

## Research Article

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# The Use of Academic Social Networking Sites in Scholarly Communication: Scoping Review

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**Abstract:** This research provides a systematic analysis of 115 previous literatures on the use of academic social networking sites (ASNs) in scholarly communication. Previous research on the subject has mainly taken a disciplinary and user perspective. This research conceptualizes the use of ASNs in scholarly communication in the space between social interactions and the technologies themselves. Keyword analysis and scoping review approaches have been used to analyze the comprehensive literature in the field. The study found a geographic variation in what motivates academics to use ASNs. Scholar discovery and sharing are the primary driving factors identified in the literature. Four main themes within the research literature are proposed: motivation and uses, impact assessment, features and services, and scholarly big data. The study found that there has been an increase in scholarly big data research in recent years. The paper also discusses the key findings and concepts stated in each theme. This gives academics a better understanding of what ASNs can do and their weaknesses, and identifies gaps in the literature that are worth addressing in future investigations. We suggest that future studies may also extend the existing theoretical framework and epistemological approaches to better predict and clarify the socio-technical dimensions of ASNs use in scholarly communication. In addition, this study has implications for academic and research institutions, libraries and information literacy programs, and future studies on the topic.

**Keywords:** scholarly communication, academic social networking sites, impact evaluation, openness, scholarly big data

## 1 Introduction

In the past two decades, the scholarly communication landscape has changed with the increasing popularization of information technologies. The advance in web technologies in particular has brought significant changes in the formal and informal strands of scholarly communication. Some of these changes include the (1) shift from print to electronic publishing; (2) emergence of open access publishing and institutional repositories; (3) shift in libraries from buying individual journals to subscribing publishers' electronic databases; and (4) popularization of using academic social networking sites (ASNs) (Hailu, Mammo, & Ketema, 2016; Nentwich & König, 2014; Shrivastava & Mahajan, 2017). With these changes, scholars and their institutions are expected to adjust themselves.

Social network sites (SNS) have been defined in a traditional sense as “web-based services that allow individuals to (1) construct a public or semi-public profile within a bounded system, (2) articulate a list of other users with whom they share a connection, and (3) view and traverse their list of connections and those made by others within the system” (Boyd & Ellison, 2007). The concept was subsequently expanded to emphasize the importance of user-generated content (Jordan & Weller, 2018). Academic social network sites (ASNs) are designed to bring the benefits of social networking sites to a specifically academic audience. ASNs assist scholars in their scholarly communication by facilitating open discussion, disseminate their published and unpublished works, ask question and reflect ideas, and facilitate collaboration and enhanced interaction (Bhardwaj, 2017; Gorska, Korzynski, Mazurek, & Pucciarelli, 2020; Manca & Ranieri, 2017b; Salahshour, Dahlan, & Iahad, 2016).

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Unlike static institutional research repositories, which have been used by researchers to deposit their research publications, ASNs are specifically designed to facilitate interaction between individuals within the academic space (Mason, 2020).

The use of ASNs has brought more pronounced changes in the scholarly communication sector. ASNs offer network-building and communication opportunities. Scholars can update themselves with respect to other scholarly publications, grants, co-authors, and also contact potential collaborators. In addition, it provides a forum for scholars to disseminate their published and unpublished works, exchange publications, discuss research-related issues, increase their scholarly visibility, and carry out objective self-assessment (ranking) within a specific discipline (D'Alessandro et al., 2020; Jordan, 2019b). In addition, ASNs provide opportunities for creating professional identity and self-marketing.

Currently, there are tens of ASNs with different degrees of popularity. ResearchGate (RG), Academic.edu, Mendeley, and Zotero are some of the most common ASNs. Overall, ASNs deliver five main services: online persona management, collaboration, publication dissemination, document management, and impact measurement (Vasquez, Karely, Bastidas, & Enrique, 2015). In recent years, the importance of ASNs has drawn the attention of many scholars and investors. For example, Bill Gates and his co-investors have invested US\$35 million in RG. Likewise, Elsevier, the publishing giant, has acquired the online reference management service, Mendeley, investing between US\$69 million to 100 million (Hoffmann, Lutz, & Meckel, 2016). These enormous investments on ASNs reflect their growing importance in science and research now and in the foreseeable future.

## 2 Problem Statement

The use of ASNs has gained the attention of many academics and their institutions. There is also a growing need to use ASNs-based metrics for scientific impact assessment. In addition, many researchers are developing innovative algorithms for improving ASN services and features, including recommendation systems, tools for extracting information, and predicting future scientific impacts. However, the knowledge about ASNs in the scholarly communication is very scattered throughout articles. Previous similar studies have selected papers only from the fields of library and information science (Kjellberg, Haider, & Sundin, 2016), educational technology (Manca, 2018) or

addressed user perspectives on how to integrate ASNs in scholarly practice only (Jordan, 2019a). Furthermore, the sparse and fragmentary nature of the evidence describing the experiences of academics on these platforms and the lack of understanding of the complex ways in which these platforms affect scholarly communication mean that it is necessary to systematically examine recent studies on the subject. Therefore, along with a comprehensive mapping of the various circumstances, a thorough understanding of the prevalent theoretical and empirical foundations and methodological approaches of current studies is needed. Identifying future study areas is also important. Hence, this study addresses the following two questions: (1) What are the characteristics of previous studies on the use of ASNs in scholarly communication? (2) What are the main themes of these studies?

## 3 Literature Review

Several studies have attempted to conceptualize theoretical frameworks and epistemological approaches to examine the relationship between technology and users' scholarly practice. In particular, in the field of information science, studying digital infrastructure for exploring users' information and communication process is well established (Borgman, 2007). In the field of educational technologies, few studies have investigated the practice of social and digital scholarships based on a theoretical framework developed in the education technology sector. Particularly, the concept of Networked Participatory Scholarship (NPS) is used to understand the emerging digital and social scholarship as "the emergent practice of scholars' use of participatory technologies and online social networks to share, reflect upon, critique, improve, validate and further their scholarship" (Veletsianos & Kimmons, 2016). Similarly, Manca (2018) examined ASNs as networked socio-technical systems reshaping scholarly practices and academic identity. Also, Greenhow and Gleason (2014) articulated the notion of "social scholarship," which includes social media affordances and their effect on the ways in which academia conduct scholarship through shared values like staff promotion and access to decentralized knowledge. Most of the existing studies largely conceptualize ASN use in scholarly communication from the disciplinary and user perspective, while its technological aspect is largely ignored.

There are two alternative viewpoints on how technology use is shaping scholarly communication.

