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The structure and priorities of researchers' scholarly profile maintenance activities: A case of institutional research information management system

Dong Joon Lee[1], Besiki Stvilia[2], Seungyeon Ha[3], and Douglas Hahn[4]

[1]Department of Information and Operations Management, Texas A&M University
[2]School of Information, Florida State University
[3]Statistical Collaboration Center, Texas A&M University
[4]University Libraries, Texas A&M University

Author Note

Dong Joon Lee, Department of Information and Operations Management, Texas A&M University, 4217 TAMU, College Station, TX 77843.
E-mail: djlee@tamu.edu. ORCID iD: 0000-0001-8994-163X.
Besiki Stvilia, School of Information, Florida State University, 142 Collegiate Loop, Tallahassee, FL 32306.
E-mail: bstvilia@fsu.edu. ORCID iD: 0000-0002-2428-6627.
Seungyeon Ha, Statistical Collaboration Center, Texas A&M University, 3143 TAMU, College Station, TX 77843.
E-mail: ha.shawn@tamu.edu. ORCID iD: 0000-0002-7460-9447.
Douglas Hahn, University Libraries, Texas A&M University, 5000 TAMU, College Station, TX 77843.
E-mail: dhahn@tamu.edu. ORCID iD: 0000-0003-4327-0476.

Correspondence concerning this article should be addressed to: Dong Joon Lee, Department of Information and Operations Management, Texas A&M University, 4217 TAMU, College Station, TX 77843.

E-mail: djlee@tamu.edu

Abstract

Research information management systems (RIMS) have become critical components of information technology infrastructure on university campuses. They are used not just for sharing and promoting faculty research, but also for conducting faculty evaluation and development, facilitating research collaborations, identifying mentors for student projects, and expert consultants for local businesses. This study is one of the first empirical investigations of the structure of researchers' scholarly profile maintenance activities in a non-mandatory institutional RIMS. By analyzing the RIMS's log data, we identified 11 tasks researchers performed when updating their profiles. These tasks were further grouped into three activities: (1) adding publication, (2) enhancing researcher identity, and (3) improving research discoverability. In addition, we found that junior researchers and female researchers were more engaged in maintaining their RIMS profiles than senior researchers and male researchers. The results provide insights for designing profile maintenance action templates for institutional RIMS that are tailored to researchers' characteristics and help enhance researchers' engagement in the curation of their research information. This also suggests that female and junior researchers can serve as early adopters of institutional RIMS.

Introduction

Higher education institutions recognize the benefits of implementing and maintaining research information management system (RIMS). Although the cost of running the system is significant, many academic institutions value the benefits derived from RIMS (Bryant, Fransen, de Castro, Helmstutler, & Scherer, 2021; Stvilia, Lee, & Han, 2021). RIMS supports diverse stakeholder groups and their different needs (Greifeneder et al., 2018; Smith-Yoshimura et al., 2014). University administrators see RIMS as an information system that can support their evidence-based decision-making processes; individual researchers use RIMS to distribute their scholarship, enhance their scholarly reputation, and/or identify their future collaborators; and students use RIMS to find advisors and monitor literature (Nicholas et al., 2015; Wu, Stvilia, & Lee, 2017). In this study, we broadly define RIMS as the type of information systems that manage and/or provide access to researchers' scholarly works, identity and expertise information, and related services (de Castro, Shearer, & Summann, 2014; Stvilia, Wu, & Lee, 2018a). This definition encompasses different types of research information management systems with different functions, use cases, and workflows in settings of global (e.g., ResearchGate, Google Scholar), national (e.g., NARCIS), statewide (e.g., Florida ExpertNet, Ohio Innovation Exchange), disciplinary (e.g., DIRECT2Experts), and institutional (e.g., VIVO, DSpace-CRIS, Symplectic Elements, Pure).

One of the use cases of institutional RIMS is to generate useful institutional research reports to support university administrators' activities of evaluation, decision-making, and reporting to external accrediting bodies (Sivertsen, 2019). These activities require accurate and complete information. Ensuring the quality of information and data in any information system is critical (Mason, 1986). Although different approaches exist (e.g., professional curator, automated curation, non-professional curator) for enhancing data and information quality in RIMS, this study focuses on profile owners' (non-professional curator) manual curation of their research information, which requires their engagement in the RIMS. As sociotechnical systems, the RIMS comprises not only software modules, but also organizational policies, norms, culture, rules, users' RIM needs, and priorities (Lee & Stvilia, 2017; Stvilia, Wu, & Lee, 2019).

Individual researchers use RIMS for many different needs, and their participation levels vary. A substantial body of literature reports on researchers' perceptions and uses of RIMS (Jeng, DesAutels, He, & Li, 2017; Lee, Oh, Dong, Wang, & Burnett, 2019; Stvilia, Wu, & Lee, 2018b, 2019; Thelwall & Kousha, 2015; Van Noorden, 2014). However, to the best of our knowledge, no study has yet examined the structure and priorities of researchers' scholarly profile maintenance activities in an operational institutional RIMS. Gaining a better understanding of these issues can substantially extend the RIMS literature. It can also inform the design of RIMS adoption and engagement strategies and the design of RIMS profile maintenance workflows to tailor

them to researchers' characteristics and context. This study addresses that gap by investigating the following research questions:

1. What is the action structure of researchers' scholarly profile maintenance activities in institutional RIMS?
2. What are the relationships between researchers' priorities for scholarly profile maintenance actions and researchers' characteristics?

Literature Review

Researchers use RIMS for different needs and in different contexts. Previous studies have shown that researchers engage with RIMS to share scholarship, monitor scholarship, reuse data, track metrics, identify potential collaborators, discover funding opportunities, discuss with other researchers, and/or find jobs (see Table 1). When researchers have needs and the tools (e.g., RIMS) to support those needs, they can engage in activities with specific actions to fulfill their needs (Engeström, 2009). The needs become their motivations for engaging with the tools in activities (Kaptelinin, 2005; Nardi, 2005). Many researchers have surveyed RIMS profile owners' activities/uses, and the activities from different studies considerably overlapped (see Table 1). Activities related to communicating with other researchers and searching for a job were only reported in global RIMS (e.g., ResearchGate; also called academic social networking sites).

Table 1

Researchers' activities in RIMS (i.e., Pure, Elements, DSpace-CRIS, Converis, VIVO, Profiles, ResearchGate, Academia.edu, and Mendeley) and their sources.

Needs	Activities	Sources
Share scholarship	Share research	Bryant et al., 2018
	Archive works	Lee et al., 2019
	Deposit works	Nández & Borrego, 2013
	Disseminate research output	Stvilia et al.,2018a
	Disseminate CV	Van Noorden, 2014
	Disseminate teaching material	
Monitor scholarship	Monitor literature and other researchers	Nández & Borrego, 2013
	Follow other researchers' activities	Stvilia et al.,2018a
	Discover recommended papers	Van Noorden, 2014
Reuse data	Generating CV, dossiers, or annual activity reports	Bryant et al., 2018
		Stvilia et al.,2018a
Track metrics	Communicating research impact	Bryant et al., 2018
	Evaluate research and researcher on impact	Stvilia et al.,2018a
		Van Noorden, 2014
Identify potential collaborators	Identify collaborators and experts	Bryant et al., 2018
	Discover peer	Nández & Borrego, 2013
	Contact peer	Stvilia et al.,2018a
		Van Noorden, 2014

Discover funding opportunities	Look for funding opportunities	Bryant et al., 2018
Discuss with other researchers	Ask and answer questions Comment on research Follow discussions	Stvilia et al.,2018a Van Noorden, 2014
Find jobs	Search for a job Discover job	Nández & Borrego, 2013 Stvilia et al.,2018a Van Noorden, 2014

The literature also reports on different data curation practices and levels of researcher participation, use, and perception in information management systems. Such differences have been defined by researchers' seniority, gender, disciplines, and various activities (e.g., read data, update data, and communicate with other users) with the systems (Birkbeck, Nagle, & Sammon, in press; Greifeneder et al., 2018; Kousha & Thelwall, 2013; Preece & Shneiderman, 2009; Stvilia et al., 2019; Wu et al., 2017).

Greifeneder et al. (2018) conducted a study to explore researchers' attitudes toward and experiences with RIMS. They found different attitudes on RIMS based on researchers' seniority. Junior and midlevel researchers expressed more usefulness of the systems to their career than senior researchers did. Similarly, junior and midlevel researchers also expressed more harmfulness of the system to their career when their profiles are not updated effectively. This indicates that RIMS affects younger researchers' careers more than older researchers' careers and requires more costs and efforts from younger researchers to make it a useful tool for their career. Lutz and Hoffmann (2018) also found that established researchers' profiles attract other researchers to connect or collaborate more; however, junior researchers use RIMS more actively. In addition, many studies have discussed researchers' openness to data sharing. One study noted that "younger and early career researchers are more reluctant to share their data than older and seasoned researchers" (Chawinga & Zinn, 2019, p. 114), which connects to concepts of trust and the concern around data sharing (Birkbeck et al., in press). However, another study discussed that a conservative attitude of data sharing in science fields might evolve with the younger researchers (Lefebvre & Spruit, 2019).

