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Readers, Personal Record Managers, and Community Members: An Exploratory Study of Researchers' Participation in Online Research Information Management Systems

SHUHENG WU[1]

Graduate School of Library and Information Studies, Queens College, The City University of New York, Queens, New York, USA

BESIKI STVILIA[2]

School of Information, Florida State University, Tallahassee, Florida, USA

DONG JOON LEE[3]

Texas A&M University Libraries, College Station, Texas, USA

Prior studies have identified a need for engaging researchers in providing and curating their identity data. This article reports findings from a qualitative study exploring how researchers use and participate in online research information management (RIM) systems, and their requirements for information quality in RIM systems. The purpose of the study was to enhance the knowledge of how to design scalable and reliable solutions for research identity data curation by examining researchers' motivations for participating in online RIM systems and contributing to research identity data curation. The findings identify nine activity-related motivations for using RIM systems, five types of information quality problems in RIM systems, and 12 information quality criteria that researchers perceived to be important in RIM systems. This study also identified three levels of participation in RIM systems: Readers, Personal Record Managers, and Community Members. Design recommendations were suggested for institutional repositories and RIM systems to provide improved services.

KEYWORDS research identity data, research information management systems, research identity data curation, participation levels, information quality, Google Scholar, ResearchGate.

1. Introduction

The evaluation of scholarly impact for individual researchers and institutions has become increasingly data-driven. There are growing needs and opportunities to share, reuse, and

[1] Shuheng Wu, Assistant Professor, Graduate School of Library & Information Studies, Queens College, The City University of New York, Queens, New York, USA. Email: Shuheng.Wu@qc.cuny.edu
[2] Besiki Stvilia, Associate Professor, School of Information, Florida State University, Tallahassee, Florida, USA. Email: bstvilia@fsu.edu
[3] Dong Joon Lee, Researcher Information Systems Librarian, Texas A&M University Libraries, College Station, Texas, USA. Email: djlee@library.tamu.edu

Address correspondence to Shuheng Wu, Queens College, CUNY, 65-30 Kissena Blvd., Queens, NY 11367-1597, USA. E-mail: Shuheng.Wu@qc.cuny.edu

aggregate data from different contexts. The Institute for Museum and Library Services (IMLS, 2016), the National Endowment for the Humanities (NEH, 2015), the National Science Foundation (NSF, 2011), and the National Institutes of Health (NIH, 2003) require applicants to submit data management plans that specify how they will disseminate and provide access to digital scholarship, research data, and related metadata. To maintain research data and scholarship in a usable and discoverable state for ongoing research, education, verification, and evaluation, it is necessary to curate research entity data or metadata. *Research entities* are distinguishable research-related objects that can be concrete or abstract (Elmasri & Navathe, 2000). Examples of research entities are researchers, research publications, data, and research institutions. *Research identity data* is a set of important attributes characterizing and representing a particular research entity for the purpose of research, scholarship sharing, education, identification, and evaluation. Research identity data can be used to construct a research entity's metadata profile, and be included in reference databases (e.g., authority databases) for entity determination and disambiguation.

Research identity data curation can be defined as the activity of managing and promoting research identity data for discovery and future use (Curry, Freitas, & O'Riáin, 2010; Lord & Macdonald, 2003; Stvilia et al., 2015). There are different *research identity management systems*, often referred to as *research information management (RIM) systems* or *current research information systems* (CRIS), from publishers, libraries, universities, search engines, and content aggregators (e.g., ExpertNet.org, Google Scholar, ORCID, ResearchGate). These systems employ different approaches and mechanisms for curating research identity data or information: manual curation by information professionals and/or users (including the subject of identity data), automated data mining and curation scripts (aka bots), and some combination of the above. With universities engaging in curating digital scholarship produced by their faculty members, staff, and students through institutional repositories (IRs), some of these universities and their IRs try to manage the research identity profiles of their contributors locally (e.g., Expertnet.org, Stanford Profiles). While knowledge curation by professionals usually produces the highest quality results, it is costly and may not be scalable (Salo, 2009). Libraries and IRs may not have sufficient resources to control the quality of large-scale uncontrolled metadata, which was often batch harvested and ingested from faculty-authored websites and journal databases. They may need help from IR contributors and users to control the quality of research identity data.

The literature on online communities shows that successful peer curation communities that are able to attract and retain enough participants can provide scalable knowledge curation solutions of a quality comparable to the quality of professionally curated content (Giles, 2005). Hence, the success of online RIM systems may depend on the number of contributors and users they are able to recruit, motivate, and engage in research identity data curation. There is a significant body of research (e.g., Cosley, Frankowski, Terveen, & Riedl, 2006; Nov, 2007; Stvilia, Twidale, Smith, & Gasser, 2008) on what makes peer knowledge creation and curation

communities successful. However, most of the previous research has focused on encyclopedia, question answering, and citizen science communities. There has been little investigation into peer curation of research identity data.

2. Problem statement and research questions

This qualitative study explored how researchers use and participate in RIM systems. It addressed the need to have greater knowledge of how to design scalable and reliable solutions for research identity data curation by examining researchers' motivations for participating in online RIM systems and contributing to research identity data curation. The findings of this study can greatly enhance understanding of the design of research identity data/metadata services, quality assurance activities, and mechanisms for recruiting and retaining researchers to provide and maintain their identity data. Design recommendations based on this study can be adopted in diverse settings and produce improved services for multiple stakeholders of research identity data such as researchers, librarians, data curators, students, university administrators, funding agencies, government, publishers, search engines, and the general public.

In particular, this study addressed the following research questions:

1. *How do researchers use online RIM systems?*
2. *What are the levels of researcher participation in online RIM systems?*
3. *What are the types of information quality problems in online RIM systems?*
4. *How do researchers perceive information quality in online RIM systems?*

3. Related literature

There have been considerable deliberations on the needs for and uses of research identity data and how to manage it effectively in Library and Information Science (LIS) research and practice communities (e.g., NISO Altmetrics Initiative; Research Data Alliance, OCLC Research). An OCLC Task Group aiming to register researchers in authority files identified five stakeholder groups in research identity data: researchers, funders, university administrators, librarians, and aggregators (OCLC Research, 2014). For researchers, the Task Group formulated five needs: disseminate research, compile all publications and other scholarly output, find collaborators, ensure accurate network presence, and retrieve others' scholarly output to track a given discipline. This set of needs was compiled based on the expert opinions of the Task Group members, supplemented with a scenario-based analysis. It would be valuable to test this typology empirically and investigate possible disincentives for researchers' participation in online research identity data sharing and curation.

Different units in universities (e.g., office of research) are increasingly interested in collecting and analyzing research output for reporting, accreditation, and organizational reputation management. These activities and interests overlap with the traditional interests of

academic libraries, which have to better align their digital services with broader organizational needs and priorities in order to avoid seeing their role and image diminished in their institutions (Dempsey, 2014; Tenopir, Birch, & Allard, 2012). One straightforward approach would be to add research identity management services to IRs (Palmer, 2013). There is practical evidence that adding research identity management services to an IR might increase researchers' interest in the IR (Dempsey, 2014; Tate, 2012). However, the increased interest in an IR might not always translate to increased use of an IR and/or increased engagement in research identity data curation, since multiple global RIM systems (e.g. ResearchGate, Academia.edu) offer similar services and strive for researchers' attention and contribution. Relying solely on automated mining, extraction, and aggregation of research identity data might result in poor quality. Salo (2009) discussed metadata quality problems in IRs caused by the lack of authority control and lack of involvement of trained professionals. She also pointed to the failure of automated batch ingest scripts to control names, and that they would often dump uncontrolled, poor quality metadata from faculty-authored webpages and journal websites into IRs without proper identity determination and disambiguation. Libraries need researcher engagement in research identity data curation to provide scalable and high quality research identity management services.