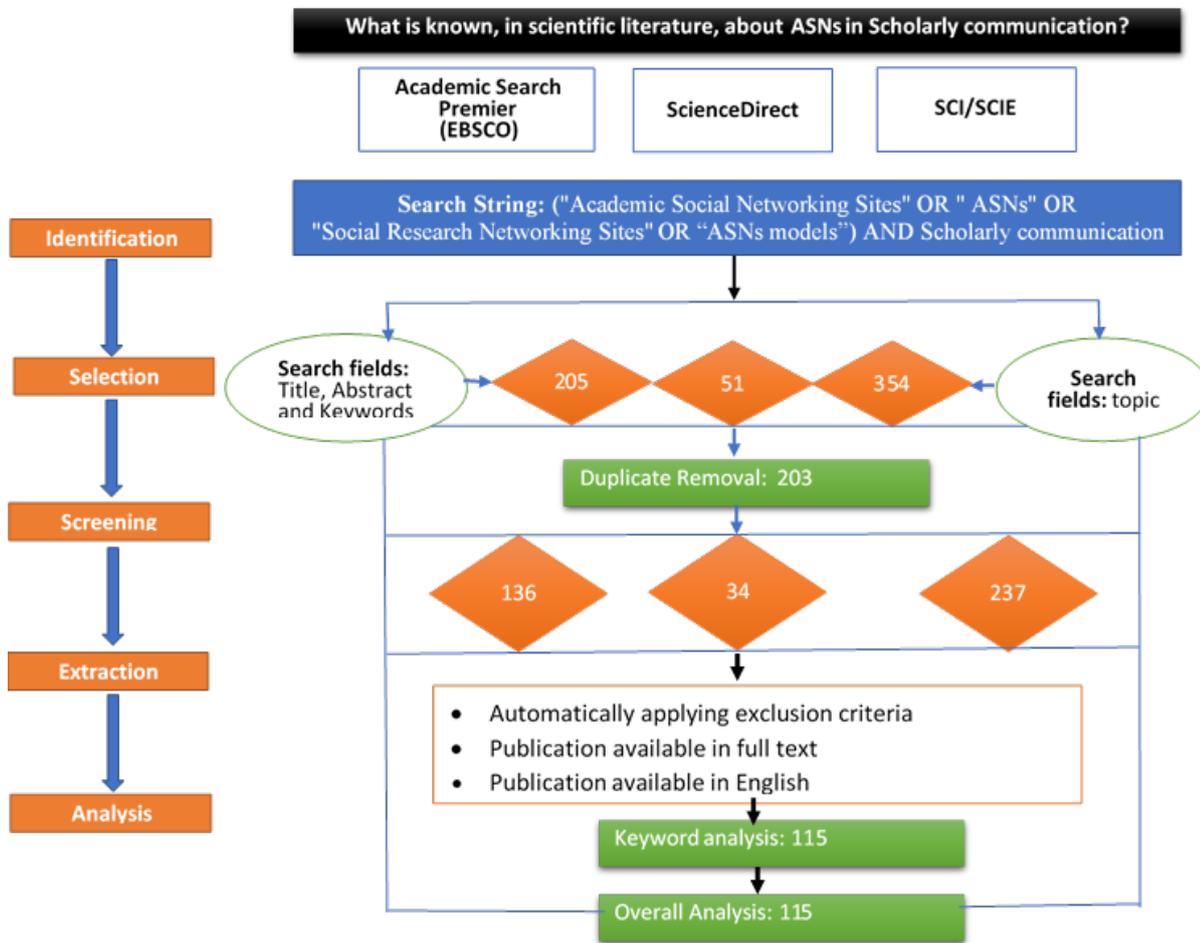


Figure 1. Study framework

The technology deterministic perspective considers that technology is by itself an autonomous system that affects all other areas of scholarly activities, hence academics behavior is solely shaped by technology (Weller, 2011). The alternate view argues that academics’ behavior is shaped by technologies and their will, attitudes, or ingenuity. Hence, the technology determinist viewpoint underestimates the human influence and the context in which the technology is used. This study adopts the alternative viewpoint which assumes that both social behavior and technologies are equally important in shaping human behavior. Many of the previous studies have taken users’ and disciplinary perspectives only (Greenhow & Gleason, 2014; Jordan, 2019a; Kjellberg et al., 2016; Manca, 2018). This study conceptualizes the use of ASNs in scholarly communication in the space between social behavior and technologies. This is made operational by selecting and reviewing of papers dealing with both the academic social behavior and the technologies themselves.

## 4 Method

There are different methods of conducting a review study and the appropriateness of the method depends on the study’s objective (Grant & Booth, 2009). This study employed the scoping review method because it is suitable for mapping expansive topics and identifying study gaps (Li, Marier-Bienvenue, Perron-Brault, Wang, & Paré, 2018; Paré et al., 2015). In particular, we have adopted the Paré et al (2015) scoping review methods and the research framework presented in Figure 1 is proposed to guide this study. The framework comprised the following five interrelated phases: identification, selection, screening, extraction, and analysis.

### 4.1 Identification

The following search strategy is formulated and used for searching the databases.

(“Academic Social Network\*” OR “Social Research Network\*”) AND (“scholarly communication” OR use OR motivation OR engagement OR self-archiving OR “digital scholarship” OR sharing OR modeling OR “digital scholarship”). The search was conducted on May 20–22, 2020.

The keywords are identified using a technique called concept mapping. Boolean operators are useful to operationalize the relationship between the selected keywords.

## 4.2 Selection

SCI/SCIE, EBSCOhost, and ScienceDirect academic databases are selected for finding the relevant papers in the topic. The Science Citation Index Extended (SCIE) encompasses more than 8,500 major journals, spanning 150 disciplines, from 1900 to the present. It owns world-leading science and technology papers due to the regressive selection process. Similarly, EBSCOhost (search. ebscohost.com) is a prominent aggregator of digital and full-text academic databases (Camilleri, 2017; Vasquez et al., 2015).

ScienceDirect (<https://www.sciencedirect.com>) is also Elsevier’s web-based electronic journals system, used to search information. It covers over 1,800 Elsevier journals, over 4 million articles, and over 59 million abstracts from all science fields (Tenopir, Wang, Zhang, Simmons, & Pollard, 2008). The three academic databases are selected because they (1) provide a gateway to multiple academic sources indexing above 5,000 publishers worldwide, (2) have peer-reviewed and compressive subject coverage, and (3) are accessible through our university library subscriptions.

## 4.3 Screening

A total of 610 papers were returned with the initial search results, of which 203 duplicates were identified and removed. However, within the limited time-frame of this study, the remaining 407 papers were too many to be reviewed. In order to further identify the most important papers, the following four exclusion criteria were thus used: (1) less than 3 pages; (2) editorial articles (non-original studies); (3) not linked to academic social networking; and (4) non-English-language articles.

## 4.4 Extraction

For further analysis, a total of 115 publications that met the above criteria were selected. Each article is read and the key points found in each study are encoded using a coding matrix. The coding matrix is a table used to annotate the title, purpose, problem statement, theory or traditions, methodological philosophy, research method, findings (relations to past research), and gaps found in each study.

## 4.5 Analysis

The data analysis is based on the following interrelated and well-established procedures used in scoping studies (Manca, 2018; Ritchie & Spencer, 2002):

**Familiarization:** Getting acquainted with the richness, scope, and variety of the collected data to begin the abstraction and conceptualization process.

**Theme identification:** Identification of key questions, concepts, and themes based on the selected material research notes. The researcher should draw on a prior issue (those told by the initial research questions), emerging issues, and theoretical themes arising from the recurrence or patterning of particular views or experiences. Furthermore, keyword analysis is also used in the theme identification process by identifying frequently used terms in the selected papers prior to the qualitative analysis. To this end, bibliographic data of selected papers were extracted and kept in CSV format. It was then translated into RIS format, and then fed to VOSviewer, an open-source software used to analyze the RIS database text corpus (Irawan, Brahmantyo, Puradimaja, Priyono, & Darul, 2018). The keyword clustering technique used in VOSviewer is known as community detection on weighted networks. The advantage of this method is that it unifies mapping and clustering approaches (<https://www.vosviewer.com/>).

**Indexing, charting, mapping, and interpretation:** This is the stage at which the research questions are addressed.

## 5 Findings

This section is organized into two main components in line with the proposed two research questions. In Part 1, the overall findings of the reviewed papers are summarized in tables and charts. Part 2 reveals the descriptive thematic analysis of the study.

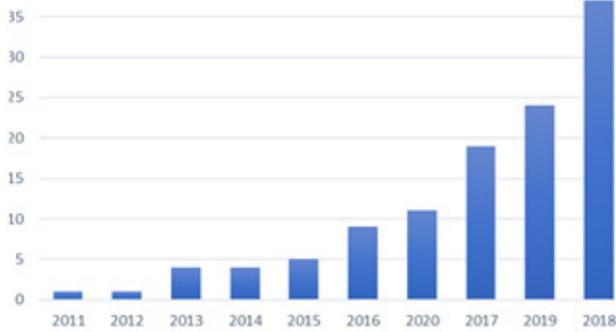


Figure 2. Papers per year

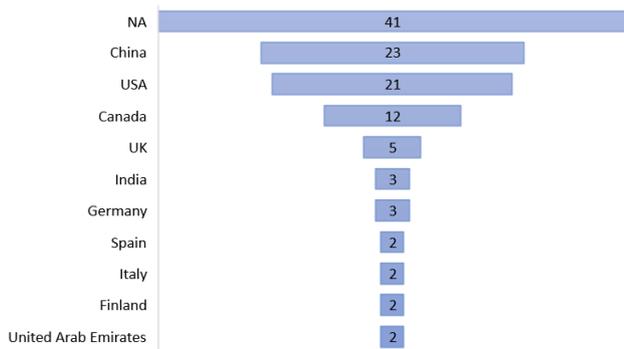


Figure 3. Papers by country specified

### 5.1 Characteristics of Publications

A total of 115 papers were collected from the databases, chosen from 5 book chapters, 20 conference papers, and 90 articles.

The number of publications increased from 2011 to 2018, and there was a significant increase from 2015 to 2018 in particular, but there were fewer publications in 2019 than in the previous year (Figure 2).

A total of 69 different journals have been extracted, of which only 14 have published two or more papers. Most of the conference papers come from the field of computer science and have been published by *IEEE*. The journals that contributed most of the selected papers include library and information science journals, computer science, information systems, technology for education, and marketing journals (Table 1).

China, the United States, and Canada dominate as the countries in which most of the first authors are centered. In general, in relation to author affiliations, only 25 countries are represented. In 41 papers, however, the affiliation information is not available (NA) (Figure 3).

Table 1  
Journals with More Than One Published Paper

Journals	Total
<i>Journal of the Association for Information Science and Technology</i>	11
<i>Scientometrics</i>	10
<i>IEEE Transactions on Emerging Topics in Computing</i>	6
<i>American Journal of Information Systems</i>	4
<i>Education and Information Technologies</i>	4
<i>IEEE Access</i>	4
<i>Online Information Review</i>	4
<i>Computers in Human Behavior</i>	3
<i>Information and Learning Science</i>	3
<i>Library Hi Tech</i>	3
<i>Future Generation Computer Systems</i>	2
<i>IGI Global</i>	2
<i>Journal of Informetrics</i>	2
<i>Journal of Marketing Management</i>	2

Most papers have reported the use of quantitative methods, with 30 papers reporting the use of qualitative methods and 24 mixed approaches. But only few studies state that the research is specifically situated in a certain theoretical context or concept. In this regard, Altmetric inquiry is widely reported in bibliometric studies, and human information behavior, scholarly information exchange, use and gratification theory, academic branding, scholarly norms, networked scholarship, and machine learning are the key concepts used and reported in two or more of the reviewed papers (Table 2).

