

Gender in IS Research: Who's on top?

ABSTRACT

The paper investigates the representativeness of women in Information Systems (IS) research. Despite effort for gender inclusion and equity, a disparity between research output in premier IS journals persists. This research evaluates the state of the IS field and representativeness women as IS faculty to assess if gender disparities exist at the university level or among research output. We evaluate the senior basket of 8 from 2001-2020 to evaluate publication statistics and differences among genders in IS research. The data is broken down in various forms to demonstrate publication patterns to identify if IS research productivity is representative of the field of IS based on gender. The paper concludes with a discussion of findings, implications, and recommendations for the field of IS.

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"We cannot change what we are not aware of, and once we are aware, we cannot help but change."
~ Sheryl Sandberg

INTRODUCTION

Women continue to be underrepresented within Colleges of Business (Hoobler & Washington, 2021), particularly within the field of information systems (IS). This uneven representation has persisted since IS began to emerge from the shadows of mathematics and computer science in the 1960s. In 2018-2019, AIS (2019) reported that women IS majors comprised 32% of undergraduate and 50% of Master's students, marking an uptick in representation in the field and showing promise for the future, if the trends continue. Importantly, AIS cast a wide net, counting IS majors in Colleges of Business (COBs), Information Sciences schools, and Computer Science (CS) departments. With a smaller net, including only computer science, technical fields, information technology, and computer engineering, for instance, fewer women are counted in technology or computer fields. Like Goldilocks, we seek to find the net that is "just right" – that is, the one that accurately captures IS academics who are typically housed in Colleges of Business or closely related colleges or schools. It is difficult to find a consistent count of IS academic proportions by gender – using the Goldilocks net – due to conflicting definitions, disparate data collection methodologies, and different reporting patterns. Thus, operationalizing women in IS is a non-trivial problem; a clear method of identifying what the field views as representative of IS in academia will allow for consistent comparisons among studies.

Despite recent gains reported by AIS and others, men continue to comprise an uneven proportion of IS academia. Thus, women IS faculty members must persevere in a culture where they are in the. In addition to the well-known pipeline metaphor, women must navigate missing rungs (McKinsey & Company, 2021) and sticky floors that make it difficult to advance. As Hughes et al. (2017, p. 413) stated so eloquently: "...as long as the dominant culture remains unchallenged — and institutional inequality remains sidelined in explanations for the gender gap — the gender gap may continue to be slow to close." However, evolving to a gender-inclusive culture does not mean that we should fail to include men's perceptions of gender issues in the conversation; to the contrary, we recommend creation of a culture that values the contributions of everyone, regardless of their

gender or other demographic characteristics. We use the lens of feminism in an inclusive and not an exclusive manner, or: “the belief that men and women should have equal rights and opportunities for initiatives to change the dominant culture” (<https://www.merriam-webster.com/dictionary/feminism>). Men are an important part of the process. They have different understandings of the struggles that their women colleagues face – and many of them want to help level the playing field (Sattari & Sandefur, 2019). We must not leave them out of the conversation.

In response to the uneven representation of women in IS, researchers have conducted many studies with an outward view to advance gender¹ equality; however, an inward view in relation to important academic outcomes has been mostly overlooked (Gallivan and Benbunan-Finch, 2008; Gupta et al, 2019). In this paper we review how men and women succeed in research endeavors, using the standard currency in the COB – peer reviewed journal (PRJ) articles. No analysis to date has evaluated publication quality and quantity to determine if women and men publish at similar levels, based on representation, in the most highly-regarded journals in the field, the eight journals included in the IS Senior Scholars’ Basket of Eight (B8) (<https://aisnet.org/page/SeniorScholarBasket>), over a long time period. This analysis addresses the gap in research, taking an inward view of the field. Have some IS women scholars overcome barriers and succeeded with high numbers of PRJ articles in the B8? We seek to broaden discussion on the topic, considering a long time period of two decades, including all of the journals that comprise the B8, and determining the gender of all authors. While this paper focuses on gender differences between men and women, we acknowledge that gender is non-binary. The current research has three objectives: 1) Evaluate gender differences in IS publications among the IS Senior Scholars’ Basket of Eight journals in the 21st century, 2) evaluate cooperative patterns used by authors, and 3) identify opportunities to bridge the increasing gap in publication patterns between men

¹ U.S. Census Bureau (USCB) questions (<https://www.census.gov/library/stories/2021/08/household-pulse-survey-updates-sex-question-now-asks-sexual-orientation-and-gender-identity.html>) ask respondents to distinguish between: sex at birth (Male or Female); how you describe yourself (Male, Female, Transgender, or None), and how you think of yourself (Gay or lesbian; Straight, that is not gay or lesbian; Bisexual; Something else; I don’t know). In this study, we review pronouns authors used to identify themselves, most closely matching the second USCB question. We assessed key terms and/or pronouns in biographies such as “she” or “his” or other and/or through publicly available University documents, Google Scholar, ResearchGate and LinkedIn profiles. We agree there are an unknown number of authors who may identify as cis-gender and for whom we are unaware of how they may describe themselves; where we are able to determine that an author identifies as Transgender or Other, we denote as such. Our comparisons are intended to highlight differences in publication patterns between authors who describe themselves as women and those who describe themselves as men; we do not attempt to evaluate more complex differences. We seek equitable publication opportunities for all underrepresented groups, beyond men and women, including race, ethnicity, sexual orientation, disability, etc.

and women in IS academia. This research contributes to the field by highlighting the advancements made and continued improvements suggested to increase the participation of women in elite IS academic publication activities, take advantage of opportunities to bridge the gender gap, and increase collaboration and cooperation in the field.

BACKGROUND

The Field of Information Systems

The field of Information Systems (IS) emerged shortly after the formation of Computer Science (CS) departments. Early IS programs were established in 1960 at the University of Pennsylvania and University of Minnesota (Vessey et al, 2002), while many others followed in the late 1960s. When compared to their CS counterparts, the field of IS focuses more on organizational operations, the connections between people and information systems, and delivering business value through technology (Bascuas, 2020).