Many studies (Igbaria, Guimaraes, & Davis, 1995; Mathieson, Peacock, & Chin, 2001; Venkatesh, 1999) have discussed users' perceptions of information systems as a critical assumption of the Technical Acceptance Model. According to the model (Davis, 1989), "perceived ease of use" and "perceived usefulness" mediate the influence of external variables on information systems' usage behavior. Mathieson et al. (2001) suggested that seniority should have a positive direct effect on usage over "perceived ease of use" and "perceived usefulness." By understanding the relationship between researchers' seniority and their RIMS actions, the current study can help design customized communication strategies based on their needs and characteristics.

Gender is also an important variable for understanding the use of global RIMS or academic social networking sites (ASNS). Many researchers have examined the differences between men's and women's use of ASNS and their information-sharing decisions with the systems. Elsayed (2016) reported that male researchers are more active when using and engaging with RIMS than female researchers. Tsou, Bowman, Sugimoto, Lariviere, and Sugimoto (2016) investigated researchers' self-presentation in scholarly profiles by characterizing their profile pictures. They found that the majority of profiles in their study were Caucasian, male, and older than the age of 35. Many studies have also discussed the different perceptions of male and female researchers when engaging with RIMS (Lin, Li, Califf, & Featherman, 2013; Lin & Wang, 2020; Venkatesh & Morris, 2000; Zhang, Lee, Cheung, & Chen, 2009). Lin and Wang (2020) reported that women care more than men about privacy risks, social ties, and commitment when they engage with social networking sites or share information through the systems. Venkatesh and Morris (2000) also found that females are more affected by "subjective norms" and "perceived ease of use.*"* On the other hand, males consider "perceived usefulness" more than females when they use technology. In the technology domain, "subjective norm" is defined as "the degree to which women/men can be influenced and the extent to which they respond to information provided by other referents," and both peer (and senior) researchers and affiliation needs are strong referents and motivators (Hoffman, 1972; Venkatesh & Morris, 2000, p. 119). Based on the literature studying gender differences in technology uses, many studies suggest that system designers should pay more attention to such differences when they design and develop new systems and communication strategies.

Lee, Stvilia, and Wu (2020) investigated researchers' metadata use by analyzing researchers' scholarly profiles. The results from the study showed statistically significant relationships between researchers' participation levels and their use of metadata elements in ResearchGate profiles. Based on their results, Lee et al. proposed sample profiles with metadata elements for researchers' different participation levels. For example, if a researcher's profile includes metadata of a picture, first name, last name, department, position, research experience, project, and skills and expertise, the profile's owner has a higher chance of being included in the *Community Member* group rather than the *Reader* and *Personal Record Manager* groups; if a profile only includes first and last name and department information, the profile's owner has a higher chance of being categorized in the *Reader* group. With these results, the authors of this study suggested the need for a better communication strategy with the system users to enhance their motivation to update their profiles as well as reduce barriers for their system uses.

In the development of machine learning techniques and human computer interactions, many studies have discussed building recommender systems for scholarly information using RIMS. To provide relevant contents for different users, designing context-aware recommender systems with the consideration of multiple facets is

critical (Champiri, Shahamiri, & Salim, 2015; Hristakeva et al., 2017). Explicit information (e.g., citation, author network), implicit user feedback and behaviors (e.g., updating profiles, adding documents to their personal libraries, such as Mendeley), recent publication activities, research interests, and discipline are some of the contextualized data captured that, along with researchers' activities, can help develop different types of recommenders (Hristakeva et al., 2017). To the best of the authors' knowledge, most RIMS studies have been conducted with non-institutional systems, such as ResearchGate, Academia.edu, Mendeley, ORCID, and Google Scholar. Hence, profile owners' specific actions when they update their profiles could not be discussed further using previous studies' data.

Study Design

This study is based on a non-mandated institutional RIMS and its users' voluntary actions. Although this study is a single case study, the results can produce many insights for other institutions that operate RIMS. In January 2018, Texas A&M University (TAMU) Libraries launched the RIMS, *Scholars@TAMU* (Scholars; http://scholars.library.tamu.edu/), which features TAMU faculty members' scholarly information (e.g., their academic backgrounds, publications, teaching and grant activities), pre-populated faculty profiles based on multiple internal and external data sources (e.g., TAMU Human Resources, Web of Science, Scopus, PubMed, CrossRef, Dimensions, TAMU grants and awards, TAMU courses). The system is based on a member-supported, open-source RIM software (i.e., VIVO; http://www.vivoweb.org/) that enables the discovery of research and scholarly activities across disciplines by providing standard scholarly profiles. Scholars first started with faculty profiles in the College of Medicine and continuously expanded the scope to include other academic departments and colleges (e.g., English, Liberal Arts, Public Health, Engineering, Agriculture and Life Science, Veterinary Medicine, Science). The system currently covers all TAMU academic departments and colleges and covers about 5,000 faculty profiles and 210,000 research publications.

The effective curation of identity data requires specialized knowledge of the data context (Atkins et al., 2003; Lee & Stvilia, 2017). Engaging researchers in the management of their RIMS profiles can bring the necessary knowledge of disciplinary context to the curation of their research information. To achieve that goal, however, a non-mandatory RIMS needs to make researchers' engagement with the RIMS low cost (Stvilia et al., 2018a). Hence, TAMU Libraries' Scholars project team slowly increased the number of curated faculty profiles in Scholars by going department by department and college by college and being guided by their feedback, needs, and comments. The initial curation service from the project team was focused on providing usefulness and easiness (i.e., completed publication record) to increase users' participation rates (Davis, 1989). In addition, the team deployed a locally developed profile editor (Editor) in order to give the faculty members control and autonomy over the content of their profiles. The Editor also enabled the team to monitor faculty

members' actions and allowed the team to send customized emails out based on their monitored actions and/or data updates. As of May 19, 2022, more than 75% of Scholars profile owners have interacted with their profiles (e.g., update, edit, request, comments), including recently adding more than 1,000 new profiles.

The Editor keeps track of users' actions by storing their use of metadata elements as log data. The Editor has 11 different modules and generates 124 unique events based on the users' actions. The uniqueness of the events offers a fine granularity view to keep track of the users' specific actions (see Table 2). The design of this study draws from activity theory (Kaptelinin, 2005; Nardi, 2005) to conceptualize users' goal-driven tasks, which helps understand the performance of the system, the use-based value of metadata (Stvilia & Gasser, 2008), and design of the systems' metadata model. According to activity theory, human activity comprises goal-oriented actions mediated by tools. Events recorded the log data represent users' actions that build users' activities.

Table 2

Summary of automatically generated log data modules and events.

Modules	# of Events within Module	Examples of Events
Profile	39	First name was added; Overview was added; Position was added; Email was added
Publication	49	Title was added; Volume was added; Begin page was added; Book title was added; Publisher was added
Grants/Awards	6	Grants was added; Awards was removed
News	3	News was added
Courses	3	Class was added
Works by Students	2	Student work was claimed; Student work was rejected
Additional Changes	1	Additional changes requested
Navigation in	9	Profile; Publication; Courses
Authentication	4	Logged in
Email Notification	4	Email notification responded

The authors combined the 124 automatically generated events into 69 different events for analysis purposes. For example, "*Education was added*" and "*Education was removed*" have been merged into the same type of event, which the authors labelled as "*Education was updated*." Currently, the database includes records for 7,316 faculty members whose profiles are public, not yet public, or archived, with 4,876 faculty profiles being publicly available in Scholars (as of May 19, 2022). This study analyzed log data records from 3,738 faculty members (i.e., currently available profiles in Scholars) who made at least a single login and data input to the Editor. This analysis allowed us to explore the structure of the RIMS profile maintenance activity and faculty members' priorities for different actions of that activity. This analysis has been conducted with the principal component analysis test, which is a widely used technique to help analyze datasets with a high number

of variables (i.e., the number of events) to identify a latent structure underlying those variables. This statistical method increases the interpretability of the datasets by reducing the number of variables into a smaller number of components. Figure 1 shows the frequency of sampled profile owners occurring in disciplines and seniority levels. The authors identified 27,249 user sessions using the timeout method, in which a user session is usually defined as a sequence of requests from the same user such that no two consecutive requests are separated by an interval of more than a predefined threshold. A 30-minute threshold is the most commonly used approach for identifying sessions (Eickhoff, Teevan, White, & Dumais, 2014; Ortega & Aguillo, 2010; Spiliopoulou, Mobasher, Berendt, & Nakagawa, 2003). For example, any events performed by the same user within 30 minutes, no matter how many events exist, are considered as a single session. Table 3 provides a sample of a standard log format collected by Scholars' Editor. In the log data, the session duration lasted between 0 and 30 minutes, with 3.08 minutes being the average duration of the sessions (see Figure 2). To answer the second research question, one of the authors used the RIMS database and faculty directory pages to manually identify the gender and seniority of 3,738 sampled faculty members. The author also queried the same database to capture the sampled faculty members' publication counts and the existence of their profile pictures and research overview paragraph(s). The selection of faculty members' characteristics for the analysis was based on previous studies in RIM communities (Elsayed, 2016; Greifeneder et al., 2018; Lee, Mutya, Herbert, & Mejia, 2019; Lee et al., 2020; Tsou et al., 2016) suggesting that the characteristics might affect researchers use of and engagement with RIMS.