### 5.2 Descriptive Keywords and Content Analysis

Keyword analysis provided insight into the main topics in the field using network visualization (Figure 4). Four major clusters were found and are highlighted in different colors.

The keywords are extracted from the title and abstract of the selected publications (Figure 4). The number of co-occurrences of two keywords is the number of papers in which both keywords appear together in the title, abstract, or keyword list. Put simply, the subtopics in each

**Table 2**  
Key Concepts Stated in the Selected Papers

Concepts	Description	Source
Scholarly Norms	Seniority is an advantage	(Manca & Ranieri, 2017a; Thelwall & Kousha, 2014)
Academic Branding	Employability, professionalism, and self-enterprise.	(Camilleri, 2017; González-Solar, 2018)
Use and Gratification Theory	Media consumers make decision based on cognitive, affective, and social needs.	(Borah, 2017; Meishar-Tal & Pieterse, 2017)
Scholarly Information Exchange	The use of ICT for conducting various academic activities sharing publication online etc.	(Goodwin, Jeng, & He, 2014; Jeng, DesAutels, He, & Li, 2017)
Altmetric inquiry	SNS may provide valuable insights to impact assessment.	(Ali, & Richardson, 2018; Haustein, Bowman, & Costas, 2016; Herman & Nicholas, 2019; Kiwanuka, 2015; Thelwall & Kousha, 2014; Yan & Zhang, 2018)
Human Information Behavior (HIB)	Peoples' information behaviors can be affected by various contextual factors	(Jeng et al., 2017; Yim & Shin, 2013)
Social Cognitive Theory	“people shape thoughts about themselves and the external world based on the nature of interaction in the platforms.”	(Hong, Lee, & Suh, 2013; Kiwanuka, 2015; Koranteng & Wiafe, 2019)
Networked Scholarship	“ use of participatory technologies and online social networks in scholarship”	(Manca & Ranieri, 2017b; Meishar-Tal & Pieterse, 2017; Veletsianos & Kimmons, 2012)
Machine Learning, Network Metrics and Data Mining	Design machine learning and other complex networking related algorithms	(Gao, Wu, Yan, Zhang, & Wu, 2020; Hassan, Iqbal, Imran, Aljohani, & Nawaz, 2018; Safder & Hassan, 2019)

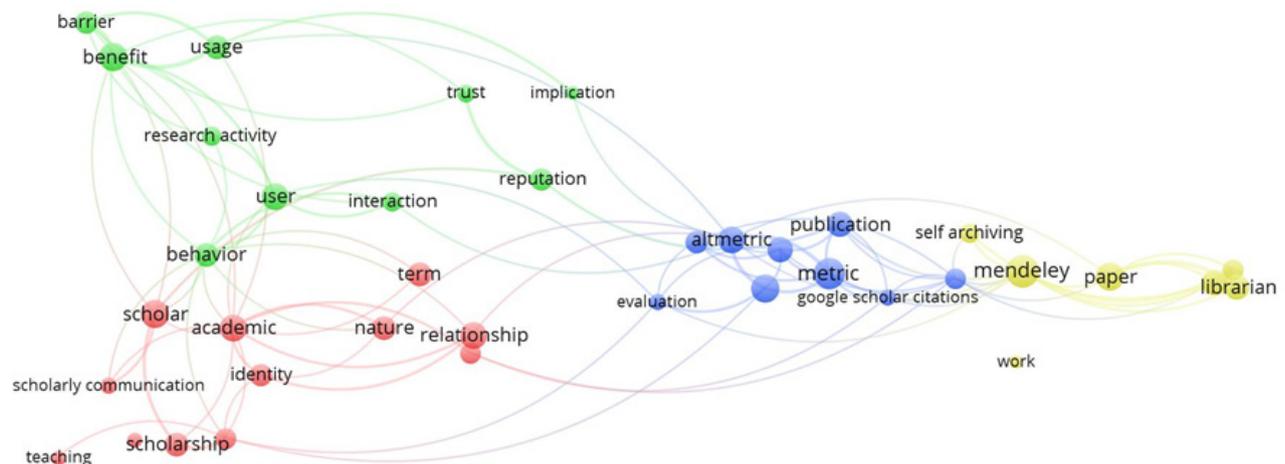


Figure 4. Networking based on keywords

Green cluster (GC) – subtopic: benefits, barriers, usage, behavior, and reputation.

Pink cluster (PC) – subtopic: scholarly communication, identity, scholarship, and relationships.

Dark blue cluster (DBC) – subtopic: altmetrics, metrics, publication evaluation, and Google scholar citation.

Yellow cluster (YC) – subtopic: Mendeley, self-archiving, and librarian.

**Table 3**  
*Thematic Classification of the Studies*

Theme	No	Papers
I	42	(Agarwal et al., 2016; Ali, Wolski, & Richardson, 2017; Allahar, 2017; Asmi, 2018; Asmi & Margam, 2018; Baro, Tralagba, & Ebiagbe, 2018; Bhardwaj, 2017; Calvi & Cassella, 2013; Camilleri, 2017; Conole & Alevizou, 2010; D'Alessandro et al., 2020; Deng, Tong, & Fu, 2018; González-Solar, 2018; Goodwin et al., 2014; Gorska et al., 2020; Greifeneder et al., 2018; Gruzd, Staves, & Wilk, 2012; Hoffmann et al., 2016; Jeng et al., 2017; Jordan, 2019b; Kapidzic, 2020; Koranteng & Wiafe, 2019; Laakso, Lindman, Shen, Nyman, & Björk, 2017; Manca, 2018; Martín, Orduna, & Delgado, 2018; Meishar-Tal & Pieterse, 2017; Ortega, 2017; Ortega, 2016; Ostermaier-Grabow & Linek, 2019; Li et al., 2018; Ponte & Simon, 2011; Radford, Kitzie, Mikitish, Floegel, Radford, & Connaway, 2018; Salahshour et al., 2016; Salahshour, Nilashi, Mohamed Dahlan, & Ibrahim, 2019; Singson & Amees, 2017; Vasquez et al., 2015; Williams & Woodacre, 2016; Yim & Shin, 2013; Ali & Richardson, 2018; Zheng, Wu, & Lv, 2019)
II	28	(Agarwal et al., 2016; Ali et al., 2017; Bai, Hou, Du, Kong, & Xia, 2017; Biljecki, 2016; Camilleri, 2017; Copiello & Bonifaci, 2019, 2018; González-Solar, 2018; Hoffmann et al., 2016; Hoffmann, Christian, Lutz, & Meckel, 2014; Kapidzic, 2020; Laakso et al., 2017; Lutz & Hoffmann, 2018; Martín et al., 2018; Ortega, 2017; Ortega, 2018; Ortega, 2015; Radford et al., 2018; Ram & Shalini, 2018; Shrivastava & Mahajan, 2017; Sugimoto, Work, Larivière, & Haustein, 2017; Vasquez et al., 2015; Yan, Zhang & Bromfield, 2018; Yan & Zhang, 2018; Yan & Zhang, 2019; Zahedi, Costas, & Wouters, 2017; Zheng et al., 2019)
III	17	(Bhardwaj, 2017; Chen, Dong, & Wang, 2018; Copiello & Bonifaci, 2018, 2019; Deng, Zhao, & Huang, 2018; Deng et al., 2018; Goodwin et al., 2014; Jordan, 2018; Laakso et al., 2017; Mohammad, Lazim, & Rosle, 2018; Ortega, 2017; Radford et al., 2018; Said et al., 2019; C. Sugimoto et al., 2017; Vasquez et al., 2015; Zhang, Zhang, Luo, Wang, & Niu, 2019)
IV	28	(Asabere, Xu, Acakpovi, & Deonauth, 2018; Bai et al., 2019, 2017; Biradar Sangam, Shekhar, & Reddy, 2020; Gao et al., 2020; Hassan, Akram, & Haddawy, 2017; Hassan et al., 2018; Ikram & Afzal, 2019; Liang et al., 2018; Liu, Huang, & Yu, 2019; Liu, Yang, Sun, Jiang, & Wang, 2018; Moravcsik & Murugesan, 1975; Nivash & Dhinesh Babu, 2018; Rathore et al., 2018; Ren et al., 2019; Safder & Hassan, 2018; Shen, Wang, Wang, Ji & Zhang, 2018; Song, Bi, Han, & Li, 2018; Sun, Lu, & Cao, 2019; Wang et al., 2017; Wang et al., 2016; Wang et al., 2019; Williams, Wu, Wu, & Giles, 2016; Wu, Sefid, Ge, & Giles, 2017; Zhang, Wu, Yan, Wang, & Zhang, 2020; Zhang & Kabuka, 2018; Zhang et al., 2018; Zhou, Liang, Wang, Huang, & Jin, 2018)

cluster demonstrate the co-occurrence of these terms in the reviewed papers.

