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General Information

Aims and Scope

The Journal of Information Science Theory and Practice (*JISTaP*) is an international journal that aims at publishing original studies, review papers and brief communications on information science theory and practice. The journal provides an international forum for practical as well as theoretical research in the interdisciplinary areas of information science, such as information processing and management, knowledge organization, scholarly communication and bibliometrics. JISTaP will be published quarterly, issued on the 30th of March, June, September, and December. JISTaP is indexed in the Scopus, Korea Science Citation Index (KSCI) and KoreaScience by the Korea Institute of Science and Technology Information (KISTI) as well as CrossRef. The full text of this journal is available on the website at http://www.jistap.org

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JISTaP at 10

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A decade ago a group of scholars recognized the need for a publishing venue that would serve the expanding global information science research community and especially welcome and encourage authors from the Asia-Pacific region to submit to a peer-reviewed, internationally recognized venue. The editors wanted to be certain that impact and practice were as welcome as theory, thus the new journal title included theory AND practice. Also, the editors wanted the journal to be accessible to the broadest possible audience. Support by the internationally acclaimed Korea Institute for Science and Technology Information (KISTI) provided the financial and intellectual resources to launch and sustain the journal. The 40 issues of JISTaP over 10 years illustrates its success in a) attracting high-quality papers from scholars around the world; b) papers on both theory and practice; c) international reputation reflected in indexing and reach; and d) an open access publishing model that supports a Creative Commons rights regime that gives authors control over their intellectual work and that provides free and reliable access to students and scholars everywhere. It has been an honor to work with dedicated visionaries such as Professors Dong-Geun Oh and Kiduk Yang and the talented team at KISTI who have worked to realize that vision incubated more than a decade ago.

As JISTaP begins its next decade of service to the information research and professional communities, I offer a few observations and encouragements for information scholars and practitioners. This is certainly not a comprehensive list but enumerates some challenges I hope we can attack in the years ahead.

1. INFORMATION OVERLOAD AND QUALITY

I view information as intellectual energy. Historically, we have focused on its captured and stored form in various media (a kind of potential energy). Increasingly the kinetic forms that were traditionally active in human minds and biological processes have been joined by the instantaneous capture and transmission of human thoughts and actions and concomitant algorithmic processing to form a new kind of distributed kinetic intellectual energy. Information science is a discipline that aims to understand and enhance the genesis, organization, flow, use, and preservation of intellectual energy and the impacts that both potential and kinetic intellectual energy have on humanity and our environment.

Information scholars have long been concerned with finding information and in recent times with filtering vast volumes to avoid overloads. Classification systems, storage and retrieval systems, and summarizations save humanity enormous amounts of time finding information and navigating knowledge. This work must be redoubled and expanded to solve the dual problems of volume and manipulative deceit. The attention economy and the growing clouds of electronic kinetic information increasingly overwhelm us, confuse us, and mis- or disinform us. Classical editorial and aggregational services such as indexes,

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reviews and research syntheses, readers advisory services, press briefings, DIY (do it yourself) videos, and content filters are not enough. We must create and apply new scalable heuristics, tools, and strategies to assess accuracy, veracity, and quality from a variety of cultural, methodological, and intellectual perspectives. This requires classic information science research and practice adapted to a highly dynamic electronic information ecology.

2. INFORMATION GENESIS

There is considerable attention given to disinformation effects and interventions in social media, however, more pervasive challenges await and require information scholars' attention. The rise of generative AI algorithms that write original texts and produce original images, videos, and soundtracks are but simple parlor tricks that serve to alert us to the more consequential generative powers of synthetic biology that aim to automatically generate our food, new drugs, new organisms, and radically altered human beings. This goes beyond the Internet of things to the creation of new things. What have we learned from our disciplinary experience organizing, documenting, and mitigating or annotating information that can be applied or adapted to these new challenges? It seems to me that our discipline has tended to focus on the organization/flow/use/preserve elements of information science and not focused so much on the genesis element. We look back toward genesis via bibliometrics/informetrics and investigations of scholarly communities or invisible colleges, but I hope we can reimagine ways to get closer to information genesis. Because so much of the genesis of distributed kinetic and stored intellectual energy is enabled by digital tools, we may be positioned to go beyond diary studies and transaction logs of discrete information behavior to more continuous and contextualized peeks at information genesis over time. Of course, privacy and human dignity challenges must be considered fully in this work—a hallmark of information science is to consider the human consequences of information research. Perhaps we can imagine some kind of digital radioactive isotope that is attached to every new bit created and some kind of global, public blockchain of provenance that persists with personalized authority control over public access. Perhaps we can image non-technical solutions such as regulatory constraints or training requirements. What is important is that we work to focus on information genesis and imagine how we can better serve both individual creators and collective humanity.

3. THE DIGITAL EXPOSOME

Every moment of our lives we are exposed to physical and informational elements that are as important to our well-being as our genetic makeup. Physical exposures from air, water, land, radiation, buildings, climate, and food have long been recognized as strong influences on our lives. Informational exposures from the built environment, human activity and interaction, and media are increasingly recognized as having strong influences on our well-being. Humanity is beginning to understand that a healthy information ecosystem is as important as our physical ecosystem. The emerging field of exposomics aims to understand the ways that these exposures affect our lives and how we might mitigate negative effects. To date, exposomics focus has been on the physical exposures and mitigating negative effects. I believe that information scholars are well positioned to investigate the informational ecosystem to better understand both the negative and positive effects of digital exposures whether these exposures are incidental, targeted, or actively sought.

Information scholars could develop and promote a framework for exposomics that includes information ecology as well as physical ecology and identifies incidental and intentional exposure drivers, costs, and risks. We could work to discover causal pathways from physical and informational exposures to states of physical and mental wellness and happiness. We could create measurements and instrumentation to assess physical and informational exposures (e.g., sensor arrays, behavior tracers grounded in informed consent) and we could build repositories of cases, practices, and solutions. There is considerable attention to the perceived problems of digital addictions, including treatment clinics and some biomedical and psychological research, however, we also want to understand why and how people seek digital exposures as well as encounter them and create tools or techniques that give people control over the exposures and consequent effects.

Information scholars have many important problems to address and contributions to make toward a better world. The three challenges included here only illustrate a few of these problems and are offered to stimulate discussion, debate, and imagination. I look forward to reading papers in JISTaP in its next decade of service as we continue to develop theory and practice in information science.

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Discovery Layer in Library Retrieval: VuFind as an Open Source Service for Academic Libraries in Developing Countries

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ABSTRACT

This paper provides an overview of the emergence of resource discovery systems and services, along with their advantages, best practices, and current landscapes. It outlines some of the key services and functionalities of a comprehensive discovery model suitable for academic libraries in developing countries. The proposed model (VuFind as a discovery tool) performs like other existing web-scale resource discovery systems, both commercial and open-source, and is capable of providing information resources from different sources in a single-window search interface. The objective of the paper is to provide seamless access to globally distributed subscribed as well as open access resources through its discovery interface, based on a unified index. This model uses Koha, DSpace, and Greenstone as back-ends and VuFind as a discovery layer in the front-end and has also integrated many enhanced search features like Bento-box search, Geodetic search, and full-text search (using Apache Tika). The goal of this paper is to provide the academic community with a one-stop shop for better utilising and integrating heterogeneous bibliographic data sources with VuFind (https://vufind.org/vufind).

Keywords: information retrieval, web scale discovery, library discovery, federated searching, VuFind, academic library

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1. INTRODUCTION

Due to the enormous growth of web resources in various forms and formats, the demand for library discovery services, especially in academic libraries, is growing, and such services have become a new standard in the domain of Library and Information Science (LIS) by replacing federated searching, meta-searching, and OPAC-based retrieval. Due to the open-source movement, new initiatives towards the management of heterogeneous knowledge resources are always on the horizon, and by examining the applications of different resource discovery technologies, both open-source and commercial (such as Primo Central, EBSCO Discovery Service, Summon, etc.), we were able to observe the paradigm change from library automation to library discovery (e.g., Blacklight, VuFind, and LibraryFind). Now, many academic libraries are planning to provide this type of service to their users keeping in mind users' diverse information needs with modern expectations for search and presentation of information resources. For instance, from 2010 to 2012, discovery services increased from 16% to 29% in the United States and Canada (Hofmann & Yang, 2012). Through these library discovery tools, thousands of academic institutions are now making their local and global collections accessible to their users (Breeding, 2007). However, the first wave of adopters of VuFind (as reported by Seaman, 2012) were the National Library of Australia, Minnesota State Colleges and universities (Digby & Elfstrand, 2011), Western Michigan (Ho et al., 2009) and Villanova itself in 2008. This paper describes in detail the user interfaces, services, and functionalities of the resource discovery model developed using open-source software (OSS), i.e., VuFind, for academic libraries. The main objective of the paper is to provide different value-added services to users, not limited to the library resources through this model.

It is to be noted that commercial discovery tools are costly to subscribe to, install, and maintain. In this context, academic libraries in developing countries like India and other countries in Southeast Asia are exploring OSS for developing library discovery systems. On this basis, this paper may be considered as a confidence-building measure among library professionals of academic libraries in developing countries for developing discovery systems. As discussed in Section 3, most of the academic libraries in developing countries are facing the problems of retrieval silos, and the advent of the OSS movement has given library professionals in developing countries an opportunity to automate their library, to go for a digital library, or to set up an institutional repository (IR) using different open-source tools.

2. LITERATURE REVIEW

The emergence of Information and Communication Technology, especially the WWW (World Wide Web) and the Internet has brought about many fundamental changes to the academic library environment and to users' information-seeking behaviours over the past three decades (such as changes in technology, library users' perceptions towards information retrieval, cataloguing, resource management, information environment, or user expectations and searching behaviour). The latest change due to the application of OSS in the domain of LIS in recent years has been the introduction of and demand for library discovery systems.

Several studies point to user dissatisfaction with the traditional library catalogue or OPAC. The "classic" catalogue has very few features, and results cannot be limited by a wide variety of facets or delimiters. The present library search environment has become increasingly fragmented, and most academic libraries offer an assortment of pathways to disparate silos of information. Martell (2008) stated correctly that academic libraries should reassess their current cataloguing procedures to better meet the demands of their customers because use of the catalogue is declining (Han, 2012). Katz and Nagy (2013) reported that users currently prefer a "self-service-oriented approach to searching" that enhances discoverability and accessibility of library-provided content and is expected to boost utilisation statistics (Way, 2010). The evaluation of whether conventional library catalogue interfaces meet or fall short of user expectations and information demands has changed with the introduction of the next-generation catalogue and, subsequently, the discovery platform (Breeding, 2007; Majors & Mantz, 2011; Nagy, 2011; Vaughan, 2011b). Breeding (2011) correctly pointed out that discovery tools are not just for searching but also for finding resources.

As a result of changes in user expectations for information retrieval and competition from commercial web search engines, libraries are under tremendous pressure to provide content (both paid and open access) and services in ways that users prefer. As a result, a brand-new category of library catalogues that make use of technological services not present in conventional library catalogues has emerged. The "next generation catalogue" actually emerged after librarians realised that the library catalogue

was no longer useful to users (Wisniewski, 2010). These new search interfaces are often referred to as library 2.0 catalogues (Wilson, 2007); next-generation OPACs, discovery tools, discovery platforms, or discovery layers (Breeding, 2007; Lindström & Malmsten, 2008; Marcin & Morris, 2008; Yang & Hofmann, 2010); *or* next-generation meta-search tools (Walker, 2015).

As a result, a new category of search system, i.e., library discovery systems, has come to the market and has become popular among the academic community, as it can index content from different locations (not limited to the library) and provide access to the content in an open manner through its unified search interface (Roy et al., 2018). Nagy et al. (2007) reported that the release of VuFind as a discovery tool has come at a perfect time when academic libraries all over the world currently recognize the need to offer their patrons a better tool to search and browse through all of their resources, both open access and subscribed/paid content. Keene (2011) said that a new breed of resource discovery services (RDSs) is an evolutionary step forward in providing academic library users with a 'one-stop shop' where they can find their information sources through a single-search box that can search a library's online and physical content. Hienert et al. (2015) reported how heterogeneous databases from different data providers can be integrated through the VuFind interface to provide the user with one point of access to social science information.

A survey report (National Information Standards Organization, 2013) on librarians from the US and UK reported that 74% of academic libraries had a RDS or were planning to implement one (17%). Another survey report in the UK reported that 77.4% of respondents were already using a discovery service at their institution and about 11% of respondents were in the process of implementing one. This was mainly covered by three products, viz., EBSCO's EDS, Ex-Libris' Primo, and Serials Solutions' Summon (Spezi et al., 2013). In the US, almost 40% of medium-sized libraries have similar offerings (Jones & Thorpe, 2014).

Another study conducted by Comeaux (2017) in 2012 reported that 31 out of 37 (84%) libraries of the Association of Southeastern Research had implemented a discovery service. Yang and Hofmann (2011) showed the use of discovery tools had doubled between 2010 and 2011 in US and Canadian academic libraries. In the same study, they also reported that about 16% of the OPACs in the sample under study did not show any advanced features of the next-generation catalogue. In another study, authors gave a different view and reported that almost 96% of the academic libraries with a discovery layer also offered users access to their regular OPAC (Hofmann & Yang, 2012). In another study (Kronenfeld & Bright, 2015), the authors found that 39% of AAHSL member institutions deployed a discovery tool (56 out of 144) for their libraries. Aaron Tay from the National University of Singapore reported that more than 40% of hits on popular databases come from discovery tools, meaning that 60% of hits come from other sources.

In spite of its success on a global scale, many authors (Fagan et al., 2012) criticized discovery systems/discovery tools and pointed out problems such as the difficulty of carrying out specific disciplinary search strategies or the absence of authority control, which negatively affect the precision of information retrieval. Shi and Levy (2015) expressed concerns about the discovery system by saying that it is no longer novel to many academicians including professional librarians. The understanding of this tool is far from inclusive, nor is it conclusive as to what they do, how they do it, or the cost of delivering this service. Other studies (Buttcher et al., 2007; Vaughan & Thelwall, 2004) confirmed that the bias of search engine coverage and the bias of information retrieval systems do exist among different discovery tools. As a result, product performance differs in many aspects and there is doubt about whether or not these products are well-designed and mature enough to fulfill the expectations of the targeted user group (Shi & Levy, 2015). Thomsett-Scott and Reese (2012) opined that information regarding tools, their implementation, maintenance, and evaluation is limited and insufficient. Narayanan and Mukundan (2015) raised some technical issues such as the level of integration with other systems, interoperability, and soundness of metadata regarding the present discovery system. Deodato (2015) also criticized existing discovery systems and offered a step-by-step guide for developing and evaluating a web-scale discovery system based on literature as well as his own experiences at Rutgers University. The author suggested a more standard set of practices for better representation of web content. On the other hand, Hanneke and O'Brien (2016) were not satisfied with the performance of the existing discovery tools. They reported that after evaluating three major commercial discovery systems, viz. EBSCO Discovery Service (EDS), Ex Libris's Primo, and ProQuest's Summon, all discovery tools returned between 50% and 60% of relevant results. Even so, technological features and performance of discovery systems/tools greatly vary, particularly in terms of search effectiveness

(Asher et al., 2013). Some other studies expressed concerns over other issues such as technical problems during implementation (Buck & Mellinger, 2011), integration with other library delivery services (Sadeh, 2013), conducting search according to certain disciplines or subject headings, or cross-collection search.

Breeding (2005) first discussed broad-based discovery tools in 2005, shortly after the launch of Google Scholar, and proclaimed the need for a centralised search model like Google Scholar (Fagan et al., 2012). However, the first discovery layer services were introduced in the early 2000s (Antelman et al., 2006). Webb and Nero (2009) observed more value in implementing discovery layers in comparison to Integrated Library System (ILS) OPACs. Some other experts (Breeding, 2010a; Sadeh, 2008) consider VuFind as a next-generation catalogue that can harvest data from OPACs and other external sources such as digital repositories. Other experts (Emmanuel, 2011; Sadeh, 2008) predicted that VuFind may be considered as the next generation catalogue which can replace the traditional catalogue OPAC to increase discoverability of a wide range of objects in different formats from a single-box search interface. Houser (2009) reported the implementation of VuFind at Villanova University whereas Han (2012) reported its implementation in the University of Illinois library. Balaji Babu and Krishnamurthy (2013) reported the implementation of VuFind as a discovery layer by Bangalore University library, India. Another study (Burchill & Rasmussen, 2014) put emphasis on the application of VuFind in public libraries to improve search results and save the searcher time. Saha (2018) reported using the VuFind open discovery tool in German and showed how this discovery tool replaced the traditional OPAC.

Jetty et al. (2011) reported that the influence of Web 2.0 tools and techniques such as social networking, tagging, blogs, wikis, and news feeds has seemed to influence the outlook of future library OPACs and has become mandatory for both the users and the creators. Some other authors (Breeding, 2007; Jetty et al., 2011; Macan et al., 2013; Moore & Greene, 2012) pointed out several features of next-generation OPAC such as faceted navigation, content enrichment, related materials, interoperability, open URL, Unicode compatibility, integration of non-MARC metadata, Web 2.0 functions, and integration with citation management tools. Another group of authors has provided useful lists of criteria such as content, user interface, pricing, and contract options (Ronda, 2010); user interface and Web 2.0 features (Yang & Wagner, 2010); breadth and depth of indexing, search and refinement options, branding and customization, organizing, and exporting results (Hoeppner, 2012); library goals, cost, and vendor support (Luther & Kelly, 2011) for the evaluation of discovery tools, both commercial and open-source. Adams (2012) rightly identified the area and opined that there is enough scope for social engagement or social interactivity in the realm of discovery services for academic libraries. Ho (2013) highlighted many Web 2.0 catalogue features such as user tagging, comments, and reviews, as well as "more like this" and "Did you mean?" supported by VuFind, and also reported how they are being used at Western Michigan University. Merčun and Žumer (2008) also emphasised important issues concerning Web 2.0 features in library catalogues. However, what academic libraries should anticipate from a discovery system is outlined in detail by Kabashi et al. (2014) and is offered as a checklist. Breeding (2015) also provided guidelines and made some recommendations, including the evolution of discovery services and delivery technology (such as OAI-PMH and KBART, Knowledge Bases and Related Tools) required for providing such services to academic libraries. He also suggested incorporating altmetrics into their products.

As a result, discovery services are emerging in academic libraries as an evolution beyond federated searching because federated searching has several drawbacks (such as speed or thoroughness) and partially fulfills users' needs by providing a single access point to multiple information sources (Kumar et al., 2008). Chen (2006) noted that "a federated search could be dozens of times slower than Google." Actually, the concept of a "Next Generation Catalogue" has merged with this idea. Even so, federated searching has existed for the last 10-15 years (Roy et al., 2018) and several prototypes are available in various domains such as agriculture (Roy et al., 2016a, 2016b), LIS (Ganaie, 2014; Roy et al., 2017; Sengupta, 2012); and health and medicine (Sarkar & Mukhopadhyay, 2012). As well, prototypes are available for different object types such as electronic theses and dissertations (ETDs) (Sarkar & Mukhopadhyay, 2010, 2015). Again, Sarkar and Mukhopadhyay (2016) discussed designing an OSS based library discovery system for full-text ETDs retrieval apart from accessing ETDs from global-scale services like NDLTD, OATD, IndCat, and ShodhGanga. Gallinger and Neville (2016) shared their practical experiences of using 'Pika,' an open-source discovery layer developed by the Marmot Library Network. Dulle and Alphonce (2016) recommended adoption of the 'LibHub' discovery tool used by the Faculty of Agriculture at Sokoine University Agriculture in Tanzania. Dhara (2016) shared his practical experiences

of designing a small-scale personalized discovery service for the Ramsaday College Library in Howrah, West Bengal and showed its integration with the library OPAC as a one-stop access to an array of library resources. Katz (2016) examined how VuFind was used as the glue to tie together the disparate components of the project at Villanova University. The following years may be considered as key events in the history of web-scale discovery services.

- 2000: The first discovery services were introduced in the early 2000s
- 2003: Federated search allows multiple databases and catalogues to be searched
- simultaneously
- 2005: Next generation catalogues with discovery layer features
- 2006: First digital library project by Villanova University
- 2007: VuFind was released for the public
- 2007: WorldCat Local delivers the first marriage of discovery layer with central index
- content
- 2007: VuFind was released as an open-source product to SourceForge
- 2008: National Library of Australia to use first VuFind as web discovery tool
- 2009: Summon joins the discovery layer with robust 'web scale' central index content
- 2010: Primo (product of Ex Libris) and EDS started functioning

3. RETRIEVAL SILOS IN ACADEMIC LIBRARIES

Before we begin the discovery search, we should consider how libraries are currently working or providing services to their users. At present, library environments are working through three parallel systems, viz. the *library automation system*, the *system for licensed collections* (also known as ERMS), and a *digital repository system* for open access resources, particularly ETDs. In a true sense, all academic libraries all over the world are presently operating in silos, meaning multi-point retrieval systems that are not related to each other in their operations and exist in isolation. For example, we use OPACs mainly for books and other macro documents in libraries, whereas institutional digital repositories are used for faculty publications, and ETDs. In addition, different retrieval silos are offered by different publishers/databases for paid/licensed/subscribed resources, as well as open-access resources distributed throughout the world in different forms and formats. Apart from the above, different retrieval systems use different search techniques as well as different metadata schemas for archiving different types of content, both textual and non-textual, which in turn provide poor search results to the reader. Additionally, different systems use different software, both open-source and commercial, and are supported by different text retrieval engines such as Solr, Lucene, and Zebra. Even so, all these systems work as independent sub-systems, and there is no such integration among them at any level of their operations. This present situation has made the retrieval process more troublesome for end-users. As a result, users are forced to go from pillar to post in order to retrieve relevant resources against a search query.

Libraries in general deal with homogeneous document types, and metadata schemas are almost the same. The search skills required by the user are almost the same and end-users are expected to know the different search techniques. Such is the present situation of library retrieval, mainly in developing countries. Naturally, questions may arise: Why are we thinking of an alternative option to solve this multi-point retrieval silo?; Should we opt for a discovery service as a solution beyond our traditional search or library search?; What are the added advantages of such a discovery system or what are the basic differences between library search and discovery search?

Our expectations of academic libraries have changed with the passing of time and major changes, particularly in the area of the OSS movement. Now the trend is towards retrieval of heterogeneous content from distributed, unrelated resource management systems. As we previously stated, these multi-point retrieval silos have already been replaced by a single-window search system that provides 'one-stop-access' to all library materials by administering a centrally located consolidated index for both internal (resources organised locally and retrieved worldwide) and external (subscribed and open-access resources not normally part of a local retrieval system) knowledge objects.

Here lies the scope of the discovery system or discovery search in academic libraries of developing countries. It is actually beyond the traditional library search, or we can say an improvement over traditional search, in that it can provide additional value-added services apart from merely supporting browsing and searching of library records. In the discovery system, the picture is totally different from the traditional library search in many aspects. This discovery system deals with heterogeneous data sources

supported by different metadata schemas. Even so, users do not require any special skills in searching for scholarly resources distributed globally. The discovery system offers a Google-like single-search interface and an OPAC-like elegance (Narayanan & Byers, 2017; Taylor, 2012). It is characterized by supporting many features such as providing ranking and navigation services to subdivide search results by facet results, along with a suitability and visually rich display, suggestions, recommendations of associated resources, full-text indexing, third-party authority search integration, and personal search environment. However, library vendors see their inclusion in discovery tools as essential to their survival. Table 1 shows the differences between Retrieval Silos (library search) and Discovery Search.

4. OBJECTIVES

In keeping with the present multi-point retrieval windows of libraries, the objectives are set as follows.

Table 1. Comparison between retrieval silos (library search) and discovery search

Parameters	Retrieval silos	Discovery search
User interface	Structure	Google-like/single-window approach
Search based on	Library catalogue	Single Entry Point/Google-like single search box beyond library
Search based on	Live and dynamic queries	Pre-index metadata/Pre-harvested metadata
Scope of search	Limited result sets, slow performance	No limit, Fast
FRBRization of resources	No	Yes
Index	No such index/authors or publishers provide data	Unified index
Ranking of search results	No	Yes
Data type	Homogeneous	Heterogeneous
Data format support	Restricted	No restriction/variety of formats
Data source type	Basically textual/documentary sources	Textual/non-textual/non-bibliographic resources
Metadata schema support	Limited/mainly for textual objects	Array of schema (different object type)
Searching skill/experience	Required	Low level/minimum skill
Nature of services	Not dynamic/real-time	Dynamic/real-time
Availability of Web 2.0 features	No	Yes
Linking to resources for live updates	No	Yes
Supporting full-text indexing	No	Yes
Supports item-wise search	No	Yes
Supports preference setting in searching	No	Yes
Supports query forwarding mechanism	No	Yes
Faceted navigation	No	Yes
Recommendation services	No	Yes
Provides use statistics	No	Yes
Interface compatible with information visualization technique	No	Yes

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4.1. Unification of Retrieval Silos

The main purpose of our paper is to create a single-window search system in place of multiple retrieval silos in an academic library. Our motto is to design a one-stop access point in place of the existing retrieval silos in libraries. The single window search offers users a single point of entry to scholarly resources (subscribed, in-house, and open access) available in multiple formats and on different retrieval platforms. Actually, it is a 'one-stop-shop' solution for libraries in providing easy access to heterogeneous collections through a single location. This single window interface allows researchers the facility to search and browse their documents in a variety of ways at a single point, bypassing the multi-point retrieval hazards of the present retrieval silos of libraries.

4.2. Integration of Enhanced Retrieval Techniques in Discovery Layer

This discovery portal not only provides access to subscribed, in-house, and open access resources owned by libraries, but also has the provision of incorporating several enhanced functionalities that provide additional value-added services through its unified interface. It integrates multiple services such as faceted navigation (here users can narrow down the search results by format, location, author, topic, subject area, call number, language, genre, region, and title), relevance-ranked results, integrated metadata search, full-text search, search history and favorites, persistent URLs, application program interfaces (APIs) like open search, etc. The "classic" catalogue has very few such features and results cannot be limited by a wide variety of facets or delimiters. Martell (2008) rightly said that use of the catalogue is down, even though this system has the ability to include query-forwarding mechanisms to fetch content from institutional repositories (OpenDOAR – https://v2.sherpa.ac.uk/opendoar; ROAR – http://roar.eprints.org); open access journal articles (DOAJ - https://doaj.org) and from different pathfinder search services (BASE – https://www.base-search.net; LENS – https://www.lens.org), Geodetic search, or Bento-box search.

5. RESEARCH QUESTIONS

To fulfill the stated objectives, we have designed two broad research questions. The main challenges in designing such a system are:

- What type of discovery tool may be selected for an academic library in a developing country that will manage internal as well as external/subscribed/open access resources distributed across the world? What should be the architecture behind it? What considerations should be given to selecting a discovery layer from an array of open-source discovery tools?
- How, and to what extent, can full-text search be integrated into the discovery interface in addition to the simple metadata-based retrieval of a typical academic library? How can a search system be enhanced with different value-added information services? Can it be converted into any native/regional language in India?

6. METHODOLOGY: DEVELOPMENT OF THE PROTOTYPE

This section is concerned with the development of the prototype. It has two parts, viz. *selection of discovery software* (Table 2), and *application of the model in a real-life situation*. Actually, the prototype has been developed using different OSS in different levels of its operations. Initially, selection of software for each stage (for example, Apache Tika – https://tika.apache.org has been selected as full-text extractor for supporting full text search) and preparing the 'LAMP' (Linux-Apache-MySQL-PERL/PHP) architecture is the most important task in developing the model. Another important task is integrating VuFind with Koha (ILS) through REST/API to display real-time item availability status, DSpace (repository software), and Greenstone.

Here, discussion has been made into three layers, viz. *identification and selection of discovery layer* (i.e., concerned with the selection of discovery tool on the basis of support for enhanced technological features (Table 2)), *advocacy for VuFind* (concerned with existing literature on and about library discover systems), and *interoperability support*.

6.1. Identification and Selection of Discovery Layer

We have already discussed in the literature review (Section 2) that VuFind has been the most preferable choice of library professionals in the open domain. After evaluating several discovery tools, both open-source and commercial, against a set of criteria, the desirable features in the context of an academic library in a developing country have been identified in three open-source tools (Table 2). We have already mentioned in the introduction why we have chosen open-source tools for developing the discov-

Table 2. Features supported by three discovery software

Criteria/parameters	Resource discovery software		
	Blacklight	eXtensible Catalog	VuFind
Flexible support for non-MARC metadata formats	*	✓	✓
Support for RDA cataloging	*	✓	✓
Authority control mechanism	*	*	✓
Availability of linking mechanism with full-text extractor	*	*	✓
Availability of multiple crosswork mapping support for managing domain specific metadata schema	*	*	✓
Full-text searching	*	*	✓
'Bento Box' search (categorization or records according to the sources)	*	*	✓
Search within search	*	*	✓
Search-term recommendations	*	*	✓
Geodetic search	*	*	✓
Persistent links	✓	*	✓
Stem search	✓	*	✓
Usage statistics	*	*	✓
OpenURL/opensearch	✓	*	✓
Google Analytics support	✓	*	✓
Support for images/multimedia objects	*	✓	✓
Support variety of data/metadata format	*	*	✓
Visualized searching tool	✓	*	✓
Visual organization (e.g., tag cloud)	✓	*	✓
Author biographies	*	*	✓
Geographic searching and map display/map search results view/GPS-enabled display	✓	*	✓
Visualizing graphs and maps	✓	*	✓
Advanced protocols (OA-DOI/OAI-ORE/RDF/ORCID)	*	*	✓
Linking with LOD	*	✓	✓
RDF/XML support	*	*	✓
Integration with commercial discovery system with connector (e.g., Serials Solutions' Summon)	✓	*	✓
Support for the Piwik open source analytics tool	*	*	✓
Integrate the library's locations and live record status	✓	*	✓
Search history	✓	*	✓
Query forwarding mechanism	*	*	✓
Multilingualism	*	*	✓

✓ indicates features supported, * indicates features not clear or under pipeline.
Source: Roy et al. (2018).

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ery interface for academic libraries. In this study, three OSS programs, VuFind (developed by Villanova University), Blacklight (developed by the University of Virginia), and eXtensible Catalog (developed by the River Campus Libraries of the University of Rochester), were compared against a set of parameters important for academic libraries in developing countries. VuFind was chosen as the discovery tool for designing the prototype. We must say that an open-source discovery tool like VuFind tends to operate in a similar way to any other commercial discovery tool.

Table 2 covers only the technical features of discovery tools, which are applicable globally to all discovery layers under discussion. Apart from these technical features, the following factors are also equally important while selecting discovery tools for academic libraries in developing countries like India. The factors include: *cost of the product* (one time and recurring), *dedicated server*, *continuous support*, *user base*, *active forum*, *software as a service (SOS) model*, *age of maintenance*, *integration with other software*, etc. For example, in India, commercial discovery systems like EDS cost more than 20 lakhs (equivalent to almost 25,593.94 US dollars) per year. It is not possible for all academic libraries to incur the cost. We cannot even say that such commercial systems are always better than open-source equivalents like VuFind. Apart from that, most of the academic libraries in India use an ILS like Koha or a digital library system like Omega (https://omeka.org), which is also LAMP-based.

6.2. Advocacy for VuFind

Still now, the search interfaces of most academic libraries rely on quasi-traditional approaches to find resources by some selected options such as title or author. As stated, Katz and Nagy (2013) noted that users now prefer a "self-service-oriented approach to searching" and the search interface offered by libraries is not supported by Web 2.0 features. Like other commercial discovery tools, VuFind includes many Web 2.0 catalogue features such as recommendations, user tagging, comments, and reviews, as well as "more like this" and "Did you mean?" to reduce the limitations of traditional library catalogue searches (Ho, 2013). Breeding (2009) reported that VuFind was one of the first open-source discovery interfaces for libraries and a number of academic libraries have implemented it, such as the National University of Australia (http://catalogue.nla.gov.au), Consortium of Academic and Research Libraries in Illinois (http://vufind.carli.illinois.edu), Minnesota State Colleges and Universities (http://plus.mnpals.net), and Yale University (http://yufind.library.yale.edu). Many authors have praised the flexibility of open-source discovery layers, which provide the ability to devise customized solutions to local problems (Barber et al., 2016). Several academic libraries have already implemented VuFind either as their primary catalogue interface or as an optional alternative (Emmanuel, 2011; Johnston et al., 2013; Leebaw et al., 2013) due to its outstanding Web 2.0 features, including author biographies, full-text search, hit highlighting, faceted search, dynamic clustering, database integration, and rich document (e.g., Word, PDF) handling (Breeding, 2010b; Shahi, 2015). Ho and Horne-Popp (2013) opined that VuFind has been proven to be a valid solution for academic libraries in providing an alternative catalogue interface for users.

This has already been covered in the literature review, and most of the researchers have preferred VuFind as their discovery layer for academic libraries. Apart from this, more than 200 institutions throughout the world are currently running or testing VuFind (https://vufind.org/wiki/community:installations). It is also found from the list that eight Indian organizations have already implemented VuFind in their institutes, such as N-List (https://nlist.inflibnet.ac.in). Apart from this, it has the most installations (https://vufind.org/wiki/community:installations) and also has the first position (Sourceforge, 2021) as per download statistics in the open-source domain. Hofmann and Yang (2012) found in their study that the top three popular discovery tools were WorldCat Local by OCLC, Summon by Serials Solutions, and VuFind. VuFind allows interoperability with most of the content and catalogue database providers such as Primo Central, EBSCO-Host, Summon, or WorldCat. Breeding (2015) stated that two open-source technologies, namely VuFind and Blacklight, have acquired significant popularity among the academic community in the discovery interface space. Parry (2009) reported that the most popular discovery tools in the open domain are VuFind, Blacklight, and eXtensible Catalog. Our paper published in *Library Hi Tech News* (Vol. 35, No. 3, pp. 16-22) has already established the fact that VuFind (Table 2) may be a potential software for designing discovery systems for academic libraries (Roy et al., 2018). The other important features which have made VuFind more popular than other discovery tools include auto suggestion, context-sensitive recommendations, use of APIs, and means of harvesting and locally indexing authority data (Katz et al., 2011). Brink-Drescher (2014) stated that VuFind is a highly customizable open-source product that allows information repositories of any size or type to

tie together and brand multiple services into a single unified interface. Burchill and Rasmussen (2014) discussed how VuFind not only indexes library catalogues but also proprietary databases through the integration of APIs, offering public libraries the opportunity to develop a seamless website-to-catalogue experience, thereby building a true virtual branch for their patrons. Chickering and Yang (2014) showed the adoption of fourteen web-scale discovery tools, both commercial and open-source, in North America and, after comparing open-source tools against sixteen parameters, concluded that VuFind is the best in the open-source domain. Denton and Coysh (2011) also reported in their usability study that users preferred VuFind's interface over the classic catalogue. Ho and Horne-Popp (2013) rightly said that VuFind has proved to be a valid solution for academic libraries.

Actually, VuFind was developed as a library discovery tool to take the place of the classic ILS database structure, which was its weakest link (Katz & Nagy, 2013). A number of academic libraries have been able to enhance their search results and add features by using VuFind. Many of the Web 2.0 features that consumers find on online article databases and commerce websites are also available through VuFind, in addition to increased search capabilities. VuFind is giving academic libraries a third way toward improving the concept of the library catalogue, the core tool for accessing library holdings (Ho & Horne-Popp, 2013). Skinner (2012) also compared the searching functionalities of VuFind with those of a traditional academic library's catalogue. Even FINNA-the National Digital Library of Finland (https://researchportal.helsinki.fi/en), TROVE-National Library of Australia (https://trove.nla.gov.au), and BASE-Bielefeld Academic Search Engine (https://www.base-search.net) also use VuFind as a back-end interface.