Data quality determines the quality of findings and decisions (Stvilia, Gasser, Twidale, & Smith, 2007). High quality data is essential if one is to make high quality decisions or validate existing decisions and results. For example, the quality of research identity data is essential to evaluate the research product, or to make related policy decisions. Data and related metadata can be used for different purposes, and have different levels of importance in various activities and to different stakeholders (Greenberg, 2001; Stvilia & Gasser, 2008). Furthermore, researchers may rely on different properties and cues of the data to assess its relevance, quality, and value (Faniel & Jacobsen, 2010; Stvilia et al., 2015). To facilitate the use of research identity data and to engage researchers in its quality assurance, it is important to identify the stakeholders' value structures and priorities for different research identity data elements and to align data quality assurance activities with those priorities. The curation and quality assurance of research identity data involve costs. While some of the costs can be alleviated through automated mining, extraction, disambiguation, and aggregation of research data and information, semantically heavier tasks (such as skill and expertise identification, or answering expert-level questions) may require researchers' involvement. Researchers' perceptions of the value of RIM services must outweigh the costs for them to contribute.

Effective knowledge creation and curation require high quality contributors and curators, effective work organization, and tools. Some RIM systems strive to build communities of users around their databases and engage those communities in curating research identity profiles, sharing knowledge through Q&A boards, and recruiting new users (e.g., ResearchGate). The challenge is how to motivate users to contribute to those activities. One can group the motivations that may stimulate researchers to engage in those activities as intrinsic and extrinsic motivations (Ryan & Deci, 2000). Intrinsic motivations are internal and self-determined because

the person finds the activity she or he performs to be interesting or enjoyable. Extrinsic motivations, on the other hand, are externally induced through external rewards or punishments. For example, researchers performing activities involving a RIM system may be motivated by extrinsic motivations such as getting paid by their institutions, receiving promotions, and enhancing their reputations. Some other activities, such as answering colleagues' questions, could be driven by an altruistic desire to help others or the gratification received from an increased self-confidence in their ability to provide the community with helpful knowledge (Lin, 2007).

The online community literature shows that volunteer knowledge curators in open peer-production systems like Wikipedia are mostly driven by intrinsic motivations such as interests in specific areas, which are often shaped by their organizational and ethnic affiliations, hobbies, professional experiences, and beliefs (Nov, 2007; Stvilia et al., 2008). For example, Nov (2007) found enjoyment or having fun as the top motivation for contributing to the English Wikipedia. Stvilia et al. (2008) argued that some of the factors that determined the success of the English Wikipedia were the low barrier to entry (i.e., simplicity of Wiki software), the ability to make changes in an article without an intermediary, and the autonomy to decide what kinds of contributions to make to the community and when.

Besides Wikipedia, previous studies have examined user motivations for contributing to other online communities. Jeng, He, and Jiang (2015) conducted an online survey to study how scholars used Mendeley and found that they were most motivated by visibility and altruism to engage in Mendeley groups. Ames and Naaman (2007) interviewed 13 "heavy" users of a Flickr application and identified four types of motivations for tagging: self-organization, self-communication, social-organization, and social-communication. A study of Flickr collections by Stvilia and Jörgensen (2007) listed eight motivations members might have for organizing photographs into groups: (1) easy finding, (2) easy sharing, (3) archiving, (4) vanity, (5) "bibliographical," in other words, documenting a particular subject or concept, (6) supporting group or community activities, (7) supporting an individual activity, and (8) no particular motivation. Nov, Naaman, and Ye (2010) found a positive relationship between being motivated to build a reputation in the community and the amount of metainformation (i.e., tags) provided. Similarly, in a study examining an online network of legal professionals, Wasko and Faraj (2005) found a significant positive effect of reputation-building activities on the quality and volume of knowledge contribution. Nature Publishing Group conducted an online survey to ask researchers from different countries about their professional use of social networking sites such as Facebook, ResearchGate, and Academia.edu (Van Noorden, 2014). The survey found that the most selected activity in ResearchGate and Academia.edu was maintaining a profile to promote their professional presence online. Preece and Shneiderman (2009) proposed a framework to characterize users' successive levels of participation in online social communities evolving from reader, to contributor, to collaborator, and finally to leader. They also summarized factors that motivate those different levels of participation based on the literature. However, this Reader-to-

Leader Framework was based on a literature review, and has not been tested empirically. Arazy et al. (2015) collected empirical data for over 10 years from Wikipedia to study the functional roles within Wikipedia and the dynamics of role transmissions between the community's periphery and the core. Differing from the successive framework proposed by Preece and Shneiderman (2009), Arazy et al. (2015) found that Wikipedia's participants in most cases moved directly from the entry levels to the community's core, skipping the intermediate functional roles.

The online community and data curation literature provide valuable insights for designing RIM systems and building and maintaining user communities around those systems. More empirical research, however, is needed to understand what motivates researchers to participate in online RIM systems, what research identify information they consider important and are willing to share and maintain, and alternatively what discourages them from having an online research identity profile or maintaining its quality.

4. Study design

This study defines the researcher population as employees and students of institutions in the United States with an IR and classified as Research Universities in the Carnegie Classification of Institutions of Higher Education[4]. To participate in this study, researchers needed to have at least one peer-reviewed research publication and have used at least one RIM system by the time of interviews. The authors used activity theory (Engeström, 1987; Kaptelinin & Nardi, 2012) and literature analysis to develop an interview protocol, and applied the snowball sampling approach to recruit participants, who received an invitation email. Two of the authors conducted qualitative semi-structured interviews (Blee & Taylor, 2002) with 15 researchers in nine disciplines from ten institutions (see Table 1) between January and July 2016 regarding their use of and participation in RIM systems. The sample consists of three participants from each of these five categories: full professors, associate professors, assistant professors, postdoctoral associates, and doctoral students. All three full professors were playing or had played an administrative role (e.g., dean, director) in their institutions. To ensure consistency in the interview context, all 15 interviews were conducted online using Skype.

Table 1. Participant demographics

ID	Sex	Scientific discipline	Highest degree	Academic seniority	RIM systems used
S1	M	Ecology	PhD	assistant professor	Google Scholar Mendeley ORCID

[4] http://carnegieclassifications.iu.edu/downloads.php

					ResearchGate
S2	F	Library & Information Studies	MA	doctoral student	Google Scholar ResearchGate
S3	M	Recreation Park & Tourism Sciences	PhD	associate professor	Google Scholar
S4	M	Library & Information Studies	MA	doctoral student	Academia.edu Google Scholar ResearchGate
S5	M	Condensed Matter Physics	PhD	postdoctoral associate	Google Scholar ResearchGate
S6	M	Management of Information Systems	PhD	full professor	Google Scholar ResearchGate
S7	F	Library & Information Studies	MA	doctoral student	Academia.edu Google Scholar ResearchGate
S8	F	Library & Information Studies	PhD	full professor	Google Scholar ResearchGate
S9	F	Library & Information Studies	PhD	associate professor	Academia.edu Google Scholar ResearchGate
S10	M	Chemistry	PhD	postdoctoral associate	Google Scholar ORCID ResearchGate
S11	F	Chemistry	PhD	postdoctoral associate	Google Scholar ResearchGate
S12	M	Library & Information Studies	PhD	full professor	Google Scholar ResearchGate
S13	M	English	PhD	associate professor	Academia.edu Google Scholar MLA CORE ORCID
S14	M	Information Systems	PhD	assistant professor	Google Scholar ResearchGate
S15	M	Mechanical Engineering	PhD	assistant professor	Google Scholar ResearchGate

The interview protocol included four sections of questions: (a) background questions asking about participants' positions, highest degrees, roles, formal disciplines, specific research areas, and number of peer-reviewed publications; (b) their use of online RIM systems, including the RIM systems they use, their activities involving the use of RIM systems, motivations for using or not using RIM systems, the advantages and costs of using RIM systems, and the services/information they use and desire in RIM systems; (c) their participation in online RIM systems, including whether they have a profile in one or more RIM systems, the benefits and costs of having a profile, motivations for maintaining their profiles and how to maintain, whether to contribute to the community beyond curating their own profiles, and how to contribute; and

(d) their perception of information quality in RIM systems, including the types of information quality problems they have encountered in RIM systems, the sources of those quality problems, and the information quality criteria they perceive important in RIM systems. The interviews, ranging from 17 to 68 minutes, were audio recorded, transcribed, and coded with NVivo 11. Two of the authors independently coded all the interviews using an initial coding scheme developed based on activity theory and literature analysis. After comparing, discussing, and resolving any differences in their coding, the two authors formed a new coding scheme with emergent codes and subcategories, and then recoded all interviews. Despite subtle differences existing, the authors found no significant discrepancies. They resolved those minor discrepancies through further discussion to obtain agreement, a procedure informed by Bradley et al. (2007).