The newly developed discipline of IS failed to settle on one overarching name, instead self-identifying as Management Information Systems (MIS), Information Systems (IS), Computer Information Systems (CIS), Business Information Systems (BIS) and Accounting Information Systems (AIS) among others (Apigian and Gambill, 2010). The commonality among the variant names of the IS field is that many are housed in the business school and fall under the Association to Advance Collegiate Schools of Business (AACSB) accreditation standards (Brooks et al, 2016), with MIS and IS accounting for over 50% of all named majors (Brooks et al, 2020). Similarly, three IS related journals appearing on the B8 and Financial Times 50 Journals (FT50) follow the same naming convention with *Management information Systems Quarterly (MISQ)*, *Journal of Management Information Systems (JMIS)*, and *Information Systems Research (ISR)*. IS has become a clearly defined field of study in the business school, although IS researchers may publish interdisciplinary research in journals outside of the field; similarly, IS journals publish articles by researchers from other disciplines. As seen from the varying degree names and openness to interdisciplinary research, IS as a discipline is broad both academically and research-wise. The discipline diversity espoused by Benbasat and Weber (1996) has, if anything, increased over time, with the ubiquity of the Internet, the penetration of mobile technology, and the

exponential increase in access points on the Internet of Things (IoT). For this research, our focus is strictly on the men and women authors who publish in IS journals agreed upon by the senior scholars of the field.

Women and Men in IS Academia

Women in IS academia are likely to experience challenges in different ways than their male peers. However, prior research is limited by the difficulty of defining and recording the gender of each author for PRJ articles. Thus, we sought a way to consistently classify authors as male or female, over a long period of time, to assess the relative contributions of women to the IS field and identify opportunities for the future. Due to the geographic diversity of authors and the lack of a standard, agreed-upon name for the field, determining the proportion of women in IS is not simplistic. To begin, we had to decide how to determine if authors are male or female.

Classification of Women and Men

To classify authors of peer-reviewed journal articles, we used the author's "gender;" that is, a term that encompasses the individual's self-reported understanding of their identity, as opposed to "sex," which is the biological designation given at birth (APA, 2020). We classified each author as Female, Male, Transgender, or Other, following Federal surveying guidelines (<https://www.census.gov/library/stories/2021/08/household-pulse-survey-updates-sex-question-now-asks-sexual-orientation-and-gender-identity.html>). While it is possible to use machine learning and artificial intelligence to help determine gender, authors who use first initials or those with Asian names or other non-Western formatted first and last names, complicate automated analyses (Wang et al., 2021). Clearly, determining the gender of authors is non-trivial, and current machine learning is inadequate for the analysis.

Proportion of Women and Men in IS Academia

An additional problem is understanding how many women are in IS academia. Overall, women have made remarkable strides in general, and were projected to earn over half of all PhDs in 2020-2021 (Digest of Education Statistics, 2021); similarly, women now earn just under half of all doctoral business degrees (Zhou & Gao, 2021). Overall, as shown in Table 1, the proportion of students earning PhDs in business increased from 1.4% in 2010-2011 to 1.8% of all doctoral degrees awarded in 2017-2018. Meanwhile, students earning

doctoral degrees in computer and information systems comprised about 1-1.1% of the total number of PhDs awarded from 2010-2018. When drilling deeper, however, as Table 2 shows, the proportion of women earning doctorate degrees in “Computer and information sciences” (CIS) (Digest of Education Statistics, 2021) has remained steady at around 20% between 2011-2020, despite numerous initiatives to attract women to the field. At the same time, women comprised a relatively unchanged percentage of undergraduate degrees in CIS, from 18-20% of the total. Master’s degrees in CIS are one of the bright spots, rising from 27-33% from 2011-2020. These percentages, however, suffer from definition problems when analyzing women in IS, since “Computer and information sciences” includes a range of majors beyond IS, and it is difficult to tease one field from another. Many studies refer to the 20-25% representation of women in “Computer and information sciences” from the Digest as the number of women in IS. For instance, in a grant application, AISInsider (2021) reported that women comprised only about ¼ of all academic appointments in the field.

However, CIS may not be equivalent to IS, which, as discussed earlier, is often housed in the COB. The number of women in business schools is very different from their CIS counterparts. As Table 3 shows, women comprised 46-48% of undergraduate and Master’s degrees in business and 42-45% of business doctoral degrees awarded from 2011-2019. Clearly, those proportions differ significantly from the number of women who earned undergraduate, graduate, and doctoral degrees in CIS. Drilling down to MIS, Table 4 shows that women earned 25-29% of undergraduate, 30-32% of Master’s, and 21-43% of doctoral degrees from 2011-2019. With small numbers of degrees awarded, from 28-64 students, yearly percentages for doctoral degrees may fail to shed light on long-term trends. Taken together, however, women earned 30.6% of all MIS doctorate degrees awarded from 2011-2019. This number compares favorably with the 32% of AMCIS (2021) members who are women, the 32% of undergraduate IS majors reported by AIS (2019), and the 38% of women in Loiacono et al.’s (2016) study. Other studies readily admitted that their sample might not be representative, such as Gupta et al.’s (2019) study, which included AIS members, with 63% of respondents who were women and 20% who chose not to reveal their gender. Moreover, the AIS (2019) study showed that 50% of all MSIS majors were female, which may be an outlier or may show great promise for the future. With the updated statistics, and focusing on IS predominantly in the COB, we conservatively estimate that women comprise 30-40% of IS academia. After we

complete the non-trivial tasks of defining the field of IS, identifying men and women, and determining the proportion of women in IS academia, we can examine other effects that may indicate differential power between men and women, including author-order and homophily. To date, these topics have received limited attention, with two editorials reflecting on the author-gender imbalance within *Information Systems Journal* (ISJ) (Avison et al., 2008; Avison & Fitzgerald, 2012).