The subtopics that appear in the two clusters (GC and PC) define the user’s experience of using ASNs and the form of scholarly activities that they undertake. This cluster is closely connected with our proposed Theme I (use and motivation) (see Section 5.3). On the contrary, the subtopics of the DBC cluster stipulate issues related to evaluating scholarly impact and the characteristics of the platforms. The DBC cluster subtopics are closely connected to the evaluation of the academic credibility of scholars and their institutions. It may also be linked to the assessment of the characteristics and features of ASNs. The DBC cluster is, therefore, closely related to our proposed Theme II (impact assessment) (see Section 5.4) and marginally related to Theme III (features and services) (see Section 5.5). The YC cluster, on the other hand, has no relation to any peculiar theme. In addition, similar subtopics have emerged in more than one cluster (e.g. scholar, user, academic, and librarian). Therefore, with keyword analysis alone, it is difficult to identify

themes correctly. Therefore, in order to define the themes, it is important to look qualitatively at each of the chosen papers using the methods outlined. Then, according to the following criteria, the selected papers were coded and analyzed:

- Author name, title, year, source type
- Type of platform
- Authors’ affiliation country
- Research approaches (quantitative method; qualitative method; mixed approach)
- Research questions
- Key arguments

Four themes are proposed and discussed in the study (Table 3). Some studies dealing with cross-cutting topics are assigned to multiple themes.

### 5.3 Motivation and Uses of ASNs (Theme I)

A total of 42 papers studied issues relating to the motivation of ASNs and their use. Quantitative approaches using surveys are the primary research methodology used in these papers. The following factors stimulated users to join and use ASNs: (1) connecting with colleagues, (Calvi & Cassella, 2013; Gruzd et al., 2012; Salahshour et al., 2016; Yousuf et al., 2018); (2) sharing/disseminating published and unpublished research works, (Baro et al., 2018; Conole & Alevizou, 2013; Gruzd et al., 2012); (3) acquiring materials, (Calvi & Cassella, 2013; Gruzd et al., 2012; Salahshour et al., 2016; Ali & Richardson, 2018); (4) knowing a number of accruing citations, (Rahmani & Asnafi, 2017; Ali & Richardson, 2018) (5) receiving more citations, (Conole & Alevizou, 2013); (6) collaborating with others, (Gruzd et al., 2012); (7) supporting openness, (Calvi & Cassella, 2013); (8) increasing one's visibility, (Baro et al., 2018) and (9) self-promotion and ego-bolstering (Meishar-Tal & Pieterse, 2017).

The main research questions presented in most of these studies examine how the usage of ASNs affects the formal and informal scholarly endeavors. The findings highlighted that ASNs are becoming useful in the entire research lifecycle for conception/discovery, information sharing/archiving, interaction, and other related activities (Meishar-Tal & Pieterse, 2017). Resource discovery is one of the major reasons that drive users to join ASNs (Calvi & Cassella, 2013; Ali & Richardson, 2018). Indeed, the importance of Web 2.0 for accessing scientific articles and educational materials was predicted a decade ago (Ponte & Simon, 2011). Much recently, Hagit Meishar-Tal & Pieterse (2017) attested that ASNs are mainly used for consumption of information, slightly less for sharing of information, and very scantily for interaction with others. The second important scholarly activity is interaction/exchanging information/networking. ASNs facilitate interaction and collaboration between researchers, and help them stay up-to-date with current knowledge in the field of study. These benefits are important for all academics, but especially for junior scholars who are still in the process of developing their network of peers, their professional image, and their portfolio of work and expertise (Camilleri, 2016; Greifeneder et al., 2018; Jeng et al., 2017; Jordan, 2019b; Manca, 2018; Martín et al., 2018; Ostermaier-Grabow & Linek, 2019; Singson & Amees, 2017; Zheng et al., 2019).

ASNs have made it possible to build personal and institutional brands that are important for the reputations of scholars and their institutions. They also provide avenues for mutual connection and research dissemination (Radford

et al., 2018). However, there are some moral and ethical dilemmas in integrating them into evaluating scholarly reputation (promotion activities). The ethical dilemmas are caused by the business interests of ASN companies. Hence, there is a call for open platforms to address some of these ethical dilemmas (e.g., ORCID). On the other hand, ASNs may incur a number of logistical problems, including time constraints and context collapse (Ali et al., 2017; Allahar, 2017; Baro et al., 2018; Bhardwaj, 2017; González-Solar, 2018; Goodwin et al., 2014; Yim & Shin, 2013).

ASNs provide ample advantages in academia, despite the ethical dilemmas of using them in scholarly evaluation. A recent study found a strong association between the presence of scholars in ASNs and international research collaboration (Gorska et al., 2020). The study surveyed 797 scholars who published their papers in the top 45 Management Journals of the *Financial Times* in 2013–2015. Data were collected and analyzed using negative binomial regression. The data analysis revealed that the study team's international collaboration was found to be strongly linked to the first author's presence on academic social networking sites (ASNSs), such as RG and Academia.edu. This finding implies that ASNs serve as a tool for building a digital footprint in academia. More importantly, the academics and their universities that are not yet internationally noticeable may benefit even more from international collaboration than universities that already have a strong reputation.

The emergence of ASNs has seen significant growth and changes in both science policy and academic publishing alongside the open access movement. In that sense, however, ASNs have been nearly forgotten from the context. Nevertheless, anecdotal evidence suggests that ASNs are complementing the traditional role of institutional repository in academic and research institutions. For instance, Laakso et al (2017) examined the use of ASNs in the Hanken School of Economics, 2012–2014. They found that the overall availability of publications in RG increased from 41% to 49% within the study period. Furthermore, ASNs turned out to be the most prevalent source of accessing full-text publications (93 out of 587 publications, 15.8%), with the majority being publisher version PDFs (70 out of the 93 publications, 75.2%). This result suggests that ASNs are an alternative medium for open scholarly dissemination, and their relevance in the wider scholarly communication environment can no longer be overlooked by academic and research institutions.

We found some contradictory findings about researchers' understanding of the value of using ASNs in scholarly communication. For example, Asmi & Margam

(2018) examined ASN usage in terms of popularity, benefits, and barriers among 200 social science researchers working in the University of Kashmir. The data analysis revealed that most researchers use ASNs on a daily basis. The major motives to join and use ASNs are to upload and share research, receive and provide feedback, and to have academic recognition and storing research in social bookmarking sites. On the contrary, Reoffender et al (2018) found that most researchers do not have an ASN profile. The study interviewed 81 researchers who suggested that it is unimportant for work, it does not belong to their culture or habits, and fear that negative representation may harm their career. However, this study did not outline whether or not researchers have decided not to have an ASN profile consciously.

These studies have also shown that academic, personal, professional, and technological factors decide the involvement of users in ASNs. Salahshour et al. (2019) found that trust, gender, experience, and age affected the intention to use ASNs, whereas effort expectancy did not influence behavioral intention. Jordan (2019b) pointed out that users' perceptions about the platforms are linked with their need for maintaining personal learning network, promoting the professional self, seeking and promoting publications, and advancing careers. Other studies, such as Kapidzic (2019) indicated that personal factors such as networking, career aspiration, social media use, and social media efficacy are stronger predictors of ASN use than demographic and academic factors.

There were concerns that most users of Academia.edu come from the humanities and social science disciplines, while RG users come mainly from the fields of science, technology, and medicine. For instance, Jordan and Weller (2018) found a disciplinary divide on scholars' preference in academia. Academia.edu attracted more scholars from the social science areas while RG attracted the attention of researchers from the biological fields (Deng et al., 2018; Ortega, 2016). However, ASNs are increasingly attaining more balance in disciplinary users' representations.

In this regard, Ortega (2017) conducted a longitudinal study to verify whether or not disciplinary representation in Academia.edu and RG is moving toward homogenization. The study collected longitudinal data from ASN profiles of 7,193 affiliated researchers in the national research center of Spain. Six consecutive quarterly samples were collected between April 2014 and September 2015. Existing evidence shows that ASNs are heading toward homogenization, that is, more stability is obtained by virtual spaces and they tend toward an atmosphere of equilibrium. Subsequent longitudinal studies will be needed to ensure that the virtual space in the equilibrium system is preserved.