6.3. Interoperability Supports

A typical library discovery system has three parts: a *harvester*, a *central index* (import mechanisms), and a *user interface*. VuFind is no exception. It has all these three essential components, supporting globally agreed-upon interoperability standards for each layer. For example, it provides support for direct database interaction, ILS-DI, and REST/API for generating item availability status in real-time for many supported back-end ILSs. It provides an array of drivers for popular ILSs like Innopac, Voyager, SirsiDynix, Koha, Aleph, Folio, Virtua, and NewGenlib. It comes with support for a variety of retrieval features like Bento-box search and Geodetic search. Apart from other features like continuous revision of code, con-

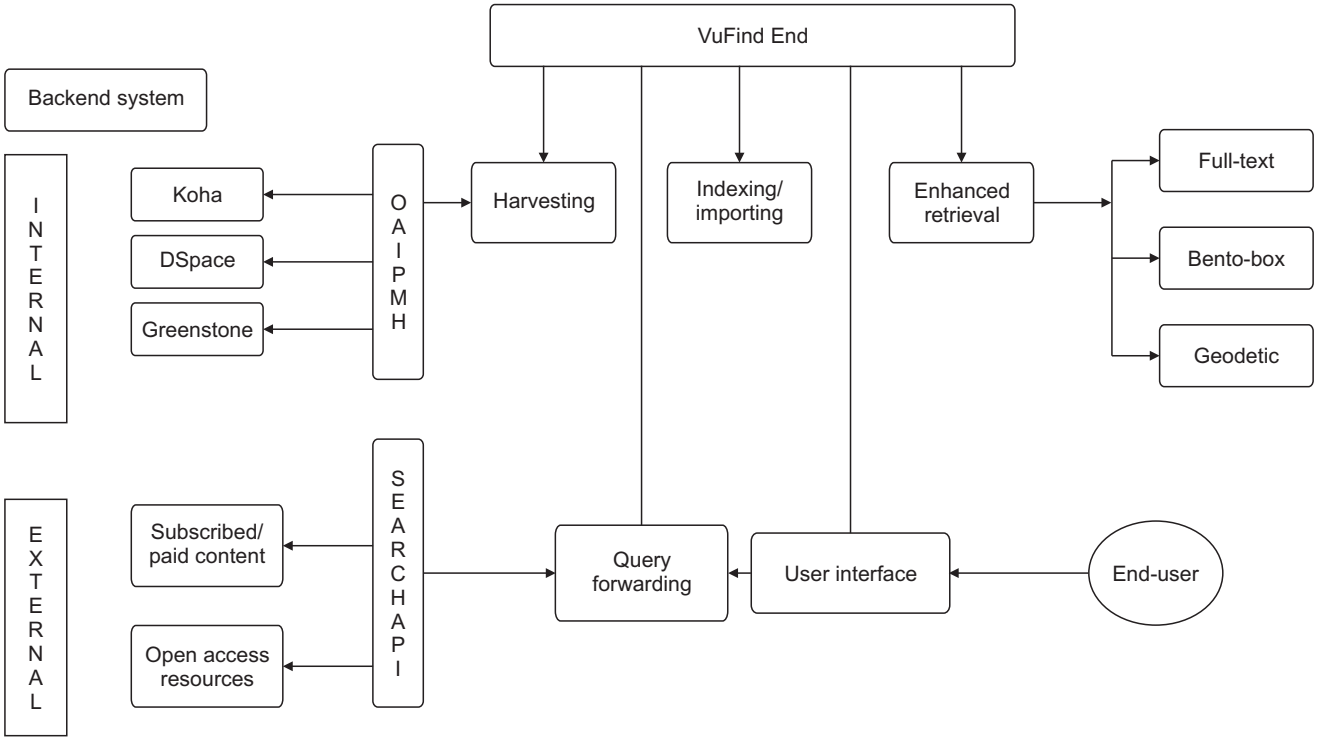


Fig. 1. Operational process of the model.

tinuous release cycle, etc., the support for almost all global standards (like REST/API) has made the software popular with academic library administrators. VuFind's standard 'biblio' core was also designed for indexing MARC as well as MARC-like data, e.g., simple and qualified Dublin Core metadata (Katz, 2016). Even so, VuFind allows interoperability with most content and catalogue database providers such as Primo Central, EBSCOHost, Summon, or WorldCat. It has many APIs to interact with other software in a library eco-system, and can act as an OAI data provider. Moreover, VuFind is compatible with the standards and protocols proposed by NISO (National Information Standards Organization) (National Information Standards Organization, 2020) and ODI (Open Discovery Initiative) (National Information Standards Organization, 2012).

The whole operational process of the model is illustrated here (Fig. 1).

In our back-end system, we have used the three open-source tools mentioned above, implemented by most of the academic libraries in developing countries, for managing their internal resources. For example, DSpace is used for providing access to ETDs, whereas Koha is used for managing bibliographic data of library resources. All these tools are OAI-PMH compliant and allow us to import and index bibliographic data as well as full-text content. Apart from in-house resources, academic libraries are procuring various external resources, including subscribed/paid and open access content. A unique query-forwarding mechanism in VuFind can allow end-users to extend their search queries to selected subscribed and/or open access services/tools from the same search interface where they can search internal resources of an academic library. The availability of features like Bento-box search (which can indicate the origin of retrieved resources distributed in different back-end silos in an academic library), and geodetic search (map-based retrieval of resources) makes VuFind an automatic choice for designing a discovery layer in an academic library.

As stated, the model has been developed considering basic theoretical and practical problems that arise during its installation and customization, as well as keeping in mind a summary of ideas or observations as covered in the literature review. The model has been tested on different configurations and against a set of heterogeneous data. Initially, the prototype has been tested against 1,000 more unique documents, including books, articles, theses and dissertations, non-book materials, and non-English knowledge objects, against different search syntax to measure the effectiveness of the model and to fulfill the promises we have made. We have checked all the features of VuFind and the knowledge has already been communicated through different workshops, training sessions, and writings so that it becomes another movement like the Koha movement in India, even though this framework has been developed in such a way that it could be integrated with any web-enabled on-line information representation and retrieval system.

7. KEY FEATURES OF THE MODEL

Like other resource discovery systems, including commercial ones such as EDS and Summon, this system offers: *basic and advanced search facilities; support for searching resources by call number/class number of the respective document* (here DDC – Dewey Decimal Classification, Fig. 2); *support for searching varieties of contents including commercial, licensed, or open databases through query forwarding mechanism* (Fig. 3); *support for full-text searching using Tika* (Fig. 4); *Bento-box search* (Fig. 5); *Geodetic search* (Fig. 6); and *search collections by a*

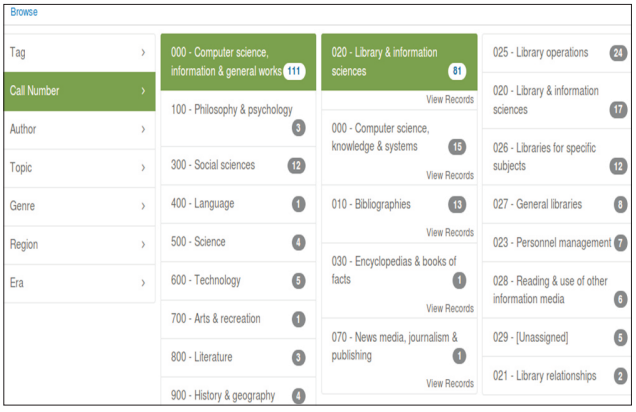


Fig. 2. Subject searching through Dewey Decimal Classification.



Fig. 3. Query forwarding.

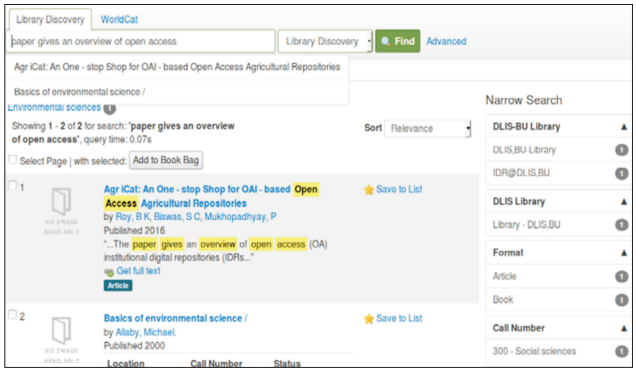


Fig. 4. Full-text search.

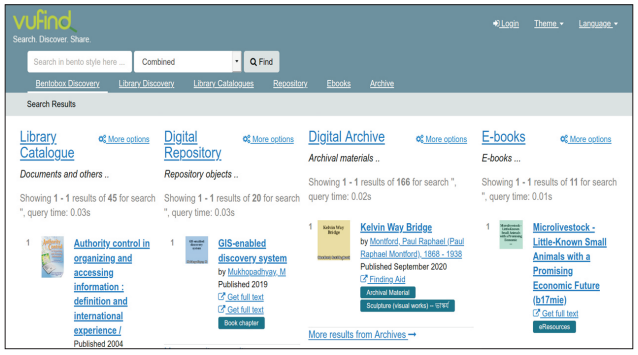


Fig. 5. Bento-box search.

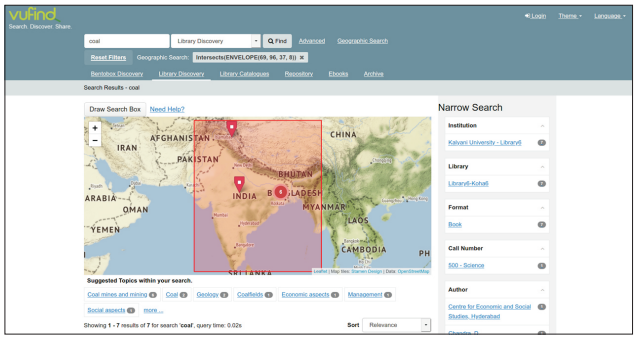


Fig. 6. Geodetic search.



Fig. 7. VuFind interface in Hindi.

particular language (here in Hindi language, Fig. 7). Some of these unique features (especially query forwarding; full-text search; Bentobox search; Geodetic search) are not generally supported by many academic libraries like the British Library (https://www.bl.uk/#) or Library of Congress (https://catalog.loc.gov).

As well, this harvested index-based interface also provides full-text access of open access/licensed content based on real time usage data. In its retrieval interface, it also facilitates the integration of information visualisation tools. Every effort has been made through its real-time application, keeping in mind several limitations of present discovery systems (Section 8) and observations as suggested by authors (in the literature review section) following several practical implementations. Here, some of the services offered by this model are now illustrated.

7.1. Catalogue in Discovery/Integrated Metadata Search

VuFind is well-equipped to index authority data from any ILS or Library Management Software (LMS). It allows data to be captured from any web-enabled and OAI-compliant bibliographic database. It supports a number of ILS or LMS, both commercial and open-source such as Koha or NewGenLib, to be integrated with its indexing mechanism. Here, MARC records were exported from Koha and then imported into VuFind (Fig. 8).

7.2. Knowledge Objects in Discovery

VuFind allows importing records from any repository system. For this study, resources have been extracted from local repository developed by DSpace software (Fig. 9).

7.3. Browsing in Discovery

Organizing resources and searching them using any subject access system is the added advantage of any online information retrieval system (Roy, 2014, 2015) and is the key to the success of an IR system (Roy et al., 2016c, 2016d). Most of the library catalogues or OPAC of academic libraries do not support browsing and facilitate only searching for resources. The most interesting feature of this framework is searching for resources by class/call number (here DDC - Dewey Decimal Classification) (Fig. 2).

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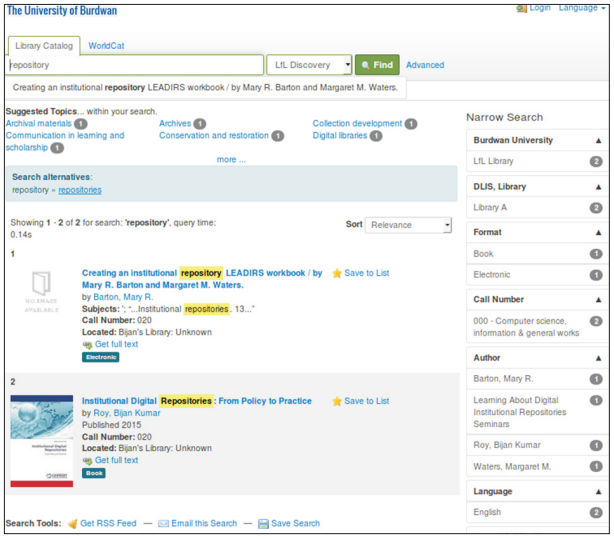


Fig. 8. Data imported from Koha.

7.4. Extended Search in Discovery

This model incorporated some of the pathfinder tools (such as BASE, DOAJ, and OpenDOAR) in its discovery interface in order to provide additional value-added/enhanced services to the users through a query forwarding mechanism (Fig. 3).

7.5. Full Text Search/Indexing

As stated, this model supports full-text searching and can extract keywords or phrases from any document (Fig. 4). For this purpose, 'Apache Tika' has been used as full-text extractor in the back-end layer of the model.

7.6. Bento-Box Search

The phrase 'bento box' is derived from Japanese cuisine where different components of a meal are compartmentalized in aesthetically pleasing ways. It is a unified approach where outcomes derived from many systems or categories are compartmentalized by system or category, like in a Japanese 'bento' style lunch box. The 'bento box' design is referred to as such because of its resemblance to the shape of Japanese lunch boxes (Singley, 2016). It provides a single search box that displays results from various libraries side by side (Fig. 5). The 'bento-box' presentation makes library search easier for users as results from several sources are returned in visually discrete boxes (Jaffy, 2020). The option to offer a 'bento box' display of search results is only available through a customization of OSS – no commercial product offers it.

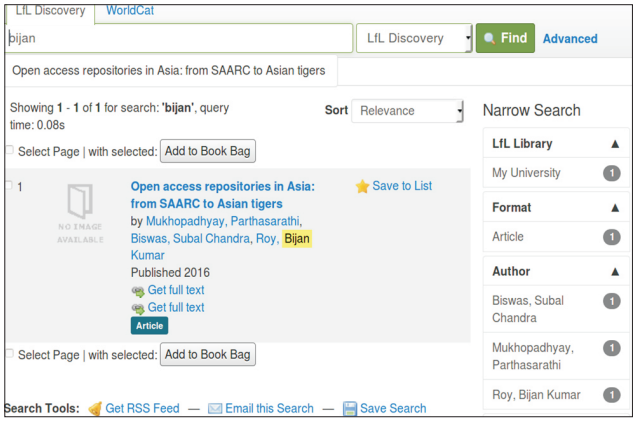


Fig. 9. Records imported from repository.

7.7. Geodetic Search

A sub-domain of the Geographic Information System is geodetic search, often known as GIS-enabled search or geographic search (GIS). A geodetic search framework is a type of land-information system that uses a mathematical framework to spatially reference all land data to appreciable locations on the surface of the Earth. These systems use a mathematical framework for spatially referencing all land data to discrete points on the Earth's surface to determine locations. When retrieving documents and data from sources where places or geographic names are the primary foci, such as information sources in the fields of geography, mineralogy, geology, travel guides, etc., the geodetic search mechanism may prove to be an effective process that goes beyond text-only search. In the bibliographic area, a geodetic search system should also facilitate the following actions: a) the document locations' longitudes, latitudes, or boundary values; b) integrating geo-coordinate values with the active map service; and c) making geodetic data sources visible in the search interface to filter search results. A MARC-formatted authority data-set has been created by Mukhopadhyay and Mukhopadhyay (2022) for Indian geo-administrative divisions due to the lack of coverage of Indian place names in worldwide authority data-sets. Fig. 6 shows the availability of documents including their physical location in the library for the search term 'coal.'

7.8. Interface in Hindi

The default interface of VuFind has been translated into two Indian languages. One of the co-authors of this paper is responsible for all Indian language translations and currently two languages (such as Bengali – https://github.com/vufind-org/vufind/blob/dev/languages/bn.ini;

and Hindi – https://github.com/vufind-org/vufind/blob/dev/languages/hi.ini; (Barman & Mukhopadhyay, 2018)) (Fig. 7) have been done.

8. FUTURE CONSIDERATIONS

As is clear from the literature review, many libraries are not using discovery tools and thus the adoption rate of such systems among academic libraries widely differs by discipline and region. It is a hard fact that there is a lot of work (as stated below in this section) to be done in different levels of its settings and operations by adding new functionalities and capabilities, to make the present-day discovery system more encompassing and efficient for academic library users to find the information that they need. As a result, the discovery system did not meet our inflated expectations, and there are numerous practical issues to consider in addition to the quantitative factors measured in our work. Simultaneously, the authors admit that the time of trials, beta testing, and debate over whether to adopt discovery tools in academic libraries is past.

Still, there is enough scope for integrating the discovery layer with transactions logs, cloud services, open linked data, incorporation of altmetrics into the discovery services eco-system, research data management, facet visualization, visual analytics, incorporation of external social networks, incorporation of learning management systems, integration of user-generated metadata into the cataloguing records, RDA-compliant MARC fields in authority records, integration of abstracting and indexing services, folksonomies or user generated tags to form 'word clouds,' integration with OpenStreetMaps, GeoNames (for the location of an item and user-driven acquisitions), OpenURL and Digital Object Identifiers, automatic mapping of search terms between different thesauri, integration with controlled vocabularies or ontologies, interoperability with link resolver, etc. to make the user interface more intuitive and visually attractive to readers.

Another important area of concern in the discovery system is maintaining the quality of metadata and integrating domain-specific metadata schemas for indexing or importing metadata of non-textual objects. The discovery system should integrate different metadata schemas meant for non-textual resources or special types of collections. Most academic libraries have some sort of special collection, but they are not accessible to users. The use of these types of objects is increasing due to their immense value to society. VuFind presently supports MARC (MARC-XML), Dublin Core, and CDWA-Lite metadata schemas. There is no such development that has been reported in the existing literature for incorporating these special collections into discovery interfaces. Some of the metadata schemas have been suggested for some non-textual objects: for example, for cultural, museum, art and architecture objects (CCO, LIDO), audio, musical materials, video or images (VRA Code), and learning objects (LOM). Further studies may be conducted in this area to make the interface more attractive to users.

Managing authority records in the discovery layer is also important as "the value of rich authority data should be shared with everyone, not just catalogers" (Katz et al., 2011). Authority file cross-references are not currently utilized in the discovery system, although this is a planned enhancement to the discovery environment (Houser, 2009; Skinner, 2012). If library catalogues can provide a Google-like experience and retain many of the 'behind the scenes' search aspects of traditional catalogues, the combined features may well result in the creation of a truly powerful discovery and search tool in the domain of academic library systems (Merčun & Žumer, 2008).

9. CONCLUSION

Still, academic library environments in developing countries are not fully aware of these new systems (Vaughan, 2011a; Way, 2010) and are in their infant stages of development. But these next-generation catalogues are emerging quickly as an alternative service model for library professionals by replacing existing practises (Tay, 2011; Vaughan, 2011a; Vaughan & Hanken, 2011). Walker (2015) correctly stated that RDSs are popular because they "offer superior performance, a much broader search scope, and no limit on the number of results retrieved by the system." Breeding (2015) supports this by saying that discovery layers provide an interface with search and retrieval capabilities, with relevancy ranking and various facets to narrow the results, and interoperability with a link resolver.

It is quite clear from the above discussions (made in Section 8) that discovery systems or discovery tools are not up to the standard in many aspects. Hence, selecting a discovery tool, particularly open-source, and designing its technical architecture best suited for academic libraries in developing countries is also a challenging task. In our study, we have made an attempt to reduce some of the lacuna of the existing discovery system by incorporating a few unique features into our model following global recommendations and best practices. To fulfill the promises

made in Section 5, we have developed a back-end architecture and customized our discovery software, VuFind, to make it unique from other discovery systems. As a result, our model, apart from supporting full-text searching through Apache Tika, provides some other value added services as stated in Section 7 and smoothly handles internal and external resources or resources from the public domain, including licensed/subscribed resources owned by commercial publishers, as depicted in Fig. 1.

Through the discussion of literature and our experience in developing discovery systems, the research questions covered in Section 5.1 have the following answers. Open-source discovery software compared to costly commercial discovery tools will be more beneficial in the long run for an academic library in developing countries (see Section 6.1 and Table 2). A LAMP-based discovery tool will have the possibility to be merged seamlessly with other library software eco-systems in an academic library. As we have said, most of the academic libraries in India use Koha as an ILS and Omega or DSpace as digital library software, and both the tools are LAMP-based. Thus, the integration of open-source discovery tools with ILS or DL systems will be much easier than with other discovery tools (see Section 7.1 & 7.2, Figs. 8 and 9); so question number 2 is fulfilled. Table 2 has already discussed in detail the technical features of VuFind and it comes in fine colour in comparison with open-source counter parts. Sometimes, VuFind is found to be at par with other discovery tools, and in some cases, it performs much better than other tools; so question number 3 is fulfilled.

Now the research questions covered in Section 5.2 are to be discussed. Many open-source tools are available for full-text extractors. As stated, VuFind is based on open architecture. We have seamlessly integrated Apache Tika with VuFind in our prototype (see Section 7.5, Fig. 4). Before populating the Solr index, VuFind can get full-text indexing done through Apache Tika and store it in Apache Solr; so the first question of this section is fulfilled. The next question is concerned with incorporating different value-added services into the discovery layer. Our prototype also discusses search enhancements like bento-box search. We are not only providing a single-window search interface but also ensuring that our model can compartmentalise the sources of data from where it is coming (see Section 7.6, Fig. 5). In addition, our model can highlight the physical location of any library holdings (see Section 7.7, Fig. 6). This is an added advantage of this model, which is not supported by other discovery systems. Apart from that, our model supports browsing and searching for resources in any native or regional language (see Section 7.8, Fig. 7). In a country like India, where a good number of knowledge objects are published in different vernacular languages such as Bengali and Hindi, there should be a provision for incorporating non-English knowledge objects into the discovery system. As a result, our system has kept its promise by making a discovery interface in Hindi, and there is enough scope for integrating any other language apart from English; so the third question of this section is fulfilled.

As a result, this integrated model offers new opportunities and innovative services to users and fulfills its promises by delivering easy, fast, and comprehensive search results effectively and efficiently through a single-entry point. The authors cannot claim this model as a 'one-size-fits-all' arena, but it may be helpful in increasing usage statistics of full-text resources or online collections including journal articles and databases. Even more, it may even help library professionals improve their service efficiency by guiding users in searching for web resources from multiple external data sources, both commercial and license-free. In this context, this model may be considered as a 'class of products' in the academic world, as it supports resource discovery beyond the library OPAC at the metadata level as well as at the full-text level. As well, the user interface is much more 'cosmetically and functionally' better than the old web OPACs of the library, so the outcome of this model may present an example to library managers who wish to integrate distributed library resources in a one-stop access and thereby want to save end users running from pillar to post in retrieving required resources.

Finally, we must say that although progress has been made in different directions in this arena and the discovery system has improved immensely over the years, discovery services still have room for improvement by incorporating different tools and services as covered in Section 8. In our proposed model, we have included some of the Web 2.0 tools in addition to incorporating different pathfinder sites as suggested in our objectives (Fig. 3). This is an attempt to better index, retrieve, and rank heterogeneous resources in a more magical way than before. As well, there is still a wealth of space for library professionals to be part of this development, and they can play a crucial role in this new journey by contributing their professional knowledge to this challenging and aspiring area. Then, discovery systems/tools can be viewed as a mixed blessing for library professionals as well as academic library users in developing countries.

CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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Information Behavior in COVID-19 Prevention: Does Anxiety among Indonesian Mothers Have an Effect?

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ABSTRACT

The pandemic of Coronavirus disease (COVID-19) has contributed more challenges for mothers as the family's primary caregiver in overcoming the widespread infection. Pandemic-related information is essential for mothers to reduce uncertainty as well as to maintain the health of family members during this unprecedented situation. Adopting the framework of the Situational Theory of Problem Solving, this study extends the theory by, first, testing the mediating role of COVID-19 anxiety on mothers' information seeking and information forwarding, referred to as active communication action of problem solving, as well as preventive behavior; and second, by predicting the effect of information seeking on preventive behavior. Referring to an online survey from 371 Indonesian mothers, the findings suggest that in terms of direct effect, only problem recognition was found to have no significant effect on situational motivation. The results suggest that Indonesian mothers perceive COVID-19 as personally relevant so that they are motivated to solve the problem by seeking and forwarding related information. In addition, COVID-19 anxiety was found to play a significant role in predicting information seeking, information forwarding, and preventive behavior. The result of this study is expected to give insights for risk communicators and health professionals in Indonesia in communicating COVID-19, particularly to mothers.

Keywords: Communivative Action on Problem Solving, information forwarding, information seeking, mothers, preventive behavior, Situational Theory of Problem Solving

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1. INTRODUCTION

The Coronavirus disease (COVID-19) pandemic has had major effects on women, particularly mothers. Due to physical distancing policies, school and office activities that were formerly conducted outside of the home are now undertaken at home. As a result, moms have more home responsibilities. In the age of COVID-19, women devote more time than men to domestic responsibilities such as babysitting and caring for others (Craig & Churchill, 2021). COVID-19 has also led women to lose more income and become more concerned about their families' well-being (Czymara et al., 2021). During this epidemic, the discrepancy in domestic responsibilities between men and women is aggravating gender inequality (Fodor et al., 2021).

In Indonesia, this phenomenon is also happening. According to UN Women (2020), COVID-19 has increased household and care duties for Indonesian women and required them to spend more time than men in supporting, guiding, and teaching children to study at home. The study found that first, 82 percent of Indonesian women who primarily relied on family businesses had diminished income sources due to the pandemic; second, the health crisis has prompted women in informal employment to work fewer hours than men; third, social limitation regulations require more women than men to perform household labor, particularly caring for and accompanying children; and fourth, due to increased domestic and caregiving burdens, job losses, and gender-based violence, the pandemic caused more women (57%) to experience stress and anxiety than men (48%). Nevertheless, women also play a key role in promoting the maintenance of family hygiene and health. In light of this, mothers' behaviors of seeking and sharing COVID-19-related information, as well as their preventative actions, are crucial.

In general, studies on information behavior in relation to the COVID-19 pandemic have been conducted, such as studies on the factors that caused information seeking (INS) (Huang & Yang, 2020; Jimenez et al., 2021; Kim et al., 2020; Zhao & Liu, 2021), information avoidance (Crowley et al., 2021; Hwang & Jeong, 2021; Siebenhaar et al., 2020), and information sharing (Islam et al., 2020; Xia et al., 2021). Factors that have been frequently studied in INS studies during COVID-19 include anxiety (Barattucci et al., 2020; Park et al., 2021), fear (Beaudoin & Hong, 2021a; Zhou et al., 2021), and need for information (Boot et al., 2021; Dreisiebner et al., 2022). Unfortunately, very little research has focused on the information-seeking and information-forwarding behaviors of women, especially mothers. An earlier work of research that used mothers as the unit of analysis found that pregnant women's anxiety caused by the COVID-19 pandemic led them to look for information regarding maternal and child health (Goldbort et al., 2021).

2. LITERATURE REVIEW

2.1. Risk Communication During COVID-19

During a pandemic, people frequently rely on information from respectable and trustworthy sources, such as the government, the media, and health professionals; therefore, risk communication in the time of pandemic is crucial. The World Health Organization (n.d.) defines risk communication as the use of critical communication skills during the preparation, response, and recovery phases of a health crisis in order to accomplish the desired behavioral change, effective decision-making, and trust. Risk communication permits the exchange of trustworthy information between linked parties, such as health specialists and authorities, as well as health professionals dealing with vulnerable persons, in order to raise awareness and comprehension of particular diseases (e.g., symptoms, transmission, treatment, and preventive behaviour) (IFRC et al., 2020; Rowel et al., 2012).

There are multiple ways to communicate a proportional risk in the context of COVID-19: first, promote the use of social media to disseminate pandemic-related information, as the majority of people today use social media as a communication tool; second, maintain a positive relationship with the media in order to spot and handle false rumors and fake news; and third, increase stakeholder engagement (Abrams & Greenhawt, 2020). According to a previous survey, mothers relied mainly on Facebook for disease outbreak information, added by information obtained from daily health ministry briefings (Alwreikat, 2022). Because risk communication has become crucial in risk reduction, primarily for mothers who are a family's primary caregiver, it is vital to identify factors that influence mothers' behaviors in obtaining and giving information to others.

2.2. Pandemic of COVID-19: Impacts and Mothers' Roles

Individuals, particularly mothers, experience apprehension when a novel infection emerges. At the onset of the pandemic, mothers encountered a variety of uncertainties, including: first, adjustment uncertainty, in which

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they were unsure how their children would adjust to a new situation in which they had to stay, study, and do their activities at home while schools and public places were closed to prevent virus transmission; second, COVID-19 threat uncertainty, where mothers were doubtful as to how to protect themselves, husbands, and children, especially family members with comorbid conditions from virus infection; third, social interaction uncertainty, where mothers were also unclear as to how to manage social distance with family and friends to protect the vulnerable; last, mothers were found to be concerned about the validity and trustworthiness of information circulated during the pandemic, since fake news and disinformation have grown to be widespread, particularly on social media (Walker et al., 2021).

Regardless of their work level, women are concerned about the COVID-19 pandemic. The shutdown of schools and offices has resulted in major financial interruptions, particularly for working women who must balance their family and professional obligations. Moreover, due to the shutdown of public facilities, families are having difficulty finding child care (Clark et al., 2021; Racine et al., 2021). Amid isolation in the time of the pandemic, mothers must play significant roles by providing multiple caregiving for members of the family and conducting additional home schooling (de Jong et al., 2022).

To address uncertainties about COVID-19, some mothers seek information about its transmission, symptoms, and treatment on social media (Alwreikat, 2022). Mothers who perceived COVID-19 as a threat to their family would be likely to seek related information, whereas mothers who did not consider COVID-19 as a threat tended to avoid it (Walker et al., 2021). In addition to information behavior, preventive behavior (PRE) is also a way to manage uncertainty. Mothers believe that by taking precautions, they may protect themselves and their families against viral transmission.

2.3. Situational Theory of Problem Solving

The purpose of the present study is to analyze COVID-19 anxiety (COA) as a mediating variable using the Situational Theory of Problem Solving (STOPS) as a theoretical framework and to predict its impact on two communicative behaviors, namely INS and INF, as well as PRE. STOPS begins with a basic premise, implying that people cannot avoid communicating and that their action is primarily motivated by the desire to solve problems in their lives. As a result, they communicate in order to address difficulties. Similarly, when the COVID-19 pandemic arises, individuals encounter problems that must be solved through communication. STOPS describes the reasons and the way people engage in communicative actions in order to solve problems (Kim & Grunig, 2011). The communicative action in STOPS is known as the Communicative Actions on Problem Solving model (CAPS), which offers a comprehensive description of communicators' communication behavior when confronted with difficult situations (Kim et al., 2010). Given that information is the primary component of communication, communicative action is also referred to as information behavior in this study. In prior research, this phrase was also often used interchangeably (Kim & Hong, 2021; Kim et al., 2011). Information behavior is described as the many actions that people do while engaging with information, including how and when they seek information and how they use it (Bates, 2018).

CAPS is comprised of three types of information behaviors: information acquisition, information selection, and information transmission. Each information behavior has two dimensions, active and passive. Active communication behavior refers to individuals who make a conscious effort to gather, choose, and provide information, whereas passive or reactive communication behavior refers to those who behave passively in reaction to the actions of others (Kim & Grunig, 2011). Information acquisition is made up of two parts: INS and information attending. INS is a deliberate, active, and planned search for certain subjects, including opinion search, whereas information attending is an unintentional and passive search for information. In problem solving, information selection indicates how selective a person is in receiving and distributing knowledge. Information forefending and information permitting are examples of information selection. Information forefending represents the level to which a person sorts out specific information by evaluating information value and relevance, whereas information permitting refers to the degree to which information is accepted without filtering. The active dimension of information transmission is information forwarding (INF), whereas the passive dimension is information sharing. Information sharing happens when a person is only willing to share information, thoughts, or ideas when others enquire, as opposed to INF, which is a sort of information activity in which a person actively and consciously sends information to others.

According to STOPS, information behavior is influenced by perceptual, cognitive, and motivational factors. The first three perceptual factors are problem recognition

(PBR), involvement recognition (IVR), and constraint recognition (Kim & Grunig, 2011). PBR is defined as an individual perception towards a situation where there is no instantly relevant way of solving a problem. IVR is referred as one's subjective perception of his or her relationship with a problem (Grunig, 1976). Constraint recognition is described as an individual perception regarding restraints that potentially limit the capacity to cope with the problem. Despite having a high degree of problem and IVR, a high level of constraint recognition might hinder someone from executing information behavior. STOPS also includes a cognitive variable, referent criterion, which comprise previous knowledge and experience that can be used to deal with problems. The motivational variable, referred to as situational motivation (SIM), is defined as "a state of situation-specific cognitive and epistemic readiness to make problem-solving efforts—that is, to decrease the perceived discrepancy between the expected and experiential states" (Kim & Grunig, 2011, p. 132). SIM mediates the influence of PBR, IVR, and constraint recognition on CAPS, the dependent variable in STOPS.

STOPS has been used in a variety of research areas, such as health communication (Chon & Park, 2021; Kim & Hong, 2021; Kim et al., 2011; Shen et al., 2019), environmental communication (Lamm et al., 2018), public communication (Chen et al., 2017; Lee et al., 2014; Pressgrove et al., 2020; Shin & Han, 2016), and students' communication regarding university crises (Poroli & Huang, 2018). Prior research revealed that perceptual variables, particularly PBR and IVR, positively influenced SIM, encouraging people to perform both passive and active informative behavior (Shin & Han, 2016; Tao et al., 2021; Zheng, 2020). Instead of testing all CAPS information behavior, the current study aims to focus on mothers' INS and INF behavior. Furthermore, in this model, this study solely employs PBR and involvement as independent variables adopted from STOPS.

2.4. Integrating Anxiety in the Framework of STOPS

Using the pandemic of COVID-19 as a study context, this research incorporates anxiety into the theoretical framework of STOPS. Specifically, the present study attempts to identify whether anxiety has a contributing role as an intervening or mediating variable between SIM and both information behaviors (INS and INF) and PRE. Based on reconstruction of the Extended Parallel Process Model (EPPM), anxiety encourages people to seek for information as a coping strategy when facing a problem (So, 2013). This study particularly focuses on anxiety which is generated by COVID-19.

Anxiety is one of the negative emotions marked by pressure and feelings of distress, and is also indicated by high blood pressure, faintness, shaking, increased heartbeat, and sweating (Kazdin, 2000). Meanwhile, according to the American Psychiatric Association (2013), generalized anxiety is a worry that is difficult to control, persistent, and excessive, and which has symptoms such as restlessness or feeling restless, tiredness, difficulty in concentrating, irritability, muscle tension, sleep disturbances, and decreased ability to engage in social activities. Communication scholars have examined the influence of anxiety on certain behavior and attitudes (Barattucci et al., 2020; Marschalko et al., 2021).

The cognitive appraisal theory of emotion explains that emotion occurs after cognition. According to Jacobs et al. (2012), cognition comprises values, beliefs, and attitudes, as well as mental processes and activities of thinking, judgment, and decision-making (e.g., uncertainty and severity). Meanwhile, emotions are communicated through physiological reactions (e.g., excessive sweating), expressive reactions (e.g., laughing), behavioral tendencies (e.g., avoiding), and emotional experiences (e.g., feeling sad or fearful) (Izard, 2007; Kleinginna & Kleinginna, 1981). In essence, certain cognition triggers specific emotions. In conjunction with STOPS, SIM is a cognitive mediating variable between perceptual variables and information behavior.