5. Findings

5.1. Using RIM systems—activities and motivations

According to activity theory (Engeström, 1987; Kaptelinin & Nardi, 2012), a direct relationship exists between needs and motivations. Humans may have different needs. When they act on their needs, those needs become the motives of activities. Hence, activity motivations or objectives cannot be separated from the needs driving those activities. Motivations stimulate humans to perform activities. Activities then are carried out through goal-directed actions consisting of context specific operations (Kaptelinin & Nardi, 2012). Furthermore, activities are often interconnected and distributed. One activity's outcome can be used as a component or input of another activity (Engeström, 1987). Some of the activities performed by researchers using online RIM systems can be driven by the motive to support or enable other activities that may affect them personally, their institutions, communities, or society as a whole. This section identifies the activities in which researchers engaged with RIM systems and the motives of those activities (see Table 2).

Table 2. Activities and RIM system functionalities

Activities	Actions	Available functionalities	Desired functionalities
Find relevant literature	Search by specific author, title, subject, and/or other bibliographic metadata	Search engine; author profile; follow papers; citing & cited papers	
	Determine whether a resource or author meets the search criteria	Author profile; publication profile/record	
	Select among multiple relevant resources or authors	Citation count; author impact scores; publication venue impact scores; manuscript status	Advanced article content analytics

Activities	Actions	Available functionalities	Desired functionalities
	Obtain a resource	Download a paper; request a paper from author(s)	
Document manuscripts	Document sources	Citation generator	
Identify researchers	Identify collaborators, reviewers, students, advisors, letter writers, etc.	Citing & cited papers; author profile; follow researchers; number of reads	Mechanism for recruiting students
Disseminate research	Make papers accessible	Upload papers; paper self-archiving status determination	Ability to share research ideas and scholarly products (e.g., software codes, instructional videos) other than research papers and data
			Ability to display the abstract or front page of a user's publications without full-text access
			Ability to assign specific keywords to a user's publications
	Promote papers	Recommend papers; recommend researchers	
Interact with peers	Ask and answer questions on public forums	Q&A service	Ability to share and receive funding information
	Send and receive private messages	Messaging service	Ability to build a trusted network of researchers
Monitor the literature	Follow known researchers	Receive updates on known researchers	Ability to disconnect with certain researchers
			Ability to filter researchers' most recent publications
			Ability to divide connections into groups and define group level policies for what types of updates from different groups should be received
	Follow known papers	Receive updates on known papers	
	Discover new papers	Recommend papers; citing & cited papers	
	Discover new researchers	Recommend researchers; citing & cited papers	
Evaluate	Evaluate papers, including benchmarking one's papers	Citation count; number of reads; manuscript status	
	Evaluate researchers, including benchmarking oneself	Author profile; impact factors; number of profile views; export a CV	
Curate	Archive papers	Upload papers	Ability to categorize a user's papers by research areas
			Ability to generate reports of a user's papers

Activities	Actions	Available functionalities	Desired functionalities
	Add/modify metadata for papers	Add/update citation information; add/update index terms; claim papers; disavow papers	Ability to link different RIM systems to each other and propagate changes made to a user's profile in one RIM system to the user's profiles in other RIM systems
	Add/modify metadata for researchers	Create/update profiles; merge profiles; add/edit index terms; endorse researchers for expertise; add/remove suggested co-authors	Ability to identify a user's duplicate online profiles
			Ability to control what can be displayed on a user's online profile
	Review papers	Open review; request feedback	
Look for jobs	Search job announcements	Recommended job postings	
	Send messages about job openings	Messaging service	

5.1.1. Find relevant literature

One of the most frequent activities in which RIM systems are used is finding relevant literature. Eleven out of 15 participants mentioned that they had used RIM systems to find literature. The outcomes of this activity can be used as input for other scholarly activities such as literature analysis, manuscript writing, or planning a research project. The activity of finding literature may include the following four actions: search, determine, select, and obtain (Tillett, 2003). Researchers may use different RIM systems for different types of searches (e.g., known item, subject, navigational searches) based on the strengths and capabilities of the RIM systems. One participant explained how she used ResearchGate and Google Scholar for different purposes:

> I think they have different functions. Like for ResearchGate I can follow some people. So I can have their most recent papers. But sometimes I also use Google Scholar when I have a specific paper that I want to look for. So if I know the title of the paper, or I know the author, and I want to see their publications, I will use Google Scholar. (S11)

Researchers may also use RIM systems to define and manage their own bibliographies by following or 'bookmarking' the core papers of a specific research area. One participant specified how he used ResearchGate to manage and expand his bibliographies:

> Some of the big papers were sort of like in everyone's research. These are the cornerstone articles that you base a lot of your research on ... I follow some of those articles [in ResearchGate]. (S4)

When selecting papers to read or use, researchers may be guided by not only the subject relevance of papers to their information needs, but also the indirect quality indicators of those

papers—quality cues. The quality cues of a paper may include its impact scores and the impact scores of its author(s), as well as its peer-review or manuscript status. One participant mentioned how she selected papers from RIM systems:

> Sometimes people put unpublished works on there [RIM systems] and they're unpublished for a reason. They really aren't good … It's kind of like when you get articles to referee, and you almost can't read through them because they don't make sense. They put stuff that didn't get published probably because it didn't make it past the referee. (S7)

To complete a literature-search activity, researchers need to obtain the desired papers. They may be motivated to use RIM systems providing open access to the self-archived versions of publications. RIM systems with social networking features can attract researchers to directly contact authors and request a copy of a publication they cannot access otherwise. One participant indicated what motivated him to use ResearchGate was that it provides open access to his work and allows other researchers to request papers:

> It's good to have your stuff easily accessible because not everyone has access to databases, but if you're a researcher, it's easy to set up an account on one of these sites [RIM systems] and connect with the authors to hopefully get the articles that you want. (S4)

5.1.2. Document manuscripts

Besides searching for literature, researchers may use RIM systems in a manuscript-writing activity to manage citations. They may use Google Scholar to verify the bibliographic metadata of the resources cited in their papers, and/or obtain citations in a specific style. One participant revealed his use of Google Scholar when working on the reference list of his paper:

> There are times that I need to verify the title just to make sure the title, authors, and year [are accurate], and just to make sure the information I put in are correct. Google Scholar is doing a good job in accurately reflecting publications, so I use it as a [citation management] resource. (S14)

5.1.3. Identify researchers

RIM systems and their citation extraction and analysis functions can be used for identifying potential collaborators, advisors, students, letter writers, and reviewers, who may have similar or specific research interests. One participant reported how she used ResearchGate's citation information to know about other researchers and identify potential collaborators:

> One of the advantages to using these [RIM] systems is the ability to discover researchers that you may not have known like this ... I'm going to follow this guy from Boston now because apparently he likes my work and I want to be helpful to him, and I want to see what he's doing with the stuff of mine that he's citing, because maybe we could be good collaborators. (S9)

A potential future collaboration can be one of the motivations to follow other researchers in RIM systems. One junior researcher stated that she hoped to convert some of the connections she was cultivating with other researchers in ResearchGate into future collaborations:

> I promote myself and reach out to those scholars whose research interest is similar to me, and to see if later we can have some collaboration. Now, probably they are not interested in a doctoral student's work, but later, if I can get a job somewhere, they probably will be willing to collaborate with me. (S2)

5.1.4. Disseminate research

One of the main motivations for using RIM systems is to disseminate research results. Researchers may use RIM systems to share publications, data, and other research products. Nearly all participants mentioned that they used RIM systems to promote their research. The dissemination activity may consist of making research results available as well as actively promoting those results. To make research results available, researchers may upload copies of their papers, presentations, or data to a RIM system. A service that participants found particularly helpful in that action was the one that helped them determine whether a publication could be self-archived in RIM systems based on the publisher's policies. After research results are uploaded to a RIM system, the system then can use push services to promote results to the community. One participant commented on ResearchGate's paper dissemination service:

> I think the nice thing is, especially with ResearchGate uploading papers, it tells you what the policies are for publishers in general, which is really helpful … I don't want to get sued because I posted an article too soon or I posted the wrong version of the article. (S4)

Researchers may choose a specific RIM system that provides more effective mechanisms (e.g., social networking) to promote their research to the community that they want to reach. One participant emphasized the social network provided by ResearchGate for promoting his research to his peers:

> I used ResearchGate besides Google Scholar because ResearchGate has slightly different methods of constructing the social network and the way they promote research is different—it's more active than Google Scholar. In that sense, it serves my purpose of trying to promote my research [to my] peers. (S14)

5.1.5. Interact with peers

Scholarly work may involve interaction. Researchers may interact on any aspect of research such as what design to employ for a particular research problem, what tools to use and how, or how to replicate research results. Researchers may also interact to exchange information about employment opportunities, and to recruit students, collaborators, external reviewers, or letter writers for grant proposals or promotions. Some RIM systems provide researchers with Q&A forums and a direct messaging service to communicate. In some cases, those communication channels become the only means on the Web of reaching a particular researcher. For example,

one participant revealed how ResearchGate helped him communicate with a researcher he could not reach otherwise when he was looking for a recommendation letter from the industry:

> ResearchGate really gives you a way to connect to the researchers if you somehow cannot find their email address or other contact information from other channels … I was looking for some recommendation letters for personal use. I wanted one from [someone in the] industry. This company cited my paper … the first author's email was not on the paper. And the last author, the corresponding author, actually left the company. So I had nowhere to find them. I even called the company. But they didn't want to release the information. Then I checked ResearchGate. He was on ResearchGate. So I tried my last resort. I just sent him a message. And surprisingly, he replied. (S10)

5.1.6. Monitor the literature

To stay current with the literature, researchers need to monitor the literature for new works or contributors. One participant indicated his motivation for using RIM systems was to monitor his network of researchers: "looking at what people whose work I'm interested in have cited is useful for me and for following up on and finding out more about information that's useful for me in my own research." (S12)

RIM systems can be helpful to a researcher in monitoring literature by sending alerts about new works from the researcher's network, and recommending new works and authors based on topical or co-citation matches. One participant summarized how she used different services provided by ResearchGate to keep up with the literature and communicate with other researchers directly and indirectly:

> Right now I think I can always keep up with publications from the scientists in a specific field. So I can know what papers they have and what they're doing in their labs. And it helps with my research. And also ResearchGate always tells me who reads my papers, who is citing them, and how many citations I have. And it also enables me to talk to people when I have some problems. I can post my questions there. And there will be some people from different fields and they can help me solve my problems. (S11)

RIM systems with social networking capabilities enable researchers to learn about junior researchers' works, which may not be as visible as those of more established researchers. For example, one participant explained how ResearchGate might enable her to know about junior researchers who otherwise could not be reached:

> Researchers who are not that famous now, like junior faculty members or doctoral students, who are not big names, I probably cannot find another opportunity to know them all. If they also have a ResearchGate account and have some publications there, I hope this site can give me some automatic suggestions. (S2)

5.1.7. Evaluate

Evaluation can be a standalone activity (e.g., benchmarking oneself against other researchers) or part of a research process (e.g., evaluating papers for inclusion in a literature review). The targets of evaluation can be different entities including, but not limited to, a publication, a publication venue, an individual researcher, a lab, an institution, or a country. Furthermore, researchers may play the role of evaluators or be the objects of evaluation by others. If the latter, a researcher still can be an active contributor to a distributed evaluation process by creating and maintaining a profile in a RIM system to support his/her evaluation by others. The context of those evaluation activities may vary. One participant mentioned that he created a Google Scholar profile to support his application for an award:

> [On] Google Scholar, I put a profile up because I was actually asked to do that. It was suggested to me that this would be a good idea by one of my colleagues because she wanted to have me apply for an award, and she noticed that I hadn't updated my webpage or my Google Scholar profile … that's the reason that I actually signed up for it. (S12)

Another participant mentioned that he used his Google Scholar profile and impact factors as evidence for his research impact when applying for U.S. permanent residency:

> I am applying for permanent residency, which needs me to evaluate the impact of my research. So Google Scholar is another good tool for that reason. (S14)

A researcher's career status may affect the types of evaluation activities she or he may engage in or be asked to perform. Senior researchers may evaluate other researchers for promotion and tenure. Doctoral students, on the other hand, may benchmark themselves against other doctoral students who are at a similar stage in their doctoral programs to assess their competitiveness for the job market. For example, one participant, who was a doctoral student, illustrated how she used ResearchGate to follow other doctoral students in the same field to know about their publication rates to help prepare herself for the job market:

> I followed some students who are at the same stage as myself … in other schools to see their publications rate, how many publications they will get in one year … And then I can estimate how much work should be expected for a doctoral student at my stage, so later, when I'm actually in the job market, I will not be too far away, because I know the baseline of this field. (S2)

Interestingly, one senior researcher, who has more than 250 publications, indicated that he used his Google Scholar profile to self-assess the impact or popularity of his own works:

> It [a Google Scholar profile] gives you an opportunity to really see how your work has influenced the field. If you ask[ed] me even last year what would be the number one article that I think would have got the most amount of citation, it would not be the article that has … It gives me a way to actually check with real data. (S6)

5.1.8. Curate

Curation of research resources can be defined as a process of managing those resources for discovery and future use (Curry et al., 2010; Lord & Macdonald, 2003; Stvilia et al., 2015). The main component of curation activities is quality assurance, which is the process of assuring that the research products, including information resources, meet the needs and requirements of the activities in which they are used (Stvilia et al., 2015). Researchers may use RIM systems to self-archive papers and data and to make them accessible. They may create and manage metadata for those resources to make them findable and reusable, and also use the metadata to construct a CV or other online profiles for different purposes. RIM systems with social networking capabilities allow researchers to request reviews of their works' content from their peers. Curation of research information enables all the other activities in which that information is used or reused. Indeed, assuring the quality of their research identity metadata can be a motivation for researchers to establish a profile in a RIM system. For example, one participant created a Google Scholar profile to correct an error after she found that Google Scholar had identified another researcher with the same name as the author of her article:

> I started using Google Scholar … after Google misidentified [my] article. I actually did not have the intention to use Google Scholar—just created an account to correct the error. (S2)

Furthermore, the quality of information determines the outcome of an activity using that information (Stvilia & Gasser, 2008). Concerns about the quality of an activity's outcome using research information and its possible effects on a researcher can be a strong motivator for the researcher to engage in curating his/her research identity profile. One participant noted:

> If you don't maintain it [your research identity profile], then it gives people an inaccurate view of your productivity, so you run the risk of potentially sending a signal about your productivity that's not accurate. (S9)

Besides quality assurance, another participant attributed his curation of his personal online profile to peer pressure:

> If I'm advising other colleagues to make sure that their pages are clear or good, it would be kind of bad if mine was not that way. It's more for peer pressure to myself. (S6)

Thirteen of 15 participants indicated that they maintained or curated their own personal profiles at least in one RIM system. Their curation activities included, but were not limited to, adding bibliographic metadata and subject index terms to their publications, uploading full-text articles, and endorsing colleagues for their skills. In RIM systems like ResearchGate, endorsement requests are pushed on researchers through automated prompts. Two of the participants questioned the value of providing endorsements though; for example:

> If I really want to see what you're good at, I check up on your publications. So that's why the system exists. All I need to do is to check your publication record, check your research record. So I will know what you're good at. I don't really find those endorsements useful. (S10)

5.1.9. Look for jobs

RIM systems may serve as a social network for researchers to look for or share job information and find job candidates. For example, one participant indicated that she had searched ResearchGate's job postings to find relevant job positions:

> [ResearchGate] has some job advertisements. So if you're looking for a job, you can input some keywords. And it will tell you some job openings related to this position. (S11)

Another participant described how he used ResearchGate's messaging services to help a researcher in another country find a job:

> For the messages I received, the only one that's not requesting a paper is the one from, I guess, an Italian researcher. She told me she's going to graduate, and she's applying for a postdoctoral position. She's personally asked me if I knew any positions in the United States. So I replied [to] her message, gave her some suggestions [about] which group might be looking for people in her background. (S10)

5.1.10. Desired services

Participants indicated several services that were needed but not provided by the RIM systems (see Table 2). The most frequently mentioned one was integrating different RIM systems so that an update to a researcher's profile in one system would be propagated to the other systems. Four of the 15 participants expressed the need for this service. For example, one of them stated:

> It would be easier if I only had one profile to manage and if they were all integrated in a way that if you updated one, they would all be updated, which is sort of why I always have my website and I direct to that so that I can just keep updating that as I need to. (S4)

Another participant identified the need for a mechanism that would allow researchers to divide their connections into groups based on the nature of those connections in a RIM system. The researcher then could receive RIM services such as new publication alerts tailored to their individual groups:

> I follow them because we are in the same field. I follow others because we are colleagues or friends. I'm not that interested in their publications, because their field is very different from mine. I wish ResearchGate could specify groups of people I followed ... I could keep them tagged, say, these are authors in my field; these are my friends, my colleagues. (S2)

Similarly, one participant expressed the need to categorize his publications by different research areas rather than just chronological sequence:

> I don't think in ResearchGate you can partition all of your publications into subcategories. This is the work I did in this area and these are the publications I did in that area. (S15)

Researchers doing multidisciplinary research or having a large number of publications may be in great need of this functionality to help manage their research products.