Several studies in this theme outlined the list of barriers that scholars face to enter and use ASNs, among which privacy and security are stated as key barrier (Ali et al., 2017; Conole & Alevizou, 2013; Gruzd et al., 2012). Copyright policy, trust, privacy, and security issues are also mentioned in prior studies (Agarwal et al., 2016; Calvi & Cassella, 2013; Salahshour et al., 2016). Other barriers include lack of relevance to academic purposes, lack of quality content, being a dumping place (no restriction on the type of content users), plagiarism, no immediate professional benefits coming from participation, unmeasured activity, and information overload (Williams & Woodacre, 2016).

A recent commentary D'Alessandro et al. (2020) argued that ASNs are not a replacement for quality research or teaching. It contended that ASNs promote narcissistic behavior and researchers should use it with caution for self-promotion purposes. The study suggested that the following two good practices are helpful in maximizing the advantages of using ASNs: (1) keep correct records of their publications on Google Scholar, including removing publications that were wrongly credited to (2) post updates on at least one, or preferably two of the following ASNs: Research Gate, Academia.edu, or Mendeley.

Several studies have warned that academic papers accessed from ASNs could not be peer-reviewed (Meishar-Tal & Pieterse, 2017). In addition, spending time on these sites does not count as a recognized academic practice and does not give benefits to academics (e.g. promotions), which discourages further interaction and sharing of information on these networks (Agarwal et al., 2016; Asmi, 2018; C. Hoffmann et al., 2016; Koranteng & Wiafe, 2018; Meishar-Tal & Pieterse, 2017; Perron-brault et al., 2018; Vasquez et al., 2015). However, one of the distinct advantages of ASNs is self-archiving of published and unpublished papers as well as research data. Sharing such vital information is likely to increase recognition by peers that can help to boost the productivity of individual scholars and their affiliate institutions (Camilleri, 2017).

In conclusion, most studies in this theme have used a quantitative approach using surveys. Scholarly discovery is stated as the main motivation to join and use ASNs, (Calvi & Cassella, 2013; Ali & Richardson, 2018) but others have indicated sharing (Indian context) (Asmi & Margam, 2018). Others believe that the use of ASNs in scholarly endeavor is unimportant. We conclude, therefore, that the use of ASNs in academic communication depends on the context. Users from different countries and social backgrounds have shown different attitudes. A previous international study on academic communication behavior noted a geographical difference in the overall behavior

of academic communication that corroborates these findings (Jamali et al., 2014). Disciplinary imbalance is also present across the platforms of ASNs. Subsequent studies, however, demonstrate that ASNs are heading toward homogenization. In general, there is a distinction in the conduct of the use of ASNs between scholars found in different contexts. This calls for a comparative study to explore the usage of ASNs in the context of developed and developing countries and why such a distinction exists.

#### 5.4 Impact Assessment (Theme II)

A total of 22 studies have addressed pertinent issues related to scholarly impact assessment (Theme II). It focuses on assessing academic performance based on data obtained from the digital, interactive, and networked environment. These researches addressed interrelated issues such as impact assessment (Agarwal et al., 2016), institutional ranking (Ali et al., 2017), altmetrics, (Biljecki, 2016; González-Solar, 2018), and measuring institutional research intensity (Yan, Zhang & Bromfield, 2018). In these research studies, much of the research methodology is bibliometric investigation of scientific impacts. Two alternative approaches are mainly employed in these studies. The first approach focuses on examining user action on different platforms, while the second approach focuses on the comparative analysis of altmetrics with traditional measurement of scholarly reputation such as citation analysis.

ASNs generate large amounts of data collected from users' digital footprints and their activities. These data are in turn used for generating real-time metrics for evaluating scholarly performances. Furthermore, it has been used to gain new insights into the structure and dynamics of academic work, hence, increasing the transparency of scientific communities (Hoffmann et al., 2014). Traditionally, the success of a researcher is assessed by the number of publications he or she publishes in peer-reviewed, indexed, high-impact journals. The increasing availability of data and computational advances in the past two decades has led to an overabundance of metrics, and indicators are being developed for different levels of research evaluation (Agarwal et al., 2016). In addition, the new metrics are more useful since the traditional approach in scientific impact evaluations is criticized for not considering the relational dynamics and social capital formation (Hoffmann et al., 2014; Ortega, 2015).

Like the traditional approach in scholarly evaluation, the measurement of impact using ASN-derived data has posed an unprecedented challenge. One of the notable

difficulties is the presence of platform-specific dynamics. Thus, before incorporating the new metrics into scholarly evaluation exercises, it is crucial to understand well the meanings, shortcomings, and relationships with the traditional metrics (Hoffmann et al., 2016; Ortega, 2017). Sugimoto et al. (2017) argued that extending the reward system to scholars' activities in social networks might bring "gamification of research activities (following Campbell's law) and large-scale goal displacement."

Lack of transparency is stated as one of the major challenges to institutionalize metrics computed based on the ASNs. For example, one of the most popular ASNs, RG, has not made public how it computes performance scores (RG score). Hence, several studies have questioned which kind of activity is responsible for having a high RG score. In this regard, Shrivastava and Mahajan (2017) found that adding publications was the major activity that increases the RG score, whereas Yan and Zhang (2018) stated that the RG score is higher for highly cited authors and researchers who had published in reputed journals. However, Copiello and Bonifaci (2018) found that the main factor that influences the RG score is users' engagement instead of users' publications. Furthermore, the relationships among RG score, full-text publication uploaded on the platform, and its number of reads were examined by Copiello and Bonifaci (2019). They found that RG promotes an innovative model of academic reputation that values sharing with the scholarly community more than how much it is a significant contribution based on the traditional merit criteria. Hence, there is no conclusive result on what influences the RG score the most. In addition, these factors can also be platform specific.

Other studies have compared metrics generated from ASNs with the established metrics. For example, Hoffmann et al. (2016) examined the interaction patterns of Swiss management researchers using social network analysis. The study found that relational measures are related with established impact metrics, that is, platform engagement, seniority, and publication have high contribution to researchers' indegree and eigenvector centrality, but less to closeness or betweenness centrality.

Similarly, Martín et al. (2018) argued that metrics available in ASNs are becoming a more reliable measure of scholarly reputation. The study examined researchers' scholarly reputations across platforms and found strong relationships among their metrics. Sugimoto et al. (2017) examined author-level impact metrics of 2,010 faculties working in 257 universities in the United States and Canada from Google Scholar, RG, and Scopus. The study found statistically significant associations among author-level impact metrics in the three databases.

A number of studies argue that metrics generated from ASNs are not a reliable measure of scholarly performance. Lutz and Hoffmann (2018) examined the RG profiles of 292 Swiss business school scholars and analyzed it using social network tools. The result indicated that ASNs are not very social at all and barely interactive. In particular, more senior academics largely restrict their involvement to the listing of their publications. Also, Copiello et al. (2018) argued that RG is not a reliable indicator of scientific and academic reputation. But it is more of a tool for implementing the entrepreneurial strategy of the company. In a follow-up study, Copiello and Bonifaci (2019) found that the RG score is strongly correlated to overall reads and, to a less extent, to the ratio between full-texts deposited in the repository and over all research items. The study reaffirmed its prior findings which suggested that RG is not a reliable measure of scientific and academic reputation and is driven by the entrepreneurial strategy of a company.

Ortega (2018) evaluated the scholarly impact of 3,793 research articles published in 2013. The study collected metrics from Scopus Altmetric, PlumX, and Crossref Event Data. Then, it generated a random sample of 50,000 Altmetric IDs of which 44,141 records were retrieved from the public API ([api.altmetric.com](http://api.altmetric.com)). The study found disciplinary differences in Altmetrics-based evaluation of scholarly performance. Publications from the general category attracted more attention in social media. Furthermore, social science articles had better usage than physical sciences. The general articles were also more cited and saved than Health Sciences and Social Sciences. González-Solar (2018) found that there is a strong correlation between altmetrics at a journal level and the traditional journal evaluation indicators (impact factor and 5-year impact factor). Hence, publications with more altmetrics tend to have more impact factor and 5-year impact factor. The study examined the correlation between the cumulative altmetric score and the impact factor at the journal level.

Zahedi et al. (2017) examined whether or not Mendeley readership scores (RS) could predict the future citation impact of publications. The citation information was collected from the Web of science from papers published in five fields during 2004–2013. Precision-recall analysis method was used in the study to determine the correlation between readership scores and journal citation scores in highly cited publications. The study found that 86.5% (7,917,494) of the publication had at least one Mendeley readership. Furthermore, publications from 2010 onwards had shown increased density of readership versus citation scores. Thus, readership scores had been more prevalent

in recent publications and hence they could work as predictors of research impact.

A few studies have suggested universities can strengthen their institutional profiles in ASNs using existing resources and existing research outputs (Camilleri, 2016). This calls for further understanding of whether or not metrics found in ASNs can be applied for ranking universities like QS University, TIME, etc. In this regard, Ali and Richardson (2017) examined the rankings of universities in Pakistan by comparing the traditional and new approaches. In the traditional approach, metrics were extracted from QS University Rankings-Asia 2016 while ASN metrics were extracted from the RG profiles of the respective universities. The study found that there is no direct relationship between the two approaches. However, strong alignment was found between lower ranked institutions and their respective institutional RG score. Similarly, Ram and Shalini (2018) suggested that altmetrics is yet to replace the traditional metrics of measuring institutional performance.