Power and Authorship

Author Order

Differential power characteristics may impact author order and citation patterns. In a large meta-analysis of scientific articles in biology (1997-2017), men were more likely to be first-authors in all combinations of author groups (Broderick & Casadevall, 2019);. Gupta et al. (2019) recognized that few studies have examined gender and author order within the field of IS, saying: *“If women are not able to negotiate being first author on papers, then, as a field, we need to ask why and consider remedies that ensure equitable access to valuable author-order positions”* (p. 1885). Other disciplines in the COB face similar challenges; for instance, there is only one woman in the top 50 Finance authors (Chan et al., 2013). Authors in political science, international relations, and other disciplines have similar patterns of inequitable representation of women in prestigious author positions (Larivière et al., 2013; West et al., 2013; William et al., 2015). One method that women use to overcome challenges of authorship is partnering with others who are like them, using homophily.

Homophily

Women may seek to publish with other women (gender homophily) (Chipidza & Tripp, 2018; Gallivan & Ahuja, 2015), with those who are in close proximity (geographic homophily), and with those who are in the same discipline (discipline homophily). Homophily effects may be further observed when women consider where to publish (Gallivan & Benbunan-Fich, 2007). Homophily is not necessarily a drawback. However, Grover et al. (2019) posit that gender homophily leads to possible biases, particularly when men stay together in groups throughout their careers. Moreover, mostly men author teams are more successful at PRJ publication than their women peers; the more selective the journal, the greater the disparity (Eisend & Schuchert-güler, 2015). Interestingly, Wiedman (2019) found that women who publish with men receive less credit and have

lower research rankings and salary as compared to their women peers who are sole authors or who publish with other women; further, women receive less credit for the same work as compared to their men co-authors, *regardless of order of authorship*. The tendency to reward male co-authors with more credit than female co-authors persists in economics as well (Guo, 2015). While William et al. (2015) found that women are just as likely to be cited as men, Malianiak (2013) found that women, men, and mixed-gender author teams cite men more often than women, with men using self-citation more frequently than women. The differential positioning of women authors and other gender homophily effects may thus negatively affect the publication and reputation success of women in IS academia, while it favorably affects the publication likelihood and reputational success of their male counterparts.

METHODOLOGY

We utilize an archival research method to evaluate gender differences of academic researchers based on scholarly publications in the 21st century. This approach consists of three stages: 1) Identifying source data; 2) data capture and cleaning; 3) triangulating for data validation (Das et al, 2018).

Identifying Source Data

The first step of the archival approach is field work to identify data to be used in the study (Das et al, 2018). The Senior Scholars' Basket of Eight (B8) journals was used as the source for publication data. Table 5 lists the eight journals in the B8 in alphabetical order. These eight journals are also included in the Australian Business Deans Council (ABDC) journal quality list (<https://abdc.edu.au/research/abdc-journal-quality-list/>), rated as A* or the highest rating possible. Moreover, MISQ, ISR, and JMIS are listed on the Financial Times 50 Journals (FT50) journal ranking list as well.

Table 5. Senior Scholar's Basket of Eight Journals

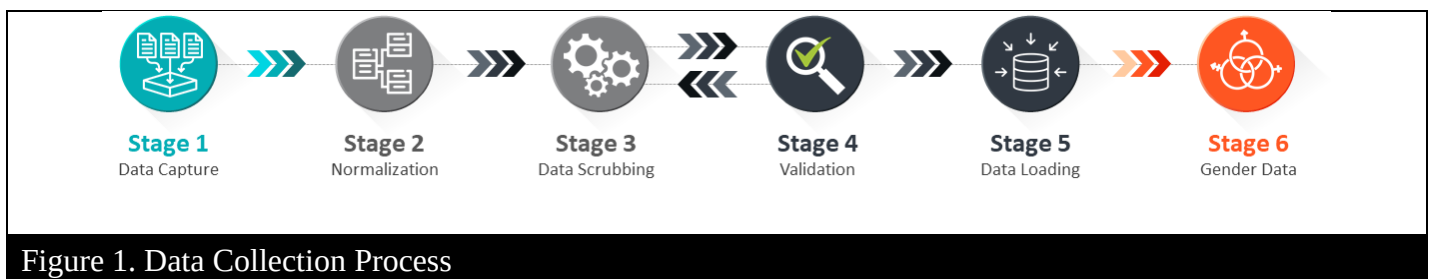
European Journal of IS (EJIS)	Journal of Information Technology (JIT)
Information Systems Journal (ISJ)	Journal of Management Information Systems (JMIS)
Information Systems Research (ISR)	Journal of Strategic Information Systems (JSIS)
Journal of Association for IS (JAIS)	MIS Quarterly (MISQ)

Source: <https://aisnet.org/page/SeniorScholarBasket> (2022)

Bibliography data was captured for all publications in the B8 journals for the first two decades of the 21st century (2001-2020). Attributes recorded from each article include: author first and last name, self-reported university (at the time of publication), title of the article, journal name, volume, issue, and year. To ensure consistency of university data and to capture location data such as country, sub-region, and region, two databases were obtained and matched from UNESCO and the United Nations. First, a list of universities organized by country was extracted from a database developed by the World Higher Education Database (WHED) in collaboration with UNESCO (UNESCO, 2021). Second, a list of countries, regions, and subregions (as identified by the United Nations) was matched to the country of each university in the UN database identifying region and subregion (UN, 2022). Lastly, gender data capturing self-identified pronouns (e.g., his/her) from each author was collected from a variety of sources such as article biography, faculty pages, Google Scholar, ResearchGate, LinkedIn, and other sources when additional research was required.

Data Capture and Cleaning

The data was captured from the sources with each attribute identified and organized to develop a third-normal relational database. This was necessary due to inconsistencies in the data, mismatching data, and other data integrity problems. The normalization process and data scrubbing helped ensure accuracy and integrity of the data for analysis. Figure 1 outlines the process for capturing, organizing, scrubbing, and loading the data.



Stage 1 included capturing the data from the three sources of data: 1) journal archival data, 2) the UNESCO university database, and 3) UN countries database. Journal data was accessed directly from each journal's website using their archive of publications. All data was entered into Excel spreadsheets and organized by attributes from the respective data sources. Using the list of attributes identified, a normalized database was created to establish a logical schema eliminating redundancy in the data. An entity relationship diagram

depicting the logical structure of the database is presented in Appendix A. Microsoft Access was used due to the small data size and its convenience and availability to the researchers.