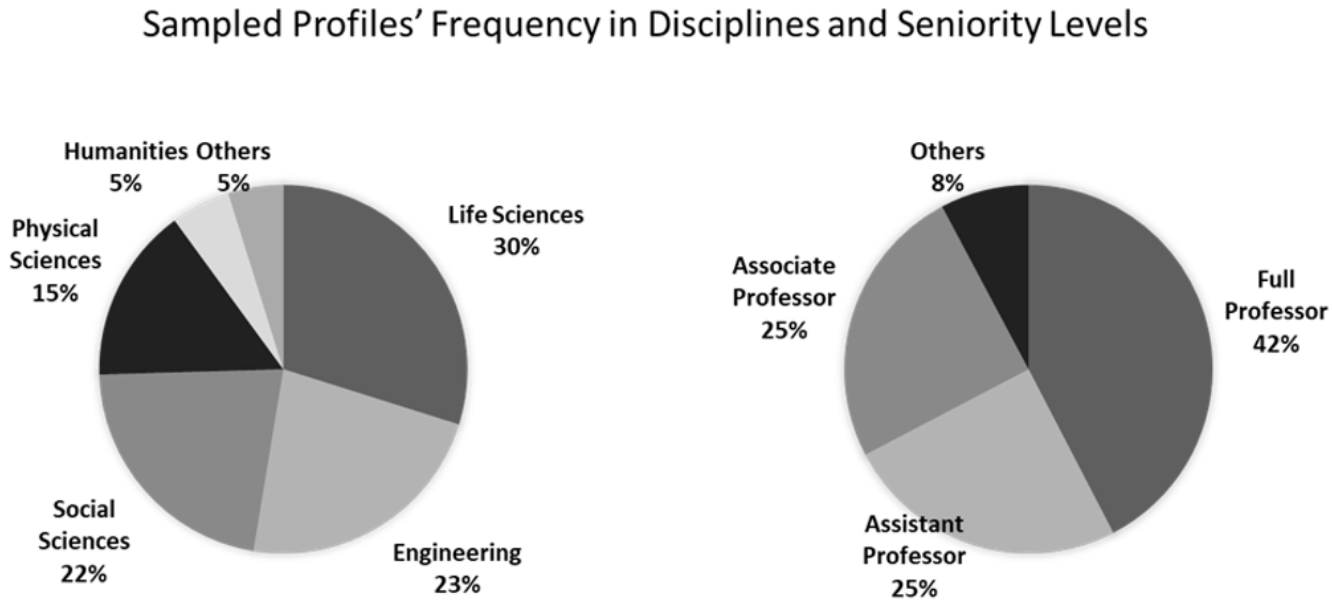

Figure 1. Sampled profile owners' frequency in disciplines and seniority levels (n=3,661).

Table 3

Snippet from Scholars profile editor log data.

ID	UID	Module	Event	Time
84	2ccaf7464213f431bf0c8ff8c2e44b13	Profile	A new picture was uploaded.	8/18/2020 13:16
85	2ccaf7464213f431bf0c8ff8c2e44b13	Profile	Preferred Email was added.	8/18/2020 13:19
87	1ae5ae54c7c1a5a5aa09ea5996bceb31	Profile	Preferred Title was added.	8/18/2020 13:22
88	1ae5ae54c7c1a5a5aa09ea5996bceb31	Profile	Preferred Email was removed.	8/18/2020 13:22
191	eae7797e8e90aa520272dc921d5dd432	Profile	Research area was added.	8/24/2020 9:47
192	eae7797e8e90aa520272dc921d5dd432	Profile	Overview was added.	8/24/2020 9:48
253	71f169cc06a8d480ccf4111d7724d232	Profile	Phone was removed.	8/25/2020 14:21

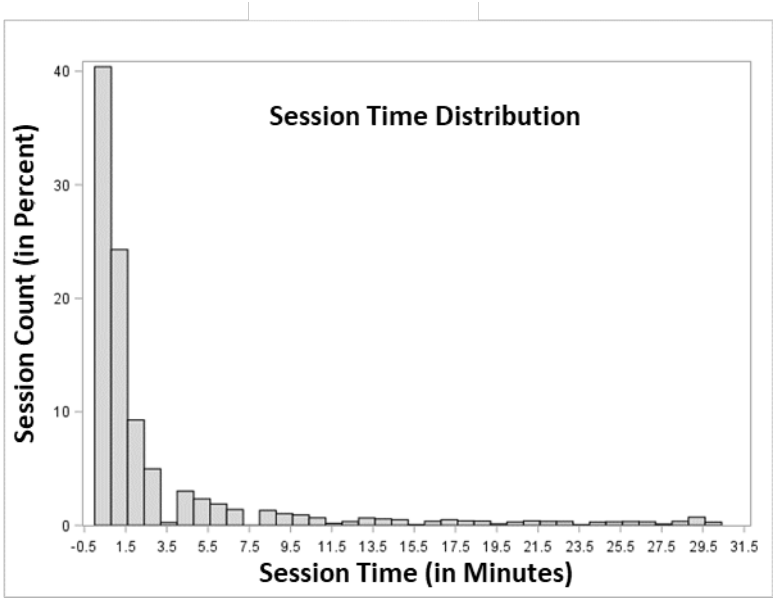

Figure 2. Session time distribution.

Findings

The data in this study include counts of events, which follow skewed Poisson distribution. The authors used the log transformation, a widely used method to address skewed data as well as reduce variation, which improves the detection power of small value signals. To identify the profile owners' tasks structure while they update their profiles, a statistical analysis was completed using the principal component analysis test, which extracts factors. The 69 events were treated as variables, and the 27,249 user sessions performed by 3,738 faculty members were the unit of analysis. A scree plot suggested selecting the first 11 components. Factor loadings of 0.4 and above were identified as significant based on the sample size: 27,249; the number of the users' event: 44; the estimated standard deviation: 0.74 at a significance level of .05; the effect size of 0.4 is detectable at a power of 80 percent. Variables cross-loaded on more than one component were removed from the model one by one, and the loadings were recalculated until no such variables were found. The final version of the model was composed of 44 variables and 11 components (see Table 4). The measure of sampling adequacy (MSA) was equal to 0.859; the Bartlett test of sphericity was significant at the 0.001 level. The model captured 62% of the total variance of the data.

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Table 4

Factor loadings for the profile owners' events.

Users' Events	Component										
	1	2	3	4	5	6	7	8	9	10	11
VOLUME WAS UPDATED	**0.924**	-0.001	-0.062	0.000	-0.162	-0.006	-0.042	0.003	0.025	-0.004	0.012
ISSUE WAS UPDATED	**0.873**	0.002	-0.061	-0.011	-0.169	-0.003	-0.029	0.009	-0.037	0.003	0.010
JOURNAL TITLE WAS UPDATED	**0.865**	0.003	-0.113	0.015	-0.097	0.000	0.045	-0.007	0.095	0.005	-0.014
START PAGE WAS UPDATED	**0.724**	0.007	0.188	0.000	0.316	-0.008	0.060	-0.003	-0.023	0.010	-0.021
END PAGE WAS UPDATED	**0.719**	0.008	0.190	-0.001	0.317	-0.008	0.061	-0.003	-0.009	0.009	-0.021
YEAR WAS UPDATED	**0.592**	-0.002	0.365	0.010	0.276	-0.003	0.082	-0.004	-0.007	-0.006	0.014
AUTHOR LIST WAS UPDATED	**0.579**	0.007	0.297	0.004	0.254	-0.007	0.087	-0.001	0.018	0.013	-0.024
PUBLICATION TYPE WAS UPDATED	**0.527**	-0.008	0.304	0.015	0.249	-0.005	0.178	-0.005	0.080	-0.011	0.033
MONTH WAS UPDATED	**0.430**	0.002	0.077	0.009	0.284	-0.012	0.284	-0.002	-0.022	-0.004	-0.007
CITY WAS UPDATED	0.000	**0.897**	0.006	0.096	-0.011	0.027	0.021	0.002	0.030	-0.104	-0.155
ZIP WAS UPDATED	0.000	**0.896**	0.002	0.053	-0.007	0.015	0.009	0.040	0.015	-0.030	-0.085
STATE WAS UPDATED	0.004	**0.874**	0.007	0.067	-0.012	0.025	0.022	0.033	0.012	-0.109	-0.136
ADDRESS LINE1 WASUPDATED	0.004	**0.847**	0.003	-0.047	-0.004	-0.020	-0.005	0.007	-0.025	0.005	0.066
ADDRESS LINE2 WASUPDATED	0.008	**0.740**	0.003	0.043	-0.006	0.008	-0.005	-0.026	0.011	0.020	0.001
ADDRESS LINE3 WASUPDATED	-0.004	**0.704**	-0.001	-0.127	0.003	-0.048	-0.022	-0.067	-0.016	0.095	0.205
PHONE WAS UPDATED	0.000	**0.547**	-0.019	0.084	0.023	-0.003	-0.020	0.083	-0.008	0.108	0.080
PREFERRED EMAIL WAS UPDATED	-0.001	**0.504**	-0.011	-0.129	0.006	-0.049	-0.013	0.019	-0.018	0.133	0.276
EDITOR NAME WAS UPDATED	0.043	0.005	**0.817**	-0.015	0.001	-0.010	-0.059	0.007	0.023	0.012	-0.001
PLACE PUBLISHER WAS UPDATED	-0.050	0.021	**0.792**	0.002	-0.067	-0.006	0.090	0.008	-0.025	0.009	-0.052
BOOK TITLE WAS UPDATED	0.031	0.003	**0.721**	-0.012	-0.049	-0.010	-0.081	-0.007	0.062	0.028	-0.018
PUBLISHER WAS UPDATED	0.008	-0.031	**0.667**	-0.002	-0.070	0.014	-0.074	0.022	-0.020	-0.031	0.090
TITLE WAS UPDATED	0.357	0.002	**0.519**	0.009	0.262	0.009	-0.022	-0.006	0.047	-0.012	0.020
RESEARCH AREA WAS UPDATED	0.002	0.061	-0.027	**0.726**	-0.002	-0.003	-0.014	0.037	-0.013	0.024	0.037
OVERVIEW WAS UPDATED	-0.008	0.023	-0.014	**0.701**	-0.009	-0.016	0.005	0.034	-0.007	0.045	0.033