There is evidence suggesting that metrics generated from ASNs can be used to evaluate the research performance of universities. In this context, Yan and Zhang (2019) examined the RG profiles of US faculties and the research performance of their institutions. The study used Carnegie Classification of US universities for selecting faculties from A, B, and C level universities. These levels are indicators of the university's strength in research. Thus, 68,059 faculties were selected across the levels using train crawler ([locoy.com](http://locoy.com)) for extracting ASN metrics from the faculty's RG profile. The data analysis showed strong and positive alignment between faculties' RG score and their level of research activities. Conversely, there was similar clustering between faculties and the expected research-activity level reproducing existing hierarchies. Hoffmann et al. (2016) proposed the use of social network analysis as proxy metrics of scientific impact. They found that seniority and publication impact contribute to members' indegree and eigenvector centrality on the platform, but less so to closeness or betweenness centrality.

We found that metrics generated from ASNs have benefits as well as shortcomings. The benefits are they (1) address the challenges of the traditional scientific impact evaluation using citations by considering the relational dynamics and social capital formation, (2) increase transparency and provide new insights into the structure and dynamics of academic works, and (3) are effective at measuring the scholarly performance of users in research-intensive universities. However, there are concerns regarding the reliability of these metrics. First, it is difficult to incorporate them in academic exercise

because of the presence of platform-specific dynamics, which are owned by private business companies. Second, no one knows about the sustainability of these services; evidence shows that a number of ASN platforms were discontinued in the past. Furthermore, embracing the platform in academic evaluation exercise at academic and research institutions may bring large goal displacement or gamification of research activities. However, further research is still required to study the reliability of these metrics in various academic communication scenarios aimed at researchers, librarians, and research managers employed in institutions at different levels of research intensity in developed and developing countries.

### 5.5 ASN Features and Services (Theme III)

Studies in this theme investigated the features and services of ASNs. A total of 17 studies are incorporated under this theme. These studies primarily investigated the feature and services of RG, (Bhardwaj, 2017; Chen et al., 2018; Copiello & Bonifaci, 2018, 2019; Mohammad et al., 2018; Ortega, 2017) Academia.edu, Mendeley, and Zotero, (Bhardwaj, 2017; Mohammad et al., 2018; Sugimoto et al., 2017) General ASNs (Jordan, 2018; Laakso et al., 2017; Radford et al., 2018; Sugimoto et al., 2017).

ASNs provide different services and features. The major services are useful for online personal management, collaboration, research dissemination, documents management, and impact measurement (Vasquez et al., 2015). ASNs often have various types of features depending on the individual platform, but with the complex and competitive market climate, these features are evolving. Questions and Answers, Searching and Browsing facility, Site Navigation and Session Filters, Output Features, Privacy Settings and Text Display, Social Tagging System and Recommendation Systems are some of the common ASN features.

The Question and Answer (Q&A) feature is one of the popular features that help to reinforce interactions among scholars (Deng et al., 2018). The study highlighted that Q&A is a very important feature for enhanced interaction between scholars through the promotion of the recommendation mechanism, the classification of questions, and the reinforcement of emotional experience.

Bhardwaj (2017) undertook a comparative analysis of the features and services of RG, Academia.edu, Mendeley, and Zotero. The study found that site navigation and session filters feature were not available in all of the platforms. Furthermore, RG was rated the highest in terms of the features and services followed by Academia.

edu and Mendeley. The searching and browsing facility of Mendeley was rated the lowest. On the other hand, all platforms prohibited users from defining their privacy settings except Zotero. The study suggested integrating new features such as session filters, output features, privacy settings and text display, and search and browsing fields across ASN platforms.

A recent study suggests that developers are incorporating robust features that connect users with common understanding and values in order to bring about the desired behavioral changes (Wiafe, Koranteng, Owusu, Ekpezu, & Gyamfi, 2020). Such persuasive system features are regarded as one of the common feature innovations adopted in the platforms to bring a change in attitude and behavior. Hence, ASNs are adopting some type of persuasive system features that exploit the social impact to purposely induce prescribed behaviors on their users. Wiafe (2020) used the theory of social capital and the model of persuasive systems design to investigate these influences of the persuasive system on academic social networking sites for knowledge sharing among students of tertiary institutions. The findings indicated that the systems feature drive the perceived support for discussion and social support, which have significant effects on the conduct of information sharing.

Examining ASN features and services may also help to understand the user's perceived acceptance, usefulness, as well as the reliability of these services. Mohammad et al. (2018) evaluated the features and services of RG, Academia.edu, Mendeley, and Zotero. The study found that the highest percentage of page views per user was observed in RG and Academia.edu. RG had the highest traffic ranking (227), followed by Academia.edu (591), Mendeley.com (4,930), and Zotero.org (13,987). The reliability of the features of RG was also assessed by Chen et al. (2018). The study selected two RG features: The Social Tagging System and the Topic-Graph Based Recommendation System. The data analysis pointed that these features are reliable and a clear correlation was found between the RG recommendation's co-occurrence baseline and the Topic-Graph Based Recommendation. Also, Goodwin et al. (2014) explored how the overtime improvements in RG communication interfaces were viewed by RG participants. The study showed that a high degree of user acceptance was reached by the changes made to the RG contact interface over time. These findings illustrated the importance of the features and the tremendous efforts made by the companies to upgrade the platform's service on a regular basis to gain the academic community's trust and acceptance.

ASN features attract different group dynamics. For example, Said et al. (2019) examined the structure of scholarly communication in Twitter. The study collected 1.4 million tweets, corresponding to 77,757 scholarly articles. The study also determined whether or not Twitter features are appealing to individual scholars, journals, or organizations. The data analysis revealed field-wise high intra-connectivity, resulting in a field-wise community structure. Large communities are dominated by organizational accounts associated with journals, while small communities are dominated by experts in the field. Thus, there is a high level of association among organizational accounts associated with highly reputable journals, such as *PLOS One*, *Nature*, and *Science*. Hence, ASN sites may consider to show the structure of the network and to determine the community network structure.

RG's services and features are evolving dynamically (Vasquez et al., 2015). Some of these main features include Questions and Answers, Searching and Browsing facility, Site Navigation and Session Filters, Output Features, Privacy Settings and Text Display, Social Tagging System, and Recommendation Systems. Furthermore, it implements a persuasive system to induce a behavior change on the users (Wiafe et al., 2020). However, more studies are needed to identify how these changes are shaping the user's characteristics in the platform. The Q&A feature enhances the scholar's interaction through the promotion of the recommendation mechanism (Zhang et al., 2019). Longitudinal studies are also needed to assess the changes on the features and services of ASNs over time. Furthermore, more studies are required to identify how the dynamically evolving features and services of ASNs influence users' acceptance across platforms and different user groups.

## 5.6 Scholarly Big Data (Theme IV)

A total of 28 papers have addressed different issues regarding scholarly big data. This theme has emerged due to rapid growth in the ability of network platforms to gather and transport huge quantities of academic data in different formats from different scholarly sources (Zhou et al., 2018). Hence, scholarly big data represent millions of authors, papers, citations, conferences, and large-scale data such as author and research networks availed through ASNs (Asabere et al., 2018). The following subthemes have emerged in the study: recommendation systems, future impact assessment, information extraction, and data storage and protection, which are discussed below.

### 5.6.1 Recommendation Systems

One of the key research subjects in academic big data is recommender systems. Collaborator recommendation and conference recommendation systems are popular recommendation systems for academic big data. Collaborative filtering, Content-based filtering, Context-awareness, and Hybrid are the main techniques used in developing recommendation systems and algorithms. Trust and social properties are also used for improved recommendation accuracy (Asabere et al., 2018). Generally, the academic recommendation system provides citation recommendation, collaborator recommendation, and conference recommendations. The citation recommendation can be classified into local citation recommendation and global citation recommendation (Zhou et al., 2018).

In the scholarly big data setting, several studies have proposed successful recommendation methods. Liu et al. (2018) put forward the group recommendation method in the big data context in order to facilitate academic group activities in big data-based library systems by recommending articles. The study proposed collaborative matrix factorization (CoMF) mechanism and implemented paralleled CoMF using the Hadoop framework. The proposed model outperformed the baseline algorithms used in the study in terms of accuracy and robustness. The scalability evaluation of paralleled CoMF shows its potential value in the scholarly big data environment.

Liang et al. (2018) proposed an algorithm-based recommendation system using the topic model for cross-disciplinary scientific collaboration. Collaboration patterns are examined by analyzing correlations of research fields. Model evaluations based on real datasets showed the proposed model to be more efficient. On the other hand, Asabere et al. (2018) proposed a recommender algorithm for scholarly big data in a smart conference named as Socially-Aware Recommendation of Venues and Environments-2 (SARVE-2). The algorithm uses the closeness centrality method to compute the shortest distances/paths between a target attendee and the presenters at the smart conference. This is followed by the Breadth First Search (BFS) and Depth First Search (DFS) strategies. The proposed method performed better than the compared relevant baseline methods.