The data was then scrubbed and organized into Excel tabs based on the table structure of the normalized database model, with a result of 5,080 articles (excluding editorials and book reviews) and 13,692 authors listed, of which 5,606 authors were unique; that is, they did not repeat over the 20-year period of analysis, across the journals studied. Further, to scrub the data, we removed inconsistencies in university names and author names, matching author names, and consolidating the data. For example, authors may list the university name or college name as their affiliation in English or their native language based on country of origin. For authors with multiple universities listed, we used the primary university as it appears on the publication. The university name was then matched to the UNESCO data to eliminate redundancy and mismatching data. In several instances, this required translating university names or looking up the university name based on the college name listed on the publication. Author name also produced inconsistencies as variations are presented with or without middle name, middle initials, or English names, which is common in Asian countries. Some articles may include native language characters and non-English names while other publications may omit these characters. The most complete version of each author's name was stored in the database with each publication mapped to that instance.

Initial data validation was conducted in Excel to ensure proper counts of publications and authors based on journal listings. Excel provided useful tools for sorting and matching data to verify its integrity. The data was then loaded into the database. In the final stage, gender data was collected using a variety of sources as listed above. Three authors used the article biographies as the first source to identify gender, based on pronouns such as she/he and him/her. If biographies were not included or gender could not be determined, faculty pages were reviewed, followed by web searches utilizing LinkedIn, ResearchGate, AISnet, Google Scholar, and other sources. When conducting web searches, the authors were identified and matched from their faculty pages or other sources to the publication(s) to ensure the correct author was identified. This data, including author gender, was then uploaded to the database.

Data Validation

The final stage of our methodology includes assessing the validity and reliability of the data. Validation procedures were used during the collections, scrubbing, and matching of the data, but the final validation included more rigorous methods to ensure accuracy. First, a full list of authors was then selected and sorted by last name and then a second list sorted by first name. This allowed for manual checks of the data going through the list end-to-end to find any duplicate names that may still exist. There were a few cases where an author's name was misspelled, which was consolidated in our database for accuracy. We also verified that duplicate names were indeed the same person before consolidating all the records. In two cases, we found two authors that shared identical names. For that case, we ensured that the publications were correctly matched to the correct authors.

Next, queries were run to create various views to compare the number of articles from each journal's website and the author listings. This ensured that the number of articles listed in the database and the number of authors on each paper was matched what was in our database. Several instances were found where the number of authors for articles did not match what was in our database. For these articles, we manually reviewed the publication and verified that the author counts were correct. The mismatching data resulted from the journal's website not listing all the authors in the metadata that appeared on the publication.

We then validated the accuracy of authors and their publication by randomly selecting names and looking up their vita (CV) listed on their faculty page. During an extensive random selection and matching, only one instance of mismatching data occurred; in that case the author failed to include on their CV an article they had published. The author was contacted to validate the data, and the error was resolved, with the author adding the article to their CV – and thanking us for alerting them to the oversight.

Finally, we assessed the validity of gender matching to each author in the database. During the initial data collection for gender, three researchers divided the list of authors evenly to collect data as described above. For validation, each of the three researchers collected data for 500 authors from the other lists of the other two researchers to compare the results. Then, each researcher reviewed a list of records at random based on author, university, publication, and gender. Only three potential inconsistencies were found. One instance was a

question about the author's university; further validation showed that the university was correct as listed in the database. The author in question had changed universities, but the university listing at the time of publication was correct. In addition, two records were found where gender was misidentified. However, one of the misidentified records was due to the author listing the pronoun "she" in the publication biography and "he" on their faculty profile page. For this author, we evaluated additional publications to determine which pronoun was commonly used and determined that the publication biography was a typing mistake. We assigned the correct pronoun for this author based on the analysis. The third instance was an error in coding the data that was corrected. Based on the extensive measures utilized for validating the data through the entire process of collecting, loading, and testing the data, we demonstrate a high level of validity and integrity in the data.

ANALYSIS AND RESULTS

Table 6 provides descriptive statistics related to the number of articles, authors, publications, and gender totals of researchers who published in the B8. There was a total of 13,692 author listings among 5,080 articles (excluding editorials and book reviews), with an average, of 2.7 authors listed per paper. The average number of authors per paper from 2001-2020 is 2.7, a number which has gradually increased from 2.25 authors in 2001 to 3.15 authors per paper in 2020 based on calculations from our data. Of the 5,606 unique authors who published in the B8 in the 20th century (2001-2020), we identified the gender of 5,381 authors, or 95.99%. After determining gender, the analysis was divided into three parts: basic publication counts, homophily, and gender opportunities.

Gender Differences Based on Publication Counts

Our analysis evaluates gender differences across a variety of factors based on publications in the B8 in the 21st century. From the population of authors who have published in B8, 26.85% self-identified as women; overall, women authors appeared in 23.13% of all publication listings. By contrast, 69.14% of authors self-identified as men, with men authors appearing in 75.07% of all publication listings. Less than 5% of authors were not identified as men or women.

Table 6. Descriptive Statistics for IS Scholars' Senior Basket of Eight Journals from 2001-2020

Category	Count	Description
Total Articles:	5080	All articles excluding editorials and book reviews.
Total Authors:	5606	Total Published Authors
Total Author Pubs:	13692	All authors publications (includes multiple publications)
Female Authors:	1505 (26.85%)	Total Number of female authors
Pct Publications:	3167 (23.13%)	Percent of publication listings by female authors
Male Authors:	3876 (69.14%)	Total Number of male authors
Pct Publications:	10279 (75.07%)	Percent of publication listings by male authors
Not Identified:	225 (4.01%)	Total Number of authors not identified
Pct Publications:	246 (1.80%)	Percent of publication listings by non-identified authors

Next, we analyzed the number of articles published by female authors for each journal in B8, as shown in Table 7. We compared the U.S. based (MISQ, ISR, JMIS, and JAIS) to the European based (EJIS, ISJ, JIT, and JSIS) journals. Three of the four U.S. based journals (MISQ, ISR, and JMIS) display a higher overall count of female authors, as compared to their European peers (EJIS, ISJ, and JIT); the higher count is due to the larger number of papers accepted by the three largest U.S. based journals. In fact, the three U.S. journals with the highest number of female authors have a lower overall percentage of female authors, ranging from 19.85% to 22.76%. Their European counterparts, in contrast, boast higher overall percentages of female authors, ranging from 24.89% to 26.93% female authors. In addition, one U.S. based journal (JAIS) has a lower count of female authors, as compared to the other U.S. journals, but with 24.43% female authors, it compares favorably to the European journals. By journal, ISJ displays the highest percentage of publication listings by female authors at 26.93%, while JMIS displays the lowest percentage at 19.85%. More women authors (533) publish in MISQ than in any other journal, with only 234 women publishing in JSIS; again, the lower raw numbers are not as easily comparable due to the varying total articles published, ranging from 939 for JSIS to 2,384 for ISR.