WEBSITE WAS UPDATED	0.003	0.012	0.003	**0.629**	-0.004	0.018	-0.043	-0.032	-0.002	-0.006	-0.024
PROCEEDINGS TITLE WAS UPDATED	-0.023	-0.004	-0.141	-0.007	**0.953**	0.004	-0.004	0.005	0.002	0.001	0.002
CONFERENCE NAME WAS UPDATED	-0.088	-0.010	-0.058	-0.006	**0.920**	-0.001	-0.048	0.012	0.029	-0.002	0.017
PUBLICATION WAS CLAIMED OR REJECTED	0.011	0.017	0.000	-0.059	0.025	**0.851**	-0.021	-0.009	0.008	-0.001	0.059
LOGGED IN	-0.005	-0.033	0.007	0.140	-0.017	**0.785**	0.079	-0.007	0.011	0.045	0.113
EMAIL NOTIFICATION WAS CLICKED	-0.012	0.035	-0.011	-0.245	0.010	**0.465**	-0.118	0.000	-0.048	-0.055	-0.307
DOI WAS UPDATED	0.051	-0.012	-0.057	0.003	0.005	-0.021	**0.751**	-0.002	0.016	-0.008	0.048
URL WAS UPDATED	0.087	0.009	-0.034	0.019	0.164	-0.012	**0.680**	-0.029	-0.057	-0.004	-0.018
ISBN WAS UPDATED	-0.181	0.023	0.451	0.018	0.027	-0.001	**0.514**	-0.027	-0.047	0.003	-0.049
PUBMED ID WAS UPDATED	0.014	-0.003	-0.082	-0.048	-0.131	0.025	**0.471**	0.033	0.056	0.009	0.006
FIRST NAME WAS UPDATED	0.011	-0.024	-0.008	-0.062	0.011	0.021	0.006	**0.795**	-0.031	-0.016	-0.011
MIDDLE NAME WAS UPDATED	-0.005	-0.026	0.033	0.114	0.009	-0.003	-0.013	**0.709**	0.005	0.026	0.017
LAST NAME WAS UPDATED	0.000	0.045	0.004	-0.035	0.002	-0.024	0.010	**0.574**	0.017	-0.005	0.000
KEYWORD WAS EDITED	-0.138	0.025	-0.004	-0.021	0.057	0.006	0.030	0.018	**0.774**	-0.007	-0.003
PUBLICATION WAS REQUESTED TO BE UPDATED	0.124	-0.014	0.079	0.014	-0.050	-0.002	0.006	-0.019	**0.629**	-0.012	0.046
ABSTRACT WAS UPDATED	0.010	-0.001	-0.034	-0.009	0.018	-0.002	-0.022	-0.004	**0.592**	0.016	-0.034
PREFERRED POSITION TITLE WAS UPDATED	0.002	-0.012	0.001	-0.018	0.002	0.020	-0.003	0.020	0.001	**0.874**	-0.060
POSITION WAS UPDATED	0.002	-0.010	0.012	0.052	-0.003	0.009	-0.001	-0.013	0.002	**0.863**	-0.059
EDUCATION WAS UPDATED	-0.011	0.038	0.010	-0.057	0.020	-0.022	-0.032	0.015	-0.013	-0.078	**0.790**
ACADEMIC BACKGROUND	-0.004	0.001	0.017	0.157	-0.003	0.131	0.051	0.033	0.016	0.018	**0.712**

Note. Extraction method: Principal Component Analysis. Rotation Method: Oblimin with Kaiser Normalization. Factor loadings of 0.4 and above were identified as significant.

Eleven components/factors were labeled by the authors based on the users' events from the log that significantly loaded on each factor. Table 5 presents event-based user actions when updating their profiles. The actions were sorted by the mean summated frequencies of the tasks included in each factor. The *Claim publication, Update educational background,* and *Share research expertise* were the first three user actions that had the highest average score.

Table 5

Users' actions ranked by the mean summated frequencies of events loaded on each factor.

Component ID	Actions	Mean summated frequency
6	Claim publication	0.5609
11	Update educational background	0.0817
4	Share research expertise	0.0296
10	Update position title	0.0191
1	Add publication with bibliographic metadata	0.0098
7	Add publication with identifier	0.0076
2	Update contact information	0.0072
8	Update personal name	0.0040
3	Add book chapter	0.0029
9	Complete publication metadata (i.e., abstract, keyword)	0.0024
5	Add conference information to publication	0.0010

To examine the relationships between the researchers' RIM profile maintenance actions and researchers' characteristics, a factor score was computed for each factor and added to the data as a variable. The factor scores as scale responses followed Gamma probability distribution, so the authors added a minimum value of each factor score to the data in each column to avoid invalid data points (i.e., negative values) for the Gamma distribution analysis. This study used a generalized linear model with gamma. For researchers' seniority, all components except *3. Add book chapter* revealed significant differences between researchers' seniority and users' actions (see Table 6). For this analysis, the authors only used the three seniority groups (i.e., assistant, associate, and full professors) to remove the noise that can be generated from the "Others" group. All components except *5. Add conference information to publication* showed significant differences between researchers' gender and their actions. Based on their mean values, female faculty members made more updates on most of the significant components, but male faculty members made more updates associated with the *6. Claim publication* component (see Table 7). Publication counts were significantly different based on all of components except *1. Add publication with bibliographic metadata* and *9. Complete publication metadata (i.e.,*

abstract, keyword). Faculty members with profile pictures in their profiles (i.e., Yes/No) reported significantly greater actions with all components except *2. Update contact information*, which had a higher mean value for faculty members without profile pictures. Researchers who added research overviews to their profiles (i.e., Yes/No) performed a significantly higher number of actions associated with components 1, 3, 4, 5, 6, 7, and 9. Components *2. Update contact information* and *11. Update educational background* showed significant relationships; however, their mean values were in the opposite direction of the other significant components. Components *8. Update personal name* and *10. Update position title* did not show significant relationships with the existence of research overview.

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Lee, D.J., Stvilia, B., Ha, S., & Hahn, D. (in press, Nov. 2022). The structure and priorities of researchers' scholarly profile maintenance activities: A case of institutional research information management system. *Journal of the Association for Information Science and Technology*.
http://doi.org/10.1002/asi.24721

Table 6

Relationships between user actions and researchers' seniority, gender, publication counts, profile pictures, and research overviews.

Users' actions	Seniority				Gender			Publication Count			Profile Picture			Research Overview		
	F	df1	df2	Sig.	Chi-Square	df	Sig.	Chi-Square	df	Sig.	Chi-Square	df	Sig.	Chi-Square	df	Sig.
1. Add publication with bibliographic metadata	11.003	2	26132	***0.001***	54.629	1	***0.001***	0.417	1	0.518	70.057	1	***0.001***	24.099	1	***0.001***
2. Update contact information	123.257	2	26132	***0.000***	27.576	1	***0.001***	74.531	1	***0.000***	101.047	1	***0.000***	155.244	1	***0.000***
3. Add book chapter	2.586	2	26132	0.075	6.611	1	***0.01***	13.025	1	***0.001***	15.989	1	***0.001***	24.002	1	***0.001***
4. Share research expertise	91.983	2	26132	***0.000***	117.512	1	***0.000***	111.000	1	***0.000***	489.571	1	***0.000***	515.159	1	***0.000***
5. Add conference information to publication	20.368	2	26132	***0.001***	0.061	1	0.806	18.495	1	***0.001***	14.543	1	***0.001***	28.234	1	***0.001***
6. Claim publication	56.078	2	26132	***0.000***	69.866	1	***0.001***	298.392	1	***0.000***	47.199	1	***0.001***	186.548	1	***0.000***
7. Add publication with identifier	74.571	2	26132	***0.000***	10.447	1	***0.001***	60.859	1	***0.001***	141.551	1	***0.000***	87.714	1	***0.000***
8. Update personal name	66.946	2	26132	***0.000***	57.767	1	***0.001***	136.071	1	***0.000***	14.197	1	***0.001***	1.408	1	0.235

9. Complete publication metadata (i.e., abstract, keyword)	8.379	2	26132	***0.001***	14.029	1	***0.001***	0.991	1	0.319	123.342	1	***0.000***	105.924	1	***0.000***
10. Update position title	6.319	2	26132	***0.002***	77.464	1	***0.000***	97.003	1	***0.000***	11.339	1	***0.001***	1.895	1	0.169
11. Update educational background	190.957	2	26132	***0.000***	119.419	1	***0.000***	113.187	1	***0.000***	6.342	1	***0.012***	51.454	1	***0.001***

Note: Significant relationships are in boldface italics.