Another service needed is more advanced content analytics, which could improve the quality of paper and author recommendations provided by RIM systems. Participants also identified a need for researchers to be able to supplement their publications in various ways, including having the ability to upload video presentations, post instructional videos on using different types of scientific analysis software, share research ideas, and distribute and receive funding information. One participant stated:

> I would really appreciate if ResearchGate could provide some more information, such as videos teaching how to use some scientific software, such as MatLab for data analysis ... And I also think the scientists should be encouraged to upload some videos to talk about their research and to sell their works to others. (S11)

Interestingly, another participant suggested RIM systems should provide a mechanism for recruiting or outreaching students because the existing application systems failed to identify a large pool of potential applicants:

> There are students or applicants who pursue me through LinkedIn or ResearchGate … For student recruiting, I don't see a very efficient mechanism to find good applications because for now, we have probably only two ways. One way is the random applications in the system, because every university has an application system … The second way is just to go out and ask my friends or colleagues ... That's very inefficient. I don't have enough applications. I don't have a big pool to select [from]. (S15)

Although several participants expressed their preference for various types of information to be available on their identity profiles, one participant pointed out that she wanted to have more control over what could be displayed or viewed by others on her online profile:

> I much prefer being able to control what is seen on my [profile]. I could enter a whole bunch of information into a site like ResearchGate or Academia[.edu] … but I don't necessarily have a whole lot of control as to how much of that information is displayed. (S7)

5.1.11. Extrinsic and intrinsic motivations

Most of the activities and related motivations identified in this study were based on the needs participants had for their research and/or academic work (e.g., find relevant literature, disseminate research). One can assume that work-related activities can be stimulated by extrinsic motivations such as getting paid or receiving a promotion for conducting successful research projects. Work-related activities can be also spurred by intrinsic motivations such as the enjoyment of research projects. Some participants pointed out incidents that were not based on work-related needs but rather the feeling of reciprocity or enjoying helping others. One of them noted:

> Every time someone endorses my skill, I receive [an] email saying who endorsed me for such and such skills. Then sometimes when I'm on ResearchGate, I also do that … I suppose it's useful for the person because when I receive email[s] saying other people

> have endorsed me, I perceive [a] certain level of value of them doing that for me. I think doing that for other people might also be useful too. (S14)

Another participant admitted that sharing his pre-prints on his online profile was motivated by self-esteem and keeping with the spirit of intellectual generosity:

> I think a lot of it is self-esteem in the profession and wanting to be generous with the scholarship that I've worked on and to make it available quite widely. I had a mentor in grad school who really urged us to do everything in the spirit of intellectual generosity, and I've tried to practice that whenever possible. I think there are certain [RIM] systems that let you practice intellectual generosity and maybe in a small way. (S13)

Researchers can be incentivized to engage in Q&A forums by interesting questions or answers. Alternatively, they can be discouraged to participate by the lack of questions that match their research interests or expertise. As one participant noted, he did not feel he had sufficient expertise to provide helpful answers to the questions he saw on the forum:

> I do not answer because when I look at the question, I don't feel that I am the best one to answer the question. …So if I find any question that I feel I am really an expert or I am really experiencing that question and I can provide useful answer, I'll probably answer it. (S10)

5.2. Participating in RIM systems

Of the 15 participants, seven had public profiles in Google Scholar, 13 used ResearchGate, three had an ORCID account, and four had profiles in Academia.edu. Seven participants also stated that they had used personal websites and/or local, institutional repositories to disseminate their research. When asked why they participated in a particular RIM system, some participants recalled incidents that led them to create a profile in that system. Some of them did not purposefully create a profile in the RIM system to meet their research identity management needs, but rather the profile was automatically generated and pushed on them. Other participants mentioned that they acted on a recommendation from a friend, colleague, or advisor to create a profile. One of these participants (S12) mentioned that he created a profile in a RIM system based on a colleague's recommendation but with a specific purpose: to make himself better known to the community and to support his nomination for an award.

Researchers can also be introduced to a RIM system by another information system such as a search engine. In these instances, they perceived the value of membership after observing specific benefits provided by the system. Several participants indicated that they first knew about ResearchGate when they searched literature in Google and found full-text articles provided by ResearchGate. For example, one of them revealed:

> I first came to ResearchGate, because a paper I was looking for at that time only had [a] full-text version on ResearchGate … our university library didn't buy it. This meant the only place that [I] could get a full text [from] was ResearchGate. Then I noticed that's a benefit. I should create an account there. (S2)

Researchers' needs for and uses of RIM systems may change as their careers evolve. Some inactive users of RIM systems may become active ones and vice versa. One participant revealed how he started a profile in Google Scholar by referral and later became an active user after finding it useful:

> For Google Scholar I set up the profile very early, like six, seven years ago. But I really started using that like two or three years ago. So basically what I mean is that when I started this was usually by referral. Somebody told me you should try this. So I set up a profile. So that's how things got started. And then at some point I found maybe I really need this to check something. Then I really started using that. (S10)

Another participant created a Google Scholar profile because of his application for promotion. He later turned into an active user and promoter of Google Scholar after he became an administrator of a research institution:

> I was going up for promotion from internship in [an institution] and a person may have asked me what my citation count was in Google Scholar. I probably created it [my Google Scholar profile] then … but when I was an administrator, I encouraged all individuals to keep their Google Scholar page clean and credible because it makes things easier. (S6)

In contrast to that practice, there was a participant who used to actively participate in ResearchGate to promote himself in the job market, but stopped using it after he found a job. He found it time-consuming to curate his profile:

> If I don't have a strong motivation to use ResearchGate, I use it less as that was the case in the recent year … I found a job so I don't feel a strong motivation to promote my research in peers, and it takes a lot of time to input the publications. It does not integrate very well with other systems, so I stopped using it. (S14)

5.2.1. Levels of participation

The data analysis identified three levels of researcher participation in RIM systems (see Table 3). Researchers belonging to the first level may or may not have a profile in a RIM system, but do not maintain the profile if they have one and do not interact with other members of the system or contribute to the system. This level was called Readers, as they use RIM systems mostly to access the literature. Of the 15 participants, this study only identified two of them as Readers, who were both associate professors. One of them stated:

> I use them [RIM systems] to locate materials. I don't use them to make myself findable … I don't use them to promote myself. I use them to find things that I might need for my own research. (S9)

Table 3. Levels of participation in RIM systems

Levels of participation	Activities	Actions of using a RIM system	Participants	
			ID	Academic seniority

Readers: They may or may not have a profile in a RIM system, but do not maintain the profile if they have one and not interact with other members of the system.	**Find relevant literature**	Search for papers or authors	**S3** **S9**	associate professor associate professor
		Determine papers or authors		
		Select papers or authors		
		Obtain papers		
	Document manuscripts	Document sources		
	Identify researchers	Identify potential collaborators		
		Identify potential employees/students		
		Identify potential advisors		
		Identify potential reviewers		
		Identify potential letter writers		
	Monitor the literature	Subscribe to updates from known researchers		
		Subscribe to updates from known papers		
		Discover new works		
		Discover new researchers		
	Evaluate	Evaluate papers		
		Evaluate researchers		
	Look for jobs	Search job postings		
Personal Record Managers: They maintain their profiles in a RIM system, but do not contribute to the system beyond that and do not interact with other members of that system directly or indirectly.		All the actions above and the following:	**S1** **S15** **S13** **S6** **S8** **S12**	assistant professor assistant professor associate professor full professor full professor full professor
	Disseminate research	Make papers accessible		
		Promote papers		
	Curate	Add/modify metadata for papers		
		Add/modify metadata for researchers		
Community Members: They not only maintain their own profiles, but also are willing to engage in curating the research information of other members by endorsing them for skills, and share their knowledge and information via messages, emails, or Q&A forums.		All the actions above and the following:	**S2** **S4** **S7** **S5** **S10** **S11** **S14**	doctoral student doctoral student doctoral student postdoctoral associate postdoctoral associate postdoctoral associate assistant professor
	Interact with peers	Ask and respond to questions/requests		
	Curate	Review papers		
		Comment on papers		
		Add/modify metadata for other researchers (e.g., endorse other researchers for expertise)		

Researchers in the second level may maintain their profiles in a RIM system, but do not contribute to the system beyond that and do not interact with other members of that system directly or indirectly. That is, they do not ask or answer questions in Q&A forums, endorse other members for their skills, send messages, or respond to other members' messages or requests. This level was labeled as Personal Record Managers. Six of the 15 participants in this study were grouped under this level (see Table 3). Three of those six Personal Record Managers were full professors, two were assistant professors, and one was associate professor.