Table 7. Female Publications by Journal from 2001-2020

Journal	Count*	Percent	Journal	Count*	Percent
MISQ	533 / 2342	22.76%	EJIS	460 / 1848	24.89%
ISR	488 / 2384	20.47%	ISJ	314 / 1166	26.93%
JMIS	456 / 2297	19.85%	JIT	289 / 1107	26.11%
JAIS	393 / 1609	24.43%	JSIS	234 / 939	24.92%

**Count is the number of female authors / total authors*

Further analysis across the B8 was conducted to evaluate publishing differences by gender based on unique authors. Table 7 displays the total number of publications, which includes all publications by all female

authors. While some authors may publish multiple papers, Figure 2 restricts the comparison to gender based on unique authors to identify how many women versus men publish in each journal.

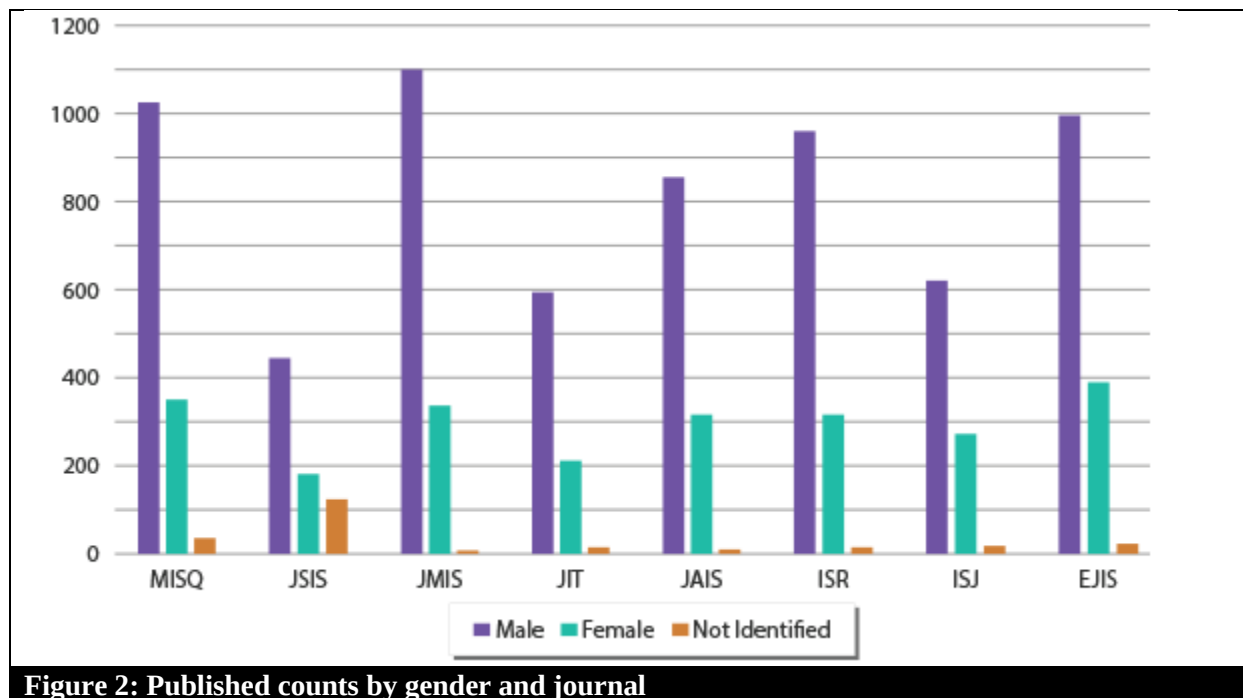


Figure 2: Published counts by gender and journal

The differences in the number of women who have published in each journal compared to men can be visually seen. It should be noted, that authors are unique for each journal so a researcher who published multiple articles in MISQ would only be counted once for that column. However, if an author published across multiple journals, then they would appear once for each journal in which they published rather than based on the number of articles published.

While raw counts and percentages provide valuable descriptive data, we sought to better understand individual contributions made to research based on gender. Authorship order is often used as an indicator for contribution on a research paper, except in disciplines where authors are listed in alphabetical order (PLOSOne citation). The first author on a paper is commonly viewed as the leader or person who contributed the most whereas the last author – depending on field – may be viewed as the supervisor on a paper (Fox et al, 2018). There is no ambiguity of contribution for solo authored papers. To evaluate contributions made to research, we aggregated data of solo authored papers based on gender and identified the first author of each paper based on gender. Table 8 lists the aggregate data for first authors and solo authors for the journals included in the study.

Table 8. First Author and Solo Authored Females from 2001-2020

Category	Count	Description
Total Papers:	5080	Total Published Papers
Total Solo Authored (TSA)	620 (12.20%)	Total Publications with a single author
Female Solo Authors:	140 (22.58%)	Solo Authored Female / TSA
Male Solo Authors:	471 (75.97%)	Solo Authored Male / TSA
Not Identified Solo Authors:	9 (1.45%)	Solo Authored NI / TSA
Multi-Authored Papers (MAP)	4,460 (87.8%)	Total Publications with multiple authors
Female First Authors	1,202 (26.95%)	First Authored Female / MAP
Male First Authors	3,176 (71.21%)	First Authored Male / MAP
Not Identified First Authors	82 (1.84%)	First Authored NI / MAP

Based on the total count of 5,080 papers included in the study, only 620 papers were published with a single author. Of the single authored papers, 75.97% were male authors compared to 22.58% percent female authors. The percentage of single authored papers by women is 4% lower than the total number of women published in the B8 journals, which is 26.85%. A comparison of first authors on all published papers demonstrates that women performed at the same pace in the leadership role as the number of women who have published in the SB8. Out of 4,460 multi-authored papers, 26.95% had female first authors.