The addition of anxiety to the extended EPPM strengthens the rationale for INS as a coping strategy (So, 2013). In line with this, prior researchers found that the higher the level of anxiety regarding COVID-19, the more likely it was individuals looked for relevant information (Barattucci et al., 2020; Marschalko et al., 2021; Park et al., 2021). Previous studies also found that anxious people were inclined to share information using interactive media with others to reduce the level of anxiety (Jin et al., 2016; Lu et al., 2022). In the time of the COVID-19 health crisis, anxious people might feel encouraged to search and share related information with others. In addition, prior studies revealed that anxiety triggered people to comply and engage in PRE (Alrubaiee et al., 2020; Kwok et al., 2020; Magdy et al., 2021).

2.5. Linking Information Behavior and Preventive Behavior

As previously stated, communicative action in STOPS consists of six information behaviors, categorized by their activeness dimension. Despite the fact that STOPS examines all sorts of information behaviors, this study focuses

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on two categories of active communication, namely INS and INF. During health emergencies, both information behaviors are critical for mothers to guarantee the safety of loved ones. Pandemic-related information was delivered in order to raise awareness and convince individuals to adopt health-PRE during pandemics (Bala et al., 2021). Prior analysis found that when individuals actively and passively acquired information from conventional and digital media, they tended to engage in preventative behaviors such as wearing masks, avoiding physical interaction, avoiding crowds, frequently washing their hands (Beaudoin & Hong, 2021b; Lee & You, 2021; Zhao & Tsang, 2022), and receiving vaccination (Jung et al., 2013). Based on the literature, people who actively seek information will be likely to perform health PRE. This study specifically concentrates on PREs of social distancing efforts (e.g., physical distancing, and avoiding crowds or travel) (Lee & You, 2021).

2.6. Research Model and Hypotheses

Given mothers' growing capacity and critical role in ensuring family well-being at this unprecedented time, the purpose of this study is to explain the causal relationship among the variables used: PBR, IVR, SIM, COA, INS, INF, and PRE. Adopting STOPS, this study seeks to test the influence of perceptional variables on SIM and its mediating effect on INS, INF, and COA. Later, this study also tests the influence of COA on INS, INF, and preventive activity, as well as the effect of INS and COA on PRE. Understanding mothers' information and PRE may guide health and family communicators with insights about how to adjust and improve risk communication to mothers. Based on previous studies detailed in the literature review, a research framework has been constructed and proposed for research purposes (Fig. 1). Hypotheses are developed based on the research framework, as outlined below:

H1: Problem recognition positively influences situational motivation
H2: Involvement recognition positively influences situational motivation
H3: Situational motivation positively influences information seeking
H4: Situational motivation positively influences information forwarding
H5: Situational motivation positively influences COVID-19 anxiety
H6: COVID-19 anxiety positively influences information seeking
H7: COVID-19 anxiety positively influences information forwarding
H8: COVID-19 anxiety positively influences preventive behavior
H9: Information seeking positively influences preventive behavior

3. RESEARCH METHODOLOGY

3.1. Survey Instrument

PBR was measured by four items, whereas IVR was assessed by two statements which were adopted from Kim and Grunig (2011). In addition, four items were used to evaluate SIM. To measure anxiety caused by COVID-19, the present study used the COVID-19 Anxiety Scale (Silva et al., 2020). Meanwhile, to measure INS and INF in the present study, we used three items for each information behavior. All answers were scored on a 5-point Likert scale (1=strongly disagree, 5=strongly agree) (Kim & Grunig, 2011). Finally, PRE was calculated using indicators pertaining to the frequency of social distancing behavior using three items (1=never, 5=always), adapted from Lee and You (2021).

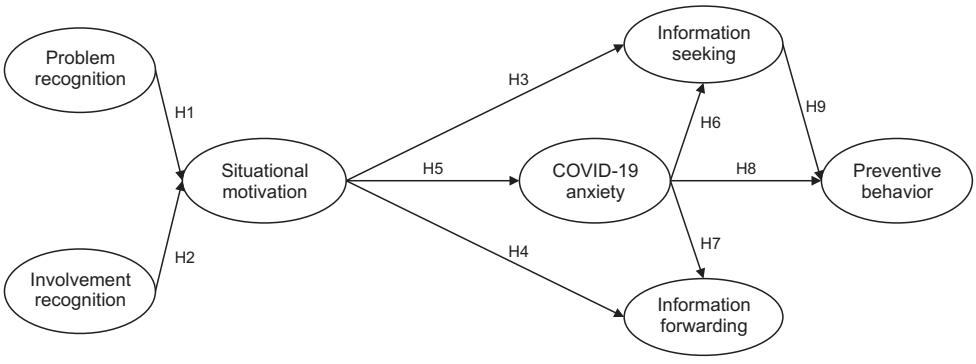


Fig. 1. Research framework.

3.2. Respondents

This study used mothers living in Perigi Baru, Banten, Indonesia as the population of interest. This study used nonprobability sampling with convenience sampling technique where researchers selected samples that were available, easy to reach, and convenient (Neuman, 2014). However, the technique has a limitation as it is not used to create representativeness of the whole population. Because the population size is unknown, this study estimates minimal sample size using a general estimation formula from Partial Least Square (PLS) Structural Equation Modelling (SEM) which is 10 times the indicator used to measure a construct (Hair et al., 2011). To collect data, a survey was distributed digitally and delivered in Indonesian through an online survey using Google Forms. Before this, a pilot test was conducted using 30 participants of mothers living in the area (Perneger et al., 2015). The study used SPSS 26 (IBM Corp., 2019) for the pilot test and the result showed that from 29 questions, 24 were declared valid and reliable for further data collection and analysis. Referring to the estimation of sample size in PLS SEM, the minimal sample size required for this study is 10 times 24, which equals to 240. Before answering the questions, respondents were required to fill in some demographic questions and declare their consent.

3.3. Analysis Method

To test the model in this study, the researchers applied SEM using WarpPLS software 6.0. This analysis is a unique development of PLS analysis which can be utilized to test hypotheses and to make models that do not have theoretical foundations (Wardhani et al., 2020). Moreover, it allows "nonlinear analyses where best-fitting nonlinear functions are estimated for each pair of structurally linked variables in path models, and subsequently used (i.e., the nonlinear functions) to estimate path coefficients that take into account the nonlinearity" (Kock, 2019, p. 2). There are several steps in WarpPLS, including making a structural model or inner model, followed by making a measurement model (outer model), designing the path diagram, converting the path diagram to an equation system, calculating the parameter, evaluating the model fit, and testing the hypothesis. A measurement model is required to meet the standard of validity and reliability. The evaluation of validity includes convergent validity, which is seen from the value of indicator loadings which should be equal to or greater than 0.5 (Kock, 2021) and average variance extracted (AVE) where the value should be 0.5 or greater (Fornell & Larcker, 1981); and discriminant validity that can be assessed using two approaches, Fornell-Larcker criterion or cross loadings. In addition, the evaluation of reliability focuses on the value of composite reliability and Cronbach's Alpha where the coefficients must be each equal to or greater than 0.7 (Kock, 2015). The structural model is evaluated by looking at the value of R^2, the level of significance, and path coefficient (Hair et al., 2011).

4. FINDINGS

4.1. Respondents' Demographic Profile

This study used IBM SPSS Statistics 26 for descriptive analysis and WarpPLS 6.0 to test the proposed model. From the data collection that was conducted from January 10 to January 26, 2022, there were 392 responses. However, after removing invalid responses, 371 responses were used for analysis. The sample included a wide range of age groups from 20 to older than 60 years old (Table 1).

4.2. Evaluation of Measurement and Structural Model

4.2.1. Model Fit and Quality Indices

The model in this study was analysed using WarpPLS 6.0. To evaluate the viability of a model, Kock (2015) provides 10 global model fit and quality indices: average

Table 1. Respondent's demographic characteristics (n=371)

Demographic characteristics		No (%)
Age	20-29 years old	27 (7.3)
	30-39 years old	192 (51.8)
	40-49 years old	121 (32.6)
	50-59 years old	26 (7.0)
	More than 60 years old	5 (1.3)
Education	Elementary school	12 (3.2)
	Secondary school	30 (8.1)
	Senior high school	101 (27.2)
	Diploma	21 (5.7)
	Bachelors	171 (46.1)
	Masters	35 (9.4)
	Doctorate	1 (0.3)
Employment status	Employed	156 (42.0)
	Unemployed	215 (58.0)

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path coefficient (APC), average R-squared (ARS), average adjusted R-squared, average block variance inflation factor (AVIF), average full collinearity VIF, Tenenhaus GoF, Sympson's paradox ratio, R-squared contribution ratio, statistical suppression ratio, and nonlinear bivariate causality direction ratio. According to Kock (2015), these criteria depend on the aim of the SEM analysis. If the objective is to test the hypothesis, the overall criteria of model fit and quality indices will be less relevant. However, there are three main criteria which should be met: APC with p-value, ARS with p-value, and AVIF. As the goal of this research is to test hypotheses, thus this study uses the three primary criteria. Nevertheless, according to the ideal value, the global model fit and quality indices showed that the proposed model was acceptable (Table 2).

4.2.2. Measurement Model

Table 3 shows evaluation of the measurement model. It indicates that the value of indicator loadings, composite reliability, Cronbach Alpha, and AVE have met the standard. Therefore, the indicators can be declared as valid and reliable (Table 3).

4.2.3. Direct and Indirect Effect

Table 4 shows the direct and indirect effects of the model. In terms of the direct effect, results show that PBR has no direct effect on SIM (β=0.003, p=0.239), with very weak effect size. Hence, H1 is not supported. Analysis reveals that IVR has a positive and significant influence on SIM (β=0.262, p<0.001), with small effect size. Thus, H2 is supported. Meanwhile, the result indicates that SIM has a positive and significant influence on INS and INF, respectively (β=0.676, p<0.001; β=0.536, p<0.001), with large effect size. Therefore, H3 and H4 are both supported. The analysis also shows that SIM has a positive and significant influence on COA with medium effect size (β=0.345, p<0.001). Hence, H5 is supported. Other results show that COA has a positive and significant influence on, accordingly, INS, INF, and PRE (β=0.082, p=0.028; β=0.141, p=0.001; β=0.095, p=0.016). However, the effect size of COA on PRE is very weak. As a result, H6, H7, and H8 are supported. Finally, the result shows that INS has a positive significant effect on PRE (β=0.232, p<0.001). Thus, H9 is supported. All findings of direct effects are summarized in Fig. 2.

With regards to R-squared (R^2), the results suggest that R^2 of SIM is 0.07 or 7%, implying that 7% of SIM can be explained by PBR and IVR, while the remaining (93%) is explained by other factors which are not investigated in this study. Concurrently, the R^2 of INS, COA, INF, and PRE is, respectively, 50%, 12%, 36%, and 7%, which means that the rest is explained by other variables which were not tested in the current study. Thus, these other variables can be studied in the future.

In terms of indirect effects, the results showed a positive and significant effect on: IVR to COA through SIM

Table 2. Result of model fit and quality indices

Element	Value	Criteria	Interpretation
APC	0.264, p<0.001	p value ≤0.05	Acceptable
ARS	0.224, p<0.001	p value ≤0.05	Acceptable
AARS	0.220, p<0.001	p value ≤0.05	Acceptable
AVIF	1.137	Acceptable if ≤5, ideally ≤3.3	Acceptable
AFVIF	1.747	Acceptable if ≤5, ideally ≤3.3	Acceptable
GoF	0.413	Small ≥0.1, medium ≥0.25, large ≥0.36	Large
SPR	1.000	Acceptable if ≥0.7, ideally=1	Ideal
RSCR	1.000	Acceptable if ≥0.9, ideally=1	Ideal
SSR	1.000	Acceptable if ≥0.7	Acceptable
NLBCDR	1.000	Acceptable if ≥0.7	Acceptable

APC, average path coefficient; ARS, average R-squared; AARS, average adjusted R-squared; AVIF, average block variance inflation factor; AFVIF, average full collinearity VIF; GoF, Tenenhaus GoF; SPR, Sympson's paradox ratio; RSCR, R-squared contribution ratio; SSR, statistical suppression ratio; NLBCDR, nonlinear bivariate causality direction ratio.

Table 3. Result of measurement model test

Constructs & Indicators	Mean	SD	Validity		Reliability	
			LF	AVE	CR	CA
Problem recognition (PBR)				0.571	0.839	0.742
In my opinion, the pandemic of COVID-19 is a problematic situation.	4.34	0.949	0.578			
Pandemic of COVID-19 is a serious national and social problem.	4.61	0.620	0.793			
Pandemic of COVID-19 must be solved immediately.	4.77	0.461	0.847			
Relevant stakeholders are required to overcome the pandemic instantly.	4.68	0.546	0.776			
Involvement recognition (IVR)				0.869	0.930	0.849
Pandemic of COVID-19 can significantly influence my life.	4.39	0.695	0.932			
Pandemic of COVID-19 can affect me and the people I care about.	4.46	0.728	0.932			
Situational motivation (SIM)				0.705	0.905	0.858
I always think about the pandemic of COVID-19.	3.55	0.933	0.736			
I keep a close watch on the COVID-19 pandemic.	3.64	0.914	0.833			
I want to have deeper understanding about the pandemic of COVID-19.	3.46	0.964	0.883			
I want to know better about the pandemic of COVID-19.	3.55	0.930	0.897			
COVID-19 anxiety (COA)				0.806	0.954	0.939
I am constantly worried about the pandemic of COVID-19.	3.50	1.071	0.827			
Pandemic of COVID-19 makes me worry about anything.	3.28	1.090	0.930			
The COVID-19 pandemic is stressing me out.	3.04	1.084	0.944			
The COVID-19 pandemic has me panicking.	2.92	1.075	0.929			
Pandemic of COVID-19 has me living in fear.	3.11	1.072	0.851			
Information seeking (INS)				0.809	0.927	0.881
I actively seek information about the COVID-19 pandemic on any media.	3.31	1.029	0.929			
I'm looking for the latest information regarding the COVID-19 pandemic.	3.36	1.024	0.890			
I purposely check the update information pertaining COVID-19.	3.08	1.094	0.877			
Information forwarding (INF)				0.861	0.949	0.919
I actively share information about the COVID-19 pandemic with others.	3.12	1.095	0.944			
I voluntarily provide information regarding the COVID-19 pandemic.	3.33	1.076	0.907			
I am actively disseminating information about the COVID-19 pandemic.	3.04	1.104	0.931			
Preventive behavior (PRE)				0.722	0.886	0.804
I avoid travelling during the pandemic of COVID-19.	3.74	0.964	0.743			
I avoid crowds during the pandemic of COVID-19.	4.18	0.818	0.918			
I maintain physical distance during the pandemic of COVID-19.	4.30	0.768	0.878			

SD, standard deviation; LF, loading factor; AVE, average variance extracted; CR, composite reliability; CA, Cronbach's Alpha.

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Table 4. Direct and indirect effects of the model

Type	Effect	β	*p*-value	SE	f^2
Direct	PBR → SIM	0.003	0.239	0.052	0.000
	IVR → SIM	0.262	<0.001	0.050	0.068
	SIM → INS	0.676	<0.001	0.047	0.476
	SIM → INF	0.536	<0.001	0.048	0.313
	SIM → COA	0.345	<0.001	0.049	0.119
	COA → INS	0.082	0.028	0.051	0.026
	COA → INF	0.141	0.001	0.051	0.045
	COA → PRE	0.095	0.016	0.051	0.014
	INS → PRE	0.232	<0.001	0.050	0.059
Indirect	PBR → SIM → COA	0.001	0.245	0.037	0.000
	IVR → SIM → COA	0.091	0.003	0.036	0.025
	PBR → SIM → INS	0.002	0.240	0.037	0.000
	IVR → SIM → INS	0.177	<0.001	0.036	0.025
	PBR → SIM → INF	0.002	0.242	0.037	0.000
	IVR → SIM → INF	0.141	<0.001	0.036	0.009
	COA → INS → PRE	0.019	0.151	0.037	0.003
	SIM → COA → INS	0.028	0.110	0.037	0.020
	SIM → COA → INF	0.049	0.046	0.036	0.028
	SIM → COA → PRE	0.190	<0.001	0.051	0.049
	PBR → SIM → COA → INS	0.000	0.250	0.030	0.000
	PBR → SIM → COA → INF	0.000	0.249	0.030	0.000
	PBR → SIM → COA → PRE	0.001	0.248	0.042	0.000
	IVR → SIM → COA → INS	0.007	0.201	0.030	0.001
	IVR → SIM → COA → INF	0.013	0.168	0.030	0.001
	IVR → SIM → COA → PRE	0.050	0.060	0.042	0.006
	SIM → COA → INS → PRE	0.007	0.207	0.030	0.002
	PBR → SIM → COA → INS → PRE	0.000	0.250	0.026	0.000
	IVR → SIM → COA → INS → PRE	0.002	0.237	0.026	0.000

PBR, problem recognition; IVR, involvement recognition; SIM, situational motivation; COA, COVID-19 anxiety; INS, information seeking; INF, information forwarding; PRE, preventive behavior; β, standardized path coefficient; SE, standard error; f^2, effect size.

(β=0.091, p=0.003) with small effect size; IVR to INS through SIM (β=0.177, p<0.001) with small effect size; IVR to INF through SIM (β=0.141, p<0.001) with very weak effect size; SIM to INF through COA (β=0.049, p=0.046) with small effect size; and SIM to PRE through COA (β=0.190, p<0.001) with small effect size.

5. DISCUSSION

The objective of this study was to test the mediating role of COA on INS, INF, and PRE among Indonesian mothers. Overall, the findings of this study did not fully support the effect sequence as described in STOPS. According to STOPS, PBR has a positive and significant effect on SIM. In contrast, the result of hypothesis testing suggests that PBR has no significant effect on SIM. There are several probable explanations: first, given that the pandemic has been going on for more than two years, mothers may have become accustomed to the existing situation; second, at the time the data was collected, 68 percent of

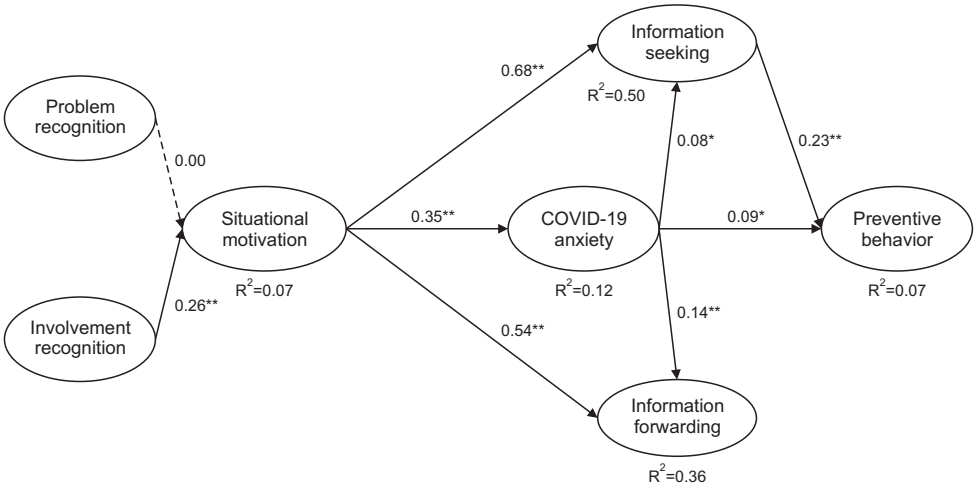


Fig. 2. The result of model testing. *p<0.05, **p<0.01.

the Indonesian population had received at least one vaccine dosage, and approximately 47 percent of the total population had been fully vaccinated (Institute for Health Metrics and Evaluation, 2022). As a result, mothers might not be motivated to know more about COVID-19. Even this result contrasts with the work of Kim and Grunig (2011), Shin and Han (2016), and Tao et al. (2021), which exhibit that PBR has a positive and significant effect on SIM; it also supports previous results which stated that there was no significant effect of PBR on SIM in the context of policy issues and corporate social responsibility campaigns (Chen et al., 2017; Lee et al., 2020). Amid conflicting findings, further studies are required to test the effect of PBR on SIM.

IVR was found to have a positive and significant effect on SIM. This result echoes prior study from Chon and Park (2021), and Shin and Han (2016). It means that when mothers perceive COVID-19 can affect themselves and their loved ones, they will be highly motivated to learn and understand better about COVID-19. In predicting SIM, IVR was found to be a strong predictor, supporting prior studies by Kim and Grunig (2011), and Shin and Han (2016). It demonstrated that mothers' perceptions of the possibility of an infectious disease could harm themselves and their family members, encouraging them to find out more about COVID-19. The higher level of IVR, the greater motivation that mothers have to understand more about the pandemic. Furthermore, this study also found that mothers' motivation was a significant trigger for mothers to seek and forward COVID-19-related information, supporting prior studies (Tao et al., 2021; Yan et al., 2018). When mothers are positively motivated in understanding the current health situation, they will be likely to seek and forward relevant information.

Results also showed that COA was a significant mediating variable between SIM and INF, and between SIM and PRE. With regards to information behavior, our model also identified COA as a positive predictor of INS and INF, indicating that the more anxious mothers feel about COVID-19, the more likely they look for and forward related information. This result resonates with previous work from Barattucci et al. (2020), suggesting that anxiety which was prompted by the public's perception on severity and susceptibility pertaining to COVID-19 had a strong predictive power on the public's health-related INS. In addition, one prior study found that anxiety led people to give information, particularly, to strangers on online media in order to reduce the level of anxiety (Lu et al., 2022). Similarly, mothers may expect that by seeking and forwarding pandemic-related information, their COA will decrease. In addition, results suggested that COA was also a significant predictor on PRE, indicating that when mothers are anxious about the current health situation, they are more likely to perform PRE, supporting prior research results (Alrubaiee et al., 2020; Kwok et al., 2020; Magdy et al., 2021). Mothers might expect that by doing PREs, they might reduce the possibility of being infected, leading them to manage their anxiety.

Finally, INS was found to have a positive impact on PRE, implying that active information behaviors encouraged people to engage in preventive action. This finding corroborates previous research suggesting that parents' INS activity affected their children's acceptance of the H1N1 vaccine (Jung et al., 2013). Having adequate knowledge about the current situation, mothers will remain attentive, aware, and motivated to confidently and deliber-

ately perform their role in ensuring the well-being of their family members.

6. CONCLUSION

As the first study using STOPS to predict the effect of COA on information and PRE among Indonesian mothers, this study provides a contribution theoretically and in practice. First, our study extends the literature of STOPS by adding COA as recommended by previous studies, revealing that COA is a significant predictor of INS and PRE and a significant mediator between SIM and INF, as well as between SIM and PRE. Moreover, this study also tests the influencing power of INS on PRE. From a practical point, the model can guide risk communicators and health professionals in adjusting and delivering pandemic information, especially to mothers. As a main caretaker of the family, mothers' information behavior and compliance on PRE are crucial during the pandemic to ensure the wellbeing of family members, particularly during a health emergency.

This study has some limitations. First, this current research examines the influencing factor of COA on mothers' information and PREs regardless of mothers' ages and their children's ages. As a consequence, more research on mothers' perspectives and behaviors based on their age and the age of their children is proposed. Mothers with small children may hold different views than mothers with mature children. Second, to expand understanding about the impact of related variables on information behavior, future research may involve together men and women, instead of women solely. Third, considering that the predicting power of variables on SIM and PRE is small, future research may involve another perceptual variable. In relation to the third point, rather than evaluating only two active elements of communicative action (INS and INF), future research may include another active and passive dimension of communicative action, such as information evaluation, information acceptance, and information attendance. Next, given the contrasting results on the effect of PBR on SIM, researchers are advised to examine the theoretical framework in other contexts. Finally, future study can anticipate the impact of other psychological cognitive factors on information and preventative behavior, such as weariness and fear.

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CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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Country-Specific Digital Inequalities in Older People's Online Health Information Seeking in Europe: Impact of Socio-Demographic and Socio-Economic Factors

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ABSTRACT

Since older people are traditionally considered disadvantaged when it comes to Internet use, it is useful to examine whether older individuals use the Internet for health information seeking (HIS). This study aims to investigate digital inequalities in terms of Internet use by older population for HIS in the European region. As methods, we applied secondary data analysis (of Eurostat data) to investigate the influence of age, educational level, sex, and countries' wealth. Cluster analysis combined with multidimensional scaling was used to find out those countries exhibiting similarities in older people's online HIS. The main results are: Older individuals do not equally use the Internet in general and for HIS in particular. Older Internet users with higher level of education and of the female sex are more likely to use the Internet for health information.

Keywords: health information seeking, digital inequality, digital divide, older people, Europe

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1. BACKGROUND

Information seeking, including online information seeking, has been a research area in information science for decades. Information seeking is an aspect of human information behavior (Bates, 2010; Fisher et al., 2005; Wilson, 2000). Health information and health information seeking (HIS) are receiving increasing attention in information science (Galarce et al., 2011; Ilhan, 2020; Johnson & Case, 2012). Health information is important for everyone (Cline & Haynes, 2001; Morahan-Martin, 2004). People engage in HIS behavior when they have to cope with a health-threatening situation, when they intend to adopt preventative behaviors, or when they want to actively participate in medical decision making concerning their health or that of their relatives (Lambert & Loiselle, 2007; Zimmerman & Shaw, 2020). Traditionally, health professionals were considered the main source of health information (Lambert & Loiselle, 2007). However, with the diffusion of information and communication technologies (ICT), public preferences have shifted to the Internet (Zimmerman & Shaw, 2020).

In 2018, 89% of households in the European Union (EU) had access to the Internet (Eurostat, 2019). The average share of Internet users in the population aged between 16 and 74 was also high, comprising 85% (Eurostat, 2019). Nevertheless, only 52% of Europeans were reported to use the Internet for HIS (Eurostat, 2020c). Furthermore, there are disparities between older and younger health information seekers both within and between countries (Eurostat, 2020a), although online HIS is especially important for older people (Bujnowska-Fedak & Mastalerz-Migas, 2015; Medlock et al., 2015; Sheng & Simpson, 2015) because they are more often confronted with chronic illness and acute diseases as well as preventative health care. At the same time, the proportion of older people in the European region increased significantly, putting additional pressure on public health care systems due to the high dependency of older population on health professionals (Quaglio et al., 2016; Vancea & Solé-Casals, 2016). Active HIS and, therefore, online HIS can be viewed as health-promotion behavior (Eriksson-Backa et al., 2018) leading to patients' empowerment and satisfaction (Longo, 2005). However, another well-known problem of the older population is digital inclusion (Matthews et al., 2019) as older people tend to use the Internet less actively and for a lesser number of activities than their younger counterparts (Heo et al., 2015; Hong & Cho, 2017; Hunsaker & Hargittai, 2018).

Digital inequality "tends to reinforce social inequality" (van Dijk, 2020). Digital inequalities in Internet access and the use of online health information by older adults form digital divides, which can be simply described as a gap between people who benefit from digital sources and those who do not (van Dijk, 2005). The first-level digital divide considers physical access to online information and includes aspects of material divides (van Deursen & van Dijk, 2019). The second-level digital divide concentrates on differences in the users' Internet skills and their levels of information literacy (van Deursen & van Dijk, 2011), i.e., the adequate usage of online information (Büchi et al., 2016; van Deursen & van Dijk, 2014). The final third-level digital divide concerns the outcomes of Internet use and the ways users really benefit from online information (van Dijk, 2020). All three levels of digital divides may be applied to the use of online health information (Brodie et al., 2000; Scherr et al., 2019; Wagner et al., 2005; Wyatt et al., 2005). Furthermore, digital divides are also present for older adults (the "grey divide") (Friemel, 2016; Quan-Haase et al., 2018). Are older persons "on the sidelines" (Johnson & Johnson, 2016)? The benefits of online health information use "are not shared by all members of older populations" (Yoon et al., 2020).

Concerning the use of online information, it should be added that although Internet access is a basic condition to profit from online information, equally important are the motivation of people to engage with online information and their level of general education, as well as their information literacy skills (Linde & Stock, 2011, p. 95). In order to adequately deal with online health information, individuals should possess "e-health skills" (Tavares, 2018; Vicente & Madden, 2017) or health information literacy, which is a combination of "health literacy" and "information literacy" (Eriksson-Backa et al., 2012; Ivanitskaya et al., 2006). The nuanced nature of ICT adoption is especially relevant for older adults who have to "reinvent themselves" and develop new routines to adopt new technology (Quan-Haase et al., 2016), and largely depends on the support from social and institutional systems to master digital skills and gain comfort experience with new technologies (Schreurs et al., 2017).

Previous studies demonstrated that digital divides are not accidental but determined by fundamental demographic and socio-economic factors (Friemel, 2016; van Deurson & van Dijk, 2014). In research on the differences in Internet use, the following factors have been most frequently discussed as Internet use predictors. They include socio-demographic variables of age and sex as well as socio-economic determinants such as educational level,

employment status, and income (van Deurson & van Dijk, 2014). On the country level, the wealth of a country positively correlates with the Internet use of older people (König et al., 2018). The examination of socio-demographic factors also became an important aspect of the research on HIS behavior (Zimmerman & Shaw, 2020); such factors as sex, ethnicity, socio-economic status, living area, and health literacy deserved special attention.

One can note that the factors influencing Internet use and HIS behavior replicate each other to a great extent. Not surprisingly, they are important also for the studies on online HIS and health information literacy. There are clear results highlighting sex-specific differences in searching and using health information from the Internet (Bidmon & Terlutter, 2015; Lim et al., 2011; Nölke et al., 2015). Similarly, higher levels of education relate strongly to higher levels of health information literacy (Eriksson-Backa et al., 2012; Estacio et al., 2019); on the macro-level, there are hints for relationships between health information literacy and socio-economic development, i.e., the wealth of the country (Liobikienė & Bernatonienė, 2018). The effects of education and sex as predictors of Internet use for HIS can be found also in relation to the older population (Eriksson-Backa et al., 2012; Bujnowska-Fedak & Mastalerz-Migas, 2015; Gazibara et al., 2016). However, the results are on the country or city level and are somewhat contradictory.

2. OBJECTIVES

As the Internet has the potential to fulfill health information needs and make people more informed partners of health professionals, it should be confirmed that older individuals can and will use online channels for HIS also in order to guarantee their "successful aging" (Holstein & Minkler, 2003). The main research question of this article, therefore, is: Are there country-specific digital inequalities in online HIS of older individuals? The data on 35 European countries, i.e., on the macro-level, concerning older adults and their use of the Internet for HIS in 2018, i.e., the period prior to the COVID-19 pandemic, are analyzed. First, the present study looks at the country-level, whether older people (and – for comparison – their younger counterparts) generally use the Internet. Medlock et al. (2015) found a positive association between Internet use and preference to use the Internet as a source of health information among older individuals, which needs to be checked on the macro-level. Second, the study investigates whether older Internet users engage in online HIS. Lastly, it is analyzed whether there are groups of older Internet users deprived of online HIS. This study examines the influence of socio-economic and socio-demographic factors such as countries' wealth, individuals' educational level, sex, and – first of all – age, whereby the focus lays on the older population. The proposed research model can be found in Fig. 1.

The concrete definition of "older person" in the literature is not clear, as different research teams work with different age ranges (starting points from 50+ to 65+). Eyeing on available data and in line with other studies (e.g., Hargittai & Dobransky, 2017), this study starts at age 55 and ends (due to data from the official statistics) with age 74. Also, the term "older people" (individuals, adults, etc.) is preferred over "seniors" and "elderlies" because it is the most neutral one and is the standard term in geriatrics (Avers et al., 2011).

There are manifold studies on people's health information behavior (e.g., Fry et al., 2015), especially HIS behavior (e.g., Cline & Haynes, 2001; Nölke et al., 2015; Zimmerman & Shaw, 2020), and there are reports on older individuals' use of the Internet (e.g., Friemel, 2016). However, there is a lack of research on the online HIS behavior of older persons on the macro-level, which is covered in the present article. In line with the aim of this study, the following research questions were formulated:

RQ1: Are there country-specific inequalities in Internet use of older people in Europe?
- RQ1a: How does Internet use vary among older individuals in the European region?
- RQ1b: How do the shares of younger and older individuals using the Internet differ within their respective countries?

RQ2: Are there country-specific inequalities in online HIS of older Internet users in Europe?
- RQ2a: How does Internet use for HIS vary among older Internet users in the European region?
- RQ2b: Do the shares of older Internet users correlate with the shares of older Internet users engaging in online HIS?
- RQ2c: Does a country's wealth correlate with the shares of older Internet users engaging in online HIS?
- RQ2d: How do the shares of older Internet users engaging in online HIS differ from the shares of their younger counterparts within the respective countries?
- RQ2e: How do the shares of older Internet users

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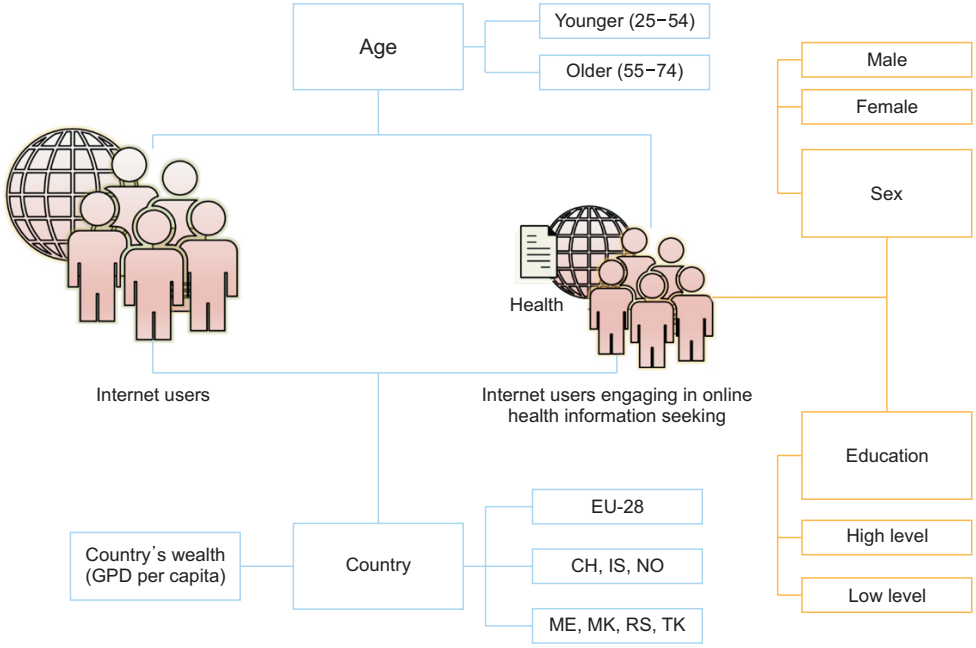


Fig. 1. Proposed research model: Older individuals' health information seeking behavior in context. GDP, gross domestic product; EU-28, 28 members of the European Union in 2018. Refer to Table 1 for the country codes.

engaging in online HIS differ depending on their educational level?

- RQ2f: How do the shares of older Internet users engaging in online HIS differ depending on their sex?
- RQ2g: Are there countries in Europe which exhibit similarities in Internet use for HIS of older Internet users?