Wang et al. (2019) proposed a model to predict the extent of collaborator recommendation using the extreme gradient boosting-based prediction model named CSTeller. The data included experiments on two scholarly datasets and demonstrated their effectiveness. The proposed model is envisaged to benefit many

practical issues such as collaborator recommendation, as a scientific collaboration is not a one-shot deal. Using a similar approach, Zhang et al. (2020) proposed a method for recommending potential friends for scholars using academic social networks. It is designed based on the framework network embedding, where the scholar attributes and network topology are jointly embedded via the attributed random walk-based graph recurrent networks. Thus, developing a recommendation system is a vibrant study topic and future studies are required to outperform the existing algorithms.

### 5.6.2 Measuring Future Impact

The big data perspective is emerging as a means of measuring current and future scholarly impact using the machine learning and data mining approach. Evaluation scholarly impact has two dimensions: an article's past impact and future impact. Citations are a common indicator of article impact. Nonetheless, it only focuses on the article's past dimension. Future impact prediction is a growing field of research area. In comparison with impact assessment, impact prediction is more likely to be relevant in identifying projected funds; scientific awards and other decisions can be allocated directly (Bai et al., 2017).

In recent years, several studies have proposed future impact prediction models. Zhang et al. (2018) proposed PePSI: a solution for personalized prediction of scholars' scientific impact through classifying authors based on their citation dynamics. The study applied random walk algorithms for predicting impact in varying temporal academic networks and time. The real data experimentation of the PePSI solution and other similar models have been successful in predicting top researchers and the overall impact of scholars with a rather short-term academic information as opposed to the current prediction methods (Nivash & Dhinesh Babu, 2018; Ren et al., 2019; Zhang et al., 2018).

Several studies proposed algorithms that are useful to recognize scholars who have demonstrated their intellectual ability in their early careers. In this regard, Ren et al. (2019) suggested a model called the "Academic Potential Index (API)" to predict the future scholarly capabilities of young scholars. With extensive experiments based on the Microsoft Academic Graph dataset, the proposed index is able to effectively evaluate the academic potentials of scholars and captures the tendency toward variation of their academic effects. Furthermore, the proposed index highlights the rising stars in academia. The testing with actual datasets indicated that the API

model showed a high level of accuracy in recognizing potential scholars. Similarly, Liu et al. (2019) proposed a metric that can be used for predicting scholarly success among the beneficiaries of the National Science Fund for Distinguished Young Scholars of China in the field of computer science. The metric used the big data co-authorship network followed by the Back Propagation Neural Network. The experimental results found a better precision rate, recall rate, and F1, which suggests that the model has good performance in award prediction. Bai et al. (2019) questioned the influence of the actual geographic distance on the future impact of scholarly papers. The study applied the law of geographical proximity, cross-institutional citations and quantum PageRank algorithm and succeeded at empirically measuring the impact of the selected scholarly articles (Moravcsik & Murugesan, 1975).

### 5.6.3 Information Extraction

Scholarly information extraction is one of the key topics in the studies grouped in Theme IV. Various open-source and commercial resources are developed for extracting academic information such as SVMHeaderParse, Grobid, ParsCit, and CiteSeerX. In addition, a number of studies have proposed novel systems for scholarly information extraction. For example, Safder & Hassan (2019) proposed a deep-learning-based system for extracting full-text publications. The system employed a search technique that classify algorithm-specific metadata, such as accuracy, precision, and recall. The test result of the proposed deep-learning based method with real data showed that the LSTM model outperformed the support vector machine (SVM) by 9.46 percent with a 0.81 F-measure in the classification of 37,000 algorithm-specific metadata lines, annotated by four human experts.

Biradar Sangam et al. (2020) proposed a search system that automatically extracts algorithm information from the Scholarly big data. The proposed system automatically searches for pseudo codes, performs indexing, analysis, and ranking using a novel collection of procedures, including rule-based methods, and machine learning methods for the detection, separation, and extraction of measured algorithms. Mixing troupes are especially used to achieve productive results using machine learning systems.

A few studies have examined how to extract knowledge from advisor–advisee relationships using the deep-learning approach. Academic scholars are involved in various social relationships such as relationships between advisee and advisor. Such relationship analysis

may provide useful information for understanding the relationships between scholars as well as providing other researcher-specific applications such as recommendations for advisors and identification of academic rising stars. However, in most cases the raw data of high-quality advisee–advisor relationship is not available. The co-authorship network (Gao et al., 2020) and deep-learning-based (Wang, Liu, et al., 2019) approach are often employed in advisor–advisee relationship identification. The deep learning method takes into account both the local properties and the network characteristics.

Wang et al. (2016) proposed a learning-based model to investigate advisor–advisee relationships. The study used Stacked Autoencoder (SAE) as the foundation of the methods. The experimental results in the study showed that this model is more effective than the classical machine learning methods. Similarly, Wang et al. (2019) proposed Shifu: a deep-learning-based advisor–advisee relationship identification method that takes into account both the local properties and the network characteristics. In particular, the model explored advisor–advisee pairs from the PhD tree project and extracted their publication information by matching them with the experimental dataset. The proposed method outperforms other state-of-the-art machine learning methods in precision (94%). Furthermore, Shifu was applied to the entire DBLP dataset and obtain a large-scale advisor–advisee relationship dataset.

Gao et al. (2020) proposed a novel method of “advisor–advisee” recognition based on dynamic network embedding. This study used the web-based embedding of attributes of academics and dynamic network-based embedding academic vectors as the input of supervised “advice relationship” learning approaches. Experimental results on the real-world dataset showed that the proposed method can deliver the best performance compared with prior methods. Wu et al. (2017) established a supervised machine-learning method to match entities in a target database to a reference database, which can be used further to extract and clean the target database metadata. Zhang & Kabuka (2018) proposed a knowledge graph-based modeling system for extracting scholarly big data. The proposed model strived to capture network relationships that include network attributes in graph nodes and edges.

#### 5.6.4 Data Protection and Storage

Issues regarding data protection and storage are less discussed in the papers reviewed under this theme.

Only Shen et al. (2018) proposed a third-party-aided, searchable, and verifiable data protection scheme that relies on cloud computing technology. The proposed model separates users according to their roles. On the basis of the novel system model and data structure, the model helps users to review the integrity of their uploaded or downloaded data at any time and search the online scholarly data with encrypted keywords. The security analysis and performance simulation demonstrate that the proposed model is secure and efficient for scholarly big data applications.

The other emerging subtopic in scholarly big data is storing, indexing, and querying the vast quantity of research outputs. The relational databases are not flexible to accommodate the vast amount of scholarly data while the NoSQL databases lack sophistication in index and partition mechanisms (Sun et al., 2019). In this regard, Song et al. (2018) proposed a Hadoop-based key-value data store that showed the performance advantages of both relational database and the flexibility of a NoSQL database as well as the parallelism of a distributed file system. The proposed model partitions and indexes the bibliographical information using the concept of facets. It also provides the attribute-specified and attribute-unspecific queries. In testing, the model was compared with Hive, HBase, MongoDB, and Cassandra in terms of query performance. The experiment results indicate that FacetsBase performs 1.4×, 3.8×, 1.4×, and 2.9× faster on average. Moreover, an innovative cube data storage structure is proposed for scholarly big data (Shen et al., 2018). The study by Rathore et al. (2018) proposed the parallel processing mechanism of the Hadoop ecosystem along with the real-time analysis approach from Apache Spark with Graph for big graphs generated by a huge number of scholarly related relationships. In conclusion, the Theme IV studies primarily looked at issues related to the recommendation systems, future impact evaluation, information extraction, and data security and storage. There is a rise in research on this subject and most of them are presented in conference papers and have been published in the past two years.

## 6 Discussion

The goal of this study was to analyze the existing literature on the use of ASNs in scholarly communication, and 115 papers were systematically selected and examined. Many of the selected studies have been published by journals in the fields of library and information science, education technology, computer science, and

marketing. In total, however, there were 69 different multidisciplinary journals which published papers on the subject, indicating that the subject has drawn the attention of multidisciplinary researchers. It also implies that the selection of the papers was made from a multidisciplinary academic database (SCI/SCIE, ScienceDirect and Ebscohost). In 2019, fewer research articles on the subject have been published than the previous year. If this pattern continues, it could mean that the subject in general is becoming less prevalent and exhausted, while the subtopics of scholarly big data are likely to gain more prominence as most of the papers on scholarly big data (Theme IV) are published in 2019/2020.