Figure 3 presents a visualization of authorship contribution based on single author, multi-author, and total authors. As depicted in the graphical representation of publication data, the percentage of publication counts for first authors and total authors are consistent while single author papers by women are lower on average. Furthermore, the representation of women in publications is considerably lower than the representation of women as IS faculty, which we estimate to be 30-38% of the total.



Homophily

Homophily refers to collaboration between people who are similar and can refer to gender, geography, culture, university, and other similarities. For our analysis, we were interested in the level of homophily that occurs among co-authors who published in B8 from 2001-2020, as shown in Table 9. Over 40% of all published papers included *only* men co-authors; in contrast, papers with all women co-authors made up less than 4% of all publications. There were 620 single authored papers, 2,330 papers where all authors were the same gender or not identified, and 2,130 mixed-gender papers consisting of both men and women co-authors. Of the mixed-gender papers, 52.18% were majority men, and 33.37% were equal numbers of men and women. Furthermore, only 5.51% of all publications consisted of more women than men co-authors.

Table 9. Homophily Analysis

Category	Count	Description
Total Papers:	5080	Total Published Papers
Female Solo Authors:	140 (2.76%)	Solo Authored Female / Total Papers
Male Solo Authors:	471 (9.27%)	Solo Authored Male / Total Papers
Not Identified Solo Authors:	9 (0.18%)	Solo Authored NI / Total Papers
All Female Authors	195 (3.84%)	All Female authors / Total Papers (>1 author)
All Male Authors	2126 (41.85%)	All Male authors / Total Papers (>1 author)
All authors not identified	9 (0.18%)	All NI authors / Total Papers (>1 author)
Majority Women	280 (5.51%)	>50% of all authors are Female
Majority Men	1065 (20.96%)	>50% of all authors are Male
Majority not identified	15 (0.29%)	>50% of all authors are not identified
Equal Men and Women	681 (13.41%)	Equal number of male and female authors
Unable to identify majority	89 (1.75%)	Unable to determine majority of gender

Longitudinal and Geographical Publishing Trends

To evaluate trends in geographical publishing patterns by gender, we assessed research productivity across different regions and over time. To determine the region, we used the location of the university identified by the author(s). Figure 10 displays gender publications by region. Based on this view, gender differences were consistent across the globe, with women publishing about 17% of articles in South America and 27% of articles in Oceania. While it is important to note that there is insufficient data to generate assumptions for the regions of Africa, Central America, Middle East, and The Caribbean due to a small number of publications for these regions, it should be recognized that no region appears to be doing substantially better than another. North America, Europe, and Asia had the largest number of publications with all three regions demonstrating similar

publication patterns among male and female authors. This demonstrates consistency in gender differences for the field of IS across the globe.

Table 10. Global Gender Differences by Region

North America			Middle East		
Gender	Count	Percentage	Gender	Count	Percentage
Male	5,970	75.96	Male	87	71.31
Female	1,808	23.00	Female	32	26.23
NI	82	1.04	Not Identified	3	2.46
Europe			South America		
Gender	Count	Percentage	Gender	Count	Percentage
Male	2,531	75.02	Male	22	75.86
Female	750	22.23	Female	5	17.24
NI	93	2.75	Not Identified	2	6.90
Asia			Africa		
Gender	Count	Percentage	Gender	Count	Percentage
Male	1,201	72.83	Male	11	73.33
Female	392	23.77	Female	3	20.00
NI	56	3.40	Not Identified	1	6.67
Oceania			The Caribbean		
Gender	Count	Percentage	Female	2	100%
Male	454	71.16	Central America		
Female	175	27.43	Male	3	100%
NI	9	1.41			

Note: There are 13,692 total authors across all regions

Figure 4 shows the timeline of publications for total author listings by gender. The number of publications by both women and men increased over the two decades studied. This can be attributed to the increasing number of articles published in each issue by the journals over time. However, men increased their rates of publication at a steeper rate than women, showing a widening gender gap.