3. DATA AND METHODS

To answer the research questions, secondary data analysis was conducted. The data used for this study were retrieved from the Eurostat database (Eurostat, 2020a, 2020b, 2020c, 2020d) and can be found in Table 1. In line with the research model, the following five datasets available in the Eurostat database were extracted: (1) percentage of individuals who used the Internet in the last three months prior to the survey (Internet users) by age (Eurostat, 2020b); and percentage of Internet users who sought health information on the Internet by (2) age, (3) formal education (high, low), (4) sex (male, female) (Eurostat, 2020c), and (5) purchasing power parity adjusted gross domestic product (GDP) per capita as a measure of countries' wealth (Eurostat, 2020d). The data from 2018 were used as a basis for the analysis because the datasets for this year were the most complete at the time of the study. The data from 2017 were taken in the case of Switzerland due to a data gap for 2018. The target group of the study was the older population aged 55 to 74. For comparison, the group of younger individuals aged from 25 to 54 was also used. The population aged 75 and above was not taken into analysis because of the insufficient data for this age group, namely the data were available for four countries only.

A total of 35 European countries were included in the analysis. These are the 28 members of the EU in 2018 (EU-28) followed by Iceland, Norway, and Switzerland, which are non-EU members but belong to the Schengen Area. Additionally, Montenegro, North Macedonia, Serbia, and Turkey were taken into the analysis as four out of five candidate countries to enter the EU. The data on Albania, the fifth candidate country, and Liechtenstein, one more Schengen Area country, were not provided in the Eurostat database for most of the chosen datasets and, hence, could not be included. In certain cases (i.e., in the descriptive analysis of Internet use for HIS by older population depending on the educational level and in the cluster analysis), Montenegro was excluded because of the partial data lack.

To analyze the relations between countries' wealth, Internet use, and Internet use for HIS, a non-parametric Spearman rank correlation was calculated because the variable of countries' wealth did not meet the assumption of normality (significance value of the Shapiro-Wilk test <0.05).

To identify those countries which may exhibit similarities in Internet use for HIS of older persons, cluster analy-

Table 1. Basic data on Internet use and Internet use for health information seeking (HIS) in 2018

Country name	Country code	GDP per capita	Percentage of Internet users[a], %		Percentage of Internet users[a] who used the Internet for HIS, %					
					Age group		Older individuals			
							Educational level		Sex	
			Y	O	Y	O	High	Low	Males	Females
I	II	III	IV	V	VI	VII	VIII	IX	X	XI
Austria	AT	39,400	95	68	62	56	53	56	54	60
Belgium	BE	36,300	94	74	54	50	59	40	44	56
Bulgaria	BG	15,700	79	34	40	50	60	32	39	59
Croatia	HR	19,400	89	46	68	70	72	63	64	75
Cyprus	CY	27,600	95	55	69	72	76	59	70	75
Czechia	CZ	28,000	97	64	65	68	71	75	53	82
Denmark	DK	39,700	99	95	71	62	73	55	57	68
Estonia	EE	25,300	97	72	68	60	60	65	49	67
Finland	FI	34,400	99	86	78	65	78	53	58	71
France	FR	32,100	94	74	52	52	62	43	48	56
Germany	DE	37,800	98	80	74	68	70	65	62	75
Greece	GR	21,100	86	40	65	73	85	53	70	75
Hungary	HU	21,900	90	45	74	81	84	67	76	84
Iceland	IS	40,400	100	97	67	54	66	39	49	59
Ireland	IE	58,600	94	55	61	49	54	40	45	53
Italy	IT	29,700	84	51	50	48	57	40	44	52
Latvia	LV	21,300	94	61	46	46	52	30	35	53
Lithuania	LT	24,800	90	54	71	72	76	76	68	74
Luxembourg	LU	80,900	99	89	57	55	68	41	49	63
Malta	MT	30,400	93	53	73	70	76	63	67	74
Montenegro	ME	14,800	88	33	62	62	-	-	65	56
Netherlands	NL	39,900	97	90	80	71	81	61	69	73
North Macedonia	MK	11,500	85	76	47	51	68	31	45	57
Norway	NO	46,900	99	93	73	57	62	61	51	63
Poland	PL	21,800	90	46	64	67	73	53	59	74
Portugal	PT	23,800	88	43	63	51	62	44	48	54
Romania	RO	20,100	82	39	46	56	71	47	50	62
Serbia	RS	12,200	89	40	57	52	62	32	47	58
Slovakia	SK	22,600	92	50	63	65	71	59	60	68
Slovenia	SI	26,900	91	53	63	60	68	55	52	68

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Table 1. Continued

Country name	Country code	GDP per capita	Percentage of Internet users[a], %		Percentage of Internet users[a] who used the Internet for HIS, %					
					Age group		Older individuals			
							Educational level		Sex	
			Y	O	Y	O	High	Low	Males	Females
Spain	ES	28,100	95	64	68	57	68	45	54	60
Sweden	SE	37,300	94	88	71	60	66	46	50	68
Switzerland	CH	48,100	97[a]	85[a]	70[a]	64[a]	69[a]	52[a]	76[a]	67[a]
Turkey	TK	19,700	79	31	71	54	77	41	55	54
United Kingdom	GB	32,500	98	86	66	50	61	38	45	55
EU-28 mean value		30,900	93	67	63	59	66	47	53	64

Internet users, individuals who used the Internet in the last 3 months prior to the survey conducted by Eurostat; GDP per capita: purchasing power parity adjusted gross domestic product per capita; O, older individuals (aged between 55-74); Y, younger individuals (aged between 25-54); EU-28, 28 members of the European Union in 2018.
[a]Values from 2017.

sis was applied. The chosen method is the agglomerative hierarchical single linkage method, which combines objects into clusters based on the minimum dissimilarity between them (Timm, 2002, p. 533). The Euclidian distance was defined as a proximity (dissimilarity) measure. The dissimilarity matrix was calculated based on five variables: percentage of older Internet users engaging in online HIS in general and depending on their educational level (higher or lower) and sex (male or female) (Table 1, columns VII-XI). As the results of cluster analysis need to undergo validation (Timm, 2002, p. 533) to ensure that data points are not randomly assigned to clusters, multidimensional scaling (MDS) was additionally employed. Therefore, the same proximity matrix was passed to the PROXSCAL module of the SPSS Software. In line with Borg et al. (2018, pp. 77-78), the initial configuration was changed to Torgerson's metric model with 1,000 iterations and a 0.0000001 stress value. Furthermore, visualization resulting from MDS can help to analyze and interpret the data in the proximity matrix (Borg et al., 2018, p. 11).

4. RESULTS

4.1. Country-Specific Inequalities in Internet Use of Older People in Europe (RQ1)

The analysis of data on Internet use in Europe (Table 1, columns IV-V) demonstrated that the second-level digital divides are present for older European population. First, the shares of older people who used the Internet varied greatly between countries, from 31% in Turkey and 33% in Montenegro to 95% in Denmark and 97% in Iceland (Fig. 2; *RQ1a*). Second, the shares of older Internet users differed from the shares of younger Internet users within the countries (*RQ1b*).

In the North and West European regions, older people were the most active in using the Internet. In Southeast countries, on the contrary, less than 50% of older people used the Internet. At the same time, the shares of younger Internet users were high in all countries (79% and above) and differed from country to country less significantly. Consequently, the in-country gaps between the two age groups were the greatest in the Southeast region (up to 55 percentage points [pp] in Montenegro and 49 pp in Serbia), whereas the differences in North countries were the lowest (e.g., three pp in Iceland and four pp in Denmark). This shows that digital inequalities between the two age groups in terms of Internet use can be tackled.

4.2. Country-Specific Inequalities in Online HIS behavior of Older Internet Users in Europe (RQ2)

The analysis of data on Internet use for HIS by older Internet users (Table 1, columns VI-XI) revealed great differences in the European region, with values below the EU-28 mean value of 59% in almost half of the analyzed countries (i.e., 17 out of 35). In Latvia, Italy, and Ireland, the Internet was used for HIS by less than 50% of older Internet users, whereas in the Netherlands, Lithuania, Cyprus, Greece, and Hungary it was used by more than 70%.

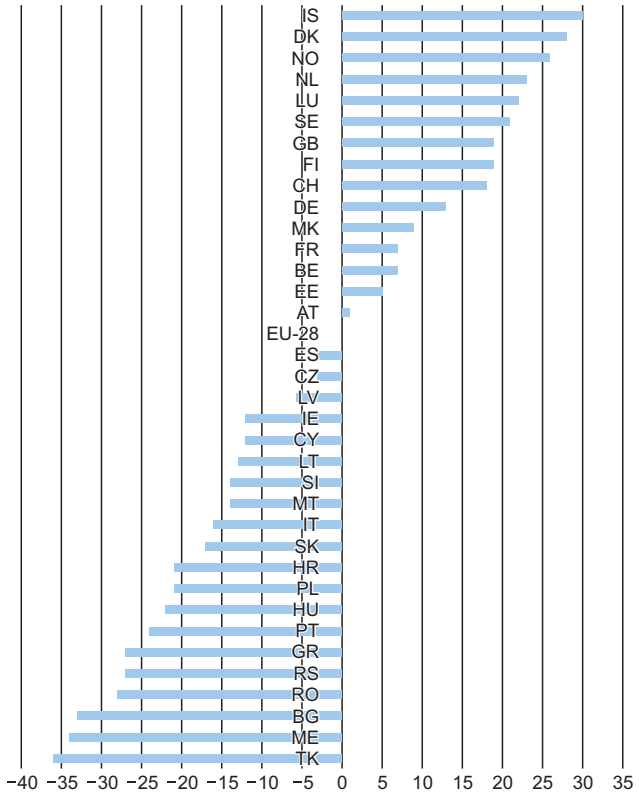


Fig. 2. Percentage of older Internet users in 2018. Deviation from the EU-28 mean value of 67%. EU-28, 28 members of the European Union in 2018. Refer to Table 1 for the country codes.

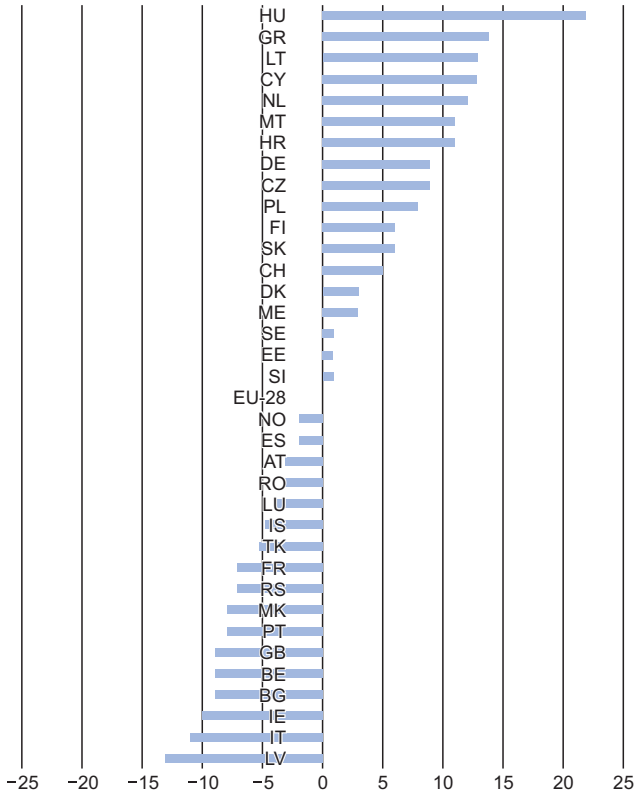


Fig. 3. Percentage of older Internet users engaging in online health information seeking in 2018. Deviation from the EU-28 mean value of 59%. EU-28, 28 members of the European Union in 2018. Refer to Table 1 for the country codes.

Further results on how Internet use for HIS varied among older Internet users (*RQ2a*) are presented in Fig. 3.

To answer *RQ2b*, a correlation of two variables was computed, i.e., between a) the shares of older people who generally used the Internet and b) the shares of older Internet users engaging in online HIS. The analysis resulted in no association ($r_s(33)$=-0.041; effect size according to Cohen (1992); Table 2), showing that the parameters do not affect or depend on each other. For instance, the shares of older Internet users were high in Iceland (97%) and the United Kingdom (86%), but those users engaged in online HIS rather inactively (54% and 50%, accordingly). Contrariwise, the shares of older Internet users can be low, but those users can actively use the Internet for HIS (e.g., older population in Hungary [45% and 81%], Greece [40% and 73%], and Croatia [46% and 70%]). At the same time, both shares can be high as in the Netherlands (90% and 71%), or low – as in Bulgaria (34% and 50%). Interestingly, the correlation between the named variables in relation to the younger generations resulted in a significant moderate (positive) correlation, showing that once younger people are online, they are likely to seek health information on the Internet.

Also, the correlation analysis between countries' wealth and the shares of older online health information seekers resulted in no linear relationship $r_s(33)$=-0.027 (effect size according to Cohen (1992); Table 2; *RQ2c*), meaning that there were both wealthy and rather poor countries where the Internet was actively or inactively used for HIS by older Internet users, e.g., Netherlands (GDP=39,900 and Internet use for HIS=71%), Ireland (GDP=58,600 and Internet use for HIS=49%), Croatia (GDP=19,400 and Internet use for HIS=70%), and Serbia (GDP=12,200 and Internet use for HIS=52%). It is noteworthy that the correlation between countries' wealth and the shares of younger health information seekers was positive and significant, although moderate $r_s(33)$=+0.349, p=0.05 (Table 2).

Focusing on the differences between younger and older Internet users engaging in online HIS (*RQ2d*), one can note that although older individuals seem to have more issues with their health, the shares of younger people using the Internet for HIS were higher than or

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Table 2. Correlations between Internet use, Internet use for health information seeking (HIS), and gross domestic product (GDP) in European countries (N=35; year: 2018)

Correlated variables	Spearman rank correlation	Effect size[a)]
Internet use (older users), % - Internet use for HIS (older users), %	-0.041	No association
Internet use (younger users), % - Internet use for HIS (younger users), %	+0.449*[b)]	Medium association
GDP per capita - Internet use for HIS (older users), %	-0.027	No association
GDP per capita - Internet use for HIS (younger users), %	+0.349**[c)]	Medium association
GDP per capita - Internet use (older users), %	+0.792*[b)]	High association
GDP per capita - Internet use (younger users), %	+0.803*[b)]	High association

[a)]According to Cohen (1992); *[b)]Correlation is significant at the level of 0.01; **[c)]Correlation is significant at the level of 0.05.

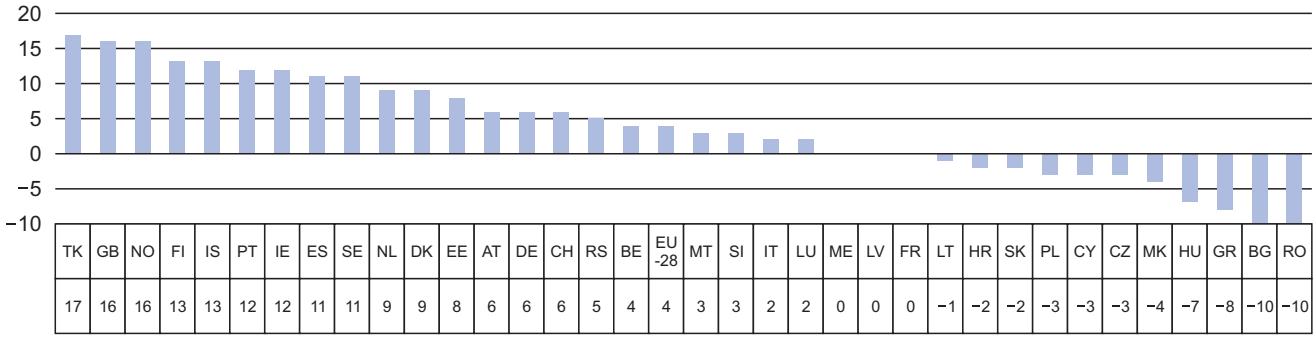


Fig. 4. Differences between younger and older Internet users engaging in online health information seeking within their respective countries (in percentage points). EU-28, 28 members of the European Union in 2018. Refer to Table 1 for the country codes.

equal to the shares of older Internet users engaging in HIS in almost two-thirds of the countries (Fig. 4). However, older individuals in eleven out of 35 analyzed countries sought health information on the Internet more actively than their younger counterparts, i.e., in Romania (-10 pp), Bulgaria (-10 pp), Greece (-8 pp), Hungary (-7 pp), North Macedonia (-4 pp), Czech Republic (-3 pp), Cyprus (-3 pp), Poland (-3 pp), Slovakia (-3 pp), Croatia (-2 pp), and Lithuania (-1 pp). Notably, most of these countries belong to the Central and Southeast regions.

Further analysis of the data on Internet use for HIS by older Internet users with high and low formal educational levels demonstrated in-country inequalities in most countries (Fig. 5; *RQ2e*). The Internet was used for HIS by more than 50% of older Internet users with high education in all the countries. At the same time, less than 50% of older Internet users with low education used the Internet for HIS in 16 out of 34 countries. Consequently, great differences, from nine to 37 pp, were observed between older individuals with low and high educational levels in more than two-thirds of the analyzed countries. However, there were countries where both groups of older individuals were equally or almost equally active, such as Norway (shares with high education=62% vs. low education=61%), Germany (70% vs. 65%), and Lithuania (76% vs. 76%). Moreover, the shares of older Internet users engaging in online HIS with high education were slightly lower than those with low education in Austria (53% vs. 56%), the Czech Republic (71% vs. 75%), and Estonia (60% vs. 65%).

Furthermore, relatively large differences were revealed among older online health information seekers depending on sex (Fig. 6; *RQ2f*). Overall, males were relatively inactive Internet users in the matter of HIS with values starting from 35%. However, that did not refer to the older men in Hungary (76%), Switzerland (76%), Cyprus (70%), and Greece (70%). At the same time, the shares of older women exceeded 50% in all the countries and were higher than those of older men in all but three countries, including Switzerland (shares of older women=67% and men=76%), Montenegro (56% and 65%), and Turkey (54% and 55%).

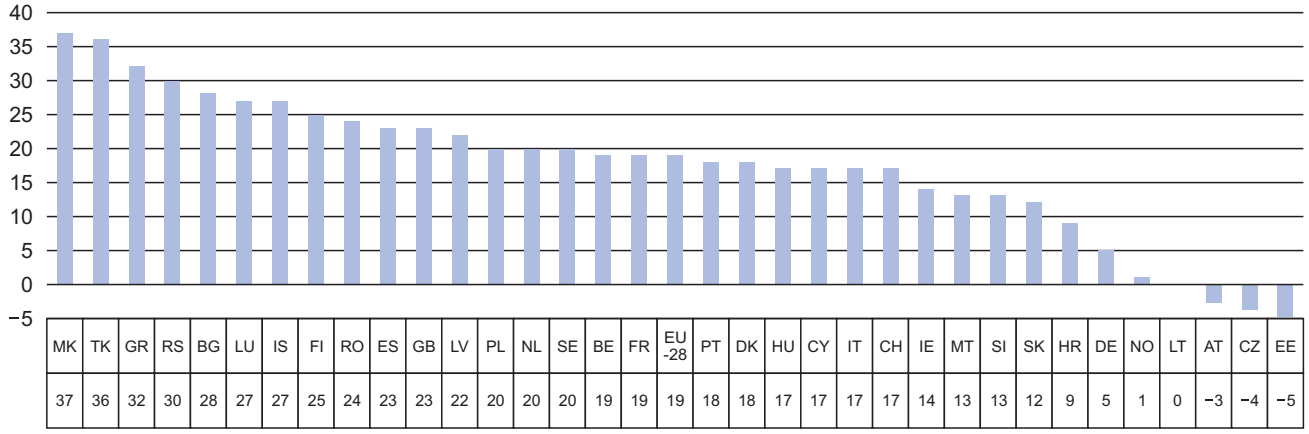


Fig. 5. Differences between older Internet users engaging in online health information seeking with high and low educational levels within their respective countries (in percentage points). EU-28, 28 members of the European Union in 2018. Refer to Table 1 for the country codes.

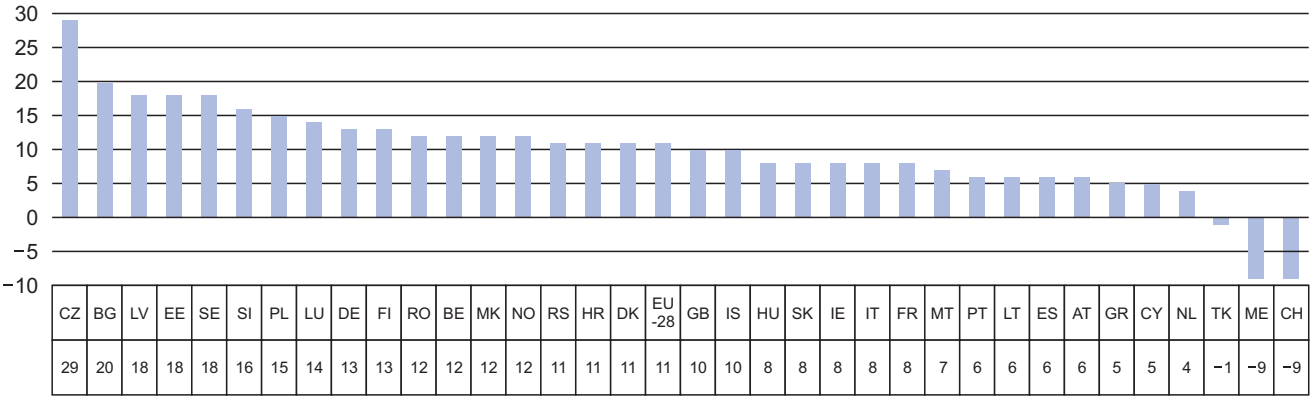


Fig. 6. Differences between older female and male Internet users engaging in online health information seeking within their respective countries (in percentage points). EU-28, 28 members of the European Union in 2018. Refer to Table 1 for the country codes.

To find out whether there are countries that exhibit similarities in Internet use for HIS by older Internet users (*RQ2g*), cluster analysis in combination with the MDS was conducted, revealing four main clusters of countries (Table 3, Fig. 7). The least active older individuals with shares starting from 31% can be found in Cluster A, the largest one. Older Internet users in countries of Clusters B and C can be characterized as moderately active in online HIS, with shares varying from 49% to 67% in Cluster B and 52-78% in Cluster C. Notably, the role of education is hardly evident in Cluster B in comparison to Cluster C. Older Internet users in countries of Cluster D engaged in online HIS most actively. In this cluster, the shares ranged from 53% for older people with low education to 85% for older individuals with high education. The dissimilarity values of the seven countries differed from their nearest neighbors to a great extent, and therefore those countries were not directly assigned to any cluster. Older Internet users in Latvia were found to be the least active in online HIS, whereas in Hungary they were the most active. The older population in Turkey can also be described as rather inactive in HIS and has its nearest neighbor in Cluster A; however, the shares of older individuals with high education (77%) and older men (55%) are higher than in other countries of Cluster A. Older individuals in Austria can be characterized as moderately active, standing between Cluster A and B. Similarly to Hungary, Lithuania had active older Internet users engaging in online HIS and stood out in that older Internet users with high and low education were equally moderately highly active (76% for both groups). Czechia could also be assigned to the most active countries, but older males there were among the least active in Europe (53%).

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Table 3. Clusters of countries exhibiting similarities in Internet use for health information seeking (HIS) of older Internet users identified by cluster analysis combined with multidimensional scaling

Cluster	Countries (country codes)	Shares of older Internet users engaging in online HIS, %				
		Generally	With high education	With low education	Males	Females
A	SE, RO, ES, LU, IS, PT, FR, GB, BE, IT, IE, RS, MK, BG	48-60	54-71	31-47	39-54	52-68
B	EE, NO	57-60	60-62	61-65	49-51	63-67
C	PL, SK, FI, DK, SI	60-67	68-78	53-59	52-60	68-74
D	DE, HR, MT, CY, NL, GR	68-73	70-85	(53) 59-65[a)]	62-70	73-75
Outliers						
Nearest cluster	Outlier	Nearest neighbor	Generally	With high education	With low education	Males	Females
A	LV	BG	46	52	30	35	53
A	TK	ES	54	77	41	55	54
B	AT	NO	56	53	56	54	60
D	CH	CY	64	69	52	76	67
D	CZ	DE	68	71	75	53	82
D	LT	MT	72	76	76	68	74
D	HU	NL	81	84	67	76	84

Refer to Table 1 for the country codes.
[a)]For one country (i.e., Greece) the value compises 53%; the values for the rest of the countries range between 59% and 65%.

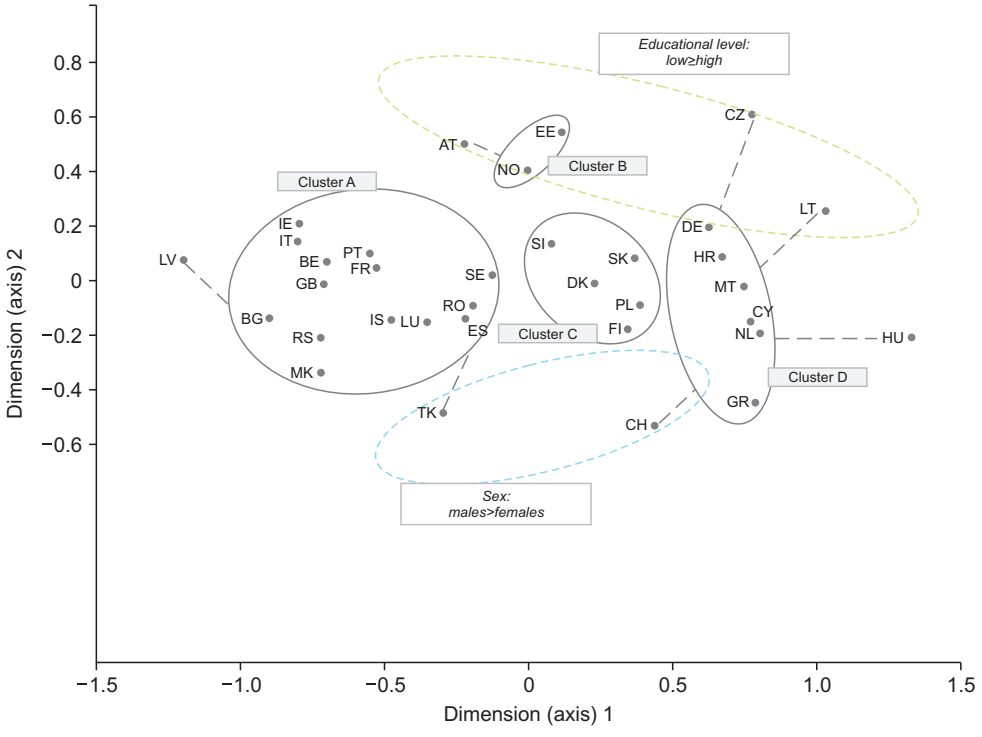


Fig. 7. Results of cluster analysis combined with multidimensional scaling. 34 countries classified into four clusters including seven outliers. Countries with the least active older Internet users engaging in online health information seeking are on the left side, and the most active are on the right side. Refer to Table 1 for the country codes.

5. DISCUSSION

In this study, Internet use by older individuals in 35 European countries was analyzed to determine whether digital inequalities (i.e., the second-level digital divides) are present in the older population. The findings show that although the average percentage of the European population using the Internet is high, digital inequalities between countries persist. This becomes especially the fact when comparing the shares of older Internet users in North and Southeast European countries. König et al. (2018) also reported such division of countries, which can be explained by countries' wealth, because the richer a country, the higher the level of Internet use. This is applicable to both older and younger generations.

The existence of country-specific digital inequalities was further confirmed by the analysis of online HIS behavior of older Internet users. The findings demonstrated that generally gaps exist between European countries, but, unlike the findings on general Internet use, it turned out that countries' wealth does not correlate with online HIS as there are both wealthy and rather poor countries where older Internet users actively or rather inactively engage in online HIS. Previous results on the positive influence of countries' wealth on online HIS reported by Liobikienė and Bernatonienė (2018) are thus extended. On the macro-level, it was also only partially confirmed that previous Internet use by older population contributes to the active engagement in online HIS (Medlock et al., 2015), as countries were found where the shares of older Internet users were high, but those users did not tend to actively use the Internet for HIS (e.g., Iceland, United Kingdom).

A comparison of older and younger Internet users engaging in online HIS additionally confirmed the presence of digital inequalities, not only between countries but also within them. Whereas younger adults are traditionally considered to be more active Internet users and this conforms to most countries also in matters of online HIS, in this study a group of countries (viz., Bulgaria, Romania, Greece, Hungary) can be observed where older Internet users engage in online HIS more actively than younger people. Remarkably, all those countries have a relatively low percentage of older Internet users (45% or less), which could serve as an explanation for the high rates of online HIS. As people with higher education generally tend to be online (van Deurson & van Dijk, 2014), this category of people probably forms the majority of older Internet users in those countries. With that, higher education is treated as a positive predictor of higher levels of health information literacy (Eriksson-Backa et al., 2012), which results in higher rates of online HIS, as people with better health knowledge are more interested in using the Internet as a source of health information (Estacio et al., 2019).

Directed by the aims of this study, the role of education and sex in online HIS behavior of older Internet users was examined. Along with the age factor, the results on the role of education and sex were also slightly mixed. Generally, higher education positively influences online HIS, which was previously confirmed by Eriksson-Backa et al. (2012) and by Bujnowska-Fedak and Mastalerz-Migas (2015). The overall importance of high education can be explained by its parallel association with better Internet skills (van Deursen & van Dijk, 2010) and with higher levels of information literacy (Eriksson-Backa et al., 2012; Estacio et al., 2019). Thus, older adults who already use the Internet efficiently will be probably more capable of using it for HIS. In addition to this, older individuals who have better knowledge and understanding of health issues perceive the Internet and online information as more useful and are generally more likely to start using the Internet for HIS (Eriksson-Backa et al., 2012; Estacio et al., 2019). However, the role of education was not proved in Austria, the Czech Republic, Estonia, and Lithuania, where older Internet users with low and high educational levels are equally interested in online HIS.

Concerning the sex differences among older Internet users, although older men are generally more active in using the Internet (Friemel, 2016), this study showed that older women are more active in online HIS. This can be interpreted by previous findings that older women are less critical of health information on the Internet (Erikson-Backa et al., 2012). In addition to this, generally, women consider the Internet to be a more efficient method for HIS and evaluate online information as more useful. Also, the Internet is viewed by women as an "efficient method of searching (easy, quick, always available, capable of enhancing search success)" (Bidmon & Terlutter, 2015). Furthermore, women may seek health information not only for themselves but also for other family members due to their well-established social role as family caregivers (Bidmon & Terlutter, 2015; Nölke et al., 2015). Not less important is the fact that women are generally more health-conscious, which may also lead to higher use of online information (Erikson-Backa et al., 2012; Nölke et al., 2015). However, sex differences in online HIS among older adults were not observed in Montenegro, Switzerland, and Turkey.

The cluster analysis and MDS reaffirmed the existence of inequalities in online HIS in Europe, revealing four

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main clusters of countries exhibiting similar online HIS behavior: from least active through moderately active to the most active. Seven countries demonstrated unique online HIS behavior. Most countries were assigned to the least active group, showing that the Internet as a source of health information should be better promoted among the older European population. With regard to the older Internet users most active in online HIS, which were found to reside in Hungary, one should take into account that although older Internet users in Hungary are active in online HIS, the majority of the population is still excluded from the benefits of online HIS, as the percentage of older Internet users there is low.

Several limitations should be considered when interpreting the results of this study. Although previous research emphasizes the role of socio-demographic factors as determinants of digital divides, HIS behavior, and online HIS behavior, the phenomenon is more nuanced. Psychological factors (such as character traits, personal trust in online information, self-efficacy, and internal locus of control), as well as previous life experience, family context, and access to social and institutional support systems (e.g., availability of health care services and their costs), should be considered for a deeper understanding of older people's online HIS behavior (Eriksson-Backa et al., 2018; Longo, 2005; Quan-Haase et al., 2016; Schreurs et al., 2017). This further relates to another particularity of the research on online HIS by older adults – the heterogeneity of the group. Older population should not be viewed as a homogenous group of "laggards," but rather one should distinguish between different types of Internet and online health information users (Quan-Haase et al., 2018). The importance of an individual or group-specific approach is additionally supported by studies criticizing techno-optimism (Cid et al., 2020) and should not be ignored by health service providers, health organizations, governments, libraries, and other institutional bodies promoting and implementing online HIS behavior and health information literacy. Another factor which appears to naturally influence online HIS behavior, but was not analyzed in this study, is individuals' health status. Previous studies reported mixed results (Bujnowska-Fedak & Mastalerz-Migas, 2015; Eriksson-Backa et al., 2012; Liobikienė & Bernatonienė, 2018), but they referred to a small number of countries and only partially to older individuals. Therefore, an additional study on the macro-level could give a better overview of how online HIS behavior depends on health status.

6. CONCLUSIONS AND FUTURE RESEARCH

This study provides an overview on the problem of digital inequalities in the European region, focusing on Internet use for HIS and older population. The analysis of data on 35 countries proved that the older population persists in being partially excluded from Internet use in most of the analyzed countries. Moreover, once older individuals start using the Internet, it does not guarantee that they will use it to fulfill their health information needs. Older Internet users are principally in a disadvantaged position in terms of online HIS in comparison to their younger counterparts. Also within the older population itself, unequal use of the Internet for HIS can be observed depending on the educational level and sex. The study suggests that more efforts are required to make Internet use for HIS more attractive for older adults and especially for older adults with low educational levels, as well as for older men. There is a practical implication of the results for health and social care knowledge services, libraries, and national health institutions: Older people's awareness of online health information and their health information literacy should be strengthened to optimize their health behavior and to minimize digital divides. Furthermore, this study indicates that attention should be paid to regional differences, as the shares of older Internet users in the South and Southeast European countries remain low and, consequently, the older population in this region is automatically excluded from the benefits of the Internet, including access to online health information. Additionally, the global COVID-19 pandemic declared in 2020 (Cucinotta & Vanelli, 2020) can only reinforce the importance of online HIS among older populations. The use of the Internet for HIS during and after the pandemic should be further investigated.

Although this study shows results on general trends in Internet use and for HIS in particular, some exceptions were found, some of which contradict previous research. The role of education was not proved in Lithuania, Austria, the Czech Republic, and Estonia, and the role of sex was not demonstrated in Montenegro, Switzerland, and Turkey. Therefore, studies on countries' levels are needed to explain exceptional cases. Furthermore, countries with a high level of Internet diffusion among the older population but low rates of Internet use for HIS (viz., Iceland, Luxembourg, United Kingdom, Belgium, France, and Sweden) represent an additional point of interest. In times of medical personal deficiency, it should be understood why older people, who are already online, do not actively

use the Internet for HIS when it can provide useful information about preventative health care as well as particular illnesses and diseases. At the same time, as the health information found on the Internet can affect individuals' decisions not only positively but also negatively, future research could control how the older population uses obtained information. This becomes important in countries with high shares of older Internet users engaging in online HIS (i.e., Hungary, Greece, Lithuania, Netherlands, Germany) but even more important in countries where older people with low educational levels are active in online HIS (viz., Lithuania, Czech Republic, Hungary, Germany) as lower educational levels are associated with lower levels of health information literacy.

What are the main findings of our study? There are inequalities in online HIS depending on age: Older Internet users are less active in seeking online information, although they experience more health-related problems. Once an older person is online, it does not guarantee that the person will use the Internet for HIS. Older Internet users in almost half of the analyzed countries are rather inactive in online HIS; however, there are country-specific differences concerning sex and education. Since the shares of older Internet users in Southeast European countries remain low, the older population in these countries is almost excluded from online HIS. Health and social care knowledge services, libraries, and national health institutions are called upon to strengthen older people's health information literacy. Due to the low levels of Internet use for HIS among older individuals in Southeast European countries, these countries should be given special attention in future research. Further research is also needed on those countries with high shares of older Internet users but low proportions of online health information seekers, as well as on the countries in which older people with lower education levels are actively involved in online HIS.

CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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Meta-Analysis of Associations Between Classic Metric and Altmetric Indicators of Selected LIS Articles

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ABSTRACT

Altmetrics or alternative metrics gauge the digital attention received by scientific outputs from the web, which is treated as a supplement to traditional citation metrics. In this study, we performed a meta-analysis of correlations between classic citation metrics and altmetrics indicators of library and information science (LIS) articles. We followed the systematic review method to select the articles and Erasmus Rotterdam Institute of Management Guidelines for reporting the meta-analysis results. To select the articles, keyword searches were conducted on Google Scholar, Scopus, and ResearchGate during the last week of November 2021. Eleven articles were assessed, and eight were subjected to meta-analysis following the inclusion and exclusion criteria. The findings reported negative and positive associations between citations and altmetric indicators among the selected articles, with varying correlation coefficient values from -.189 to 0.93. The result of the meta-analysis reported a pooled correlation coefficient of 0.47 (95% confidence interval, 0.339 to 0.586) for the articles. Sub-group analysis based on the citation source revealed that articles indexed on the Web of Science showed a higher pooled correlation coefficient (0.41) than articles indexed in Google Scholar (0.30). The study concluded that the pooled correlation between citation metrics with altmetric indicators was positive, ranging from low to moderate. The result of the study gives more insights to the scientometrics community to propose and use altmetric indicators as a proxy for traditional citation indicators for quick research impact evaluation of LIS articles.

Keywords: traditional metrics, citation metrics, altmetrics, citations, altmetric indicators, pooled correlation

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1. INTRODUCTION

Altmetrics or article-level metrics are alternative indicators that measure the social impact of scholarly outputs by gauging online discussion on research outputs from different platforms, chiefly social media, reference managers, news & policy documents, social bookmarking, and mainstream traditional media outlets (Ali, 2021; Daraio, 2021). Although altmetrics is a new concept, the investigation into altmetrics is escalating wildly compared to traditional citation metrics (Kwok, 2013). As a result, the debate on whether newly emerged social media metrics will replace traditional metrics for measuring impact is still going on. Many of the studies ratified that altmetrics can be used as a supplement for showing instantaneous societal impact along with scientific impact because of the positive association between these two metrics (Costas et al., 2015; Haustein et al., 2014b; Schlögl et al., 2014; Zhang et al., 2019; Zuccala et al., 2015). On the other hand, a handful of studies opposed this proposal, citing a negative and weak correlation (Chi et al., 2019; Gumpenberger et al., 2016; Haustein et al., 2014a; Thelwall et al., 2013). Since the magnitude of association between these metrics varies from weak to strong from domain to domain, it is unsure to conclude whether altmetrics can replace traditional metrics or can only be a complement due to positive correlation, or if it cannot replace or cannot complement due to negative correlation (Barnes, 2015; Thelwall, 2021). On account of all these issues, controversy still exists among the scientometric community across the globe and disciplines. The best solution is to pool the entirety of associations (both positive and negative) and vindicate the final pooled correlation coefficient (PCOR) by conducting a meta-analysis. Meta-analysis is usually employed to assess quantitative information from interconnected studies and generate results that encapsulate a whole body of research (Riley et al., 2011).

Studies assessing the pooled correlation between citation metrics and altmetrics have rarely been found in the scholarly world. Kolahi et al. (2021) reported a positive weak pooled correlation between citations and altmetric attention scores (AAS) (r=0.19; 95% confidence interval [CI], 0.12 to 0.25) when 27 health science-related studies were subjected to meta-analysis. In another comprehensive meta-synthesis, Bornmann (2015) reported the magnitude of the pooled correlation between citations and three social media indicators as negligible (microblogging, r=0.003), small (blog count, r=0.12), and medium to large (CiteULike, r=0.23 and Mendeley, r=0.51) after assessing a handful of studies that happened in prime disciplines. Other systematic reviews conducted by Patthi et al. (2017) and Araujo et al. (2021), by exploring outputs from various disciplines, primarily medical and health science, discovered a positive association between these two metrics.

As far as the library and information science (LIS) domain is concerned, a few studies were found narrating the association between traditional metrics and social media metrics under the article category of 'review / systematic reviews' (Borah & Madhusudhan, 2022; Sugimoto et al., 2017; Tahamtan & Bornmann, 2020). However, the longstanding debate of whether the new generation metrics replace or complement the old citation metrics has been extended to the LIS domain too, and no attempt with a meta-analysis approach has been undertaken hitherto to contribute to this debate. Thus, the present study bridges this gap by pooling the correlation reported in LIS outputs between citation metrics and social media indicators. The value of the pooled correlation decides whether they are positively or negatively correlated, and also at what magnitude for the outputs would contribute to the current dispute in general and LIS discipline in specific.

1.1. Objectives of the Study

The primary objective of this study is:

- To conduct a meta-analysis of the association between citations and altmetric indicators of the selected LIS research articles

The study has a secondary objective as follows:

- To conduct a meta-analysis of the association between citations and altmetric indicators of the selected LIS articles based on the source of citations

2. METHODS

2.1. Formatting the Review Question and Outcome

The review question is framed to determine the PCOR between classic metric and altmetric indicators of the LIS articles that satisfies the eligibility criteria.

2.2. Search Strategy

Mainly Google Scholar, Scopus, and ResearchGate databases were searched for articles collected during the last week of November 2021. The keywords included 'Altmetrics of LIS articles,' 'Altmetrics of library and information science articles,' and 'Correlation between citations and altmetric indicators of LIS articles,' which were carried out as free searches in Google Scholar and ResearchGate, and in 'Search within' fields as 'article title, abstracts, keywords'

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in the Scopus database.

2.3. Eligibility, Inclusion, and Exclusion Criteria

The LIS articles were selected following the systematic review guidelines (Sensuse et al., 2021). Later, documents were identified and screened through Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines (Fig. 1). Only peer-reviewed articles published in the English language were considered. Other research outputs like review articles, letters, and articles in press and conference papers were excluded since these research outputs did not have enough altmetrics for the analysis. Also, studies did not take place at large in the LIS domain. Furthermore, those articles which inquire about the association between classic metric indicators and social media metric indicators were considered. For conducting the meta-analysis, articles that attempted to correlate traditional citation indicators, majorly 'citations' (journal impact factor [Art. no. 4] and impact points [Art. no. 3] in the absence of citations) with social media indicators, primarily 'altmetric attention scores (AAS)' (Mendeley metrics [Art. no. 1], Twitter mentions [Art. no. 2], ResearchGate score (RG score) [Art. no. 3], and social media indicators [Art. no. 5] in the absence of AAS) were considered. RG score has been treated as a significant source of altmetrics in this study after referring to previously published articles (Ahmad, 2019; Shrivastava & Mahajan, 2015). Studies with sub-studies (Art. nos. 7 & 8) and those not having identical/standalone traditional or social media indicators like 'citations' or 'altmetric attention score' (Art. no. 11) were excluded from the meta-analysis. Contrary to Article 11 (Art. no. 11), the first and second article (Art. nos. 1 & 2) have been taken for the meta-analysis after considering that the study tried to correlate Mendeley and Twitter metrics chiefly against classic indicators (See Table 1 for details). Articles having no keywords such as 'Altmetrics of LIS' or 'Correlation between citations and altmetric indicators of LIS' in the title were also included (Art. nos. 1, 2 & 4) after acknowledging that the article tried to correlate citation indicators with altmetric indicators (Mendeley or Twitter) predominantly.

2.4. Meta-Analysis

The meta-analysis was carried out by using two major

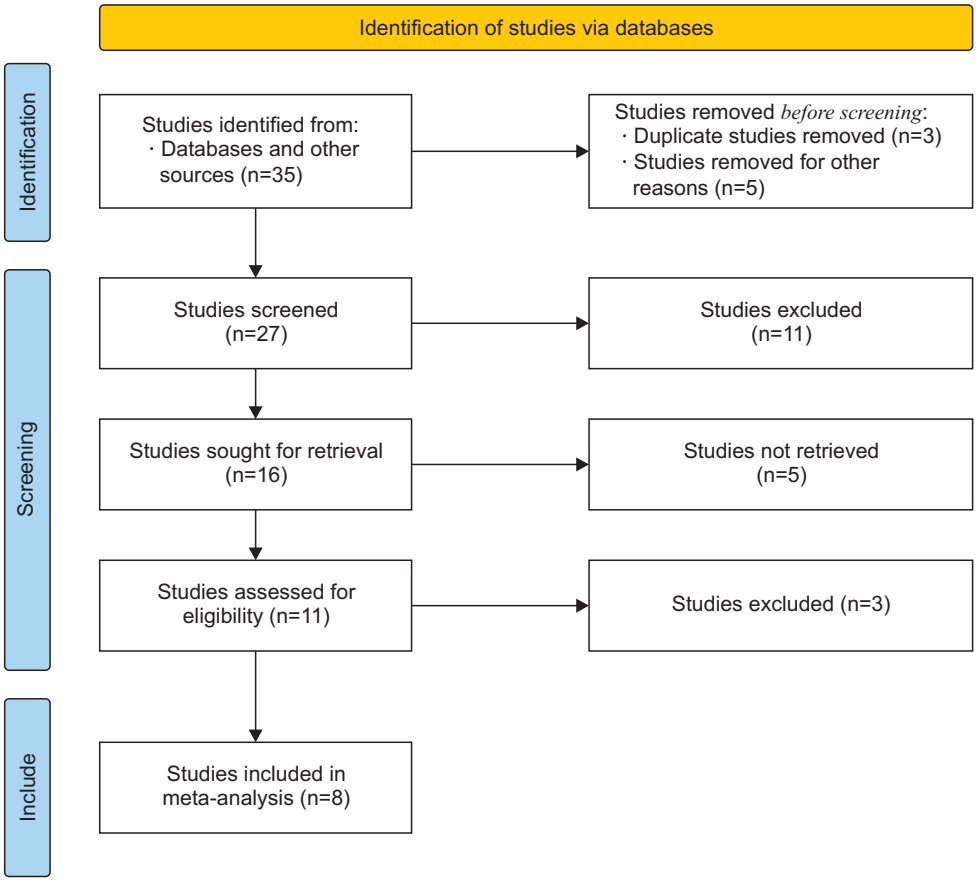


Fig. 1. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) flow diagram.

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Table 1. Characteristics/details of the articles selected for the study (including excluded studies)

Article/ studies no.	Authors and year of publication	Title	Journal	Source of citations	Methods followed	Correlation conducted between	Correlation value	Findings	Meta-analysis conducted between
1	Mohammadi and Thelwall (2014)	Mendeley readership altmetrics for the social sciences and humanities: Research evaluation and knowledge flows	Journal of the Association for Information Science and Technology	WoS	Samples- 2,552 LIS articles indexed in 2008. Correlation- Spearman	Citations with Mendeley metrics	rho=.369	Positive correlation	Citations with Mendeley metrics
2	Zhao and Wolfram (2015)	Assessing the popularity of the top-tier journals in the LIS field on Twitter	Proceedings of the Association for Information Science and Technology	WoS	Samples- 30 Top tier LIS journals as per JCR ranks published in 2013. Correlation- Spearman	Twitter mentions with i. Total cites ii. Impact factor iii. 5-year impact factor iv. Immediacy index v. Articles vi. Cited half-life vii. Eigen factor score viii. Article influence score	i. rho=.169 ii. rho=.074 iii. rho=-.010 iv. rho=.202 v. rho=.178 vi. rho=-.189 vii. rho=.364 viii. rho=.043	Positive and negative correlations	Total cites with Twitter mentions
3	Ali and Richardson (2017)	Pakistani LIS scholars' altmetrics in ResearchGate	Program: Electronic Library and Information Systems	RG	Samples- 78 RG profiles through purposive sampling. Correlation- Spearman	Impact points with RG score	rho=.903	Positive correlation	Impact points with RG score
4	Htoo and Na (2017)	Disciplinary differences in altmetric for social sciences	Online Information Review	WoS	Samples-19,580 articles published from 2008 to 2013. Correlation- Pearson	Journal impact factor with i. AAS i. Mendeley ii. Twitter iii. CiteULike iv. Facebook v. Blogs vi. News vii. Google+ viii. Reddit ix. F1000 x. Pinners	i. r=0.49 ii. r=0.58 iii. r=0.08 iv. r=0.37 v. r=0.09 vi. r=0.20 vii. r=0.09 viii. r=0.20 ix. r=0.25 x. -	Positive correlation	Journal impact factor with AAS

Table 1. Continued

Article/ studies no.	Authors and year of publication	Title	Journal	Source of citations	Methods followed	Correlation conducted between	Correlation value	Findings	Meta-analysis conducted between
5	Saberi and Ekhtiyari (2019)	Usage, captures, mentions, social media and citations of LIS highly cited papers: an altmetrics study	Performance Measurement and Metrics	GS	Samples- 10 LIS classic papers in 2006. Correlation- Spearman	Citations with i. Usage metrics ii. Capture metrics iii. Mentions metrics iv. Social media metrics v. Citations metrics	i. rho=.450 ii. rho=.683 iii. rho=.366 iv. rho=.162 v. rho=.950	Positive correlation	Citations with social media metrics
6	Ezema and Ugwu (2019)	Correlating research impact of library and information science journals using citation counts and altmetrics attention	Information Discovery and Delivery	WoS GS Scopus	Samples- 18 LIS journals with high altmetric attention. Correlation- Pearson	Citations from WoS, GS and Scopus with AAS	r=.444 r=.531 r=.733	Positive correlation	Citations with AAS
7	Verma and Madhusudhan (2019a)	Altmetric analysis of highly cited publications on digital library in Brazil and India: a comparative study	Library Philosophy and Practice	WoS	Samples- 10 articles on Digital Library Published from India and Brazil. Correlation- Spearman	Citations with AAS i. Brazil ii. India	i. rho=-0.2 ii. rho=-0.11	Negative correlation	Excluded
8	Verma and Madhusudhan (2019b)	An altmetric comparison of highly cited digital library publications of India and China	Annals of Library and Information Studies	WoS	Samples- Top 10 highly cited articles on 'digital library' from India and China. Correlation- Spearman	Citations with AAS i. India ii. China	i. rho=-0.11 ii. rho=0	Negative correlation and no correlation	Excluded

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Table 1. Continued

Article/ studies no.	Authors and year of publication	Title	Journal	Source of citations	Methods followed	Correlation conducted between	Correlation value	Findings	Meta-analysis conducted between
9	Vysakh and Rajendra Babu (2021)	Altmetrics linked scholarly information from Dimensions.ai datasets for the top 100 LIS articles	SRELS Journal of Information Management	Dimensions	Samples- 100 highly cited LIS articles. Correlation- Spearman	Citations with AAS	rho=0.19	Positive correlation	Citations with AAS
10	Rangaswamy and Rajendra Babu (2021)	A correlation comparative analysis of top articles in library and information science using citation and altmetric attention scores	SRELS Journal of Information Management	GS	Samples- 100 top cited articles from top 10 LIS journals. Correlation- Spearman	Citation with AAS	rho=-.106	Negative correlation	Citation with AAS
11	Cho (2021)	Altmetrics analysis of highly cited academic papers in the field of Library and information science	Scientometrics	WoS	Samples-Highly cited 1,000 articles in the LIS sub-domain. Correlation- Pearson	Citations with i. Usage view ii. Capture readers iii. Blog mention iv. Reference mention v. Social media tweet	i. r=.03 ii. r=.29 iii. r=-.00 iv. r=.01 v. r=-.04	Positive and negative correlations	Excluded

LIS, library and information science; WoS, Web of Science; RG, ResearchGate; GS, Google Scholar; JCR, Journal Citation Reports; AAS, altmetric attention score.

software packages, viz. MedCalc 20.015 (trial version) and Meta-Mar, a free online meta-analysis service accessible at https://www.meta-mar.com. The minimum number of samples for carrying out a meta-analysis is two (Israel & Richter, 2011; Ryan, 2016), and in Meta-Mar it was four, and the correlation coefficient ranged from zero to one (Meta-Mar, 2021). The effect sizes were computed by using Fisher's transformation of correlations. The formula to transform r to a z-score is z'=.5[ln(1+r)–ln(1-r)] (Statistics How To, 2022). Data were analyzed using the random effects model (REM) since the study involved considerable heterogeneity (I^2>75%, p<0.05). The value of heterogeneity varies from 0 to 100% and can be treated as 25% low heterogeneity, 50% medium heterogeneity, and 75% high/considerable heterogeneity (Higgins et al., 2003).

2.5. Characteristics of the Included Studies

The result according to Table 1 shows that out of eleven studies, five studies (Cho, 2021; Ezema & Ugwu, 2019; Htoo & Na, 2017; Saberi & Ekhtiyari, 2019; Zhao & Wolfram, 2015) had sub-studies by correlating citations with other altmetric indicators. As opposed to these studies, Mohammadi and Thelwall (2014), Ali and Richardson (2017), Vysakh and Rajendra Babu (2021), and Rangaswamy and Rajendra Babu (2021) examined the correlation between two prime indicators, i.e., citations and AASs. Furthermore, the studies were based on citations from different databases, majorly Web of Science and Google Scholar, and the total sample size accounted for 22,468. The studies reported negative and positive associations once citation indicators correlated against different altmetric indicators. Two correlation methods, i.e., Spearman and Pearson, were recognized and the correlation value ranged from -.189 to 0.93.

3. RESULTS

Following the guidelines given by Erasmus Rotterdam Institute of Management for interpreting meta-analysis results (Hak et al., 2022), firstly we present a forest plot for all the articles with pooled correlation and heterogeneity; secondly, forest plots for subgroup analysis based on the source of citations, and finally, a funnel plot for exhibiting the publication bias among the articles selected for the analysis.

3.1. Meta-Analysis for All the Included Articles

Meta-analysis was carried out between the classic metric indicators and social media metric indicators of the eight eligible LIS articles. Fig. 2 shows the forest plot for the meta-analysis. The X-axis shows the correlation coefficient values of each study. The Y-axis shows the corresponding study's lead author and year of publication. The size of the boxes in blue colour shows the number of samples, and a larger size represents a higher sample size. The blue diamonds represent the investigated articles' total fixed and random effects. In the meta-analysis, the fixed-effect model assumes the underlying effect is the same across all studies, and the REM assumes heterogeneous effects across studies (Mantel & Haenszel, 1959; DerSimonian & Laird, 1986). The aggregate samples from all eight studies were 22,468. Except for one article, i.e., Rangaswamy and Rajendra Babu (2021), all other remaining studies reported a positive correlation. The highest positive correlation was observed for the fifth and third studies, i.e., Saberi and Ekhtiyari (2019) (rho=0.95) and Ali and Richardson (2017) (rho=0.90) (Appendix 1).

3.2. Pooled Correlation and Heterogeneity

As per Table 2, the PCOR was 0.47 (95% CI, 0.339 to

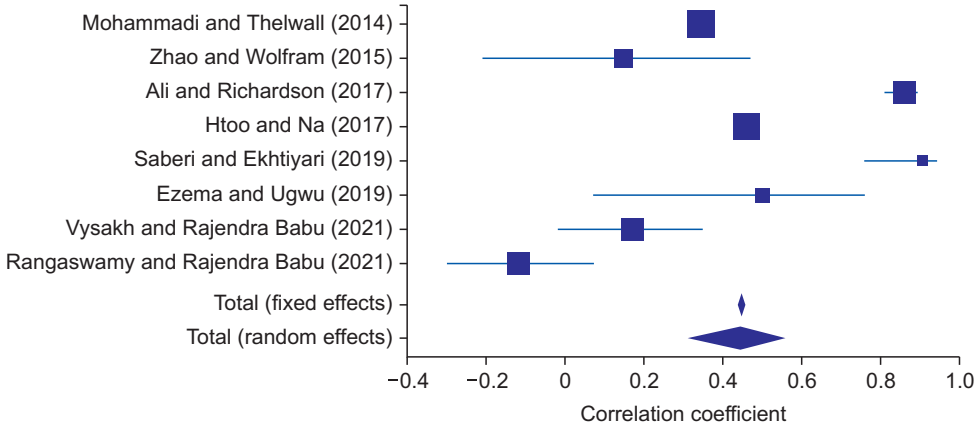


Fig. 2. Forest plot for the meta-analysis.

Table 2. Pooled correlation and heterogeneity

	n	Fisher Z	r	SE	95% CI	z sore	*p*-value	Heterogeneity
Random effect model	22,468	0.51	0.47	0.081	0.339, 0.586	6.308	0	I^2=96.2%, Tau^2=0.035

SE, standard error; CI, confidence interval.

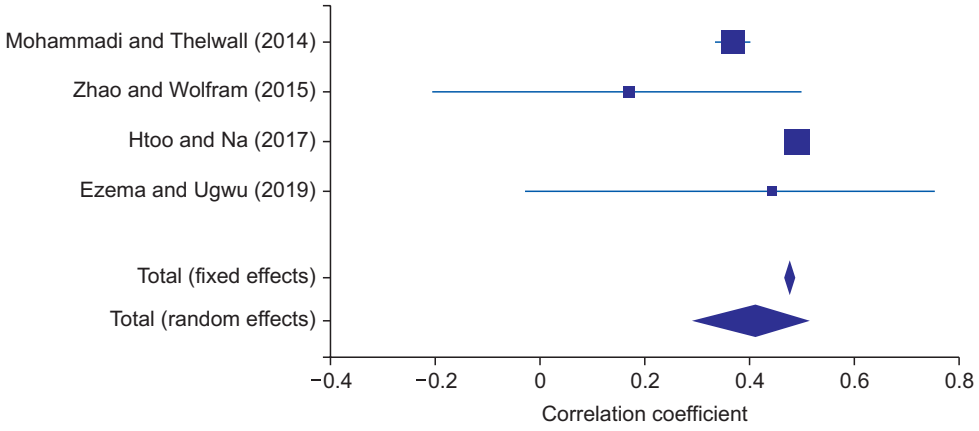


Fig. 3. Meta-analysis of articles from Web of Science.

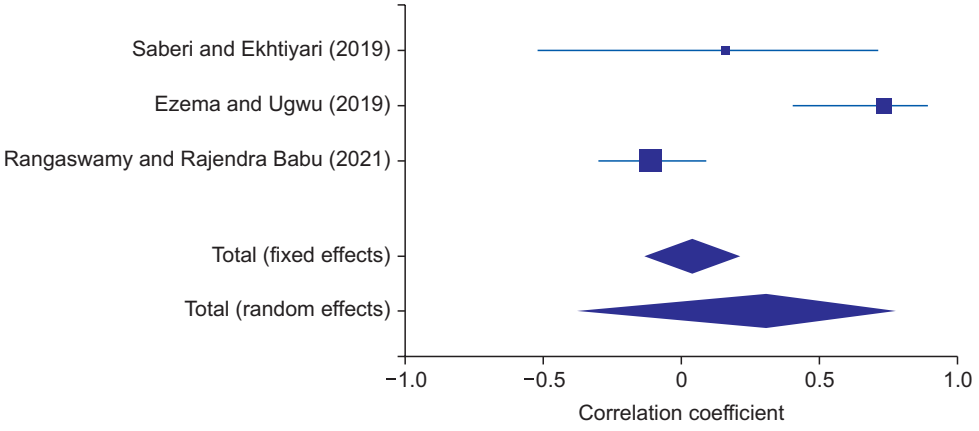


Fig. 4. Meta-analysis of articles from Google Scholar.

0.586) for the REM. The general heterogeneity was high for the articles (I^2=96.2%), representing the variability in the selected studies. If the heterogeneity is very high, the REM is nearly equal regardless of the number of samples reporting a meta-analytic summary close to the more easily calculated arithmetic mean of each study's results.

3.3. Sub-Group Analysis Based on the Source of Citations

Since the overall meta-analysis result showed considerable heterogeneity, sub-group analysis was carried out to know the correlation variation based on the source of citations. For this purpose, four articles whose source of citations is from Web of Science (Fig. 3) and three articles whose source of citations is from Google Scholar (Fig. 4) were subjected to the analysis, including articles having sub-studies (Ezema & Ugwu, 2019). The remaining two studies, i.e., Ali and Richardson (2017) and Vysakh and Rajendra Babu (2021) were not considered owing to the lack of number of studies to carry out meta-analysis based on the source of citations. The result showed that the PCOR for Web of Science articles was 0.41 (95% CI, 0.292 to 0.515), and for Google Scholar, it was 0.30 (95% CI, -0.373 to 0.771).

3.4. Publication Bias

Fig. 5 and Appendix 2 demonstrate the funnel plot and the result of Egger's test and Begg's test applied to deter-

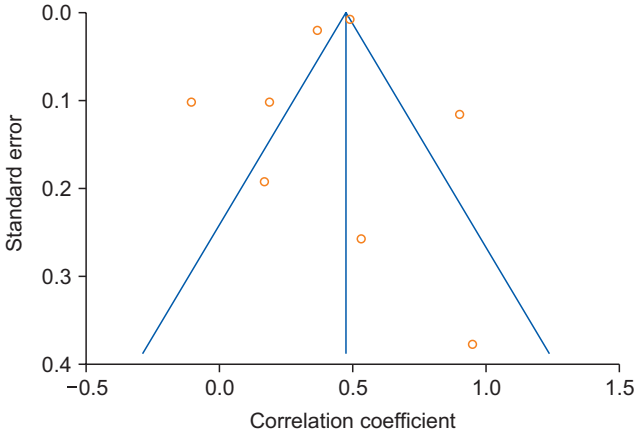


Fig. 5. Funnel plot for publication bias.

mine the publication bias in the articles selected for the study. The symmetry of the diagram shows that no publication bias existed, and Egger's (p-value=0.82) and Begg's test (p-value=0.25) confirmed the same since the p-value stood higher than 0.05 (p>0.05).

4. FINDINGS AND DISCUSSION

To our best knowledge, this is the first meta-analysis to quantify the pooled correlation between classic metric indicators and altmetric indicators of LIS research articles. We estimated the pooled correlation between citation metric indicators from five prime databases: Web of Science, Google Scholar, Scopus, Dimensions, and ResearchGate (as a source of altmetrics also), with the altmetric indicators of selected eight articles published between 2014 and 2021. The articles qualified for meta-analysis exhibited positive and negative correlations between citation indicators with various altmetric indicators and had considerable heterogeneity (I^2=96.2%). As a result, we followed the REM for the analysis. Israel and Richter (2011) opined that "there are no accepted guidelines for when a meta-analysis should not be completed due to statistical heterogeneity, and it is left to the author's discretion to determine if a meta-analysis is appropriate." The result of the REM exhibited a PCOR of 0.47 (95% CI, 0.339 to 0.586) between citation indicators with altmetric indicators, which are treated as a medium correlation (Cohen, 1988).

When we carried out the sub-group analysis based on the source of citations, we discovered that articles indexed on the Web of Science showed a higher PCOR (0.41) than articles indexed in Google Scholar (0.30). The possible reason for this could be that the articles indexed in the Web of Science subjected to analysis include higher samples than those indexed in Google Scholar. In addition, the negative correlation of one article (Art. no. 10) estimated at -.106 as per the Spearman correlation indexed on Google Scholar could also be a possible reason.

We also inspected the publication bias among the articles through funnel plot and Eggers and Begg's test. The reason for conducting the Eggers test was that if the study involved considerable heterogeneity and the number of articles was less than ten, the visual inspection of the funnel plot would not be enough to interpret the publication bias. Therefore, the Eggers test will be preferred (Simmonds, 2015). The result of the tests discovered zero publication bias since Egger's test for a regression intercept reported a p-value of 0.82, and Begg's test for rank correlation demonstrated a p-value of 0.25.

5. CONCLUSION

Studies galore have investigated the association between traditional metrics and altmetrics to decide the novelty of the newly emerged social media metrics to use as a replacement or supplement to measure the immediate and broad impact of research. The association between these metrics varied from positive to negative (weak to strong) from domain to domain. As per our study findings, the PCOR shows a low (sub-group analysis) to a medium association (for all the articles, Fig. 2) for LIS articles. Thus it can be concluded that for LIS articles, the AAS and other significant indicators, i.e., Mendeley and Twitter, show similar characteristics to traditional citation metric indicators. Thus it can be used as a proxy for measuring the immediate invisible impact of LIS research articles.

The present study has some limitations. First, the study is limited to conducting meta-analysis between citation indicators with a few altmetric indicators, as explained in the 'eligibility, inclusion and exclusion criteria' section. Out of the eleven studies, three were omitted from subjecting to overall meta-analysis even though two studies tried to correlate citation with altmetric score but have had sub-studies (Verma & Madhusudhan, 2019a, 2019b). Contrary to this, studies having sub-studies were also considered for sub-group analysis based on the source of citations. Another possibility for sub-group analysis by considering sampling methods has not been explored. Future studies can observe how the correlation between citation and altmetric indicators varies over time.

Furthermore, a comprehensive meta-synthesis should be conducted between classic and social metric indicators

to understand the existing friction better. Similar meta-analyses or syntheses can be conducted in other domains to understand whether altmetrics exhibits the same feature as classic metrics. If so, the potential of the newly emerged social media metrics in the quick social impact evaluation of research in that particular domain can be substantiated.

CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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APPENDICES

Appendix 1. Result of meta-analysis

Article no.	Correlation (r)	Samples (n)	Standard error	r_lower	r_upper	Fisher z	Weight(%) _fixed	Weight(%) _random
1	0.36	2,552	0.019	0.330	0.407	0.387	11.357	18.731
2	0.16	30	0.192	-0.208	0.546	0.170	0.120	9.186
3	0.90	78	0.115	0.676	1.129	1.488	0.334	13.703
4	0.49	19,580	0.007	0.475	0.504	0.536	87.225	18.914
5	0.95	10	0.377	0.209	1.690	1.831	0.031	3.717
6	0.53	18	0.258	0.024	1.037	0.591	0.066	6.506
9	0.19	100	0.101	-0.009	0.389	0.192	0.432	14.620
10	-0.10	100	0.101	-0.305	0.093	-0.106	0.432	14.620

Appendix 2. Egger's and Begg's test for publication bias

Egger's test	
Intercept	-0.54
95% CI	-6.2328 to 5.1353
Significance level	p=0.82
Begg's test	
Kendall's Tau	0.32
Significance level	p=0.25

CI, confidence interval.

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Information Dissemination During the COVID-19 Pandemic in Bangladesh

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ABSTRACT

The main aim of this study is to identify the role of information dissemination on urban and rural citizens of Bangladesh during the COVID-19 pandemic and the role of misinformation in this process. The study also aimed at finding appropriate counter misinformation strategies regarding COVID-19. An online questionnaire was prepared to collect the viewpoints of the urban and rural citizens of Bangladesh regarding dissemination of information during COVID-19, misinformation regarding COVID-19, and counter misinformation strategies. Along with demographic and general information, a five-point Likert scale was used to measure COVID-19 related misinformation beliefs and how to counter them. Chi square tests were used to determine the association between current residency, information sources, the importance of information dissemination, reactions after getting COVID related information, and evaluative steps after getting information and before disseminating it. Additionally, nonparametric Mann–Whitney U and Kruskal–Wallis tests were conducted to know the significance of difference in respondents' assessment on COVID-19 related misinformation in terms of their demographic characteristics. Cronbach's alpha score was obtained to see the reliability of the questionnaire items. The current study reveals that both urban and rural citizens of Bangladesh are influenced by information dissemination regarding COVID-19 and they have lower level of misinformation belief. The respondents have differences in misinformation belief by different demographic groups. Respondents' educational status, information literacy, sources of getting information, and evaluative steps after getting information have significant differences in misinformation belief. The study also noticed the support of respondents for countering misinformation strategies regarding COVID-19.

Keywords: information dissemination, misinformation, counter misinformation strategies, COVID-19, Bangladesh

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1. INTRODUCTION

Information dissemination is a complex phenomenon. It is necessary to address what information is before going deeper into the topic of information dissemination. Simply, information may be defined as a fact or circumstance of which one is told (Madden, 2000). But information is not confined to a specific notion. Attempting to learn more about "information" immediately runs into obstacles. Since information is concerned with getting informed, with the decrease of ignorance and uncertainty, it is paradoxical that the term "information" is itself ambiguous and can be employed in a variety of ways in different contexts (Buckland, 1991). According to *Merriam-Webster dictionary* (n.d.), information can be defined as knowledge that one gets about someone or something: facts or details about a subject. *Cambridge Dictionary* (n.d.) defines information as facts or details about a person, company, product, etc. The *Oxford Learner's Dictionaries* (n.d.) considers information as facts or details about somebody/something. According to *Collins Dictionary* (n.d.), information consists of the facts and figures that are stored and used by a computer program. Braman (1989) noted that single-definition and pluralistic approaches to define 'information' are difficult. All decision-making concerns can be addressed through a hierarchy of four categories of definitions that expand in scope and complexity of the social structure to which they are applied, as well as the degree of authority granted information. Information can be classified as a resource, a commodity, a pattern perceiver, and a constitutive force in society.

Dissemination is the method of spreading information, messages, thoughts, and so on. The act of disseminating, sharing, or broadcasting information is known as information dissemination. Furthermore, it refers to the act of distributing and disseminating information of various types to those who require it or to those who are deserving of such information (IGI Global, n.d.).

In December 2019 the Novel Coronavirus was initially detected in Wuhan, which is located in China, and subsequently announced as SARS-CoV-2 (World Health Organization, 2020a). The virus spread across the world within about three months, triggering a global public health emergency. COVID-19, an acute respiratory disease caused by the novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), was declared a pandemic by the World Health Organization on 11 March 2020 (World Health organization, 2020b). On 8 March 2020, Bangladesh found 3 confirmed patients who were affected by Coronavirus, which was an indication of the arrival of COVID-19 in the country (Hasan & Shaon, 2020). Approximately half a billion affected patients got into the report worldwide, and this deadly virus has caused the death of over 6 million lives as of July 2022 (Worldometer, 2022).

de Bruin et al. (2020) noted that governments across the earth introduced various risk reduction measures to minimize the outbreak of coronavirus, such as social distancing, mobility restrictions, socioeconomic restrictions, and hygiene measures. However, the global economic situation and healthcare system were badly affected by the initiatives taken. They have also had a significant impact on people's social, physical, and psychological health (Dinleyici et al., 2021; Wang et al., 2020).

The spread of COVID-19 has influenced the dissemination of information. A dramatic rise of misinformation surrounding it has also been seen in this COVID-19 pandemic. During this pandemic, there has been unprecedented collaboration among researchers in the medical sector. However, such progress has been accompanied by a deluge of misinformation. Such misinformation poses a serious threat to public health. Treating misinformation has become a great part of scientific inquiry (Agley, 2020; Oliver & Wood, 2014).

Misinformation and conspiracy theories are common phenomena in crises situations. Various conspiratorial thoughts normally spread during social crises. At such moments, endorsement of misinformation and conspiratorial thinking is very common. In the US, many people believe in conspiracy theories while affirming the uncertainty of the possibilities of such theories (van Prooijen & Acker, 2015). This same phenomenon can also be noticed in the case of COVID-19 conspiracy theories (Miller, 2020). A study conducted by Brennen et al. (2020) indicated fact-checkers revealed that a significant proportion of misinformation is generated on social networking platforms. The widespread presence of misinformation reminds us that believing in misinformation is not only caused by delusions or discrete pathologies. Belief in misinformation and conspiratorial theories are varied across various socio-demographic groups (Agely, 2020). Education level and status play a significant role in shaping conspiratorial beliefs of people (Douglas et al., 2019; Freeman & Bentall, 2017; Galliford & Furnham, 2017). Political ideology plays a pivotal role in making people believe in misinformation. The role of misinformation in politics was widely noticed during the 2016 US presidential election (Guess et al., 2020). Belief in conspiracies positively correlates with rejection of science (Lewandowsky et al.,

2013; Lobato & Zimmerman, 2019; van der Linden, 2015). Interestingly, misinformation about COVID-19 is sometimes disseminated through confusing interpretations of preliminary empirical studies. Yet it should be kept in mind that those who share misinformation may not have the intent to harm others. People might have various motivations to share a particular piece of misinformation via social media. They can share misinformation to encourage discussion on social media and to ensure the validity of that particular misinformation (Lobato et al., 2020).