Researchers in the third level not only maintain their own profiles, but also are willing to curate the research information of other members by endorsing them for skills, or are willing to share their information and knowledge via messages, emails, or Q&A services. This level was labeled as Community Members, who may be motivated by the feeling of reciprocity and the sense of being 'a good member' of the community. Of the 15 participants in this study, seven of them were identified as Community Members (see Table 3). One participant, who was categorized as a community member, explained why she endorsed others for skills in ResearchGate:

> I just want to be a good member. And I think they deserve it. Maybe I know them. I want other people to know them, to know they are good at this skill. (S11)

Some of the community members may even be willing to suggest corrections to the content of other researchers' publications. One participant revealed that if he had the contact information of an author whose paper had a critical error, he would contact the author to suggest a correction:

> If I can clearly identify the contact, email, and affiliation of the author whose article has a clear, obvious typo, which might have a negative impact on other readers, I will do that. (S14)

Participants classified as Community Members in this study were either postdoctoral associates or doctoral students, except that one was assistant professor. However, as mentioned above, that assistant professor (S14) became inactive to participate in and contribute to ResearchGate after he found the job, acting more like a Reader.

Researchers may move from one level to another over time as their perception of the costs and benefits of using a particular RIM system changes. One participant attributed his inactivity in a RIM system to the time and effort spent learning the system, which outweighed the benefits of using it:

> I think the time spent learning the system itself is a cost. If the cost, investment of learning the system was not turned into a benefit for using the service for the long-term, then it is a cost … So far, [for] ResearchGate, the time that I spent learning the system has not turned into long-term use. I sort of ceased using it. (S14)

5.3. Types of information quality problems in RIM systems

The third research question examined the types of information quality problems in RIM systems. In particular, during the interviews participants were asked to recall if they had encountered any information quality problem incidents in the RIM system(s) they used. All participants indicated that they had encountered information quality problems in RIM systems. The identified types of information quality problems include inaccuracy, irrelevance, outdatedness, incompleteness, and spuriousness.

5.3.1. Inaccuracy

One participant mentioned that he found an abnormal increase in the number of citations on his Google Scholar profile in one night:

> This paper, the citation went from like 40 to 60 in one night. That's obviously impossible. When [I] checked this, [it was] because they [Google Scholar] added a lot of papers [that] don't really [cite my paper]. (S10)

Interestingly, another participant implied that a small inaccuracy in the citation count could be tolerated, especially if it was an overestimation:

> The typical problem with Google Scholar is that they overestimate things, overestimate citations … mostly it's just moderate inaccuracies. Since it's always an overestimation, that's good for me in some respect. (S12)

Besides inaccurate numbers of citations, participants found publications on their profiles in RIM systems that did not belong to them. They attributed this inaccurate information quality problem to the failure of RIM systems to disambiguate researchers having the same last names or full names, especially those of Asian authors. Although several participants attributed this quality problem to database algorithms, one participant thought that the quality problem was caused by the incomplete metadata of publications harvested by RIM systems:

> Not every publication lists author affiliation … has full name … It's just that the metadata associated with a lot of publications is insufficient. For any algorithm, you need more context to be able to say with confidence that the person that you have in mind is actually the author of a particular publication. (S8)

As mentioned above, participants using RIM systems as a citation management resource expressed concern about the inaccuracies frequently found in citations automatically generated by RIM systems.

5.3.2. Irrelevance

Five of 15 participants indicated that they had received irrelevant article and/or author recommendations from RIM systems; for example:

> With ResearchGate I do read some things when it says, 'Oh, this person in your department [an iSchool] or in your college has recently published this.' I guess those emails don't bother me. I guess it's just when they're really way off target with what they think I might want to read, like marine biology. (S7)

One participant who was on the job market, commented on a RIM system which provided him with irrelevant job information: "I'm trying to find some job in the United States, but ResearchGate gave me some weird information, like [job advertisements] in some European countries." (S5)

5.3.3. Outdatedness

Four participants specified that they had received obsolete information or services from RIM systems. Two of them described receiving notifications from a RIM system that contained outdated publication information about other researchers; for example:

> Like in ResearchGate you get an alert when people you are networked with have uploaded a publication, but often it's an older publication. It's not their current research. Being alerted about maintenance in people's profiles isn't necessarily that helpful. (S8)

Another participant indicated that the hyperlinks in a RIM system were occasionally old and broken, which prevented him from having access to full text articles:

> The search results will have a link to a full text version, either a doc or a PDF somewhere that is found on the web. Sometimes those are old links and they don't work. That does happen on occasion on Google Scholar. (S4)

5.3.4. Incompleteness

One participant implied that a RIM system provided her with incomplete readership information about her papers that prevented her from identifying potential collaborators:

> They [ResearchGate] will send you [an] email probably on a weekly basis to say how many views you have [on your papers] … That part I actually have no interest [in], because they will not tell me who viewed it, which means I cannot find collaborators based on that. (S2)

Another participant expressed his concern regarding the lack of bibliographic control or metadata in a RIM system, which failed to indicate the version of his publications and thus might not accurately reflect the number of citations for his publications or help build his reputation:

> Google Scholar will ingest new things automatically which is nice, but often it grabs whatever metadata it finds and that's not always the version that I would highlight as sort of the most preferred version of this. My concerns are in bibliographic control, whether it's the journal version, or the IR [institutional repository] version, or whatever ... I would probably feature in the profile citation of the published version … we're in the business of reputation and those official citations are what accrues reputation to scholars. (S13)

5.3.5. Spuriousness

One participant found spurious publications in his online profile in a RIM system, which were references to entities or activities that were falsely determined to be publications:

> With ResearchGate, they find a lot of spurious publications, things that shouldn't be publications … They found me as a co-author with people, because I've been on a program committee with somebody else or something like that. You know it's an annoyance for me. (S12)

5.4. Requirements for information quality in RIM systems

The fourth research question focused on researchers' quality requirements for research identity information. Participants identified 12 information quality criteria or virtues that they perceived to be important in RIM systems: accessibility, accuracy, authority, completeness, consistency, currency, flexibility, interoperability, security, simplicity, stability, and validity. Among these criteria, the most frequently mentioned ones were accuracy, currency, simplicity, completeness, security, and interoperability.