Table 7

Estimated means and standard errors for researchers' gender, profile picture, and research overview on 11 components.

Component	Descriptor	Gender		Profile Picture		Research Overview	
		Mean	Std. Error	Mean	Std. Error	Mean	Std. Error
1	0	3.5476	0.0065	3.4627	0.0055	3.4794	0.0053
	1	3.4888	0.0046	3.5218	0.0043	3.5136	0.0044
2	0	0.9812	0.0038	1.0333	0.0042	1.0386	0.0041
	1	0.9568	0.0026	0.9804	0.0031	0.9741	0.0031
3	0	5.0197	0.0066	4.9817	0.0057	4.979	0.0054
	1	4.9989	0.0047	5.0106	0.0044	5.0139	0.0045
4	0	4.5868	0.0087	4.3615	0.0076	4.3668	0.0073
	1	4.4711	0.0061	4.5812	0.0061	4.5889	0.0063
5	0	5.5058	0.006	5.4842	0.0051	5.4794	0.0049
	1	5.5039	0.0043	5.5092	0.0039	5.5137	0.004
6	0	3.0131	0.0106	2.9436	0.0101	2.8952	0.0095
	1	3.1255	0.0079	3.033	0.008	3.0699	0.0083
7	0	9.0357	0.009	8.9258	0.0077	8.9452	0.0075
	1	8.9998	0.0064	9.0435	0.006	9.0365	0.0061
8	0	1.5302	0.0051	1.4861	0.0045	1.4959	0.0044
	1	1.483	0.0035	1.5081	0.0035	1.5027	0.0036
9	0	3.0201	0.0048	2.9629	0.0041	2.9678	0.0039
	1	2.9977	0.0034	3.0217	0.0032	3.0214	0.0033
10	0	2.5374	0.007	2.4827	0.0064	2.5066	0.0062
	1	2.4625	0.0048	2.5101	0.0049	2.4955	0.005
11	0	4.5314	0.0082	4.4836	0.0081	4.5437	0.0079
	1	4.4212	0.0058	4.5095	0.0062	4.4708	0.0063

Note. Gender descriptor: 0 for female and 1 for male, Profile picture descriptor: 0 for picture does not exist and 1 for picture exist, Research overview descriptor: 0 for overview does not exist and 1 for overview exist.

In addition, to identify the pairwise importance of user actions among researchers' seniority, the authors analyzed the user actions that exhibited significant differences in the researchers' groups using the Bonferroni test of post-hoc pairwise comparisons. The analyses revealed that assistant and associate professors had significantly higher mean ranks than full professors for the components *Add publication with identifier, Update educational background, Update contact information, Update personal name, Share research expertise,* and

Add conference information to publication; meanwhile, full professors had significantly higher mean ranks than assistant and associate professors for the component *Claim publication* ($p < 0.05$; see Figure 3).

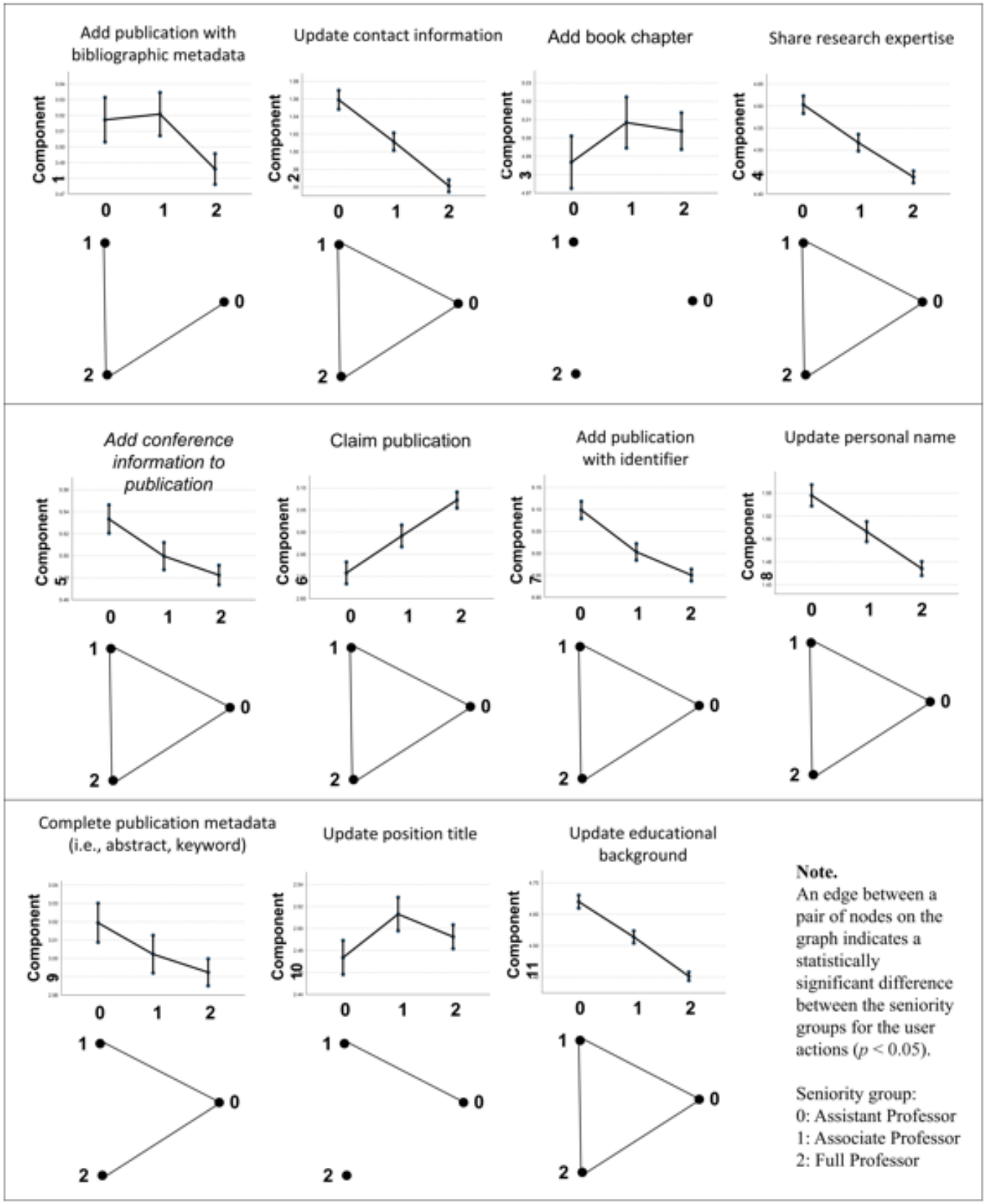

Figure 3. Relationships between user actions and researchers' seniority levels. Numbers indicate the mean ranks of user actions for seniority groups. An edge between a pair of nodes on the graph indicates a statistically significant difference between seniority groups for user actions ($p < 0.05$).

Finally, the authors conducted mediation analyses to determine if publication count acts as a mediating variable between all components and seniority as well as between all components and gender. The publication count refers to each faculty member's number of publications stored in the RIMS. The authors used the multiple linear regression model and Sobel test (Sobel, 1982). The indirect effects (i.e., a*b) of seniority with *3. Add book chapter* and *6. Claim publication* components, via the publication count as an intermediary variable, were statistically significant (see Figure 4). This suggests that seniority would have a negative effect on actions related to the number of added book chapters and a positive effect on claiming (or rejecting) pending publications if senior researchers had more publications than junior researchers. Seniority did not have significant direct effects on *Add book chapter* or *Claim publication*, and the effects were only through the publication count as an intermediary variable. However, seniority showed both significant negative direct and indirect effects on the *4. Share research expertise, 7. Add publication with identifier, 8. Update personal name, 10. Update position title*, and *11. Update educational background* components (see Figure 5).