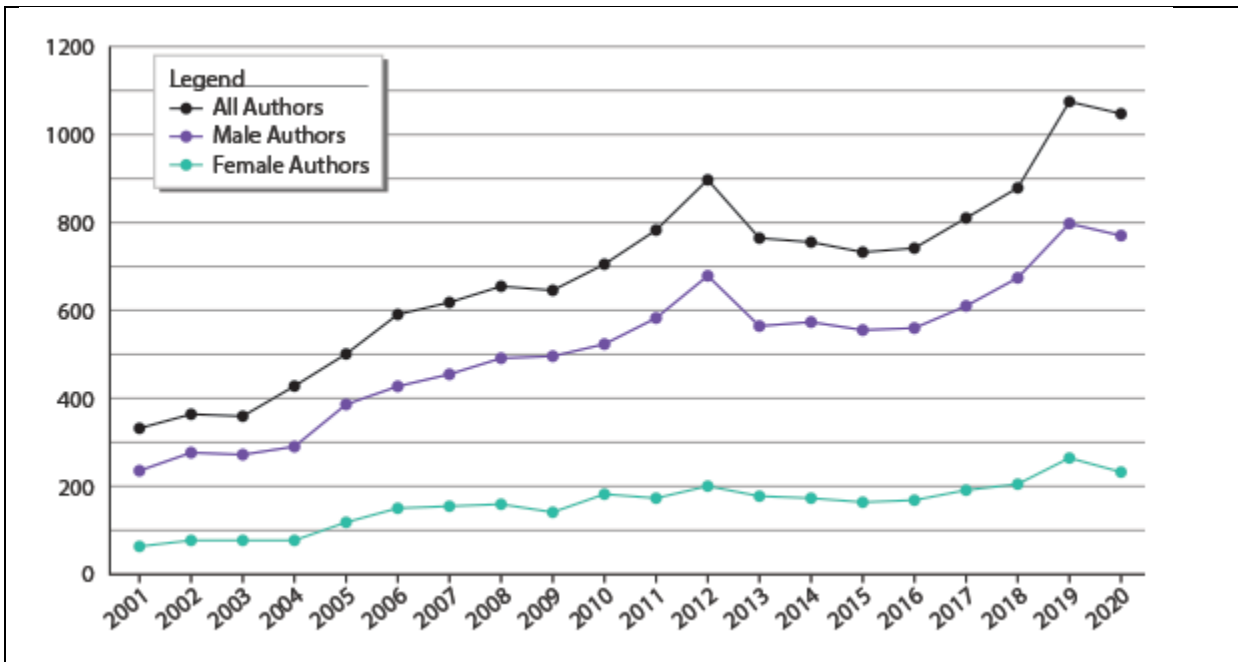


Figure 4: Time Analysis of Total Publications by Gender and Year

As we investigated further, we speculated that the percentage of women publishing in IS might be weighted by the early parts of the analysis (2001-2005), when there were fewer women in IS, as opposed to more recent publication patterns (2016-2020). Thus, we compared the total unique authors and publications by gender based on two five-year gaps of 2001-2005 and 2016-2020. Table x presents this comparison. As demonstrated, the number of women publishing and total publications both increased over this time but not at equal rates. The representation of women in the SB8 increased by 6% during these two periods, but only translated into a 3% percent increase in publication by women over the same period. A view of the number of articles published per author by gender shows that productivity by women only improved from 1.4 papers per author to 1.5. This falls well below the productivity increase by men, which jumped from 1.5 papers per author to 1.9.

Table x: Growth in Female Authors versus Publications

Year	Female Authors	Percent	Female Publications	Percent	P/A(W)	P/A(M)
2001-2005	288	21.33%	410	20.58%	1.4	1.5
2016-2020	704	27.44%	1070	23.49%	1.5	1.9

P/A(W) – Papers / Author (Women); P/A(M) – Papers / Author (Men)

While women are better represented in the more recent 5-year analysis, the output by gender has resulted in an increasingly wider gender gap in publications. Table 11 demonstrates the publication gap between the number of publications by male and female authors with 5-year, 10-year, and 20-year aggregates displayed to the right.

For instance, men published 1,106; 1,116; 2,052; and 2,338 more articles than women in 2001-2005, 2006-2010, 2011-2015, and 2016-2020, respectively, for a total of 7,112 more articles during the two decades studied. Our analysis did not uncover any patterns of discrimination or inequality; however, women are falling behind men in the rate of publication in the B8, and the gap is growing. This may present opportunities for editors, reviewers, senior scholars, and leaders in IS academe to recognize these trends and take proactive steps to bridge this gap.

Table 11: Difference in Gender Publications by Year

<u>Year</u>		<u>1yr</u>		<u>5yr</u>		<u>10yr</u>		<u>20yr</u>
2001	-	173	{	1,106	{	2,722	{	7,112
2002	-	201						
2003	-	196						
2004	-	266						
2005	-	270						
2006	-	283	{	1,616	{	4,390		
2007	-	302						
2008	-	336						
2009	-	351						
2010	-	344						
2011	-	411	{	2,052	{	4,390		
2012	-	483						
2013	-	375						
2014	-	393						
2015	-	390						
2016	-	388	{	2,338	{	4,390		
2017	-	416						
2018	-	468						
2019	-	535						
2020	-	531						

DISCUSSION

Pioneers in the Field

In spite of the hurdles faced by women and their disproportionate representation, numerous women have persevered and thrived. From 2001-2020, Table 12 shows the top ten women authors, with Ritu Agarwal leading the way with 27 B8 publications, and with the top five women boasting 20 or more publications. From 2011-2020, Susan A. Brown leads the way, with an impressive 14 publications in the B8, followed by eight peers with ten or more publications in the decade. Clearly, there is a path for women to successfully publish in the B8.

Table 12. Top 10 Female Authors by Publication

2001-2020 Top 10 Ranking			2011-2020 Top 10 Ranking		
Rank	Author	Count	Rank	Author	Count
1.	Ritu Agarwal	27	1.	Susan A. Brown	14
2.	Dorothy E. Leidner	24	2.	Ritu Agarwal	13
3.	Sue Newell	21	2.	Dorothy E. Leidner	13
3.	Susan A. Brown	21	4.	Sue Newell	12
5.	Atreyi Kankanhalli	20	4.	Tracy Ann Sykes	12
6.	M. Lynne Markus	18	6.	Suzanne Rivard	11
7.	Suzanne Rivard	17	6.	Elena Karahanna	11
8.	Elena Karahanna	16	8.	Atreyi Kankanhalli	10
8.	Saonee Sarker	16	8.	Carol Stoak Saunders	10
10.	3 authors tied*	15	10.	5 authors tied**	9