Accessibility was one of the reasons that researchers prefer using RIM systems to find literature rather than subscribing to journals or database services. One participant explained:

> These [RIM systems] are the tools researchers are now using to identify articles … if you look at the top half a dozen articles of mine, the copies of those articles or the electronic files are available online so you don't have to subscribe to a journal, and you have access to those articles. (S6)

Three participants commented on the authority or trustworthiness of bibliographic information or altmetrics provided by different RIM systems. Interestingly, they all considered Google Scholar as more authoritative or widely accepted for curation, documentation, and evaluation activities. For example, one of them specified:

> Google Scholar detects a new publication that requires a minimal author input into the system, and it verifies. People trust this information from Google Scholar. The trustworthiness among your peers is [a] kind of advantage, which I value. (S14)

One participant, who played the role of administrator, explained the importance of completeness in terms of the types of publications provided by RIM systems when evaluating an online profile for promotion:

> I'm usually looking at records or fields where conference proceedings are an important type of contribution. Web of Science is just no good for that purpose, and Scopus is a bit limited. So Google Scholar is the only place that I can really look at, which I know will take account of at least most of the publications and conference proceedings. (S12)

Another participant valued completeness in the types of scholarly activities automatically detected by RIM systems and recorded on her online profile:

> They [ResearchGate] have things I haven't even thought about, that may not even be on my CV. From a [X Conference] Proceedings, if you were part of a panel, then you do show up in the proceedings as a contributor. It's actually without much effort on my part … to build up quite a comprehensive profile [through ResearchGate] … What for me is a more exhaustive identification of scholarly activities than my CV may provide. (S8)

Seven of the 15 participants emphasized the currency of publication information provided by RIM systems, that is, "how fast the systems can preserve or capture my recent publications" and those of other researchers, which could be "useful for me to follow the recent trend[s] for research." (S10)

Four participants expressed their concerns about the security of the information they made available in RIM systems. For example, one stated:

> I would like them [RIM systems] to keep part of my profile secure … I am concerned about what they do with my personal data. I don't want them to share my personal data with, for example, a company, so that I start getting a lot of sales e-mails, phone calls. (S9)

Two of them were worried that not only they themselves, but also collaborators in their networks, would receive spam because of their online presence in RIM systems. One participant suggested RIM systems should build a more secure network of researchers:

> There's a lot of individuals who are on ResearchGate where there's no screening … I get emails from individuals who I don't know and they are requesting my article. It might be better that if ResearchGate had a trusted network, and in order to join, an individual have to join it through one of them [in the network]. (S6)

6. Discussion

6.1. Motivations for using RIM systems

The first research question was concerned with identifying researchers' motivations for using RIM systems. The interview data analysis identified nine activity- or task-related motivations: (1) find relevant literature, (2) document manuscripts, (3) identify researchers, (4) disseminate research, (5) interact with peers, (6) monitor the literature, (7) evaluate, (8) curate, and (9) look for jobs. A comparison of these motivations with those for user participation and contribution found in the online communities and digital libraries literature shows some overlap. For example, Stvilia and Jörgensen (2009) found Flickr users were motivated to participate in collection building activities to enable finding, sharing, and archiving. One can map those three motivations to the curation motivation identified in the current study. Similarly, there is a commonality between the curation motivation found in the current study and the self-organization and self-communication motivations identified by a study of tagging activities in Flickr (Ames & Naaman, 2007). Nature's online survey revealed that scholars' popular activities in ResearchGate and Academia.edu were maintaining their profiles, posting work-related content (e.g., asking a question in the Q&A forum), discovering peers of interest, tracking metrics, and finding recommended papers (Van Noorden, 2014). These can also be mapped to six of the motivations identified in the current study: curate, interact with peers, identify researchers, evaluate, monitor the literature, and find relevant literature.

An OCLC Task Group formulated researchers' five needs for research identity data: (1) to disseminate research, (2) to compile all publications and other scholarly output, (3) to find collaborators, (4) to ensure accurate network presence, and (5) to retrieve others' scholarly output to track a given discipline (OCLC Research, 2014). Those five needs can be nicely

mapped to five of the motivations identified in the current study: disseminate research, curate, identify researchers, find relevant literature, and monitor the literature. However, the empirical data collected from the current study identified four more motivations for using RIM systems or research identity data: document manuscripts, interact with peers, evaluate, and look for jobs. Indeed, most of the IRs do not support those four activities (Lee, 2015). Interestingly, six participants in the current study pointed out that the social network provided by ResearchGate enabled them to follow and communicate with other researchers and look for jobs. These functionalities motivated them to use ResearchGate instead of or in addition to Google Scholar. IRs and RIM systems may consider incorporating these functionalities into their databases to allow their users to communicate with each other and generate tailored profiles to support different evaluation activities (e.g., self-evaluation, annual review). One participant, who was an associate professor, specified a need for RIM systems to support her university's merit review:

> [My] university requires me to keep up my [CV in their] CV database system ... As the person who has a CV in that system, which is every faculty member, you are responsible every semester for going in there and updating your [CV]. It's used for merit review … so it's really a big deal ... I would say if there were some way that what is in ResearchGate would feed [into] the system [that] would really be very helpful. (S9)

Most of the motivations identified in the current study that influenced participants' work-related activities as researchers and/or administrators were extrinsic (e.g., to promote papers, receive an award, find a job, the feeling of reciprocity). At the same time, participants brought up incidents associated with intrinsic motivations such as enjoying helping others and intellectual generosity. This corresponds to the findings of a previous study that both extrinsic (e.g., reciprocal benefits) and intrinsic (e.g., enjoyment in helping others) motivations have an influence on employees' knowledge-sharing intentions (Lin, 2007). Similarly, Jeng et al. (2015) found that both extrinsic and intrinsic motivations were associated with researchers' group engagement in Mendeley, though intrinsic motivations were more important. To increase researcher contributions to the community, RIM system designers can emphasize the norm of reciprocity and altruism in the messages used to solicit contributions, encourage interpersonal interactions between community members to enable the perception of reciprocal benefits, establish an honor system, and make the contribution mechanisms more game-like (Jeng et al., 2015; Lin, 2007; Ren, Kraut, Kiesler, & Resnick, 2012).

6.2. Levels of participation in RIM systems

The second research question sought to identify the levels of researcher participation in RIM systems and the factors that may affect their participation. The current study identified three levels of participation: Readers, Personal Record Managers, and Community Members (see Table 3). These three levels can be mapped to the first three levels of participation in Preece and Shneiderman's (2009) framework (i.e., Reader, Contributor, Collaborator, and Leader). Only two participants of the current study were categorized as Readers. All the other participants (13 out of

15) were classified as either Personal Record Managers or Community Members, who at least maintained their profiles in a RIM system. The current study did not identify any participants acting as Leaders defined in Preece and Shneiderman's framework, who promoted participation, mentored novices, established community norms and policies, and contributed to the community beyond their personal gain. This can be explained by most of the existing RIM systems not supporting that level of participation. In contrast to Wikipedia, Encyclopedia of Life, and other open knowledge curation platforms whose community members can play a leading role in setting the community's long-term goals and establishing/enforcing policies and rules (Burke & Kraut, 2008), most of the existing RIM systems do not enable community self-governance and self-moderation.

A study of data curation practices in IRs by Lee (2015) found that IR staff's curation activities focused on ensuring the quality of publication metadata for the long-term preservation of publications in order to increase their reusability. The findings of the current study suggest that a majority of researchers may be willing to at least maintain their research identity profiles. Hence, IR managers may consider recruiting researchers not only as research data providers and users, but also as curators of their own research identity data. The largest number of participants (seven out of 15) in the current study was classified as Community Members, who not only maintained their own profiles in a RIM system, but also contributed to the curation of the research information of other community members. IR managers may also consider encouraging their users to curate the research identity data of researchers with whom they are familiar.

All of the seven Community Members identified in this study were either doctoral students or postdoctoral associates, except for one participant (S14) who was less active in ResearchGate once he became an assistant professor. Compared to those identified as Community Members, participants classified as Readers or Personal Record Managers in this study were more senior researchers, holding the position of full, associate, or assistant professor (see Table 2). This finding suggests that the levels of participation in RIM systems may be affected by researchers' academic seniority. Junior researchers may be more active not only in maintaining their own profiles but also in curating the research information of other community members. Some previous studies have found that junior researchers were active in data curation. For example, Stvilia et al. (2015) found that in condensed matter physics, graduate students had the primary responsibility for managing the data in their project teams. Similarly, Wu et al. (2016) found that in earthquake engineering, doctoral students and postdoctoral researchers were responsible for data management and curation in their project teams. Thus, IRs should promote their services not only to faculty members, but also to students and postdoctoral associates, providing researchers (especially junior researchers) with training in research identity data curation.