This study has made an attempt to investigate the role of information dissemination on general citizens, including both urban and rural people in Bangladesh during the COVID-19 pandemic, and the role of misinformation in this process. It has also tried to navigate the workability of counter misinformation strategies.

2. LITERATURE REVIEW

2.1. Information Needs During Crises

A crisis is considered to occur when people of a society, an institution, a city, or a country experience a sudden threat to fundamental values or activities based on leading lives. Therefore, the situation might deal with uncertainty (Rosenthal et al., 2001). A variety of threats may arise from a crisis. The crisis may be both man-made and natural: for example, SARS, MERS, tsunamis, and cyclones, which are considered to be natural crises. On the other hand, the missile crisis in Cuba, Chernobyl, and 9/11 are known as man-made crises.

In the time of pandemics like the H1N1 virus in 2009, bioterrorism threats, or natural calamities, most people want to know information on how the threats behave and how to react in these crisis moments. Over the last two decades, people's interest in the necessity of the reliability of sources of information about how to minimize the effects of such risks have increased, especially in the case of the emergence of Anthrax attack, West Nile virus, and the outbreak of SARS in the early 2000s. Diseases like *Escherichia coli* and *Salmonella* also increased the intention to get the right sources of information during a crisis (Zach, 2011).

The output obtained from the cases of communication regarding health risks reflects the fact that people search for solid, appropriate, and competent information that may be taken to protect themselves and their families (Wray et al., 2008).

2.2. Information Dissemination During the COVID-19 Pandemic

Information dissemination is defined as the distribution of information to intended users while meeting specific conditions such as timeliness, dependability, and so on. Information dissemination can be accomplished in a variety of ways (Wu et al., 2016). Although in a simple sense, information dissemination is regarded as the exchange of information, in a comprehensive sense it is not just a one-way activity. There has to be a sender to deliver the message and a recipient to decide how the rest of the exchange should proceed. These involved people exchange thoughts, facts, opinions, perceptions, and ideologies (Ifukor, 2013).

During the COVID-19 pandemic, disseminating information has been the most significant aspect of the twenty-first century. There has never been a time when the requirement for rapid information dissemination was more essential than it is during the COVID-19 outbreak. Social media is a legitimate and fast communication tool that is utilized for the dissemination and gathering of information specially related to health (Kudchadkar & Carroll, 2020).

People from urban and rural areas can barely access authentic information and materials. They often receive and disseminate information via various platforms (e.g., social media), in which the circulated information can be unreliable. Since librarians and information workers have access to credible sources of information, they should disseminate that information as far as possible. They must reach user groups and satisfy their desire for the most up-to-date information that is relevant to them (Okike, 2020).

In the time of global public health crises like the pandemic, dissemination of reliable and authentic information plays a significant role regarding strategies to control the outbreak. Timely and proper information of the pandemic can help to take precautionary steps and other measures for responding in that critical situation, which may in turn contribute to the betterment of health outcomes (Voeten et al., 2009). It has been observed that appropriate dissemination of information to the general public can help to minimize reactions generated by a negative mentality (Hall et al., 2003).

It has been reported that the selection of information sources can shape people's knowledge, which in turn influences health beliefs and preventative steps. Studies have found that choice of information sources and way of disseminating information may vary due to people's place of living (e.g., urban and rural), educational qualifications, and ethnicity (Ifukor, 2013; Voeten et al., 2009).

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Awa (1998) and Fayose and Dike (2002) stated that the attendance of family members during various familial programs helps to disseminate information in the rural community. Oral literature is composed of three major categories: discussion, music, and drama. All of these transfer information that are essential to a society's welfare.

Different social gatherings are an essential part of rural people's lives. Yazidu (1975) highlighted social gatherings, traditional meetings like wedding ceremonies, celebrating birthday functions and burial arrangements, and agricultural festivals as means for disseminating information interpersonally. Likewise, Aboyade (1987) stated that announcers using loudspeaker instruments, gatherings of rural people, churches, and mosques are a medium of acquiring and disseminating information among rural people.

The advancement of infrastructure and technology has enhanced urban people to avail Internet facilities. People from urban areas seek more information, including about health, on the Internet than do people living in rural areas (Flynn et al., 2006; Licciardone, 2001). Use of the Internet may be useful for people to make important decisions including about health care through linking people to local and broader social networking sites to avail information and suggestions if it is used properly (Boase et al., 2006). Researchers state that there is some interlinked connectivity so that distinct usage of the Internet can influence social welfare. For instance, people can search for information regarding health to help others to take significant health-care decisions; improve accessibility to and acquirement of health-care resources, including information exchange with healthcare personnel and the ability to participate in support groups; buy medical and health-related resources online; and enhance interaction with their social networks, both near and far away in geographical location (Boase et al., 2006; Cotten, 2001).

2.3. Misinformation and COVID-19

Misinformation occurs when individuals firmly adopt false beliefs, differentiating between illiteracy (or lack of knowledge) and confident but faulty knowledge (Kuklinski et al., 2000). More than a pandemic has occurred since the introduction of the novel coronavirus (COVID-19). The virus is generating a variety of other problems as it spreads over the world. One of these concerns is a storm of misinformation (Krause et al., 2020). Along with the COVID-19 pandemic, there has been seen a parallel 'infodemic' or fake news, with bizarre ideas spreading across the globe via social media platforms such as Twitter, Facebook, TikTok, and WhatsApp. Even leading politicians also claimed that the virus was nothing but a hoax. Others suggested that if it was not, there was nothing to worry about because even pushing hot hairdryer air up one's nose might destroy it. Gun-toting mobs have formed in the western United States to turn back fanciful busloads of 'Antifa' gangs that persist mostly on their Twitter feeds (Buchanan, 2020).

It can be noticed that several types of misinformation are being circulated through social media platforms during this pandemic. Some of the most common ones are summarized in the following:

- A tropical climate creates hindrance in spreading COVID-19 (Harvey, 2020)
- Wearing facemasks are not effective against coronavirus (Hornik et al., 2021)
- Coronavirus was formed in a laboratory (Guevara et al., 2021)
- Consumption of alcoholic substances can cure coronavirus (World Health Organization Eastern Mediterranean Regional Office, n.d.)
- Bill Gates played a role in the spreading of COVID-19 (Huddleston, 2021)
- 5G towers play an impact in the spreading of coronavirus (Goodman & Carmichael, 2020)

When research demonstrates that lies are now spreading quicker than truths it is threatening to notice that human psychology is severely flawed (Vosoughi et al., 2018). Experts, however, feel that the true problem is a series of subtle practices that, by altering human interactions and the way they make decisions, have transformed social media into a source of misinformation (Buchanan, 2020).

According to Chakravorti (2020) and Taylor (2020), misleading information regarding the COVID-19 pandemic is fast spreading and often these misleading materials include references to ostensible remedies such as gargling with salty water, eating oregano, and even drinking bleach. Further spreading of misconceptions is aided by other sorts of incorrect information, such as pointing to "bat soup" eating as the source of the illness, or conspiracy theories, such as the virus being manufactured by the United States. Aguilera (2020) stated that these types of news not only support the development of racist ideas and actions but also jeopardize public health and the ability of governments to successfully execute prevention measures. In this outbreak of the coronavirus the spread of misinfor-

mation, fake news, and conspiracy theories has emerged as an additional concern. This is why the World Health Organization also considered this scenario as an 'infodemic' (The Lancet Infectious Disease, 2020). Many studies have found that the majority of COVID-19 YouTube videos that are watched contain misleading information (Nguyen & Catalan-Matamoros, 2020). Searches including "COVID-19" and "coronavirus" indicated around 27.5% of content on YouTube that was not authentic; on top of that such material was also viewed over 60 million times (Li et al., 2020). Therefore, the detection and eradication of various COVID-19 misinformation is required (West et al., 2020).

2.4. Social Media and COVID-19 Misinformation

Social media platforms are Internet-based apps that allow communities of users to produce, interact with, and share material with others. There are various platforms for different content categories, and each platform has its own set of features. Real-time communication among users is enabled by them, allowing users to actively participate in a public conversation. In contrast to traditional media, social media enables users to easily create and share content globally without the need for editorial oversight or approval (Puri et al., 2020). Even though social media has provided great tools for individuals to engage with one another, it has also played a significant role in the spread of false information that is potentially hazardous to public health (Wilson & Wiysonge, 2020).

In moments of crisis, social media may have both direct and indirect effects on the public (Austin et al., 2012). During times of crisis, people's use of social media increases (Princeton Survey Research Associates International for the Pew Internet & American Life Project, 2006), and in some cases they regard social media as more credible sources of information than traditional forms of media (Procopio & Procopio, 2007). COVID-19's quick spread and resulting global pandemic have recently become a subject of intensive social media discourse, with Twitter reporting a COVID-19-related post every 45 milliseconds; the hashtag #coronavirus quickly became the second most used in 2020 (Cinelli et al., 2020). Sadly, inaccurate and misleading information concerning COVID-19, and possibly harmful treatments, continues to spread via social media platforms (Brennen et al., 2020; Kouzy et al., 2020). Cinelli et al. (2020) investigated the "infodemic" in the initial phases of COVID-19, utilizing epidemic modeling to information dissemination on different social media platforms to measure basic reproduction numbers for the "transmissibility" of posts on each platform. Regardless of platform, there were no significant differences in the dissemination patterns of doubtful versus reliable information.

Various misinformation and conspiracy theories regarding the COVID-19 vaccine are also being spread throughout the world via social media, such as claims that the vaccine contains a microchip, the vaccine causes infertility, the vaccine changes DNA, and the vaccine controls human brains (Nuzhath et al., 2020). COVID-19-related health behavior is being negatively affected by the propagation of misinformation and conspiracy theories on social media platforms such as Facebook and Twitter (Tasnim et al., 2020). A significant portion of general people in Bangladesh are hesitant to take COVID-19 vaccines due to dissemination of such various misinformation and conspiracy theories (Mahmud et al., 2021).

Pennycook et al. (2020) noted that members of the general public spread inaccurate and misleading information about COVID-19 through social media because they fail to consider whether or not the content they were about to share is accurate before they do so. This phenomenon could be countered by reminding people to check their facts before they confirm their social media post, which would result in a more than twofold increase in participants' willingness to share the truth. Although spreading misinformation through social media is a phenomenon that is not recently observed, the emergence of COVID-19 related misinformation via social networking sites during this outbreak has created a sense of need for tackling the circumstance and deploying necessary steps.

2.5. Countering COVID-19 Misinformation

Alongside with the COVID-19 pandemic, people are also going through a condition called *infodemic*. Fake news, misinformation, and conspiracy theories have become commonplace in the age of social media, and their prevalence has increased significantly since the outbreak of the coronavirus. This scenario is particularly concerning because it undermines public confidence in healthcare organizations and initiatives (The Lancet Infectious Diseases, 2020). A number of individuals are propagating a wide range of misinformation through the Internet and social media by disseminating unscientific, false, or misleading statements or distributing false news, both intentionally and unintentionally. The broad dissemination of erroneous COVID-19-related misinformation has the potential to spread the disease rapidly (Mejova & Kalimeri, 2020; Shimizu, 2020; Thomas, 2020). Misconceptions

regarding COVID-19 may have negative effects on the fight against COVID-19 and control of the pandemic, as previous SARS and Ebola outbreaks were noticeable instances (Cheung, 2015; Maunder et al., 2003; Person et al., 2004).

In light of the fact that misleading information spreads quickly and extensively via a variety of channels, providing reliable information that expresses accurate scientific perspectives on COVID-19 is the most effective strategy for reducing fear and panic associated with misconceptions about scientific facts and epidemiology of the coronavirus (Garrett, 2020). Local community and health organizations, non-governmental organizations, the print and electronic media, and other support groups should make every effort to convey accurate information regarding COVID-19 to their constituents and the general public. In order to achieve this goal, collaboration at the local and global levels is necessary, as well as the integration of physical and digital resources via collaborative endeavors to ensure that authoritative information is disseminated throughout many media forms (Tasnim et al., 2020).

Technical corporations can be assigned, in collaboration with health institutes, for developing a centralized system for identifying YouTube, Facebook, and Twitter offenders. Advertisements, including video messages, should be intercepted and deleted from media sharing platforms that make fictitious and/or unrealistic (i.e., deceptive) medical claims in order to project COVID-19-related information for monetary advantage. These objectives can also be fulfilled through the application of modern technology, such as natural language processing or text mining, to detect online information that lacks empirical support. Data mining algorithms have been helpful in identifying distinguishing characteristics of fake news or misinformation that has been eliminated from various platforms (Shu et al., 2017).

Existing fact-checking structures should be integrated into new strategies to promote accurate COVID-19-related information on practical preventive measures (e.g., washing hands with soap frequently, using hand sanitizers, using facemask, receiving vaccines, and maintaining social distancing), which should be implemented immediately. Local authorities and media workers should engage with public health specialists, particularly those who are experts in infectious disease, in order to clearly deliver accurate and timely information to the public and reduce anxiety among the population (Mian & Khan, 2020). Another rigorous step might include charging those responsible for the creation and dissemination of COVID-19 misinformation or false news on online news portals and forcing them to appear in court in order to serve as a deterrence to other possible perpetrators of the crime. Notification of these issues should be made to the appropriate local and national governing bodies as well as law enforcement agencies so that the required procedures can be taken to carefully handle them in different regions (Ahinkorah et al., 2020). Dib et al. (2022) noted that digital health literacy, such as capability to search, access, and comprehend information related to health from online resources, is also necessary to counter misconceptions regarding COVID-19. Widespread literacy, which integrates both informative and scientific literacy, is essential to gain knowledge and the ability to use information efficiently in the pandemic situation (Gu & Feng, 2021).

Although identifying authentic information is a tough task, there is a check list which can be helpful to detect it. The check list according to the Pledgetopause (2021) has been outlined in the following:

- By whom it was made
- The origin of the information
- From which way it came
- The reason why you are going to disseminating this
- The date of its publication

Since the dissemination of misinformation regarding COVID-19 is being spread quickly, especially via Internet and social media, which ultimately has negative effects on the fight against this deadly disease and control of this pandemic, the necessity of countering this issue by taking essential steps and ensuring the proper dissemination of reliable information has increased.

There are a few reported studies regarding the role of information dissemination on ordinary citizens during the COVID-19 pandemic in the Asian sub-continent, but no reported study has been found in Bangladesh so far. Without these kinds of studies, government agencies are at a loss; hence, the current study has been conducted to explore the role of information dissemination on general citizens in this pandemic situation and how misinformation belief influences them.

3. RESEARCH AIM AND OBJECTIVES

The main aim of this study is to identify the role of information dissemination on general citizens, including both urban and rural citizens, of Bangladesh during the COVID-19 pandemic. This study also includes the follow-

ing objectives:

1. To know the sources of information related to COVID-19
2. To know the extent of misinformation related to COVID-19
3. To determine effective methods to counter COVID-19 related misinformation

Based on the objectives stated above, the current study combines the following research questions (RQs):

RQ1. What is the major source of getting COVID-19 related information?
RQ2. Is influence of information dissemination associated with respondents' current residency?
RQ3. What demographic characteristics are associated with belief in COVID-19 related misinformation?
RQ4. How do the ratings for COVID-19 misinformation differ depending on respondents' demographics?

4. HYPOTHESIS OF THE STUDY

The present study tests the following null hypothesis.

H01: There is no relationship between current residency and sources of getting information.
H02: There is no relationship between current residency and importance of information dissemination.
H03: There is no relationship between current residency and reaction after getting COVID related information.
H04: There is no relationship between current residency and evaluative steps after getting information and before disseminating it.

5. METHODOLOGY

To gather data for this study, an online survey was undertaken in Bangladesh from January 2022 to May 2022. To facilitate a larger involvement of residents from all backgrounds the survey was constructed in Google Forms using Bengali, as it is the native language of the country. A target group of around 700 people was chosen by the convenience sampling method and the survey link via emails and personal messages. The respondents were assumed to be active on social networking sites. The respondents had to be citizens of Bangladesh and they were at least able to comprehend and write as well as they have given their consent to participate in the survey.

The structure of the questionnaire contained three sections. The first section of the questionnaire included the respondents' demographic and general information, such as sex, age, educational qualifications, and place of living. The second section comprised COVID-19-related misinformation, taken from previous studies as well as social networking platforms. Participants of the study were asked to rate their level of agreement with such fraudulent information on a five-point Likert scale, from 1 – 'Strongly disagree' to 5 – 'Strongly agree.' In the third part, participants rated their opinions on strategies to be taken to combat misinformation on a 5-point Likert scale (Appendix).

Descriptive statistics were obtained to examine respondents' demographics and general information. Regarding the ratings on misinformation related to COVID-19 and the strategies to be undertaken, the data were also analyzed descriptively using frequencies and percentages, and by means and standard deviations. Cronbach's alpha score was obtained to see the reliability of the questionnaire items. Cronbach's alpha score was 0.872, which was in the range of 0.81-0.93 (See Table 1). This implies a high degree of internal consistency in the responses to the individual measures, as α values above 0.7 are acceptable indicators in this respect. Chi square tests were used to determine the association between current residency and sources of getting information, current residency and importance of information dissemination, current residency and reaction after getting COVID related information, current residency and evaluative steps after getting information, and before disseminating it. Moreover, nonparametric Mann–Whitney U tests and Kruskal–Wallis tests were applied to know the significance of difference in respondents' assessment on COVID-19 related misinformation in terms of their demographic characteristics. The statistical analysis was carried out using IBM SPSS Statistics version 25 (IBM Co., Armonk, NY, USA).

5.1. Reliability Statistics

The reliability of the questionnaire has been tested by using the SPSS program. Table 1 shows the reliability coefficient of the questionnaire. Cronbach's alpha score is 0.872,

Table 1. Reliability statistics

Cronbach's alpha	No. of items
0.872	24

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Table 2. Demographic profile of the respondents (N=406)

Demographic/personal characteristics	Frequency	%
Sex		
Male	281	69.2
Female	125	30.8
Age groups (yr)		
<18	7	1.7
18-30	278	68.5
31-40	63	15.5
41-50	26	6.4
51-60	15	3.7
>60	17	4.2
Highest academic qualification		
Primary	7	1.7
SSC/Equivalent	19	4.7
HSC/Equivalent	113	27.8
Graduation	180	44.3
Postgraduation	87	21.4
Current place of living		
Urban area (e.g., Metropolitan, City)	312	76.8
Rural area (e.g., Small town, Village)	94	23.2
Sources of getting information		
Social media	271	66.7
Print and electronic media	84	20.7
Friends/Family	17	4.2
Experts/Doctors	8	2.0
Government information portal (e.g., Bangladesh National Portal)	26	6.4
Reaction after getting COVID-19 related information		
Disseminate the information without checking the fact	14	3.4
Check the source of the information before dissemination	310	76.4
Ignore	82	20.2
Evaluative steps after getting information and before disseminating it		
Check quality of links/references provided	191	47.0
Check number of links/references provided	54	13.3
Check the length of the article	16	3.9
Check others' reactions/opinions	46	11.3

Table 2. Continued

Demographic/personal characteristics	Frequency	%
Check information about the author/poster	49	12.1
Check tone/style of writing/argument	42	10.3
Nothing	8	2.0
Importance of information dissemination		
To spread the information	109	26.8
To raise awareness among people	225	55.4
To become popular	4	1.0
To pass leisure time	46	11.3
Don't know	22	5.4

SSC, secondary school certificate; HSC, higher secondary certificate.

which can be called as reliable as the alpha value is greater than 0.05.

6. DATA ANALYSIS

6.1. Demographic Profile of Respondents

A total of 406 respondents participated in this study. Among them, 281 (69.2%) were male and 125 (30.8%) were female. A vast majority of the respondents (278, 68.5%) were between the ages of 18 and 30 years. The greater portion of respondents had bachelor's or similar degrees, followed by those who had higher secondary certificate (HSC) or equivalent degrees. In case of place of living, a vast majority of the participants belong to urban areas, whereas the number of respondents from rural areas was low. The largest group of participants considered social media as sources of getting information, followed by those who considered print and electronic media. All the demographic details of the participants are demonstrated in Table 2.

6.2. Misinformation and COVID-19

The result, illustrated in Table 3, revealed the frequency and percentage of COVID-19 related misinformation on a five-point Likert scale. The majority of respondents strongly disagreed with statements like "Drinking alcohol may prevent COVID-19" (176, 43.3%), "COVID-19 is a deception" (171, 42.1%), and "COVID-19 does not affect religious people" (167, 41.1%), respectively. A vast majority of the participants neither agreed nor disagreed with the misinformation, suggesting that they were uncertain about its reliability. Table 3 highlights that the highest mean score of 3.12 was gained for the statement "COVID-19 affects urban people more than rural," with a standard deviation of 1.36. Other items were negatively rated in term of mean score (<3.00). The mean scores for all the items indicated an overall negative rating that means low levels of misinformation belief, although the high SD values suggested that the participants had differences in their ratings for the statements among themselves as they showed wide variability in their responses.

The results of Mann–Whitney U test found no significant difference between respondents' residency and misinformation except for "Facemasks don't work" (Mann–Whitney U=17,178.500, p<0.05) and "COVID-19 does not spread in the hot and humid weather" (Mann–Whitney U=16,695, p<0.05). No significant difference was found between respondents' previous infection with COVID-19 and misinformation regarding COVID-19. No significant difference was noted between the deaths of family members of respondents due to COVID and misinformation related to COVID. There is no significant difference between respondents' vaccine uptake and COVID-19 misinformation except for "Facemasks don't work" (Mann–Whitney U=2,800.500, p<0.05), "5G towers may spread COVID-19" (Mann–Whitney U=2,171, p<0.05), "COVID-19 was created in the lab" (Mann–Whitney U=2,443.500, p<0.05), and "COVID-19 affects urban people more than rural" (Mann–Whitney U=2,869, p<0.05).

Mann–Whitney U testing found significant difference between respondents' sex and certain COVID-19 related

Table 3. Misinformation and COVID-19 on a five-point scale (N=406)

Misinformation about COVID-19 vaccine	Strongly disagree *Freq*. (%)	Disagree *Freq*. (%)	Neutral *Freq*. (%)	Agree *Freq*. (%)	Strongly agree *Freq*. (%)	Mean (SD)
Facemasks don't work	83 (20.4)	135 (33.3)	68 (16.7)	66 (16.3)	54 (13.3)	2.69 (1.323)
COVID-19 is a deception	171 (42.1)	109 (26.8)	77 (19.0)	15 (3.7)	34 (8.4)	2.09 (1.228)
5G towers may spread COVID-19	142 (35.0)	78 (19.2)	139 (34.2)	25 (6.2)	22 (5.4)	2.28 (1.163)
Bill Gates is behind COVID-19 pandemic	144 (35.5)	79 (19.5)	135 (33.3)	20 (4.9)	28 (6.9)	2.28 (1.195)
Drinking alcohol may prevent COVID-19	176 (43.3)	95 (23.4)	87 (21.4)	13 (3.2)	35 (8.6)	2.10 (1.243)
COVID-19 does not spread in the hot and humid weather	104 (25.6)	119 (29.3)	117 (28.8)	36 (8.9)	30 (7.4)	2.43 (1.175)
COVID-19 was created in the lab	59 (14.5)	69 (17.0)	183 (45.1)	58 (14.3)	37 (9.1)	2.86 (1.115)
COVID-19 does not affect religious people	163 (40.1)	104 (25.6)	88 (21.7)	19 (4.7)	32 (7.9)	2.15 (1.224)
COVID-19 Vaccine does not work	97 (23.9)	140 (34.5)	110 (27.1)	32 (7.9)	27 (6.7)	2.39 (1.129)
COVID-19 does not affect poor people	167 (41.1)	115 (28.3)	76 (18.7)	19 (4.7)	29 (7.1)	2.08 (1.194)
Thankuni leaves may prevent COVID-19	148 (36.5)	100 (24.6)	111 (27.3)	23 (5.7)	24 (5.9)	2.20 (1.166)
COVID-19 affects urban people more than rural	75 (18.5)	55 (13.5)	95 (23.4)	107 (26.4)	74 (18.2)	3.12 (1.362)

SD, standard deviation.

information such as "Facemasks don't work" (Mann–Whitney U=13,491.500, $p<0.05$), "COVID-19 is a deception" (Mann–Whitney U=14,071, $p<0.05$), "5G towers may spread COVID-19" (Mann–Whitney U=15,074, $p<0.05$), "COVID-19 does not affect religious people" (Mann–Whitney U=13,511, $p<0.05$), "COVID-19 vaccine does not work" (Mann–Whitney U=12,796, $p<0.05$), "COVID-19 does not affect poor people" (Mann–Whitney U=13,788, $p<0.05$), "Thankuni leaves may prevent COVID-19" (Mann–Whitney U=14,852, $p<0.05$), and "COVID-19 affects urban people more than rural" (Mann–Whitney U=1,308, $p<0.05$).

Kruskal–Wallis testing revealed no significant difference was noted between ages of the respondents and COVID-19 related misinformation. Significant difference was also not found among respondents' maintenance of COVID related guidelines and misinformation regarding COVID-19, except for "Vaccine doesn't work against COVID-19" ($p=0.018$). There is no significant difference among respondents' frequency of Internet or social media usage and misinformation regarding COVID-19 except for "Facemasks don't work" ($p=0.016$) and "Bill Gates is behind the COVID-19 pandemic" ($p=0.031$).

Significant difference was found among level of education and all misinformation except for "COVID-19 was created in a lab" ($p=0.86$). Significant difference was also noted among respondents' level of information literacy and COVID-19 related misinformation except for "COVID-19 was created in a lab" ($p=0.707$) and "COVID-19 affects urban people more than rural" ($p=0.655$). Significant difference was noted among respondents' sources of getting information and certain misinformation like "COVID-19 is a deception" ($p=0.09$), "Drinking alcohol may prevent COVID-19" ($p=0.014$), "COVID-19 does not affect poor people" ($p=0.044$), "Thankuni leaves may prevent COVID-19" ($p=0.028$), and "COVID-19 affects urban people more than rural" ($p=0.024$). Significant difference was noted among respondents' evaluative steps after getting information and certain COVID-19 related misinformation such as "Facemasks don't work" ($p=0.016$), "Vaccine doesn't work" ($p=0.031$), and "COVID-19 doesn't affect poor people" ($p=0.045$).

6.3. Strategies to Counter COVID-19 Related Misinformation

Data presented in Table 4 indicate that respondents have shown their support in the case of most of the strategies to counter COVID-19 related misinformation. They strongly supported steps like removal of false social media contents (207, 51.0%), easy and straightforward representations of information regarding COVID-19 (192, 47.3%), awareness campaigns or workshops (178, 43.8%), developing tools and guidance to promote and disseminate trusted information regarding COVID-19 (177, 43.6%), only sharing scientific facts will be helpful (173, 42.6%), religious scholars can play an important role to eradicate COVID-19 related misinformation (171, 42.1%), and print and electronic media can provide right information regarding COVID-19 (164, 40.4%). Respondents provided some support for steps like the role of local information centers and libraries in disseminating right and accurate information regarding COVID-19 (201, 49.5%), the role of information professionals in providing accurate information (200, 49.3%), and the role of interactions with health officials that are polite, nonjudgmental, and factual (198, 48.8%).

6.4. Hypotheses Testing

H01: There is no relationship between current resi-

Table 4. Strategies to counter COVID-19 related misinformation on a five-point scale (N=406)

Misinformation about COVID-19 vaccine	Strongly disagree *Freq*. (%)	Disagree *Freq*. (%)	Neutral *Freq*. (%)	Agree *Freq*. (%)	Strongly agree *Freq*. (%)	Mean (SD)
Interactions with health officials that are polite, nonjudgmental, and factual will be helpful	0 (0.0)	3 (0.7)	49 (12.1)	198 (48.8)	156 (38.4)	4.25 (0.688)
Only sharing scientific fact will be helpful	0 (0.0)	1 (0.2)	41 (10.1)	191 (47.0)	173 (42.6)	4.32 (0.660)
Promoting information literacy, media literacy, and health literacy	0 (0.0)	5 (1.2)	50 (12.3)	186 (45.8)	165 (40.6)	4.26 (0.716)
Easy and straightforward representations of information regarding COVID-19	0 (0.0)	5 (1.2)	41 (10.1)	168 (41.4)	192 (47.3)	4.35 (0.710)
Public figures/celebrities may play a role to eradicate COVID misinformation	4 (1.0)	15 (3.7)	44 (10.8)	203 (50.0)	140 (34.5)	4.13 (0.821)
Information professionals can disseminate right and accurate information regarding COVID-19	0 (0.0)	6 (1.5)	40 (9.9)	200 (49.3)	160 (39.4)	4.27 (0.694)
Local information centers and libraries can disseminate right and accurate information regarding COVID-19	0 (0.0)	3 (0.7)	42 (10.3)	201 (49.5)	160 (9.1)	4.28 (0.672)
Print and electronic media can provide right information regarding COVID-19	0 (0.0)	7 (1.7)	43 (10.6)	192 (47.3)	164 (40.4)	4.26 (0.715)
Religious scholars can play an important role to eradicate COVID-19 related misinformation	0 (0.0)	8 (2.0)	58 (14.3)	169 (41.6)	171 (42.1)	4.24 (0.766)
Removal of false social media contents will be beneficial	0 (0.0)	3 (0.7)	27 (6.7)	169 (41.6)	207 (51.0)	4.43 (0.651)
Developing tools and guidance to promote and disseminate trusted information regarding COVID-19	1 (0.2)	3 (0.7)	29 (7.1)	196 (48.3)	177 (43.6)	4.34 (0.666)
Through awareness campaigns or workshops	0 (0.0)	8 (2.0)	31 (7.6)	189 (46.6)	178 (43.8)	4.32 (0.700)

SD, standard deviation.

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dency and sources of getting information.

Chi-square test for current residency and sources of getting information found that there is no significant relationship between current residency and sources of getting information (χ^2=7.422; Df=4; p=0.115). So, the null hypothesis can be retained.

H02: There is no relationship between current residency and importance of information dissemination.

Chi-square test for current residency and sources of getting information found that there is significant relationship between current residency and importance of information dissemination (χ^2=17.533; Df=4; p=0.002). So, the null hypothesis can be rejected.

H03: There is no relationship between current residency and reaction after getting COVID related information.

Chi-square test for current residency and reaction after getting COVID related information found that there is significant relationship between current residency and reaction after getting COVID related information (χ^2=7.101; Df=2; p=0.029). So, the null hypothesis can be rejected.

H04: There is no relationship between current residency and evaluative steps after getting information and before disseminating it.

Chi-square test for current residency and evaluative steps after getting information and before disseminating it found that there is no significant relationship between current residency and sources of getting information (χ^2=4.957; Df=6; p=0.549). So, the null hypothesis can be retained.

7. DISCUSSION

During the COVID-19 pandemic, dissemination of information is one of the most important components of the twenty-first century. There has never been a time when swift and prompt dissemination of information was more crucial than it is in this coronavirus outbreak (Kudchadkar & Carroll, 2020). The current study reveals that the general citizens of Bangladesh are influenced by dissemination of information related to COVID-19 and they have a lower level of misinformation belief. However, the respondents have differences in misinformation belief by different demographic groups (e.g., sex).

Statistically significant differences were found between education levels and misinformation related to COVID-19 included in this survey. A significant difference was reported between participants' sources of getting information and their misinformation belief. There was also a significant difference between their evaluative steps after getting information and their belief in misinformation. The respondents have also differences in misinformation belief by their level of information literacy. It was found that a vast majority of the respondents use social media platforms as their sources of getting information.

When it comes to global public health crises like pandemics, the dissemination of reliable and authentic information is critical in terms of outbreak control strategies. Timely and accurate information about the pandemic can assist in taking precautionary measures and other steps for responding in that critical scenario, which may result in improved health outcomes (Voeten et al., 2009). In terms of recommendations indicated by the respondents based on strategies to fight against misinformation related to COVID-19, authorities must apply essential measures to eradicate social media posts that are incorrect. The proactive authenticity, clarification, or even elimination of incorrect content on social media can be improved to reduce its spread by misinformation monitoring and surveillance. The health ministry under the government has to deliver impartial, appropriate, and authentic COVID-19-related information to mass audiences.

In order to reach the general public, health instructions should also be created, ideally in the mother tongue. Appropriate videos and documentaries should be broadcasted on television regarding COVID-19. All COVID-19-related information should be simple to understand and need to be created after consulting regional authorities. Justified and convenient information regarding prevention strategies related to coronavirus also needs to be delivered through print and electronic media. Moreover, information literacy, media literacy, and health literacy should be promoted among the mass public. As Jones-Jang et al. (2021) noted, information and media literacy might not be enough to counter the negative impact of misinformation. The dissemination of appropriate and convenient information can serve as a barrier to the spread of COVID-19-related misinformation.

The influence of regional public libraries or information centers in circulating information regarding coronavirus is also crucial. They may play a vital part in obtaining access to coronavirus related authentic information. Hence, these regional institutions are useful for disseminating this kind of information. Information professionals can also be helpful in this regard. Religious scholars can also play a vital role to stop the spreading of misinformation. Stopping the circulation of misinformation cannot be possible by a single approach. To address this issue,

many flexible techniques and policy-level initiatives are required.

8. LIMITATIONS AND FUTURE RESEARCH

The survey could not reach out to people located in backward places and those who are not properly aware of COVID-19. That is why the study population was not entirely representative. As a result, the results cannot be generalized. But still this study can provide critical insights for further studies. Further, the misinformation included in the study was adopted from earlier research and social media platforms. There are many local misinformation beliefs which were not included this study. Upcoming studies may include local misleading information beliefs and study their impact on the people of Bangladesh. Alongside demographics, there might be other issues such as political beliefs, religious viewpoints, and socio-economic conditions that might be influential factors. These factors need to be investigated in upcoming studies.

9. CONCLUSION

This study's findings lead to the conclusion that there is a significant role of information dissemination in the case of the general public, including both urban and rural citizens of Bangladesh, during this COVID-19 pandemic. The findings provided insight from where urban and rural citizens get their information regarding COVID-19 and indicated that most of them depend on social media as their information sources. Although people have lower belief of misinformation regarding COVID-19, differences in misinformation belief were based on demographics such as sex, educational status, sources of getting information, and information literacy. Steps should be taken to reduce misinformation belief and stop spreading misinformation. Dissemination of timely, authoritative, and accurate information regarding the pandemic can help in taking necessary measures for responding in this pandemic situation, which may lead to better health outcomes.

CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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Appendix. Questionnaire

Section A. Demographic and general information

1. Your age:
   - Below 18
   - 18-30
   - 31-40
   - 41-50
   - 51-60
   - Above 60

2. Your sex:
   - Male
   - Female

3. Highest educational qualification:
   - Primary school
   - SSC/Equivalent
   - HSC/Equivalent
   - Graduation
   - Postgraduation

4. Where do you currently live?
   - Urban area (e.g., Metropolitan, City)
   - Rural area (e.g., Small town, Village)

5. Did you get infected with Coronavirus?
   - Yes
   - No

6. Has anyone from your close family members died of COVID-19?
   - Yes
   - No

7. Do you follow the guidelines regarding COVID-19 (e.g., staying at home, wearing masks, social distancing, washing hands frequently, etc.)?
   - Yes
   - No
   - To some extent

8. Have you taken a COVID-19 vaccine?
   - Yes
   - No

9. What are the sources you often use to get information?
   - Social media
   - Print and electronic media
   - Friends/Family
   - Experts/Doctors
   - Govt. information postal (e.g. Bangladesh National Portal)

10. "Information literacy is a set of abilities requiring individuals to 'recognize when information is needed and have the ability to locate, evaluate, and use effectively the needed information.'" According to the mentioned definition rate the level of your information literacy is:
   - Extremely low
   - Low
   - Moderate
   - High
   - Advance

11. How often do you use the Internet and social media?
   - Several times a day
   - At least once a day
   - At least once a week
   - Occasionally
   - Never

12. Why do you disseminate information/Why is dissemination of information important for you?
   - To spread the information
   - To raise awareness among people
   - To become popular
   - To pass the leisure time
   - Don't know

13. How do you react when you get COVID-19 related information?
   - Disseminate the information without checking the fact
   - Check the source of the information before dissemination
   - Ignore

14. What evaluative steps do you take after getting any information and before disseminating it?
   - Check quality of links/references provided
   - Check number of links/references provided
   - Check the length of the article
   - Check others' reactions/opinions
   - Check information about the author/poster
   - Check tone/style of writing/argument
   - Nothing

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Section B. COVID-19 misinformation

COVID-19 misinformation	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Facemasks don't work					
COVID-19 is a deception					
5G towers may spread COVID-19					
Bill Gates is behind COVID-19 pandemic					
Drinking alcohol may prevent COVID-19					
COVID-19 does not spread in the hot and humid weather					
COVID-19 was created in the lab					
COVID-19 does not affect religious people					
COVID-19 Vaccine does not work					
COVID-19 does not affect poor people					
Thankuni leaves may prevent COVID-19					
COVID-19 affects urban people more than rural					

Section C. Strategies against COVID-19 related misinformation

Strategies against COVID-19 misinformation	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Interactions with health officials that are polite, nonjudgmental, and factual will be helpful					
Only sharing scientific fact will be helpful					
Promoting information literacy, media literacy, and health literacy					
Easy and straightforward representations of information regarding COVID-19					
Public figures/celebrities may play a role to eradicate COVID misinformation					
Information professionals can disseminate right and accurate information regarding COVID-19					
Local information centers and libraries can disseminate right and accurate information regarding COVID-19					
Print and electronic media can provide right information regarding COVID-19					
Religious scholars can play an important role to eradicate COVID-19 related misinformation					
Removal of false social media contents will be beneficial					
Developing tools and guidance to promote and disseminate trusted information regarding COVID-19					
Through awareness campaigns or workshops					

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A Systematic Review on the Application of the Theory of Information Worlds

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ABSTRACT

Previous studies have found that the use or development of theory in library and information science (LIS) research is comparatively low and may be trending downward. LIS has also been criticized for relying on theories imported from other disciplines rather than applying or developing theories from within. The theory of information worlds, a social information behavior theory originally introduced in 2008, represents a newer LIS theory whose level of adoption is understudied. This study features a systematic literature review of peer-reviewed research articles which cited or used the theory of information worlds from 2008 to early 2022 to identify trends related to levels of theory use, publication venues, author affiliations, countries, and collaborations, as well as research methods, topics, and populations. Findings suggest that both awareness and use of the theory of information worlds are positively trending, though at slower rates for higher levels of theory use, such as full applications of the theory to guide the collection and analysis of empirical data. The theory has also been used by researchers from around the world and across disciplines, most often with mixed and qualitative methods. While the growth of a new LIS theory is promising, the authors echo calls for increased use and development of the theory of information worlds, and other LIS theories more broadly, and as more interdisciplinary collaboration.

Keywords: theory of information worlds, research trends, theory use, information behavior research, systematic literature review, library and information science based theory

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1. INTRODUCTION

The guiding paradigmatic foundations of library and information science (LIS) have been defined and influenced by a variety of theoretical perspectives. Some LIS researchers have focused on the measurable, organizable, or quantifiable aspects of information using the physical paradigm and others focus on the internal and social processes of how users seek, find, use, share, and reproduce information through cognitive and social paradigms of information (Raber, 2003). The last two paradigms are particularly aimed at examining the full spectrum of information behaviors, which are, as Wilson (2000, p. 49) describes, "the totality of human behavior in relation to sources and channels of information." Research in the 1980s and 1990s yielded several foundational LIS theories such as Dervin's (1983) sense-making, Mellon's (1986) library anxiety, Ellis's (1987) model of information-seeking behavior, Bates' (1989) berrypicking, Kuhlthau's (1991) information search process (ISP), Chatman's (1996) information poverty, and others. Pettigrew and McKechnie (2001) found that these theories were the most frequently discussed and used in information behavior research.

While McKechnie et al. (2001), Pettigrew and McKechnie (2001), and Kim and Jeong (2006) noted that the use of theory in LIS research was increasing during the 1990s and early 2000s, Pettigrew and McKechnie (2001) noted a lack of theory originating from LIS and frequent importation of theories from other disciplines. Kim and Jeong (2006) also found that articles specifically focusing on theory development were trending downward and called for LIS researchers to conduct more research using and developing theory. Vakkari (2008) and Julien et al. (2011) found decreasing use of theory in LIS conference papers, and research and professional articles, respectively. This study will explore these trends and address gaps in the literature related to the adoption and use of a single, new LIS-based theory: Burnet and Jaeger's (2008, 2011) theory of information worlds (TIW).

Among the theorists listed above, Chatman conducted research on social factors and contexts that influence information behaviors of specific homogenous user groups, such as the working poor (Chatman, 1987), retired women (Chatman, 1991, 1992), and women prisoners (Chatman, 1999). Through serial research on small worlds, Chatman (1999) explored and described how people in a small world engage in day-to-day activities that are strongly defined by recognized and shared beliefs, social norms, social types, and worldviews, and developed her theory of normative behavior. Later, Chatman and her colleagues, Gary Burnett and Michele Besant, applied the theory to information-rich virtual environments (Burnett et al., 2001). Burnett began to look at how people in small worlds were influenced by larger social influences and outside perspectives, inspired by Habermas' concepts of the lifeworld and the public sphere (Habermas, 1992). By linking these two theoretical frameworks of Chatman and Habermas, Burnett and Jaeger (2008) initially introduced TIW in a 2008 article and then followed with a more detailed presentation in book form in 2010.

The first article using TIW came from Kathy Burnett, Manimegalai Subramaniam, and Amelia Gibson in 2009, where they used it in conjunction with the concept of boundary objects (Bowker & Star, 1999; Star & Griesemer, 1989) to understand how gender mediates the information worlds of Latinas working in leadership positions in information technology. As seen in the Findings Section 4.3, TIW has been applied in a variety of contexts since then as well. Park (2022) found a large portion of research using TIW can be found in doctoral dissertation projects in LIS programs, particularly from Florida State University in the United States where Gary Burnett is a full professor. Between 2008 and 2018, Park (2022) identified 14 dissertation projects using TIW and found that the research was mostly qualitative in nature, examining how the five core concepts are intertwined with each other to create individuals' social information worlds. While TIW has been active for over 14 years, an extensive review of its use and impact, outside of Park (2022), has not yet been conducted.

The purpose of this study is to explore and describe how and to what extent the TIW has been adopted and used in peer-reviewed research articles since the theory's inception in 2008. Through a systematic literature review approach, the researchers will also identify the research contexts within which the theory has been used, such as populations, topics, and methods, as well as publication trends, such as journal titles and collaborations across disciplines. The level of theory use will be analyzed using a revised version of Kumasi et al.'s (2013) seven categories of theory talk. The three guiding research questions for this project are:

RQ 1: How and to what extent has Burnett and Jaeger's (2008, 2011) TIW been cited, used, or applied since its inception?
RQ 2: What publication trends related to authorship, affiliation, country, language, and journal titles are as-

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sociated with the citation, use, or application of the TIW since 2008?
RQ 3: In what research contexts (research methods and populations) has the TIW been applied since 2008?

The answers to these research questions will address gaps in the literature about how TIW has been used and explore its potential versatility across research contexts and disciplines. Additionally, the findings may spotlight prominent and emerging scholars who have adopted TIW, which may help inspire further use and collaboration with a newer theory from a field that may be facing theoretical stagnation or drought.

2. LITERATURE REVIEW

This brief literature review will discuss the use of theory in LIS and introduce the TIW (Burnett & Jaeger, 2008; Jaeger & Burnett, 2010).

2.1. Use of Theory in LIS

The definition of theory varies depending on the academic field and researcher. Buckland (1991, p. 18) argues for a broad definition of theory, stating that a theory is "in the broad sense of a description or extension of the nature of things, not in the more restricted sense, used in some sciences, of denoting fundamental laws formally stated and falsifiable." To understand theory, it is necessary to compare and examine the definitions of similarly used analytical or interpretive tools: models. As one of the definitions of a model in the field of literature and informatics, Wilson (1999, p. 250) defined a model as a "framework for thinking about a problem… [that] may even contribute to a statement of the relationship." When comparing Buckland's definition of a theory with Wilson's definition of a model, one can see that the two are closely related together, but difficult to differentiate. Many studies use theory and model interchangeably. However, Frankfort-Nachmias and Nachmias (1996) distinguish a theory from a model by the fact that a theory provides an explanation of the phenomenon, while the model describes the phenomenon. This emphasizes that the description of the phenomenon alone cannot show academic growth, and the maturity of the study can be measured through theories that can explain the phenomenon. Therefore, this study aims to see the degree of maturity by examining how theory is used in research.

Several studies have been conducted on how theories are used in the field of library and information science. Peritz (1980) reported that only 14% of sample articles from 1950 to 1975 could be theoretical research. Similar results have been reported in the 1980s, with Nour (1985) identifying theory in 21.2% of the literature published in 1980; Feehan et al. (1987) identifying 13% in articles published in 1984; and Järvelin and Vakkari (1990) finding theory in 10% of journal articles published in 1985. In addition, the ratio used for information behavior research was very low at 6% to 8% (Järvelin & Vakkari, 1990). They speculated the low usage of theory in information behavior research was due to the professional or practitioner origins of the field. In contrast, Pettigrew and McKechnie's 2001 study found that 34.1% of studies applied theory. Pettigrew and McKechnie (2001) argue that while there were differences in which journals were sampled and when in previous studies, the use of theory, whether from LIS or elsewhere, in LIS research appeared to be increasing at the time. Kim (2004) also disagreed that theoretical research was insufficient in LIS, finding that 41.4% of the studies deal with theoretical development and utilization. However, Vakkari (2008) found a decreasing trend of theory use in papers within the Information Seeking in Context (ISIC) conference proceedings. Julien et al. (2011) found that the use of theory in research articles published by both scholars and practitioners is trending down, with 22.7% of articles using theory. These studies suggest that while theory use has increased over time, it may have reached a plateau and begun to trend down more recently. However, more current research is needed to investigate this trend. Variations in theory use may also be regional. In Korean LIS research journals, Jeong and Kim (2005) found only 10% of studies apply a theory. Wu et al. (2017) found 49.9% of articles published in Taiwanese LIS journals between 2010 and 2015 use theory.

Lund (2019) analyzed how often an information theory was cited using Google Scholar and found that Kuhlthau's (1991) ISP was the most frequently cited theory to date. Lund (2019) also forecasted ISP to be the most frequently cited theory in the next 25 years. In a follow-up study, Lund (2021) analyzed dissertations studying information behavior and found that the ISP model was the top theory in information behavior studies, with TIW ranked in eighth place, being identified in 8 dissertations.

Theory can be used in different ways and for different purposes in research. Jeong and Kim (2005) suggested the degree of theory use in studies can be classified across five levels: spot citing, background review, theory discussion, theory application, and analytic evaluation. The five levels they proposed were used by Wu et al. (2017) to analyze

the status of theoretical use in the Taiwanese LIS journals previously mentioned. Kumasi et al. (2013) subdivided the five levels and classified them into seven levels, and the classification is as follows:

- Theory dropping (TD): a discussion of theory is dropped after literature review and not revisited later
- Theory positioning (TP): introducing a theory either at the beginning or end of a study without citation
- Theory diversification: multiple theories are introduced but their relevance to the study may be unclear
- Theory conversation (TC): the contribution of a particular theory to LIS is discussed in a scholarly essay
- Theory application (TA): employs theory throughout to inform the research design and data analysis
- Theory testing: empirically validating an existing theory
- Theory generation (TG): building, revising or expanding a theory to create a new theory (Kumasi et al., 2013, p. 178)

Kumasi et al. (2013) developed these categories of theory talk by looking where and how theories are used within all articles from seven LIS journals published between 2009 and 2011. These categories ranged in intensity, with TD and positioning being minimal, theory diversification and conversation being moderate, and TA, testing, and generation being the highest major intensity. As discussed in Methods Section 3, the authors of this study modified the Kumasi et al. (2013) categories of theory talk to focus on a singular theory.

2.2. Theory of Information Worlds

The TIW was introduced in 2008 (Burnett & Jaeger, 2008) and then formalized and more fully presented in a book published in 2010 (Jaeger & Burnett, 2010). TIW is a revision and expansion of Chatman's theories of small worlds and normative behavior (Burnett et al., 2001; Chatman, 1991, 1992, 1999) influenced by Habermas' (1992) concepts of the public sphere and lifeworld. Based on these concepts and theories, TIW establishes a scalable framework consisting of five core concepts (Jaeger & Burnett, 2010):

- social norms, a world's shared sense of the appropriateness of social appearances and observable behaviors
- social types, the roles that define actors and how they are perceived within a world
- information value, a world's shared sense of a scale of the importance of information
- information behavior, the full range of behaviors and activities related to information available to members of a world
- boundaries, the places at which information worlds come into contact with each other and across which communication and information exchange can - but may or may not - take place (Jaeger & Burnett, 2010, p. 8)

The five core concepts of TIW interact with each other, rather than acting independently. Until now, many studies applying TIW have revealed that by applying the five core concepts of theory to phenomena, individuals follow the norms and value systems of the small world(s) to which they belong. TIW has been criticized by some scholars and some have combined it with other theories or proposed new theories to overcome the limitations of the theory. As an example of the former, Kitzie (2017) combined TIW with Goffman's (1963) stigma theory, McKenzie's (2003) information practice, Chatman's (1996) information poverty, and de Certeau's (1984) concept of spatial practice to analyze information behaviors within the LGBTQ+ community. In addition, Post (2020) used Becker (1982)'s concept of art worlds in combination with TIW in designing theories and methodologies for analyzing the information world of artists and curators. In an example of the latter, Yu (2012) critiqued TIW for its sole focus on social contexts of information behavior and a perceived dismissal of individual factors such as emotions and agency and instead proposes a concept for an individual's information world based on Popper's (1972) time, space, and world perspectives. Yu's (2012) critique and insights from his research with hermeneutics and textuality led Burnett (2015) to build upon information worlds with an expanded theory of information domains to provide a more holistic analytical framework through which to examine, describe, and interpret information behavior. Through the framework of information domains, Burnett (2015) repositions the existing TIW as the social domain, and then adds the domain of the individual to interpret individual factors that may impact information behavior and the domain of signification to understand and interpret how signs, symbols, languages, and other tools may influence or add context to information behaviors. Despite the introduction of information domains, TIW still functions as an independent theory.

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3. METHODS

This study employs a systematic literature review derived from literature review methods that focus on the use or impact of theory, particularly Kumasi et al. (2013), Lund (2021), and Williams et al. (2015). Like these studies, this study employs a search strategy involving keyword and Boolean searching[1] in relevant databases accessible to the authors via their institutions[2] to find all academic, peer-reviewed research articles that cite or use Burnett and Jaeger's (2008, 2011) TIW from 2008, the year of the theory's introduction, until March of 2022, the end of the authors' data collection period. Given the databases accessible to the authors, those searched for this study included the general databases: *EBSCOHost, Google Scholar, ProQuest Central, ScienceDirect, SCOPUS, Web of Science,* and *Wiley;* as well as the specialist databases *Emerald Special Collection* and *Library, Information Science and Technology Abstracts (LISTA)*. Differing from Kumasi et al. (2013), Lund (2021), and Williams et al. (2015), this study also employed reverse citation tracking searches facilitated through *Google Scholar, SCOPUS,* and *Web of Science* using citations for Burnett and Jaeger's 2008 introductory article and the 2010 book to identify additional articles that cited or use the theory that may not have been retrieved through keyword searching.[3] As this study focuses solely on peer-reviewed academic articles, other publication formats were removed. Additionally, articles published in languages other than English or Korean were screened due to the combined limitations of the authors' language abilities.[4]

An analytical framework adapted from the seven categories of theory talk developed by Kumasi et al. (2013) was used for the screening process as well as to guide directed content analysis (Hsieh & Shannon, 2005) of the research articles themselves. The original theory talk categories were developed to explore and describe where and how any theory or theories are used or discussed within LIS research articles (Kumasi et al., 2013). After initial inter-coder reliability testing failed to reach 80% agreement,[5] the research team decided to modify and test an adapted framework that focuses specifically on the use of one theory rather than trying to account for all of them that could be mentioned or used within an article, which could vary widely. Of course, while this project is focused on Burnett and Jaeger's (2008, 2011) TIW, the revised single theory talk model could be tailored to any other social science theory. A level of agreement of over 80% percent was reached after three rounds of inter-coder reliability testing and revision of the adapted codebook. The final adapted single theory talk model is as follows:

- Not Applicable (0) is applied when the manuscript does not directly identify or address TIW or its core concepts, even if the core TIW publications are cited. This is used as an exclusionary criterion for screening purposes.
- Theory Dropping (TD) is the mention of TIW or its core concepts within the manuscript (with accompanying citation to core TIW publications) but without a clear connection to the main focus of the article, research design, or analysis.
- Theory Positioning (TP) is the short discussion, description, or critique of TIW or its core concepts alongside or in relation to other theories used for the purpose of providing context for the study/manuscript at hand but not as a main focus of the manuscript nor to guide the research design or analysis. This may include using TIW or core concepts to discuss the findings/results.
- Theory Conversation (TC) refers to a focused, in-depth discussion or critique of TIW, its core concepts, or its theoretical implications or practical applications within LIS or in other fields. This category is limited to articles that specifically discuss TIW or its core concepts as part of the core focus of the pa-

[1]Direct entry, Boolean, and database-specific operators were applied as needed. Search teams such as "information world*", "theory of information world*" OR "information world* theor*", "information world* AND theor*", and other related variations were used.
[2]None of the authors' institutional libraries provided access to EBSCO's LIS specialist database, *Library Literature & Information Full Text*, but some overlap with the general *EBSCOHost* database is assumed.
[3]A reverse citation search using Burnett & Jaeger's 2011 book chapter was also conducted but yielded no results that were not duplicates of others.
[4]Two potentially relevant research articles were eliminated due to the language criteria during the screening process: one German (https://doi.org/10.1515/bfp-2017-0019) and one in Chinese (https://doi.org/10.6120/JoEMLS.202111_58(3).0024.RS.AM). While both articles included English abstracts or summaries and indicated the use of TIW, the articles were excluded because the authors were unable to translate or interpret the original text of the full manuscripts given resource constraints.
[5]Eighty percent agreement between coders is generally accepted in most situations, though 70% is permissible in exploratory studies (Lombard et al., 2002).

per but do not report empirical research. This may occur in the literature review, discussion, or conclusion sections.

- Theory Application (TA) refers to the application of TIW or its core concepts to the research design or methodology (research questions, design, or method); the analysis or interpretation of empirical data; or the evaluation, assessment, testing, or validation of TIW or its core concepts.
- Theory Generation (TG) refers to the theoretical development, revision, or expansion of TIW or its core concepts through empirical research or inductive reasoning. This may entail the expansion or revision of TIW, the proposal of propositions, or the building or creation of new theories.

In addition to the modifications to Kumasi et al's (2013) original theory talk levels themselves, the relationships between the levels have also been altered. The levels in Kumasi et al's (2013) original model were not mutually exclusive to better account for the variety of ways theory could be located or used within a manuscript. In the single theory talk model, the levels 0, TD, TP, TC, and TA are mutually exclusive to emphasize a more sophisticated use of the theory at "higher" levels such as TC and TA, which involve more in-depth understanding and integration of the theory into the works. However, like the original theory talk model, the TG level in the single theory talk model is not mutually exclusive, as the authors found that theory was often developed or generated in papers that heavily discuss the theory (TC), used the theory to guide data collection and analysis or empirically test the theory (TA), or to position the theory in relation to alternative or newer theories (TP). Kumasi et al's (2013) original "theory testing" level was integrated into the TA level to streamline coding as it seemed they often overlapped and because the authors did not want to imply that quantitative methods were higher level than qualitative methods. The research-

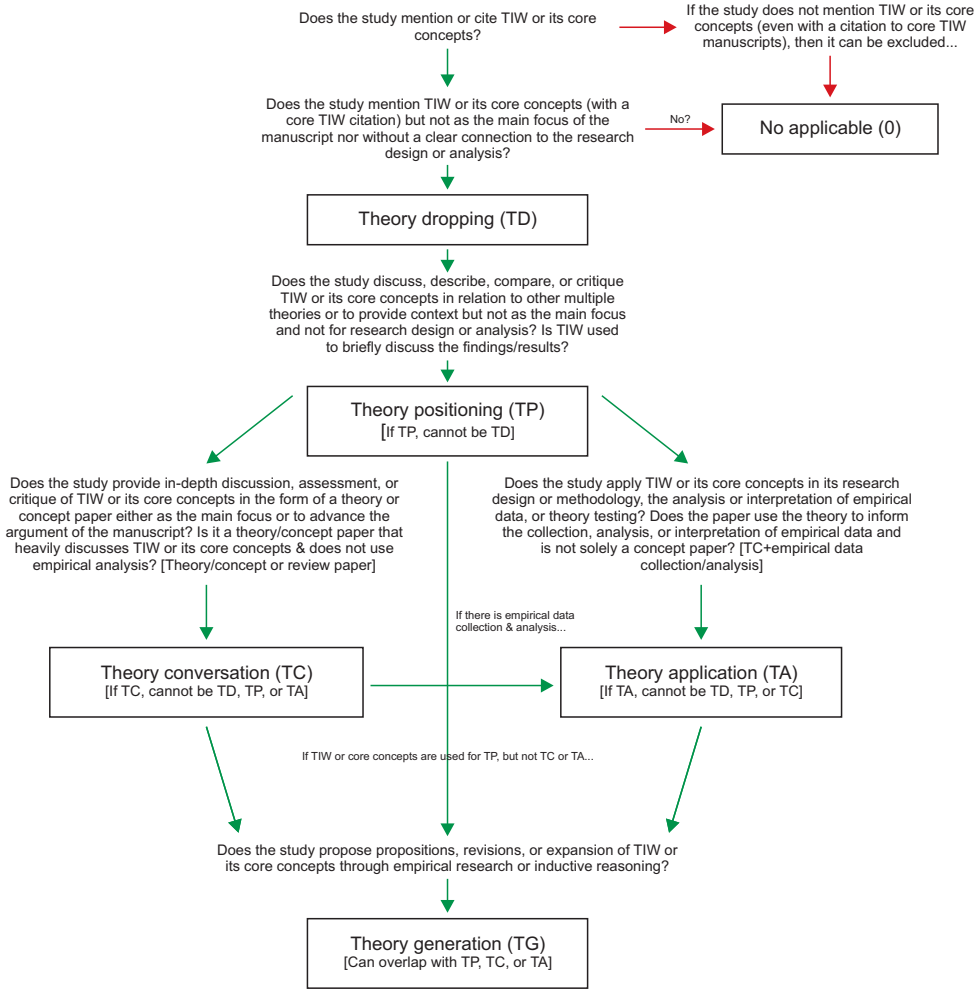


Fig. 1. Coding flow chart for the single theory talk model. TIW, theory of information worlds.

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ers also view theory work as just as important as empirical work, so in the hierarchical sense, TC and TA are roughly equal in level of sophistication. Similarly, the researchers wanted a balanced perspective on quantitative and qualitative methods, so the originally higher-ranked level of theory testing was absorbed into the revised TA level. Fig. 1 highlights the flow of the coding process and explains the relationships between the levels.

The screening and coding process of the systematic literature review is demonstrated in Fig. 2. Through multiple rounds of screen and coding, a sample of 68 peer-reviewed research articles which cited or used TIW was identified. Focusing on higher levels of theory use, the final sample includes 26 articles coded as TA, TC, or TG. Articles coded with TA make up the final sample with 18 articles. The asterisk (*) in Fig. 2 is a reminder that while that TD, TP, TC, and TA are mutually exclusive, any of these codes can be coded alongside TG.

Due to scope and space limitations, this study primarily reports on the results of the systematic literature review and a portion of the content analysis used for categorizing and describing research articles. Additional reporting on the content analysis will be addressed in a follow-up study to provide additional depth and nuance in the exploration and descriptions of research articles categorized with TA, TC, or TG.

4. FINDINGS

The findings are presented in the order of the research questions.

4.1. Theory Citation & Use Levels

From the third screening and initial coding of manuscripts, 68 peer-reviewed articles were identified as relevant to this study. Of these, 35 (51.47%) use TIW for TD; 12 (17.65%) for TP; 3 (4.41%) for TC; 18 (26.47%) for TA; and 11 (16.18%) for TG; again, noting that TG is not mutually exclusive with other codes. As such, a subsample of 26 peer-reviewed research articles uses TIW at the higher levels of TA, TC, and TG. In the findings, figures, and tables herein, the overall sample of all codes is designed as All Codes (n=68), the subsample of higher-level uses of theory is designated as TA, TC, or TG (n=26), and a subsample of only articles that applied the theory in empirical studies is designated as TA (n=18). As grouped, research

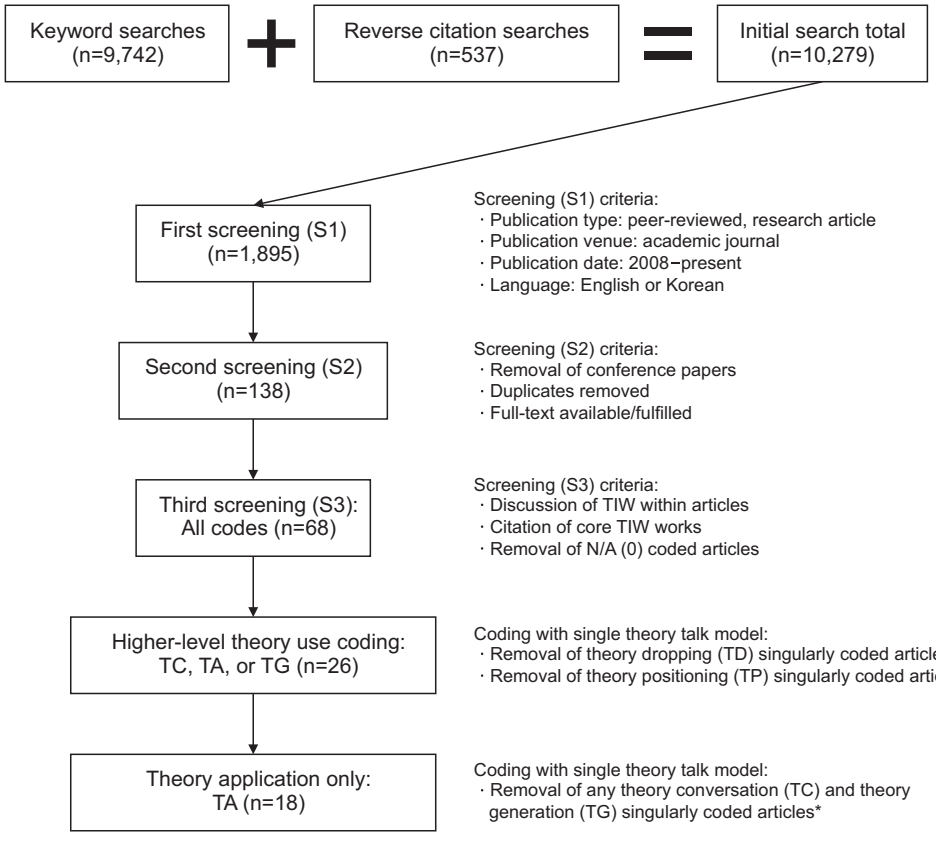


Fig. 2. Systematic literature review screening. TIW, theory of information worlds. *While TD, TP, TC, and TA are mutually exclusive, any of these codes may be coded alongside TG.

articles with higher levels of theory use (TA, TC, or TG) account for 38.24% of the overall sample, and articles specifically applying the theory for empirical research account for 26.47% of the overall sample.

As depicted in Fig. 3, both overall citation (n=68) and use as well as higher usage levels (TA, TC, or TG; n=26) of the TIW are trending upward. Overall citation and use of the theory have a trendline with a linear R-squared value of 0.525 and higher-level usage has a linear trendline R-squared value of 0.468. TA only has the lowest upward trendline with an R-squared value of 0.285.

Additionally, as depicted in Fig. 4, the number of research articles at each theory use level of the single theory talk model is also trending upward. TD has a linear trendline R-squared value of 0.459, TP has an R-squared of 0.269, TC has an R-squared of 0.159, TA has an R-squared of 0.286, and TG has an R-squared of 0.272. The trendlines and corresponding R-squared values[6] in Figs. 3 and 4 are calculated using the function built into Google Sheets (https://www.google.com/sheets/about/).

4.2. Publication Trends

4.2.1. Author Affiliations & Countries

The affiliation information of authors was collected

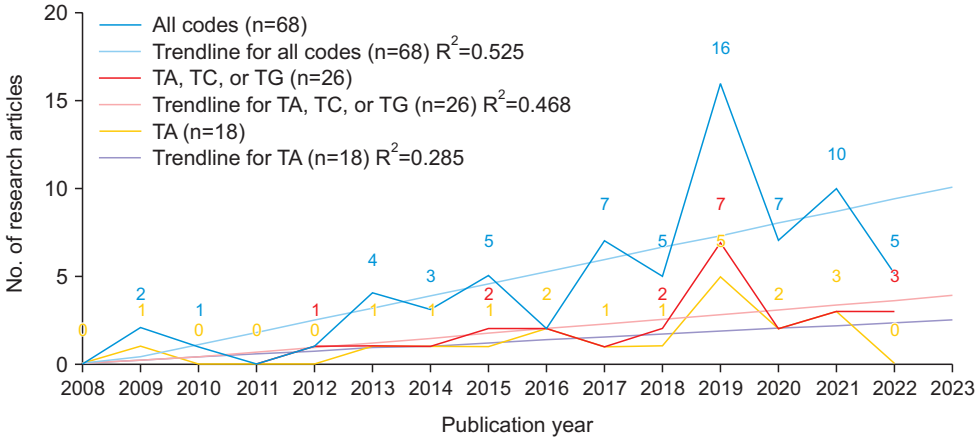


Fig. 3. Theory of information worlds citation and use count in articles, 2008 to March 2022. TA, theory application; TC, theory conversation; TG, theory generation.

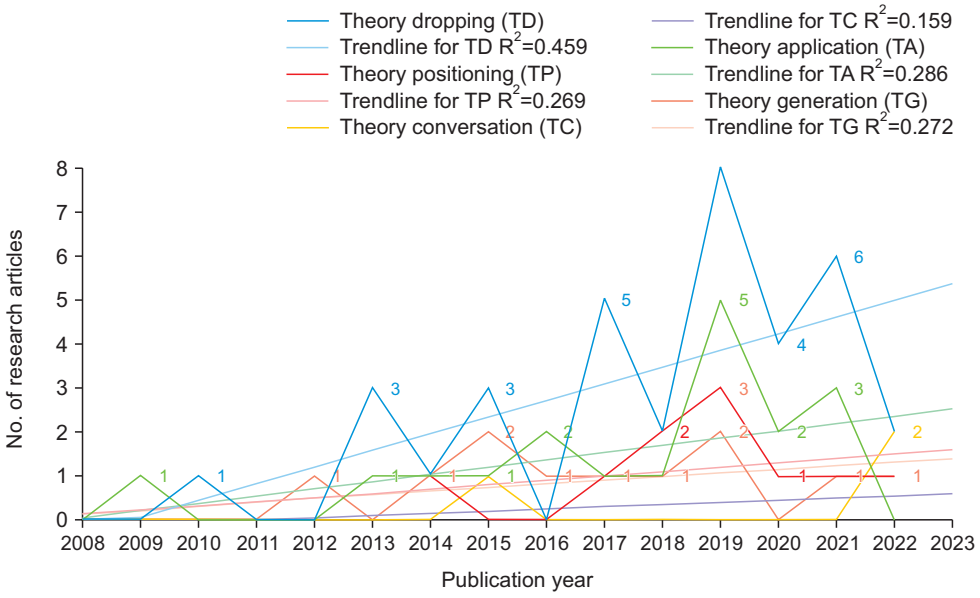


Fig. 4. Frequency of theory use levels per year, 2008 to March 2022.

[6]It should be noted that higher R-squared values, those closer to 1 or 100%, indicate a better or closer fit of the data to the regression line or how much of the data's variance can be accounted for by a linear model, and that lower R-squared values are not uncommon in the social sciences (Minitab Blog Editor, 2013).

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and ranked according to the descending number of authorships, as summarized in Table 1. Articles that did not provide affiliation information were not counted and for authors with multiple affiliations, each was included. Authors who published more than two articles were listed in three categories, and authors with single-article publications were not shown in the table.

For 68 articles including all codes, Huvila, I. who published five articles (Åbo Akademi University, Finland and Uppsala University, Sweden) was the most productive researcher, followed by Burnett, G. (one of the theorists of TIW; Florida State University, US), Gibson, A. N. (University of North Carolina, US), and Ndumu, A. (Florida State University, US) with four articles respectively. Authors with three articles included Hollister, J. M. (Pusan National University, Republic of Korea) and Worrall. A. (University of Alberta, Canada). Another theorist of TIW, Jaeger, P. T. (University of Maryland, US) produced two articles. Ten more researchers including Burnett, K. (Florida State University, US), Butler, B. S. (University of Maryland, US), Fulton, C. (University College Dublin, Ireland), Greyson, D. (University of British Columbia, Canada), Lee, J. (Pusan National University; Chonnam National University, Republic of Korea), Lee, M. (University of Maryland, US), Lingel, J. (University of Pennsylvania, US), O'Brian, H. (University of British Columbia, Canada), Skinner, J. (Kennesaw State University, US), and Yu, L. (Nankai University, China) also published two articles.

For articles with higher levels of theory usage (TA, TC, or TG), and TA category, Burnett, G. (Florida State Uni-

Table 1. Authors and affiliations

Number of articles	All codes	TA, TC, or TG	TA
5 articles	Huvila, I (Åbo Akademi University, Finland; Uppsala University, Sweden)		
4 articles	**Burnett, G. (Florida State University, US)** **Gibson, A. N. (University of North Carolina, US)** **Ndumu, A. (Florida State University, US)**	**Burnett, G. (Florida State University, US)**	
3 articles	Hollister J. M. (Pusan National University, Republic of Korea) **Worrall. A. (University of Alberta, Canada)**	**Gibson, A. N. (University of North Carolina, US)**	**Burnett, G. (Florida State University, US)** **Gibson, A. N. (University of North Carolina, US)**
2 articles	Burnett, K. (Florida State University, US) Butler, B. S. (University of Maryland, US) Fulton, C. (University College Dublin, Ireland) Greyson, D. (University of British Columbia, Canada) Jaeger, P. T. (University of Maryland, US) Lee, J. (Pusan National University; Chonnam National University, Republic of Korea) Lee, M. (University of Maryland, US) Lingel, J. (University of Pennsylvania, US) O'Brian, H. (University of British Columbia, Canada) Skinner, J. (Kennesaw State University, US) Yu, L. (Nankai University, China)	Butler, B. S. (University of Maryland, US) Hollister J. M. (Pusan National University, Republic of Korea) **Jaeger, P. T. (University of Maryland, US)** Lee, J. (Pusan National University; Chonnam National University, Republic of Korea) **Ndumu, A. (Florida State University, US)** **Worrall. A. (University of Alberta, Canada)**	**Jaeger, P. T. (University of Maryland, US)** **Ndumu, A. (Florida State University, US)** **Worrall. A. (University of Alberta, Canada)**

TA, theory application; TC, theory conversation; TG, theory generation.

versity, US) was ranked first in both categories. Burnett, G. published three articles that applied TIW in empirical research (TA) and published one article using TIW for TC and TG. Gibson, A. N. (University of North Carolina, US) was ranked second with three TA articles. Jaeger, P. T. (University of Maryland, US), Ndumu, A. (Florida State University, US), and Worrall. A. (University of Alberta, Canada) are ranked third with two TA articles and one TC and/or TG article respectively. These researchers were also the most active researchers in using TIW in more than two articles and were shown in bold in Table 1. Hollister, J. M. (Pusan National University, Republic of Korea) and Lee, J. (Pusan National University; Chonnam National University, Republic of Korea) also produced two articles respectively in higher level theory usage and TA categories. They published one TA article respectively and one TC and TG article together. Butler, B. S. (University of Maryland, US) published two articles coded with TP and TG. The summary Table 7 in Section 4.3 shows detailed information about TA, TC, or TG-coded articles.