*Yajiong (Lucky) Xue, Carol Stoak Saunders, Sirkka L. Jarvenpaa

** Monideepa Tarafdar, Iris A Junglas, Manju K. Ahuja, Dubravka Cezek-Kecmanovic, Deepa Mani

CONCLUSION

REFERENCES

Appendix A: Entity Relationship Diagram

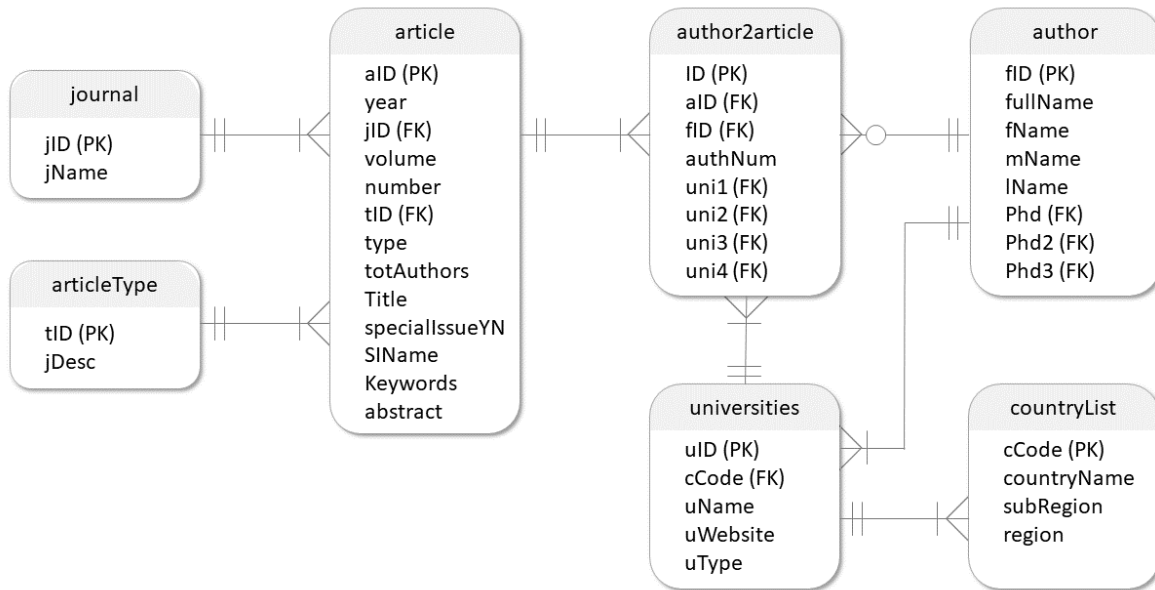


Table 1. Doctor's degrees conferred by postsecondary institutions, by field of study: 2010-2020

Field of study	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
Total	163,827	170,217	175,026	177,587	178,548	178,134	181,357	184,074
Business	2,286 (1.4%)	2,538 (1.5%)	2,828 (1.6%)	3,039 (1.7%)	3,116 (1.7%)	3,325 (1.9%)	3,328 (1.8%)	3,338 (1.8%)
Computer and information sciences	1,588 (1.0%)	1,698 (1.0%)	1,834 (1.0%)	1,982 (1.1%)	1,998 (1.1%)	1,989 (1.1%)	1,982 (1.1%)	2,017 (1.1%)

Table 2. Computer and information sciences degrees awarded (2011-2020)

	Bachelors degree				Master's degree				Doctoral Degree			
	Total	Male	Female	% Female	Total	Male	Female	% Female	Total	Male	Female	% Female
2011-2012	47,384	38,773	8,611	18.2%	20,917	15,129	5,788	27.7%	1,698	1,332	366	21.6%
2012-2013	50,962	41,874	9,088	17.8%	22,777	16,538	6,239	27.4%	1,826	1,473	353	19.3%
2013-2014	55,367	45,393	9,974	18.0%	24,532	17,484	7,048	28.7%	1,982	1,566	416	21.0%
2014-2015	59,581	48,840	10,741	18.0%	31,474	21,892	9,582	30.4%	1,998	1,548	450	22.5%
2015-2016	64,405	52,333	12,072	18.7%	40,128	27,787	12,341	30.8%	1,979	1,582	397	20.1%
2016-2017	71,420	57,766	13,654	19.1%	46,555	32,173	14,382	30.9%	1,982	1,538	444	22.4%
2017-2018	79,598	63,704	15,894	20.0%	46,468	31,397	15,071	32.4%	2,017	1,580	437	21.7%
2018-2019	88,633	70,319	18,314	20.7%	45,667	30,670	14,997	32.8%	2,224	1,716	508	22.8%
2019-2020									2,361	1,859	502	21.3%

Table 3. Business degrees awarded (all majors) (2011-2019)

	Bachelors degree				Master's degree				Doctoral Degree			
	Total	Male	Female	% Female	Total	Male	Female	% Female	Total	Male	Female	% Female
2011-2012	366,815	190,082	176,733	48.2%	191,571	103,253	88,318	46.1%	2,531	1,460	1,071	42.3%
2012-2013	360,823	187,789	173,034	48.0%	188,625	101,584	87,041	46.1%	2,836	1,612	1,224	43.2%
2013-2014	358,079	188,418	169,661	47.4%	189,328	101,043	88,285	46.6%	3,039	1,722	1,317	43.3%
2014-2015	363,799	191,310	172,489	47.4%	185,222	98,587	86,635	46.8%	3,116	1,716	1,400	44.9%
2015-2016	371,694	196,312	175,382	47.2%	186,834	99,491	87,343	46.7%	3,323	1,931	1,392	41.9%
2016-2017	381,353	201,886	179,467	47.1%	187,404	98,768	88,636	47.3%	3,329	1,854	1,475	44.3%
2017-2018	386,201	204,839	181,362	47.0%	192,184	99,860	92,324	48.0%	3,338	1,926	1,412	42.3%
2018-2019	390,564	208,098	182,466	46.7%	197,089	101,515	95,574	48.5%	3,636	1,986	1,650	45.4%

Table 4. Management information systems degrees awarded (listed under business) 2011-2019)

	Bachelors degree				Master's degree				Doctoral Degree			
	Total	Male	Female	% Female	Total	Male	Female	% Female	Total	Male	Female	% Female
2011-2012	7,102	5,358	1,744	24.6%	3,288	2,236	1,052	32.0%	64	43	21	32.8%
2012-2013	7,396	5,506	1,890	25.6%	3,306	2,320	986	29.8%	52	41	11	21.2%
2013-2014	7,477	5,581	1,896	25.4%	2,950	2,051	899	30.5%	41	27	14	34.1%
2014-2015	7,341	5,424	1,917	26.1%	2,518	1,731	787	31.3%	46	32	14	30.4%
2015-2016	7,634	5,475	2,159	28.3%	2,271	1,528	743	32.7%	40	31	9	22.5%
2016-2017	7,838	5,628	2,210	28.2%	2,140	1,482	658	30.7%	34	21	13	38.2%
2017-2018	8,335	6,006	2,329	27.9%	1,760	1,171	589	33.5%	28	16	12	42.9%
2018-2019	8,429	5,971	2,458	29.2%	1,686	1,133	553	32.8%	28	20	8	28.6%
									333	231	102	30.6%