2023; Eze et al., 2024
Adding institutional output in Wikipedia topic articles	Wikipedia articles can link to resources indexed in digital repositories, thereby increasing visibility not only of the repository but also of the publications themselves, contributing to maximizing their impact. This is also reflected in altmetrics. Additionally, the reuse of repository resources in Wikimedia Commons or sharing linked data via Wikidata are recommended.	Bridges et al., 2021; Kelly, 2023
Optimization of files stored in the repository to promote reuse and ease of access	Optimizing stored files, whether PDFs or tabular files like Excel spreadsheets or CSVs, serves to make information more accessible, reusable, and contributes to its visibility.	Choi & Xin, 2021
Repositories with a multilingual interface	A repository with a multilingual interface becomes academically and culturally more accessible to different audiences, contributing to the optimization of content visibility.	Kumar et al, 2023

Integrating the repository into the institutional discovery platform, where this exists	If an institution has a discovery platform, integrating the repository as a source is essential. This involves integrating both systems and mapping their metadata to ensure efficiency and increase the visibility of the collection stored in the institutional repository.	MacGregor, 2020; Thompson & Hoover, 2023
Registration of the repository in directories such as OpenDOAR or others	Adding the digital repository to recognized directories or registers for systems of this kind can contribute to its broader dissemination and increase access to the resources it stores.	Ahcene & Nabil, 2019; Pramudyo & Hendrawan, 2020; Pradhan & Maharana, 2022; Murillo González & Saavedra, 2022; Dong & Tay, 2023; Kumar et al, 2023; Msoffe & Buhomoli, 2023; Nosé et al., 2024
Promotion of repository content via social media or academic social networks	Promoting repository items via social networks such as Facebook, X, BlueSky, and academic social networks like Academia.edu or ResearchGate. This can include item-level share buttons to facilitate content dissemination on these platforms.	Valles et al., 2020; Khan et al., 2022; Herr et al., 2023; Majhi et al., 2023; Eze et al., 2024
Conducting outreach campaigns for the repository within the community and fostering access via accessible web links	Conducting promotional campaigns for the repository within the community, by means of newsletters or other channels, is recommended. Linking the repository on the institution's homepage or intranet can also increase its visibility.	Hwang et al., 2020; Blanco-Olea, 2021
Development of national or thematic digital repository infrastructures	Based on interoperability protocols, the development of technical infrastructures that allow the indexing of content from institutions at the country, regional, or thematic level is recommended.	Habukali et al, 2021; Eze et al., 2024
Optimization of search algorithms and recommender systems	Some studies propose optimizing search algorithms by ensuring use of robust search engines or by improving article recommendation systems through citation networks or keyword combinations.	Guan et al, 2019; Waheed et al., 2019; Msoffe & Buhomoli, 2023
Strengthening visibility optimization skills of repository managers	Training repository staff is essential to developing new strategies for optimizing visibility, from a technical standpoint, as well as regards metadata, communication and as part of the staff's continuous learning process.	Emezie et al., 2023
Collaborative metadata assignment for repositories or photographic archives	Collaborative metadata optimization is proposed. This can be effective for certain projects, especially photographic archives, through the exploitation of collective knowledge. However, in other projects, it may affect control over vocabulary, resulting in inefficient descriptions.	Felsing et al., 2023

Source: Authors' own

In short, based on the analysis undertaken, the elements that contribute to optimizing the visibility of an institutional repository are multiple and heterogeneous. Despite differing degrees of specificity, the most frequently discussed topics are metadata optimization, the use of persistent identifiers, the implementation of interoperability protocols, the indexing of the repository in directories and external aggregators, and the application of search engine optimization strategies at the repository level.

5. Conclusions

This article has reported the use of a scoping review to determine and clarify how the concepts of visibility, discoverability, findability, SEO, and ASEO are addressed in relation to digital repositories. Based on the analysis conducted, our results show that digital repositories, as tools for scientific communication and open access, are clearly conceptualized, there being a high degree of consensus across the literature. However, in the case of the other properties attributed to the visibility of repositories, there is no clear distinction between them, and they are frequently used interchangeably, even within the same article.