The levels of participation in RIM systems can be affected by the needs motivating researchers to perform research identity management activities and the priorities researchers place on those activities. The levels of participation also can be affected by the costs and benefits

of using a specific RIM system. These may include the set of functionalities or benefits provided by the services of a RIM system, the costs of using those services, and the quality of activity outcomes from using the system. Indeed, the disincentive or amotivation most frequently mentioned by participants to explain their lack of participation in RIM systems was the cost of learning the system and maintaining their profiles. One participant, who was classified as a Reader, admitted the usefulness of having a profile in a RIM system, while also pointing out the time and effort required to invest in learning and using the system:

> I can see that [having a profile in a RIM system] is very valuable. I just actually have not made the time to get in here and figure out what the investment is [for] participating. It is really nothing more complicated than that. (S9)

Rogers (1995; 2002) proposed that the perceived compatibility of an innovation (i.e., the degree to which an innovation is perceived as consistent with people's existing values, past experiences, and previously introduced ideas) is positively related to its rate of adoption. One participant, who was classified as a Community Member, attributed his adoption of ResearchGate to the similar experience he had in Facebook:

> [For] ResearchGate, the convenience for me is that it's like Facebook. Somehow they forward whatever updates directly to your academic email address you entered there. So basically everyday when you check emails, you can also see the information ResearchGate forwards … Like Facebook, it makes following people more convenient. It will be more fun to do that. (S10)

This participant found his use of ResearchGate compatible with his past experience with Facebook and daily activities (checking emails). This compatibility saved time and effort in learning and using the system, and increased his interest in taking part in research-related activities (following other researchers' works) in the new system. RIM system designers may consider emulating researchers' experiences in other popular databases, social network sites, or online communities.

Some participants directly referred to a cost-benefit analysis when justifying their decision to choose one RIM system over another; for example:

> Because the cost outweighs the benefits, I don't prefer to use it [ResearchGate]. Also because I have Google Scholar, which is the number one tool used by others, I think that's sufficient for me to maintain the profile by only using Google Scholar and not using ResearchGate anymore. (S14)

This finding indicates that increasing the benefits and reducing the costs to users should be the main target of RIM system design (Preece & Sheiderman, 2009; Stvilia et al., 2007). One can draw a parallel between this finding and the literature that suggests members' commitment to a group is affected by the cost-benefit structure of membership in the group and available alternatives (Meyer, Stanley, Herscovitch, & Topolnytsky, 2002). For a researcher to stay motivated to continue to use a RIM system, the benefits or added value of using a particular

metadata element, service, and system as a whole must exceed the cost of using it and the cost-benefit structure of switching to an alternative.

Researchers can also be concerned about the longevity of a RIM system. Several participants in the current study expressed a concern that their investment of time and effort in a RIM system could be lost if the system does not receive or retain enough adoption and therefore goes away. For example, one of them stated:

> I think there's too many of them out there and it's too much to keep up with, and that it's a little overwhelming ... I sometimes wonder if ResearchGate and Academia.edu are just fads and that they will be replaced or disappear at some point with something that is more effective and more [widely used] across the board. (S7)

This finding is in agreement with the literature suggesting that setting high expectations for the community's success can help recruit new members and retain existing ones (Resnick, Konstan, Chen, & Kraut, 2012). A RIM system design that highlights positive statistics regarding the community's growth and commitment from established institutions (e.g., funding agencies, universities) may translate into an increase in researchers who commit to the system.

The data analysis found that a researcher's career status might affect her/his priorities for research identity related activities, and consequently her/his perceived values for different RIM services and metadata. For example, junior researchers, who have few publications, may find the cost of contributing to the author disambiguation service of a RIM system higher than the benefits they may receive. One participant, who was a doctoral student, explained:

> When one first registers for that site [ResearchGate], they will have a list for you to review ... So they had a list of 25 papers for me. You have to select which one is yours. That's very time consuming to check, but if that's the first time, I can understand because they don't have any of my information ... Later, once I already have some data entries on the site, they still keep consistently providing those incorrect citations, asking me to verify. I feel it's not that understandable, because those papers, even using their own pre-defined list, are obviously in some other fields. (S2)

This finding suggests that RIM systems providing users with service configurations and communications adapted or tailored to their career status and priorities may result in higher usage and increased user satisfaction.

6.3. Quality

The quality of information and services provided by a RIM system determines the outcome quality of the activities using that system, and consequently may affect a researcher's motivation to use that system. Different activities may have different quality requirements for RIM system services and information. One participant described how his needs for RIM system services and quality might differ depending on the role he played when using the system:

> I think this is from the reader's point-of-view. When readers search for other people's publications, he or she cares if the publication information is accurate, timely or recent,

> reflecting the recent publications, and also whether or not they provide links to download the paper and whether or not the link is correct ... For the authors, I think I mentioned automation, the amount [of effort] required for the author … to update the profile is another criterion for [the] quality of the system. (S14)

This participant valued the accuracy and currency of information provided by RIM systems in the role of a reader, but cared about the simplicity of curating his identity data when he was the owner of the online profile. To meet these often competing quality priorities (e.g., the completeness and currency of publications versus the simplicity of adding publications, the accessibility of publications versus the security of researchers' personal information), RIM system designers may consider adding an automated publication harvesting service to the system, and also providing researchers with the flexibility to select the audience and accessibility levels for their own research profiles. A RIM system may also harvest publications on its own to accumulate a critical mass of content to attract researchers as Readers, and then recruit them to maintain their own research profiles and make other contributions to the community (Preece & Shneiderman, 2009; Stvilia et al., 2008). The findings of the current study show that both high quality indicators (e.g., a database of comprehensive types of research literature, unique content) and quality problems (e.g., an incorrect attribution of publications in a researcher's profile) can motivate researchers to be engaged and curate their research identity data. Hence, signaling high quality criteria in the design of RIM systems and alerting researchers about potential quality problems in their research profiles may increase their engagement with the systems.

A single system may not provide all of the functionalities or meet all of the quality requirements for a particular activity (Stvilia & Choi, 2015). The current study also found that researchers valued interoperability of RIM systems, and that they might use more than one tool to meet their RIM needs. For example, one participant explained how he used different services from three RIM systems and that his quality requirements varied for each of those systems:

> Google Scholar is probably the most convenient way for me to just get a quick check about how my citation gets up-to-date … ResearchGate for me is more like a social network platform. Sometimes it's more convenient to actually follow somebody you are interested in ... And for ORCID, my colleagues recommended it to me because that can give you a very specific identity and also because that's attached to Web of Science. So that's a pretty formal ID ... it seems important to keep an ID, so that people know exactly who you are and what publications you have. (S10)

As mentioned above, a major component of the curation activity is quality assurance. One distinguishable characteristic of Community Members is that they curate other members' research information. One participant, who was categorized as a Community Member, attributed her curation of other members' research identity information to her motivation to be a good member and establish a reputation in the community. This finding indicates that researchers' quality assurance actions may be associated with their motivation to build a reputation in the community. This corresponds to the findings of previous studies by Nov et al. (2010) as well as

Wasko and Faraj (2005). As suggested by Stvilia et al. (2008), RIM system designers may consider deploying reward mechanisms to encourage researchers' engagement in research identity data curation and quality assurance. For example, RIM systems may increase the visibility of those active community members, and promote their profiles to researchers looking for job candidates.

7. Limitations

The purpose of this qualitative, exploratory study was to identify researchers' activities involving the use of RIM systems, identify their motivations for using and participating in RIM systems, and learn about their quality requirements for RIM systems. The participants of this study were limited to researchers as defined in Section 4 above. The findings may be applicable to other researchers similar to those interviewed in this study in terms of discipline and sonority. Because of the exploratory nature of this study, the findings are not intended to be generalizable to any populations at large. Another limitation of this study is that some of the profile information for participants (e.g., the number of publications and citation indices) was not reported due to concerns over jeopardizing their anonymity, and thus no analysis is provided of the influence of citation activities on using and participating in RIM systems.

8. Conclusion

This study provides rich qualitative data regarding how researchers use and participate in online RIM systems, and their requirements for RIM systems. The analysis of the qualitative interview data identified nine researcher activities and motivations for using RIM systems, and categorized researchers' participation in RIM systems into three levels. The data analysis also identified five types of information quality problems that participants had encountered in RIM systems and 12 information quality criteria or virtues they perceived to be important in RIM systems.

Based on the findings of these interviews, future research will develop and implement a survey to build a quantitative model of researchers' participation in RIM systems. The interview data suggests that the researchers' participation levels in RIM systems and their needs and requirements may change depending on their seniority, roles, number of publications, and career status. The survey will examine if there is a relationship between any of the demographic characteristics (e.g., seniority, discipline, role) and the motivations for using and participating in RIM systems.

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