The use of quantitative and bibliometric methods is reported in most of the reviewed papers. Fewer papers have explicitly mentioned the use of certain theoretical underpinnings. In this regard, altmetric inquiry, human information behavior, scholarly information exchange, use and gratification theory, academic branding, scholarly norms, and networked scholarship are the key concepts mentioned in the reviewed papers (Ali et al., 2017; Borah, 2017; Camilleri, 2017; Gao et al., 2020; González-Solar, 2018; Goodwin et al., 2014; Hassan et al., 2018; Haustein et al., 2015; Herman & Nicholas, 2019; Hong et al., 2013; Jeng et al., 2017; Kiwanuka, 2015; Koranteng & Wiafe, 2018; Manca & Ranieri, 2017a; Hagit Meishar-Tal & Pieterse, 2017; Safder & Hassan, 2019; Thelwall & Kousha, 2014; Veletsianos & Kimmons, 2012; Wang et al., 2019; Wu et al., 2017; Yan & Zhang, 2018; Yim & Shin, 2013). The diversity of these theoretical and conceptual orientation reaffirms that ASNs have attracted the interest of scholars from multiple disciplines. China, the United States, and Canada-centered writers have dominated the authorship, but most studies did not examine the situation in specific countries empirically. This could suggest that the scenario is being examined at a global level. However, it may also mean that, in terms of culture and social context, the phenomenon is not largely studied.

The second part of the finding analyzed the papers thematically. It showed that the field is under development and scholarly big data, in particular, has become an emerging research topic. Most of these studies are descriptive in nature. Perhaps, this may explain why some studies prefer to use a certain theoretical underpinning. However, we did not find a unified theory that explains the use of ASNs in scholarly communication. There is also inconsistency among studies on how they chose the type of ASNs, often based on convenience, while RG, Academia.edu, and Mendeley are often considered mostly. This has made it difficult to examine the studies based on the evolution of these platforms.

The main reason for university academics to join ASNs is finding scholarly content (Ali et al., 2017; Asmi & Margam, 2018; Calvi & Cassella, 2013; Ali & Richardson., 2018). This may have implications for the provision of library services in academia. Perhaps libraries may not have enough access to academic databases in compliance with the needs of the academics or that the information literacy program of the libraries is not strong enough. This calls for libraries to extend their access to academic databases or to make a concerted effort to market their academic databases better. Above all, this implies that libraries can no longer neglect the impacts of ASNs in the scholarly communication landscape and they need to reposition themselves to embrace these changes. For example, academic and research libraries might consider to (1) provide support and training for academics and postgraduate students on how to effectively use ASNs, (2) integrate ASNs such as RG with their institutional repository using API and other technological solutions, and (3) draft policies on the use of ASNs which consider their effect on existing resources and academic practices, such as archiving, impact evaluation, and academic promotion.

A few studies have shown that sharing research work (e.g. Indian context) (Asmi & Margam, 2018) is the primary reason to join and use ASNs, and others claim that it is unimportant for academic works. This finding corroborates with previous studies, suggesting that there is a geographic difference in researchers' scholarly communication behaviors. For example, researchers from less developed countries according to the Human Development Index (HDI), such as India, compared with those in developed countries, such as the United States and the United Kingdom (very high HDI), employed external factors more in determining what to read, factors such as authors' names, affiliation, country, and journal name. Even when deciding where to publish, the publisher of the journal was more important for developing countries than it was for researchers from the United States and the United Kingdom (Jamali et al., 2014). This perhaps implies that the behavior of academics in ASNs may also differ in the specific country context. This might call for an international study to compare the developed and developing countries context and why such differences have existed.

In recent years, the use of persuasive system features has become prevalent in ASNs. It brings "induce prescribed behaviors" such as information sharing (Wiafe et al., 2020). However, ASN companies may take into account that there are already some concerns regarding the increased use of ASNs in academia which may disorient

academics from their primary duties and lead to the gamification of research activities (Sugimoto et al., 2017). But more studies are needed to characterize the nature of these “persuasive system features” in ASNs and to what extent it influences the user’s decision-making process.

## 7 Conclusion

This research provides a systematic analysis of 115 previous literatures on the use of academic social networking sites in scholarly communication. Most of the previous research on the subject has taken a disciplinary and user perspective. This research conceptualizes the use of ASNs in scholarly communication in the space between social interaction and technology. Keyword analysis and scoping review approaches have been used to analyze the comprehensive literature in the field. The following four themes are proposed: motivation and use of ASNs, impact assessment, ASN features and services, and scholarly big data.

The quantitative approach using surveys is used in most studies grouped under Theme I. Scholarly discovering/accessing scholarly information is the key reason for joining and using ASNs, while some have suggested sharing. Some other studies also report that it is unimportant for academics. We conclude that using ASNs in scholarly communication is context-dependent. Disciplinary imbalance is also present across the platforms of ASNs. Subsequent studies, however, demonstrate that ASNs are heading toward homogenization.

The use of scholarly metrics generated from ASNs have benefits and challenges: the benefits are that they (1) address the challenges of the traditional scientific impact evaluation using citations by considering relational dynamics and social capital formation and (2) increase transparency and provide new insights into the structure and dynamics of academic works. However, there are concerns in the reliability of these metrics. First, it is difficult to incorporate them in academic exercise because of the presence of platform-specific dynamics; they are owned by private business companies; hence, no one knows about the sustainability of these services. Second, evidence shows that a number of ASN platforms have been discontinued in the past. Furthermore, embracing the platform in academic evaluation exercise at academic and research institutions may bring large goal displacement or gamification of research activities. However, there is evidence of suggestions that these metrics are reliable to measure the scientific scholarly performance of users in

research-intensive universities. However, more research is still needed in various academic communication scenarios aimed at academics, librarians, and research managers working in developed and developing countries to study the trustworthiness of these metrics.

RG is rated the highest in terms of features and services followed by Academia.edu and Mendeley. Site navigation and session filters features are not available in RG and in Academia.edu and Mendeley. The Q&A feature enhances scholars’ interactions through the promotion of the recommendation mechanism. Longitudinal studies are needed to assess the overtime changes in the features and services of ASNs. In the future, more and more studies are required to identify users’ acceptance across platforms and different user groups.

Research on scholarly big data is gaining momentum in recent years. These studies mainly focus on metadata extraction, impact evaluation, advisee–advisor relationship, classification of citations, and the recommendation system. The big data perspective is also emerging as a means of measuring the current and future scholarly impact. Machine learning and data mining approaches are often used in these studies. Modeling is also one of the emerging topics within the scholarly big data field.

ASNs’ ever-expanding use also has implications for academic libraries. Academic and research institutions should draw up a roadmap that maximizes their digital presence and the use of ASNs. More precisely, academic libraries should complement their information literacy programs to educate academics and postgraduate students on the benefits of using ASNs to improve their exposure and best practices in building an effective profile. A well-planned post-publication strategy is important for enabling the widest possible access to one’s research as well as for maximizing its impact (Ali & Richardson, 2018).

## 8 Future Study Areas

This section highlights potential research topics that may be of interest to researchers in the field. We discovered that policy issues surrounding the use of ASNs are the least investigated. There are also less studies dealing with the feature and services of ASNs. Future studies might consider examining the use of ASNs in driving the policies of academic publishers, universities, research institutions, etc. Moreover, given the relatively low citation impact and visibility in developing countries, further investigation

may explore the impact of ASNs in different country contexts. Another interesting topic might be a comparative study of ANS use in different disciplines in developed and developing countries as well as information exchange scenarios such as face-to-face, open interaction, and open sharing.

Exploring the relationship between advancement in ASNs, academic experiences, and the resulting social structures may be a possible area of research in the future. It is possible to further analyze the social structures, rules, and resources using a qualitative approach. Future studies can also explore ASNs from various levels: (1) at a higher level, the emphasis may be platform control, governance, and business model, (2) mid-level problems involve the content and features and services of the technology, and (3) human practices such as knowledge exchange, networking, and cooperation may be investigated at a lower level (Manca, 2018).

It is also worth researching ASNs from an open access, open data, and open science viewpoint. Future studies in the library discipline may indicate how best to utilize institutional repository and ASNs simultaneously. Future studies may also compare the social structure of academic networks in RG, Academia.edu, Mendeley, etc. In addition, the use of the relational approach in impact assessment, such as social network analysis, through subject to platform-specific dynamics may add richness and differentiation to scientific impact assessment.

Building a more robust model for future impact prediction, metadata extraction, scholarly data storage, and security are potential topics for future studies. Focusing on relational measures derived from network analysis and big data studies could be a good research direction for upcoming studies. In particular, we suggest that future research may attempt to develop a unified way of evaluating academic impact and tools for multiple academic data integrations. ASN features attract different group dynamic results in field-wise high intra-connectivity, resulting in a field-wise community structure. Hence, future studies may consider examining the community structure of RG, Academia.edu, Mendeley, etc.

## 9 Limitation

A full bibliometric analysis has not been done in this study and the keywords analysis is only used to support the qualitative analysis. Future studies may use a bibliometric analysis to carry out similar studies.

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