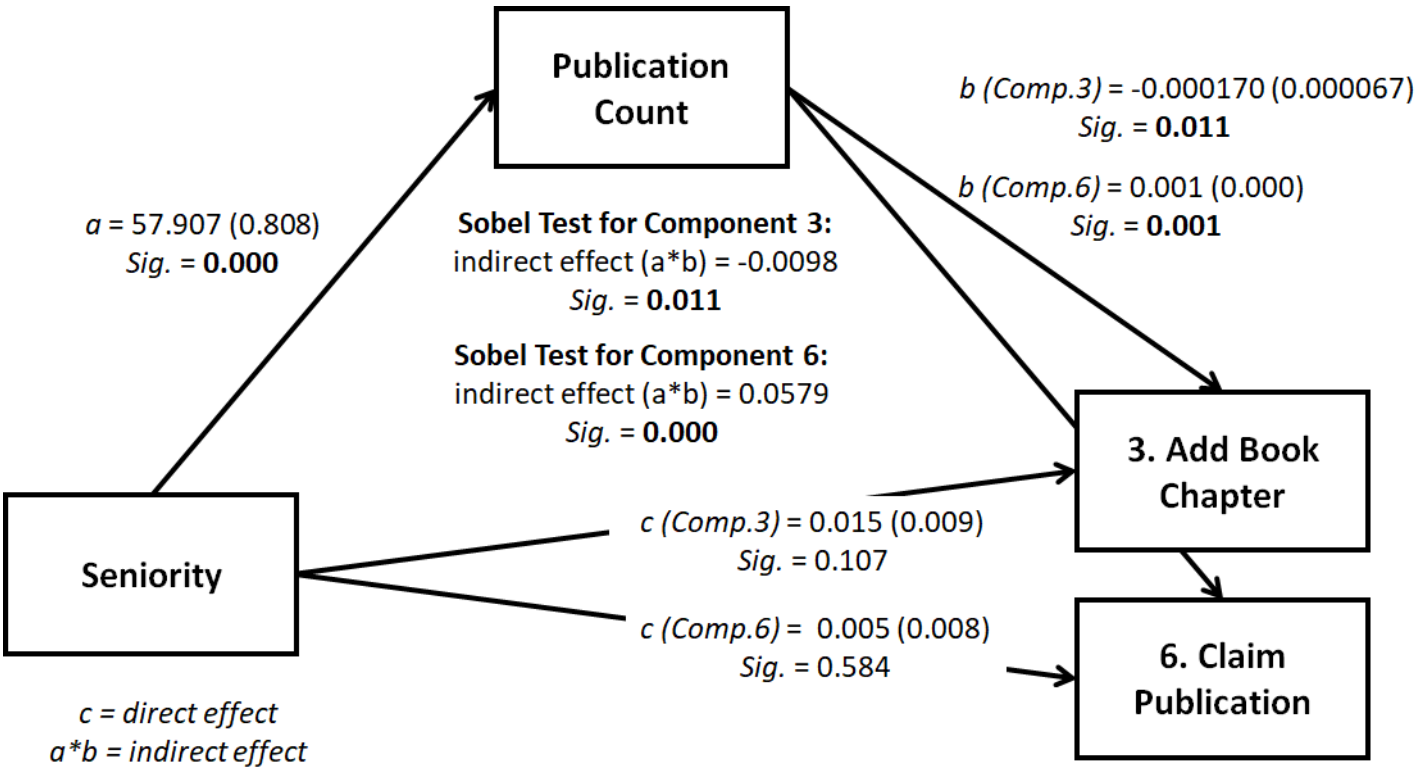

Figure 4. Mediation analyses of seniority with *Add book chapter* and *Claim publication*, with publication count as an intermediary variable.

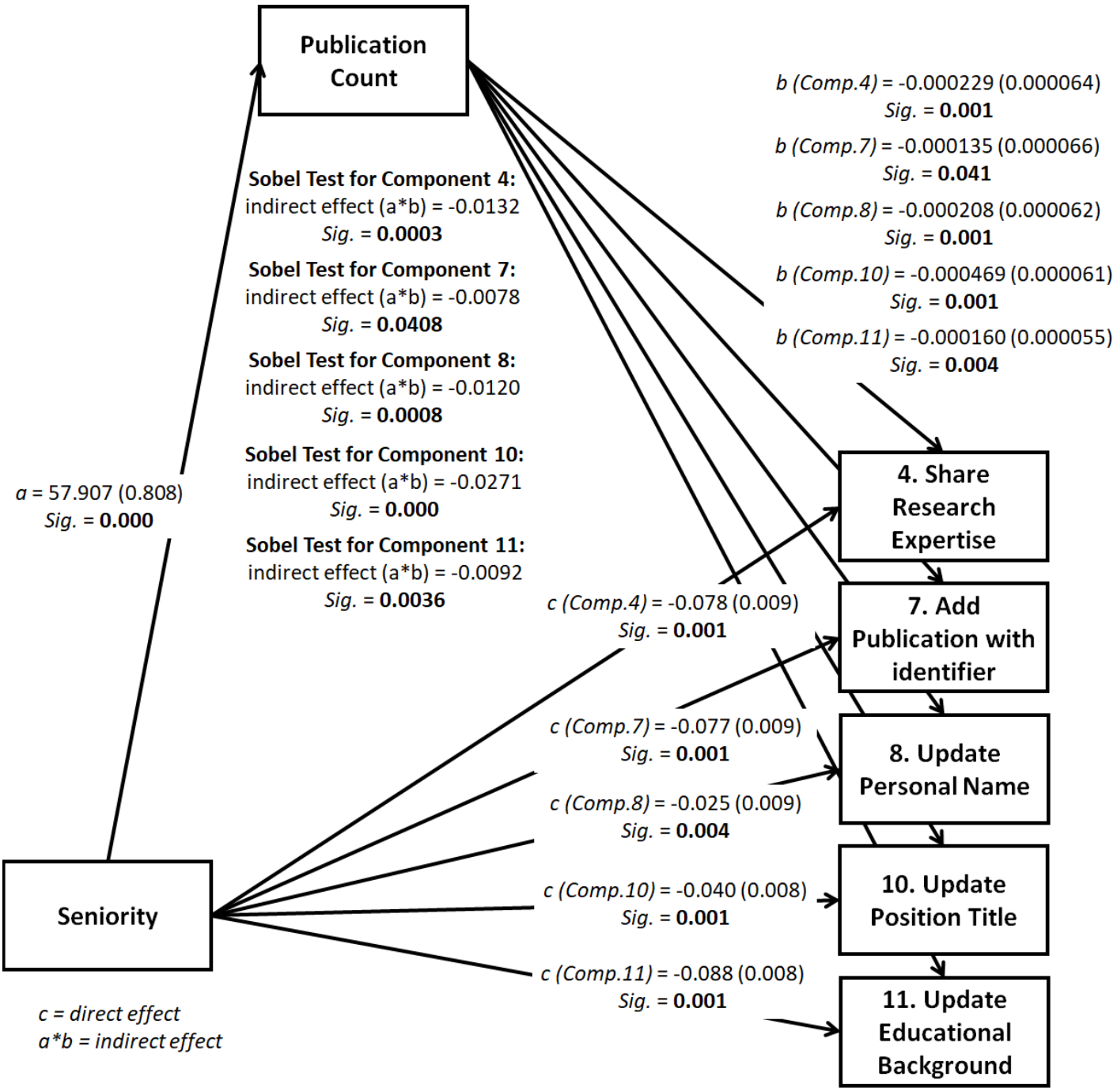

Figure 5. Mediation analyses of seniority with the components 4, 7, 8, 10, and 11, with publication count as an intermediary variable.

Gender showed significant negative indirect effects on components 2, 5, and 7, with publication count as an intermediary variable (see Figure 6); it also showed significant negative direct and indirect effects on the components of 4. *Share research expertise, 8. Update personal name, 10. Update position title*, and *11. Update educational background and* a significant positive direct and indirect effect on the component *6. Claim*

publication (see Figure 7). Thus, in general, female researchers completed these first four actions significantly more often than male researchers, notwithstanding the influence of publication count. On the other hand, male researchers completed the action *6. Claim publication* significantly more often than female researchers (see Figure 7).