The lack of conceptual clarity presented by these properties highlights a significant gap in the state of the art on digital repositories, given that, if each property were more clearly defined, more effective optimization strategies could be developed for each one. Additionally, this lack of conceptual clarity gives rise to a set of problems that includes inconsistent definitions, overlapping usage, and the absence of any consensus in the literature, all of which are quite patent in the discourse dedicated to digital repositories.

Moreover, despite the vast body of literature produced in recent years on ASEO and its close ties with the promotion of research output and academic materials, this set of techniques has not been applied in recent studies of the optimization of digital repositories. Integrating ASEO strategies could prove valuable for strengthening and complementing existing optimization techniques, particularly at the level of individual repository items.

To address these gaps, this study contributes – within its theoretical framework – to the conceptualization of the aforementioned properties, highlighting their similarities and differences, which can be extrapolated to the domain of digital repositories.

It should be stressed that all these properties are closely interrelated. As such, a single optimization technique can impact more than one property. Nevertheless, acquiring conceptual clarity is essential for categorizing these techniques according to the specific property they seek to enhance.

Moreover, clear terminological distinctions can be usefully incorporated into institutional policies, guidelines, or best practices in order to provide clarity in the objectives of the optimization strategies of each property. Should institutions adopt this differentiation, it would also promote greater clarity when conducting assessment processes, potentially based on the use of different metrics.

Additionally, the analysis reported here points to the existence of a wide range of different techniques applicable within the environment of the system's metadata, technical infrastructure, and communication and marketing strategies, as well as those linked to the enhancement of the skills of digital repository managers. Notably, these techniques have been applied across varied contexts and in different regions of the world, and despite this there is an obvious convergence.

However, there remains a lack of conceptual clarity as to whether the techniques employed contribute to the optimization of a specific property. As discussed, visibility, discoverability, findability, and even SEO, are frequently used interchangeably, as if they were synonyms. This occurs despite the fact that, in the broader literature – outside the repository domain – these concepts are treated as distinct. A potential solution lies in extrapolating the definitions used in the general web domain to the context of digital repositories. This would allow for a more precise classification and conceptual clarification.

In summary, this article constitutes a substantial first step toward strengthening the conceptualization of key properties deemed essential for the effective promotion of digital repositories and their content. Furthermore, it contributes to the identification of the techniques currently being employed to optimize these properties.

6. Limitations and future research lines

While this scoping review offers valuable insights into the conceptualization of the key properties of repositories – including, visibility, discoverability, findability, SEO, and ASEO – it is not without certain limitations that need to be taken into account. First, the study considers only articles, books, book chapters, and conference papers, all other document types being excluded. Future research could usefully broaden the scope to include grey literature, as well as institutional or international organizational guidelines on these topics.

Second, given the wide range of databases available and the vast volume of documents they store, the selection of sources and the execution of search queries using specific keywords may also be considered a limitation of this study. Furthermore, the conceptual diversity presented by digital repositories – be they institutional, subject-based, or digital libraries – may have led to the exclusion of relevant content for this analysis.

Nevertheless, this study opens up new avenues for future research by contributing to the growing body of literature on repositories and their visibility. It also lays the groundwork for the development of robust guidelines and optimization techniques for visibility that integrate multiple factors.

Given the widespread overlapping use of terminology and the presence of inconsistent definitions in relation to digital repositories, future studies could focus on mapping existing techniques in the literature to the specific property that each aims to optimize.

Additionally, despite the significant interest generated by artificial intelligence (AI) in recent years, no articles were identified examining the adoption of practices aimed at promoting the use of digital repositories as sources for generative AI systems. However, it should be acknowledged that this subject has begun to be addressed in other sources, such as grey literature (LIBER Europe, 2025), suggesting a potential new area of study for optimizing repository visibility.

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