Florida State University is the most productive institution in all three samples with 21 times, 9 times, and 7 times each, respectively, followed by the University of Maryland with 16 times, 13 times, and 10 times. This shows the two primary theorists, Burnett and Jaeger, and their colleagues (including faculty and doctoral students) at their respective institutions actively conduct research using TIW across all levels of theory use. The next most active institutions are the University of North Carolina at Chapel Hill (with 5 times, 3 times, 3 times) and Pusan National University (4 times, 3 times, 2 times). Other active institutions are the University of British Columbia, Uppsala University (with 6 times, 0 times, and 0 times each) and Åbo Akademi University (with 5 times, 0 times, 0 times each). This means even though articles from the University of British Columbia, Uppsala University, and Åbo Akademi University partly mentioned TIW by TD or TP in many articles, they did not use or apply TIW for the higher-level theory usage at all. The University of Alberta did not appear in the top ten institutions for the sample including all codes but does appear in the two higher-level theory usage categories. The University of Oulu was not ranked in the top ten institutions for all codes but is listed in the two higher-level theory usage categories (two times each). In this case, two different authors from the University of Oulu collaborated and published one TA article. The University of Leeds appeared twice in TA, TC, or TG category and was not listed in both all codes and TA categories, because two out of three authors of one TP and TG article were affiliated with the University of Leeds.

The countries of the author's affiliated institutions were also collected for each sample by using the countries within which the author's affiliations are located. The countries of the authors' affiliated institutions are presented in

Table 2. Ranking of countries by authors' affiliated institutions of coded articles

Rank	All codes	TA, TC, or TG	TA
1	United States (74)	United States (31)	United States (21)
2	Canada (14)	Canada, Republic of Korea (5 each)	Canada (5)
3	Sweden (10)	People's Republic of China (3)	Australia, Finland, Republic of Korea, Tanzania (2 each)
4	Australia (9)	Australia, Finland, United Kingdom, Tanzania (2 each)	Indonesia, Singapore (1 each)
5	Finland, People's Republic of China, Republic of Korea (8 each)	Indonesia, Singapore (1 each)	Denmark, Ireland, Japan, Norway, United Kingdom, People's Republic of China, Poland (0 each, unranked)
6	Norway, United Kingdom (6 each)	Denmark, Indonesia, Ireland, Japan, Norway, Poland (0 each, unranked)	
7	Denmark, Poland (3 each)		
8	Ireland, Tanzania (2 each)		
9	Indonesia, Japan, Singapore (1 each)		

TA, theory application; TC, theory conversation; TG, theory generation.

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Table 2. For authors with multiple affiliations in different countries, then each country was counted. For authors with multiple listed affiliations within the same country, their countries were only counted once. Overall, TIW was found to be used or cited in 16 different countries. Citation and use of TIW across all samples are highest among institutions based in the United States, with 74, 31, and 21, respectively. In the overall sample of all codes (n=68), the next highest countries are Canada with 14; Sweden with 10; Australia with 9; Finland, China, and Republic of Korea all with 8; Norway and the United Kingdom with 6; Denmark and Poland each with 3; Ireland and Tanzania with 2; and Indonesia, Japan, and Singapore with 1 each. In the higher levels of theory use subsample (TA, TC, or TG; n=26), Canada and Republic of Korea are tied at second with 5; China with 3; with the remaining countries with 2 or less. In the TA only subsample (TA, n=18), the United States is ranked first with 21, followed by Canada with 5, Australia, Finland, Republic of Korea, and Tanzania with 2 each; Indonesia and Singapore with 1; and the remaining countries with zero.

In the overall sample, 65 (95.6%) of the research articles are published in English, with the remaining 3 (4.4%) in Korean. In the higher levels of use (TA, TC, or TG; n=26) subsample, 24 (92.3%) are published in English and 2 (7.7%) in Korean. In the TA subsample, 17 (94.4%) are published in English and 1 (5.6%) is published in Korean.

4.2.2. Author Disciplines

The authors' affiliated institutions were also collected to determine which academic disciplines TIW has been used, as summarized in Table 3. Since most of the authors belonged to universities, the academic fields were classified using the department name. In some papers that do not present departments, academic fields were classified using college information. There was a total of eight academic disciplines, including LIS/informatics, business, journalism/communication, health/medicine, arts & design, history, social work, and education. The discipline accounted for the largest number of these disciplines, with 124 out of 153 authors is LIS/informatics, with 81.05% of the total. Next, it was found that there were some authors in the business field, with 14 people, accounting for 9.15%. The journalism or communication fields include 6 people, accounting for 3.92% of the total. In addition, the number of authors in health or medicine, arts & design, history, social work, and education are 4 people (2.61%), 2 people (1.31%), 1 person (0.65%), and 1 person (0.65%), respectively.

The percentage of researchers who published reviews or theory/concept papers (TC), application (TA) papers, or TG papers using TIW was similar to the overall results. The LIS/informatics sector accounted for 90.74% of the total with 49 people, with business accounting for 7.41%, and journalism/communication accounting for 1.85%. This suggests that although the information world theory has not yet been used in the five fields, the theory has been introduced in the field and is likely to be used. The remaining five fields were found to have no paper in those three categories.

The results of analyzing papers in the TA category show that LIS/informatics, business, and journalism/communication were 92.32%, 5.13%, and 2.56%. The main field in which the information world theory is being used is the LIS field, the academic field where the theory was developed, and it accounted for most of the papers.

Table 3. Home disciplines of authors

Discipline	All (freq., %)	TA, TC, or TG (freq., %)	TA (freq., %)
LIS/Informatics	124 (81.05)	49 (90.74)	36 (92.32)
Business	14 (9.15)	4 (7.41)	2 (5.13)
Journalism/Communication	6 (3.92)	1 (1.85)	1 (2.56)
Health/Medicine	4 (2.61)	0 (0.00)	0 (0.00)
Arts & Design	2 (1.31)	0 (0.00)	0 (0.00)
History	1 (0.65)	0 (0.00)	0 (0.00)
Social Work	1 (0.65)	0 (0.00)	0 (0.00)
Education	1 (0.65)	0 (0.00)	0 (0.00)

LIS, library and information science; TA, theory application; TC, theory conversation; TG, theory generation.

When analyzing the academic field of the first author, the results were similar to the overall results of author disciplines. The home disciplines of the first authors are summarized in Table 4. Among the academic fields of the first author, the LIS/informatics field accounted for the largest number with 85.29%, followed by the business and journalism/communication fields with 5.88%, respectively. In addition, there was one paper each in the fields of arts & design and history, accounting for 1.47 percent of the total. The fields of health/medicine, social work, and education did not appear in the first author analysis, so they were found to be the disciplines that participated as joint researchers.

One of the differences between the analysis conducted on all authors and the analysis of the first authors was that the business field disappeared from the TA category and one paper was included in the journalism/communication field. In the field of journalism/communication, the spread of the information world theory in this field is expected in the future, given that the first author used the information world theory in the research and design process.

The analysis results of whether collaboration between academic fields has been conducted are shown in Table 5. Among the total 65 papers, 46 studies in the field of LIS/informatics accounted for 70.77% of the total. There were five studies in other fields, accounting for 7.69% of the total. However, in the case of papers consisting only of authors in fields other than LIS/informatics, it was found that they simply mentioned or explained TIW. These fields were mainly found in the journalism/communication field, business field, and arts & design field. There were 14 papers in which researchers from LIS/informatics and other fields participated as authors, accounting for 21.54% of the total. This collaboration can be expected to expand the theory in that it was also found in the TA category, a research group that applies the theory to the actual information environment. Mainly, the fields of research through this collaboration were health/medicine, business, education, history, and social work.

4.2.3. Journal Titles

Among the publication venues for the overall sample with all codes (n=68), the most frequently used one is the *Journal of Documentation* (with 10 times), followed by the *Journal of the Association for Information Science and Technology* (with 9 times), *Library & Information Science Research* (with 6 times). The next highest publication venues are *First Monday* and *Journal of Librarianship and Information Science* (with 4 times each); *Journal of Korean Society for Library and Information Science* and *The Library Quarterly* (with 3 times each); *Journal of Critical Library and Information Studies*, *Journal of Education for Library and Information Science*, *Journal of Information*

Table 4. First author's home discipline

Discipline	All (freq., %)	TA, TC, or TG (freq., %)	TA (freq., %)
LIS/Informatics	58 (85.29)	24 (92.31)	17 (94.44)
Business	4 (5.88)	1 (3.85)	
Journalism/Communication	4 (5.88)	1 (3.85)	1 (5.56)
Arts & Design	1 (1.47)		
History	1 (1.47)		

LIS, library and information science; TA, theory application; TC, theory conversation; TG, theory generation.

Table 5. Collaboration across or within disciplines

Collaboration	All (freq., %)	TA, TC, or TG (freq., %)	TA (freq., %)
LIS/Informatics	46 (70.77)	22 (88.00)	15 (88.24)
LIS/Informatics +	14 (21.54)	3 (22.00)	2 (11.76)
Other disciplines only	5 (7.69)		

LIS, library and information science; TA, theory application; TC, theory conversation; TG, theory generation.

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Table 6. Publication venues

Rank	All (n=68)	TA, TC, or TG (n=26)	TA (n=18)
1	**Journal of Documentation** (10)	**Journal of the Association for Information Science and Technology** (6)	**First Monday** (3) **Journal of the Association for Information Science and Technology** (3)
2	**Journal of the Association for Information Science and Technology** (9)	**First Monday** (3)	
3	Library & Information Science Research (6)	**Journal of Documentation** (2) Journal of Librarianship and Information Science (2) Journal of Korean Society for Library and Information Science (2)	**Journal of Documentation** (2)
4	**First Monday** (4) Journal of Librarianship and Information Science (4)		The rest of the journal publishers are listed once.
6	Journal of Korean Society for Library and Information Science (3) The Library Quarterly (3)		
8	Journal of Critical Library and Information Studies (2) Journal of Education for Library and Information Science (2) Journal of Information Science Theory and Practice (2) Journal of the American Society for Information Science and Technology (2) Zagadnienia Informacji Naukowei - Studia Informacyjne (2)	The rest of the journal publishers are listed once.	

TA, theory application; TC, theory conversation; TG, theory generation.

Science Theory and Practice, *Journal of the American Society for Information Science and Technology*,[7] and *Zagadnienia Informacji Naukowei - Studia Informacyjne* (with 2 times each). The publication venues are ranked across each sample in Table 6. The remaining articles are respectively published in distinct publishers, but those publication venues with 1 or fewer articles are not listed in Table 6 for space considerations.

In the higher level of theory use subsample (TA, TC, or TG, n=26), the *Journal of the Association for Information Science and Technology* (with 6 times) is ranked first, followed by *First Monday* (with 3 times) at second, *Journal of Documentation*, *Journal of Librarianship and Information Science*, and *Journal of Korean Society for Library and Information Science* at third (with 2 times each). For the TA only subsample (TA, n=18), *First Monday* and *Journal of the Association for Information Science and Technology* are tied first (with 3 times) and the *Journal of Documentation* is ranked third (with 2 times). From the entire sample set, the *Journal of Documentation*, the *Journal of the Association for Information Science and Technology*, and *First Monday* are the most preferred publication venues for research using TIW.

4.3. Research Contexts

Table 7 briefly summarizes the contents of articles coded for TA, TC, or TG (n=26). Due to scope and space limitations, a more in-depth analysis and discussion of the contents of articles coded as TA, TC, or TG will be conducted and shared in a follow-up study. Full citations for the articles referenced in Table 7 can be found in the appendix. These summaries provide context for the findings shared.

[7]Of course, this journal was renamed to the *Journal of the Association for Information Science and Technology*; it is listed separately to be clear about the citation/source.

Table 7. TA, TC, & TG research article summaries

Level of theory use	Author(s)	Year	Brief summary
TA	Burnett, K., Subramaniam, M. M., & Gibson, A.	2009	Burnett et al. used TIW to analyze successful Latina IT professionals' perceptions of gender as a boundary object.
	Burnett, G., Whetstone, M., & Jaeger, P. T.	2013	Burnett et al. applied TIW to analyze personal health record interface.
	Känsäkoski, H. & Huotari, M. L.	2016	Känsäkoski and Huotari analyzed information behavior of families in childhood obesity care in the patient value creation process.
	Brattland, K.	2018	Brattland explored the information behaviors of three subreddits in discussing the Brock Turner case using the theories of rape culture, information worlds and communities of practice.
	Lee, J.	2019	Lee explores the political information sharing behaviors of opinion leaders on Twitter using the theory of information worlds and interviews.
	Pang, N., Karanasios, S., & Anwar, M.	2019	Pang et al. applied TIW to better understand the information behaviors of the older persons in rural Indonesia before, during, and after disasters.
	Ndumu, A.	2019	Ndumu examined the information behavior of Black immigrants in the U.S. focusing on the linkage between information overload (information behavior) and acculturative stress. Participants indicated that they were affected by the voluminous, dispersed nature of information in the U.S.; and by undertaking high-stakes tasks such as immigration procedures, finding employment, at times mastering a new language, and understanding cultural norms.
	Worrall, A.	2019	Worrall applied boundary objects and TIW for analyzing information behavior of users of Goodreads and LibraryThing.
	Welch, C.	2019	Welch applied TIW in the process of developing questions for interviews with LAM practitioners. In terms of information value, the interviews were deeply analyzed.
	Hollister, J. M.	2020	Hollister explored and examined the social information behaviors of role-players in MMORPGs by using TIW.
	Ndumu, A.	2020	Ndumu applied TIW for analyzing information overload of black immigrants. In the analysis section, TIW was used and suggestions to address information realities were made.
	Xie, J., He, Z, Burnett, G., & Cheng, Y.	2021	Xie et al. investigated how mothers exchange pregnancy- and parenting-related information in online communities. By using TIW, they found that mothers behaved normatively, had a common perception of information values, and engaged with interactions between online communities, offline communities, and lifeworld.
	Ndumbaro, F. & Ochieng, L.	2021	Ndumbaro and Ochieng used information worlds to understand married women' and maternal healthcare workers' access to information related to family planning.
TA, TG	Jaeger, P. T., Gorham, U., Bertot, J. C., Taylor, N. G., Larson, E., Lincoln, R., Lazar, J., & Wentz, B.	2014	Jaeger et al. applied the theory of information worlds to develop an online resource, LibEGov.org, and proposes bridges as a new concept to expand the theory.
	Froggatt, D. L.	2015	Lang studied the high school students' access to school libraries and academic success and integrated the theory of information worlds and social justice meta-theory to propose a theoretical model of the informationally underserved.

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Table 7. Continued

Level of theory use	Author(s)	Year	Brief summary
	Gibson, A. N.	2016	Amelia Gibson used TIW to analyze information behavior of parents of children with Down Syndrome and proposed a progressive model of health information seeking.
	Gibson, A. N. & Kaplan, S.	2017	Gibson and Kaplan used TIW for a framework guiding data collection and analysis. Based on the results, they provided a spatial model of information source preferences.
	Worrall, A., Cappello, A., & Osolen, R.	2021	Worrall et al. studied social and emotional motivations of online scholarly communication communities by using the theory of information worlds. They co-developed the codebook using codes informed by the theory of information worlds and used a grounded theory approach to analyze data and suggested an integrated socio-emotional paradigm for social informatics studies.
TP, TG	Yu, L.	2012	Yu critiqued Jaeger and Burnett's theory of information worlds for prioritizing social influence and overlooking self-agency and proposes an alternative conceptualization of the information worlds of individuals based on related theories (primarily Popper's (1972) three worlds concept) and interview data.
	Hovious, A.	2018	Hovious conceptualized the concept of transliteracy with the social perspective. TIW was used one of theories explaining the socially constructed behaviors.
	Lee, M. & Butler, B. S.	2019	Lee and Butler applied TIW for the development of the framework for the local information landscapes.
	Oh, C. & Butler, B. S.	2019	Oh and Butler developed a theory for local information behavior.
	Riley, F., Allen, D. K., & Wilson, T. D.	2022	Riley et al. conducted a case study of the information behaviors of a large-scale municipal project team which uses the theory of information worlds to discuss the findings and propose a related concept of information spheres.
TC, TG	Burnett, G.	2015	Burnett overcomes limitations of TIW by creating two new information domains (of the individual and of signification) and repositioning information worlds as the social information domain.
TC	Park, S.	2022	Park analyzed 14 dissertations using the theory of information worlds and provided findings about how the theory was applied and emergent themes.
	Hollister, J. M., Burnett, G., Lee, J., & Skinner, J.	2022	Hollister et al. recounts the approach used by a group consisting of three doctoral candidates and Burnett to develop a general codebook for the theory of information worlds to be used across research contexts.

TA, theory application; TC, theory conversation; TG, theory generation; TIW, theory of information worlds.

4.3.2. Author Keywords Analysis

Out of the sample of all 68 articles, 22 articles with no keywords were eliminated (n=46). The total number of keywords from 46 articles was 202. The top 3 most frequently appearing keywords included *information behavior/behaviour* (16 times), *information worlds/theory of information worlds* (8 times), and *information seeking/information seeking behavior/information seeking in context* (6 times). Following those, *information practice/practices* and *public library/libraries* appeared 4 times, and *information needs, online communities, information literacy* were counted 3 times. Many keywords, including *methodology, social inclusion, art-based methods, information overload, theory, interviews, mmorpg, role-playing, information value, information sharing, ethnography*, and *information inequality* appeared 2 times. Considering the focus of TIW was individuals' information values and information behaviors directed by certain social types and

associated social norms, articles with the top 3 keywords (30 out of 202, 14.9%) were focused on information behaviors (particularly information seeking) or TIW itself.

Those articles that applied TIW in empirical research (TA) or examined TIW in the forms of theoretical discussion (TC) or TG comprise a total of 19 articles with 86 keywords. The top 2 most frequently appeared keywords were the same: *information behavior/behaviour* (7 times), and *information worlds/theory of information worlds* (7 times). *Information seeking behavior/information seeking in context, online communities, social inclusion, information overload, information sharing, information literacy, boundaries,* and *immigrants* were respectively found 2 times. Lastly, articles coded TA form a total of 14 articles with 65 keywords. The top 2 keywords mostly shared are *information worlds/theory of information worlds* (5 times), and *information behavior/behaviour* (4 times). *Online communities, social inclusion, information overload, information sharing,* and *immigrants* were followed with a frequency of 2. The keyword analysis results are ranked across each sample in Table 8.

4.3.3. Research Methodologies and Populations of TA Articles

For research articles coded with TA (n=18), 8 (44.4%) use mixed methods (some combination of quantitative and qualitative methods); 7 (38.9%) use qualitative methods, 2 (11.1%) use a multiple qualitative methods design; and 1 (5.6%) use quantitative methods. Since many of the studies used mixed or multiple methods, the total number of data collection and analysis techniques is greater than the number of TA articles. For data collection, interviews, of any sort, were applied in most articles with 12 (36.4%) instances; surveys, of any sort, were used in 8 (24.2%); field research (field-site based observations or ethnographic methods) was applied in 7 (21.2%); and assessment (testing or evaluation) was applied in 2 (6.1%). Case studies, systematic literature reviews, focus groups, and mapping methods were each applied in 1 study (3.0% each). For data analysis techniques, 17 (56.7%) implemented some sort of qualitative content analysis; 6 (20.0%) articles used descriptive statistics (excluding the typical reporting of sample demographics), 6 (20.0%) used grounded theory; and 1 (3.3%) used inferential statistics.

It should also be noted that research methodology, data collection methods, and data analysis techniques were categorized based on the descriptions from the articles' respective authors or interpretations of the research team if these concepts were not explicitly stated. Relatedly, data collection methods and data analysis techniques reflect broad categories rather than specifically naming unique approaches or techniques.

In overlapping, non-exclusive categories, the populations of interest included 6 articles (33.3%) focused on social media users or online communities; 4 (22.2%) on working professionals; 4 (22.2%) on family units; 3 (16.7%) on women; 2 (11.1%) on children and young adults; 2 (11.1%) focused on immigrants in the United States; 2

Table 8. Keyword analysis

Rank	46 articles (all codes) with 202 keywords	19 articles (TA, TC, or TG) with 86 keywords	14 articles (TA) with 65 keywords
1	Information behavior/behaviour (16)	Information behavior/behaviour (7)	Information worlds/theory of information worlds (5)
2	Information worlds/theory of information worlds (8)	Information worlds/theory of information worlds (7)	Information behavior/behaviour (4)
3	Information seeking/information seeking behavior/information seeking in context (6)	Information seeking/information seeking in context; online communities; social inclusion; information overload; information sharing; information literacy; boundaries; immigrants (respectively 2)	Online communities; social inclusion; information overload; information sharing; immigrants (respectively 2)
4	Information practice/practices; public library/libraries (respectively 4)		
5	Information needs; online communities; information literacy (respectively 3)		

TA, theory application; TC, theory conversation; TG, theory generation.

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(11.1%) focused on public or government websites; and 1 (5.6%) article focused on seniors or the elderly. The population categories are overlapping and non-exclusive because some articles used mixed or multiple methods with different or multiple populations related to the phenomena or topics being researched.

5. DISCUSSION

5.1. Research Question 1 - Theory Citation & Use

Based on the citation and use trends reported in Findings Section 4.1, it appears that the overall awareness and use of TIW are trending upward, albeit at a low rate. Higher levels of theory use, such as TC, TA, and TG are also trending upward, but at even lower rates. However, it is important to note that the goal of the figures and R-squared values presented in Section 4.1 is to identify potential trends and not to make predictions, which would not be possible based on the limitations of this study's design, data, and sample size. While McKechnie et al. (2001), Pettigrew and McKechnie (2001), and Kim and Jeong (2006) found overall increases in theory use in the 1990s and early 2000s, Vakkari (2008) and Julien et al. (2011) reported downward trends in theory use and development. While the citation and use of TIW may be trending upward across all the theory talk categories, this study did not collect data related to other LIS theories, and as such, may not be indicative of the use of theory in LIS writ large.

The percentages of higher-level theory use (38.24%, TA, TC, or TG) are between the findings of Pettigrew and McKechnie (2001), who found that 34.1% of articles used theory, and Kim and Jung (2006), who found 41.4% of articles in their sample. Of course, those studies did not focus on a single theory, and applied different analyses on different samples at different times. However, if using the smaller subsample of only articles in the TA, which accounted for 26.47% of the overall sample, this rate is lower than the aforementioned studies but higher than historical studies from the 1980s and 1990s. While Kim and Jeong (2006) noted increases in theory use, articles focused on theory development were trending down. Aside from TA, the codes of TC and TG from the single theory talk model are closely associated with theory development, and both TC and TG articles trended upward, albeit slowly. TG articles were identified 11 times (16.18%). However, TC papers were the least common in the sample, with just 3 articles (4.41%) and the lowest R-squared value of all codes. While not focusing on TIW, Budd (2011) argues that, while challenging, continued research and debate about concepts and theories is important for LIS. Based on the findings, the authors would also encourage more theory and concept papers. TG papers were co-coded with 5 TP articles, 5 TA articles, and 1 TC article, suggesting that TG or development of TIW or related theories was or is not limited to empirical research. Again, these findings speak for the sample presented here and are not representative of the broader field.

5.2. Research Question 2 - Publication Trends, Affiliations, & Collaborations

Within the overall sample of any type or level of theory use, Huvila, a Professor at Uppsala University, appears to reference TIW the most. However, Huvila is not included among the other authors in the higher levels of theory use at all. The overwhelming majority of work related to TIW across all samples can be linked to Gary Burnett, one of the theory's creators, or to his current or former students, whether he was a direct dissertation advisor or committee member. As described in Hollister et al. (2022), several doctoral candidates worked with Dr. Gary Burnett to develop a general codebook for the theory based on three methodologically and topically different dissertations. The general codebook was shared with other students and scholars, both at Florida State University as well as at other institutions. Of course, other students and scholars have used TIW in their own way, without the codebook. However, this finding suggests that effective mentorship and collaboration during doctoral studies can promote the use of theory (Hollister et al., 2022).

Intuitively, the most active institutions and countries using TIW are associated with these same scholars, who are mostly situated at institutions in North America, primarily at Florida State University and the University of Maryland. However, there are some noticeable efforts in Europe and in the East Asia and Pacific/Oceanic regions. As data collection was limited to articles in English and Korean, expanding the scope to other languages and using databases that have broader coverage of international journals and journals published in other languages may have identified more relevant or related works using TIW. As the findings stand, however, greater efforts to collaborate and support scholarship in the Global South and other areas outside of North America, Europe, and East Asia are needed.

While most authors were based in LIS, collaborations spanned 7 other disciplines in the overall sample. Business and journalism/communications were represented in both of the narrower subsamples of higher levels of theory

use. Additionally, lead authors from other disciplines were identified in both the TA, TC, or TG subsample, with 1 in business and 1 in journalism/communication, and 1 in journalism/communication in the TA-only subsamples. While author order is not always indicative of an individual author's level of contribution to a manuscript and author order norms vary across disciplines, these findings may suggest that TIW is making its way into other disciplines, primarily through interdisciplinary collaborations.

Given the authors' discipline breakdown, it is unsurprising that the top journal venues across all samples are based in LIS. The top publication venues are mostly highly ranked journals in reputable indexes, suggesting that TIW is gaining exposure and use in highly visible journals with high impact factors. By identifying the publication venues as well as authors, affiliations, and disciplines associated with TIW, the authors hope to highlight the potential versatility of the theory, spotlight prominent and emerging scholars who have adopted it, and encourage further collaboration around TIW both within and outside of LIS.

5.3. Research Question 3 - Research Contexts

Aside from TIW being used as its own descriptive keyword in the research articles, the keyword analysis found that TIW is often described or associated with keywords related to information behavior and information-seeking behavior. However, other more specific types of information behaviors were used as keywords, such as information practices, information literacy, information sharing, and information overload.

The majority of articles coded with TA used mixed methods or qualitative methods, and both of the two articles that specified multiple methods approaches combined only qualitative methods. Only one of the studies was specifically focused on quantitative methods. Burnet and Jaeger (2010) note that TIW is intended to be amethodological and thus usable with whichever methods researchers deem best for their research questions. However, given the heavy focus on qualitative methods in the research articles so far, more quantitative studies could be conducted for further theory testing and development. Relatedly, propositions or hypotheses for TIW have yet to be officially published by Burnett and Jaeger (2010). Additional quantitative studies could help in their development.

Qualitative interviews and content analysis appear to be the most used methods for data collection and analysis with TIW in the research articles collected. Survey and field research were also common but to a lesser degree. Cross-referencing these findings with those from Park (2022), which exampled 14 TIW-using dissertations, sees similar trends: 7 used qualitative methods and 7 used mixed methods, with 10 overall using interviews. It should also be noted that 6 of the dissertations analyzed by Park (2022) overlap with 7 of the articles in the TA sample, meaning that 6 of the scholars successfully published a research article using TIW from their dissertations, and one published 2. This finding is also encouraging because publishing articles out of one's dissertation is highly encouraged and helpful for emerging scholars, especially those on the job market.

The TA research articles also focused on a variety of groups and communities in both online and offline contexts. Eight (44.4%) of the articles focused on marginalized or protected communities, such as immigrants, children or young adults, women, and seniors. This was also observed by Park (2022), who found that 7 or 50% of the dissertations focused on marginalized communities.

Given scope and space limitations, additional implications and applications of the findings from TA articles, as well as TC and TG articles, will be explored through content analysis in a follow-up study. This follow-up study will address how TIW has been used alongside other theories, frameworks, or models and how TIW has been developed or revised based on the findings.

5.4. Limitations

As mentioned, there are several limitations to this study. As stated in the Methods Section 3, the literature review screening and sampling process were limited due to the databases and full-text articles available through their respective institutional libraries, and the respective scope and coverage limitations of said databases and library collections. However, the researchers attempted to counteract this by using an effective search strategy as well as external sources and services like Google Scholar, email, or the academic social network ResearchGate,[8] to identify and secure additional access to full-text versions. The data collection period also ended in March 2022. Given the trends identified here, it is likely that relevant articles have been published between then and prior to the publication of this article.

This study also focused on the trends associated with a single theory, so the findings may not be representative or similar to general theory citations or use trends in LIS

[8] https://www.researchgate.net/

or other specific theories in LIS. Relatedly, while based on an existing framework, this study is the first to use the revised single theory talk model. To ensure its trustworthiness and accuracy, the authors revised and evaluated the codebook through multiple rounds of inter-coder reliability testing.

6. CONCLUSION & FUTURE RESEARCH

Despite the perceived dearth of LIS-originated theory, this study shines a light on a new theory that is gaining adoption and use across research contexts, methods, disciplines, and countries around the world. While this study only focuses on TIW, it demonstrates that new theories can and are making an impact. Building on the findings and discussion, the authors echo other scholars developing theory or studying theory use in LIS to call on LIS scholars and practitioners to embrace and engage with theory, especially newer ones, in their research and practice more actively.

Based on the findings and limitations of this study, there are multiple areas of future work to lengthen this research thread. First, the authors will conduct a content analysis of the research articles associated with TC, TA, and TG to explore their respective findings, implications, and applications to provide a more nuanced account of how TIW is being used and adapted. Another area of future research may include additional regional analyses of theory use, such as Kim and Jeong (2006) and Wu et al. (2017), to explore how TIW or other new theories have been applied in different regions and additional languages. Co-citation analysis or other bibliometrics analysis could also identify other research trends and patterns. Relatedly, the single theory talk model could be used to explore the use and impact of other newer theories in LIS, including information domains, which Burnett introduced in 2015 as an expansion of information worlds. While there is good reason for scholars to rely on and use established theories of information and information behavior, additional research on new theories being developed within LIS or imported from outside the discipline should be pursued.

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CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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APPENDIX.

Full citations of TA, TC, or TG-coded research articles in Table 7 (same order)

• TA-Only Articles

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• TP & TG Articles

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• TC & TG Articles

Burnett, G. (2015). Information worlds and interpretive practices: Toward an integration of domains. *Journal of Information Science Theory and Practice,* 3(3), 6-16. https://doi.org/10.1633/JISTaP.2015.3.3.1.

• TC-Only Articles

Park, S. (2022). A reflection on social perspective of information behavior: Around the theory of information worlds. *Journal of the Korean Society for Library and Information Science,* 56(1), 425-447. https://doi.org/10.4275/KSLIS.2022.56.1.425.

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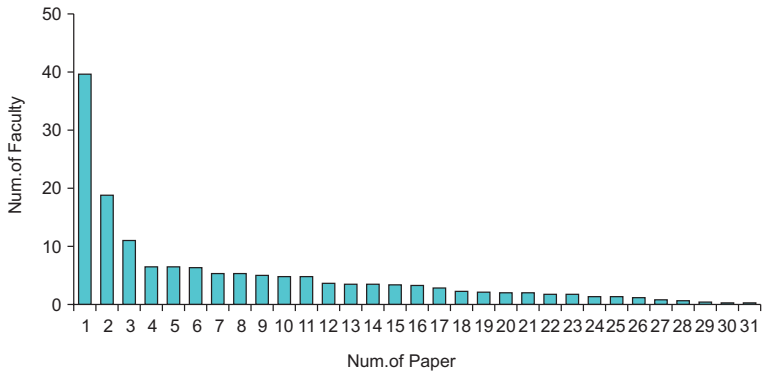


Fig. 1. Distribution of authors over publication count.

Table

Table 1. The title of table goes here

Study	Time period study	Data
Smith Wesson (1996)	1970 - 1995	684 papers in 4 SSCI journals
Reeves [a (2002)	1997 - 2001	597 papers in 3 SSCI journals
Jones Wilson [b (2011)	2000 - 2009	2,166 papers in 4 SSCI journals

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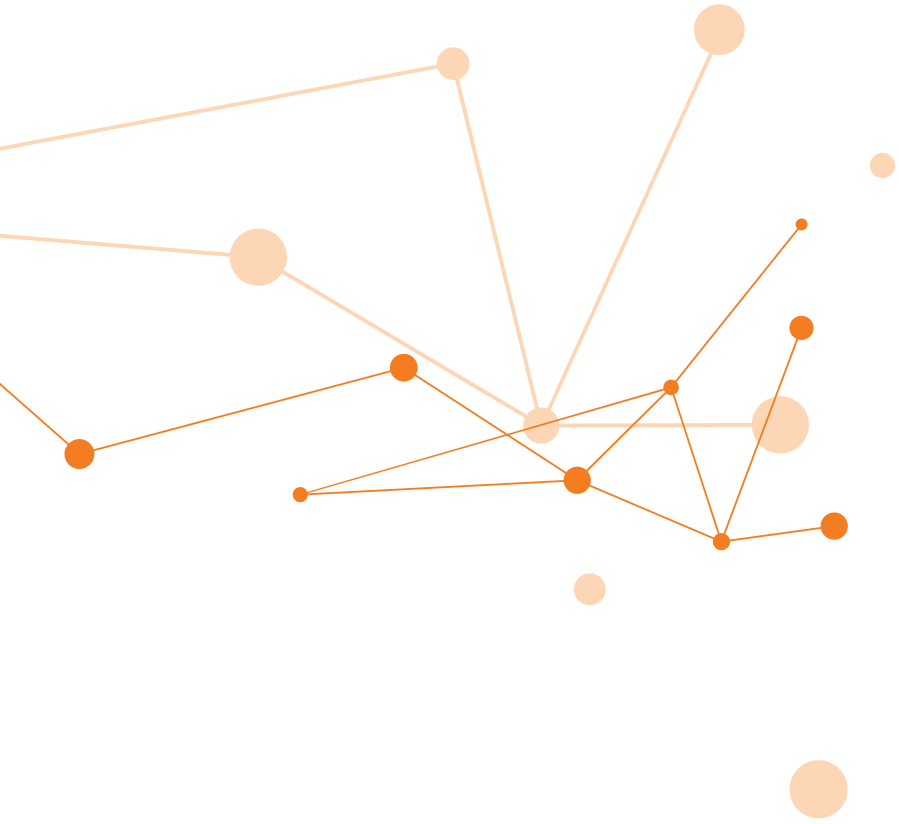
Journal article
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- Smith, K., Jones, L. J., & Brown, M. (2012). Effect of Asian citation databases on the impact factor. *Journal of Information Science Practice and Theory*, 1(2), 21-34.

Book
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- Smith, K. & Brown, M. (2012). Author impact factor by weighted citation counts. In G. Martin (Ed.), *Bibliometric approach to quality assessment* (pp. 101-121). Springer.

Conference paper
- Author, A., & Author, B. (Year, Month Day). Article title. In A. Editor & B. Editor (Eds.), *Conference title* (pp. xx-xx). Publisher Name.
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