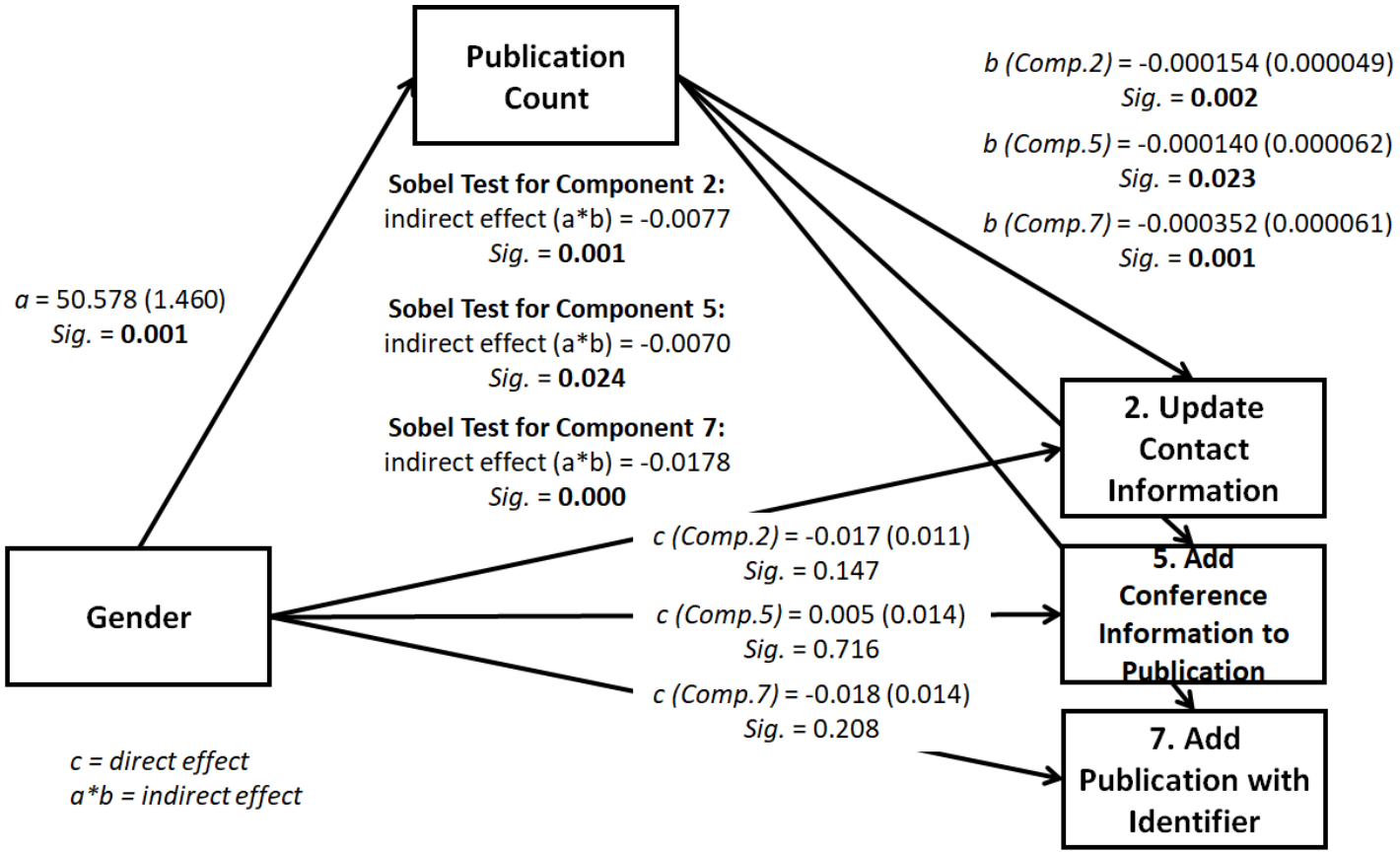

Figure 6. Mediation analyses of gender with *Update contact information, Add conference information to publication*, and *Add publication with identifier*, with publication count as an intermediary variable.

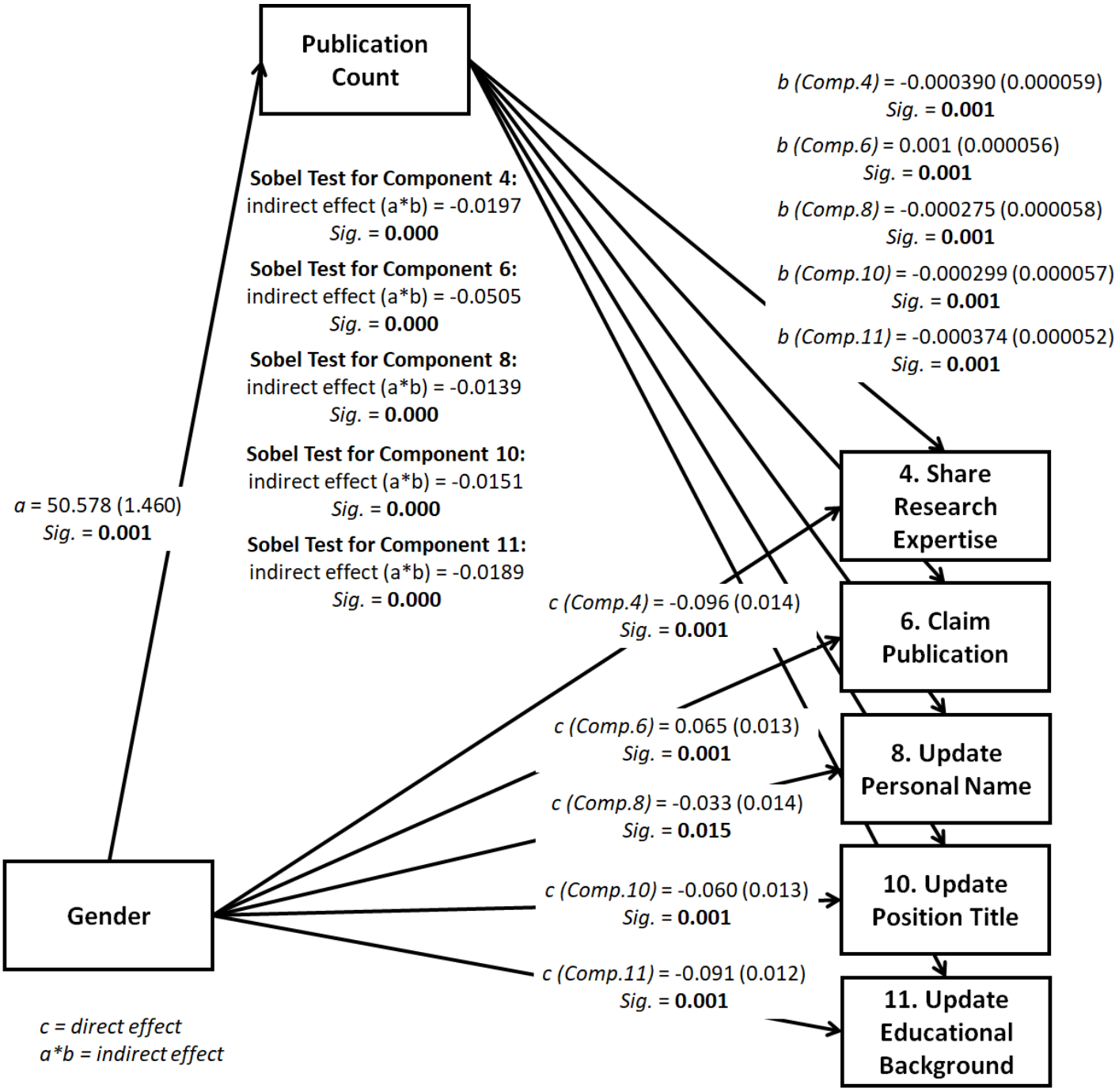

Figure 7. Mediation analyses of gender with *the components 4, 6, 8, 10, and 11*, with publication count as an intermediary variable

Discussion

This study explored the structure of researchers' RIMS profile maintenance activities in an institutional RIMS of a large R1 university. The factor analysis of researchers' actions in the RIMS identified 11 components can be further grouped into three activities: (1) add publications, (2) enhance researcher identity, and (3) improve research discoverability (see Figure 8). These three groups were identical to the most highly

used three metadata categories by their users in ResearchGate, which includes person, publication, and research subject (Lee et al., 2020).

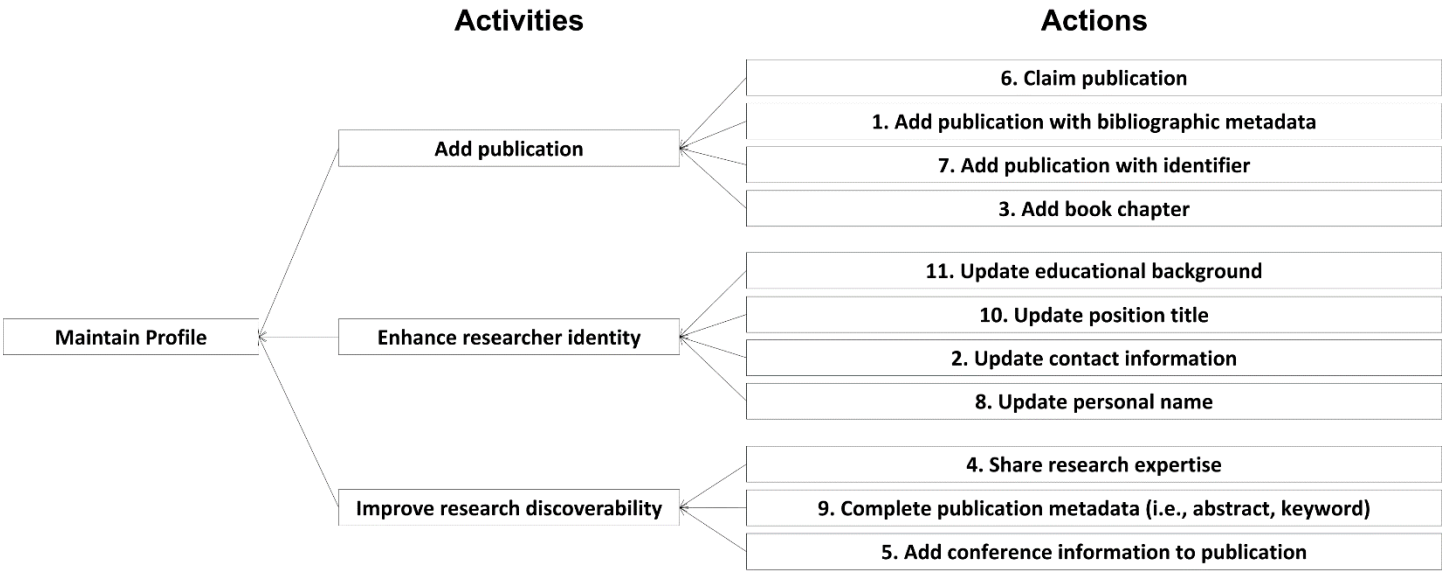

Figure 8. Users' priority activities and actions when researchers update or maintain their scholarly profiles.

All the actions except *Claim publication* showed that, compared to full professors, both assistant and associate professors had higher probabilities of engaging with the actions of updating or maintaining profiles. This parallels users' system use or engagement in non-institutional RIMS. Haustein and Larivière (2014) found that the majority of Mendeley users in four disciplines (i.e., biomedical research, clinical medicine, health, and psychology) were junior scholars (i.e., doctoral students, postgraduate students, and postdocs). Stvilia and his collaborators (2018a) also found that assistant professors and postdocs had higher usage in RIMS than full professors. However, this study considered only three seniority levels (i.e., assistant, associate, and full professors) that do not fully capture researchers' seniority range in academia. Many institutional RIMS, including the one examined in this study, do not curate the research information of graduate students or postdoctoral scholars. In addition, a professor may have been promoted from associate professor to full professor in the last year while another professor has been a full professor since 2000. This difference could be captured by their academic age (e.g., the year graduated from a Ph.D. program). Nandez and Borrego (2013) explored usage patterns on Academia.edu and found significant differences among age groups; younger scholars showed more active use with the system. However, Salahshour, Dahlan, Iahad, and Nilashi (2017) found no significant differences between age and researchers' ASNS use behavior. The authors of the current study plan to expand the study with academic age for a better understanding of the relationship between researchers' different academic levels and RIMS use.

Our study provides a unique, empirical examination of the gender-based differences in institutional RIMS uses. Most studies of global RIMS reported that male researchers use RIMS more actively than female researchers (Elsayed, 2016; Tsou et al., 2016). However, our study discovered that, in a nonmandated institutional RIMS, female researchers updated their profiles more often than male researchers (see Tables 6 and 7). We found a possible explanation for this gender-based difference in the literature. Lin and Wang (2020) presented that women are more privacy conscious than men when using social networking sites. However, privacy concerns can be lessened by using systems within local organizations (Venkatesh & Morris, 2000). In addition, women are more likely than men to commit to a system that they choose (Lin & Wang, 2020) and are more willing to collaborate and respond to peer referrals for information technology use (Hoffman, 1972; Venkatesh & Morris, 2000).

Researchers with a profile picture (see Table 7) made more frequent updates to their profiles. According to Lee et al. (2020), profile owners who include their pictures have a higher chance of being a *Community Member* rather than a *Reader* or a *Personal Record Manager*. *Community Members* not only update their profiles but are also willing to communicate with other people through RIMS. *Personal Record Managers* update their profiles, but do not communicate with other profile owners. *Readers* do not update their profiles but consume and read data in the system. The profile picture is a communication tool that provides higher web credibility and trust to social networking site users (Edwards, Stoll, Faculak, & Karman, 2015; Meinert & Krämer, 2020; Sundar, 2008). The findings in the current study and previous literature suggest a new use case for institutional RIMS. They can serve as local research networking sites to help researchers identify local collaborators and mentors for student projects and/or form and maintain local research project groups (Stvilia & Gibradze, 2019). Adding networking, communication and team building functionalities to institutional RIMS can facilitate that use.

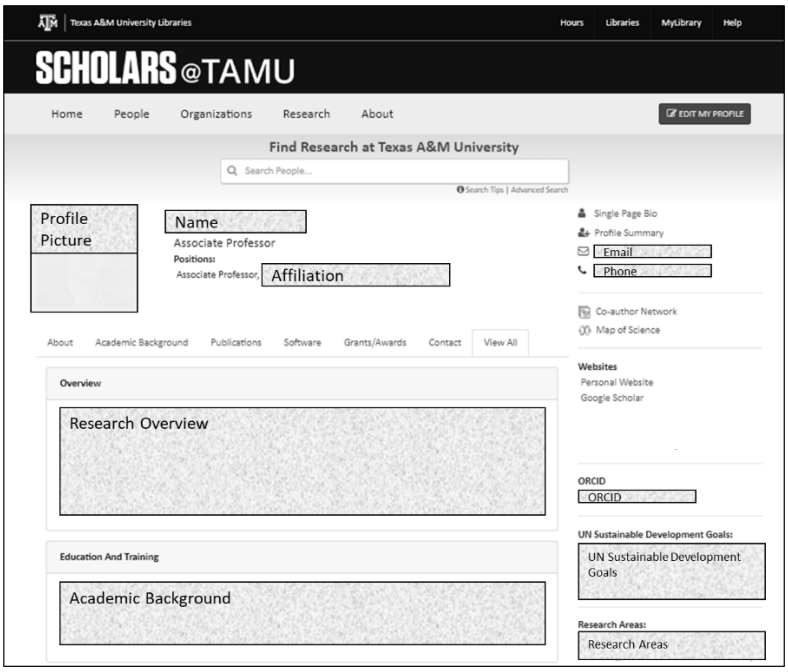

Figure 9. Typical layout of Scholars@TAMU profile pages.

This study also found statistically significant relationships between research overview paragraph(s) (see Figure 9) and two activities: *Add publication* and *Improve research discoverability* (see Figure 8). Researchers with their own research overviews made significantly more updates to all actions in the two activities, but not in the *Enhance researcher identity* activity. This indicates that the researchers with their overview updates might have higher response rates on any research-related recommendation or communication delivered from the system or system administrator (Stvilia et al., 2019).

The actions of *Add publication with bibliographic metadata, Add publication with identifier,* and *Add book chapter* are the events to update newly published or missing publications. Adding publications with metadata elements has been divided into three different actions according to users' different metadata uses. Researchers have used persistent identifiers (i.e., Digital Object Identifier, PubMed ID, International Standard Book Number) and URLs to add their publications. A persistent identifier along with the profile owner's name and affiliation data from the Editor's login were sufficient metadata for the Scholars' data curator to add a new publication.

The *Enhance researcher identity* activity as researchers' priority indicates that profile owners are willing to share or add some of their personal information in their Scholars profiles. These actions comprise metadata fields of educational background, position titles, contact information, and personal name, which help disambiguate researchers from others. This group of actions, except *Update position titles*, showed significantly higher mean ranks for junior researchers and lower mean ranks for senior researchers, indicating that junior researchers made more efforts to enhance their research identity profiles. However, the same pattern has not been discovered from the *Update position titles* action, which may reflect midlevel and senior researchers' wide

range of activities in their institutions as their careers grow, relevant to their joint appointments and/or administrative roles (see Figure 3). In addition, all four actions of the *Enhance research identity* activity had higher mean ranks for female researchers, indicating female researchers made more efforts to enhance their researcher identity than male researchers (see Table 6 and 7), however the *Update contact information* action did not have a significant direct effect with gender difference, but the action had significant indirect effect via the number of publication count as a mediator (see Figure 6).

Share research expertise showed a relatively higher mean summated frequency than the other two actions under *Improve research discoverability* (see Table 5). This action includes adding research areas (i.e., Library of Congress' controlled subject headings), editing research overviews, and adding links to external websites, indicating that researchers try to improve discoverability of their expertise by updating more research-related concepts and keywords. Accurately summarized and descriptive web content affect and increase its rankings in Google search results (Google, n.d.). Researchers also wanted to complete some missing metadata elements in their publications.

Limitations

Our study has a few limitations. First, in this study, RIMS is an institutional system, and the system and its users may reflect the institution's goals and missions. However, the results provide useful direct (i.e., not recall based) evidence of researchers RIMS behaviors for similar institutions categorized as research intensive academic institutions. Second, this study considered gender as a binary value. Hence, some researchers might be represented in the sample with a gender identity different from the gender identity they identify with. Third, the number of profiles in the system has been increased slowly, one department at a time. As the system gains attention from university administrators, some colleges start or plan to use the system as a supporting tool for the University's performance-reporting platform. Hence, different departments' levels of engagement in the RIMS might differ. Therefore, we decided not to analyze researchers' use of the RIMS by discipline.

Conclusion

RIM systems have become critical components of information technology infrastructure on university campuses. They are used not just for sharing and promoting faculty research, but also for conducting faculty evaluation and development, facilitating research collaborations, and identifying mentors for student projects as well as expert consultants for local businesses. Although prior studies have examined researchers' motivations for and uses of RIMS, to the best of our knowledge this is the first empirical study that investigated the structure of researchers' profile maintenance activities in a non-mandatory institutional RIMS by using direct (i.e., not recall-based) data of their RIM behaviors. We identified 11 actions or tasks researchers performed when updating their profiles. These tasks were further grouped into three activities: (1) adding publication, (2)

enhancing researcher identity, and (3) improving research discoverability. In the add publications activity, researchers claimed publications, added publications with identifiers, added publications with bibliographic metadata, and added book chapters. In the enhance researcher identity activity, researchers tried to enhance their discoverability by adding their personal information (name, educational background, position titles, contact information, etc.). In the improve research discoverability activity, researchers added or updated their research overview, list of research areas, external websites, and publications' missing metadata to increase their discoverability of their research. These findings can help RIMS software designers and librarians design RIMS editor that are aligned with researchers' RIM needs and priorities.

We also found that junior researchers and female researchers put more effort into maintaining their RIMS profiles than senior researchers and male researchers. Thus, this study extends the theoretical framework for researcher participation in RIMS proposed by Stvilia et al. (2019) by adding the structure of gender- and seniority-based priorities for RIMS profile maintenance actions (see Figures 4, 5, and 6). The results provide insights for designing profile maintenance action templates for institutional RIMS that are tailored to researchers' characteristics and help enhance researchers' participation in the curation of their research information. Our findings also suggest that female and junior researchers can serve as early adopters of institutional RIMS.

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