Abstract

Purpose – The purpose of this paper is to find out which research topics and methods in information science (IS) articles are used in other disciplines as indicated by citations.

Design/methodology/approach – The study analyzes citations to articles in IS published in 31 scholarly IS journals in 2015. The study employs content analysis of articles published in 2015 receiving citations from publication venues representing IS and other disciplines in the citation window 2015–2021. The unit of analysis is the article-citing discipline pair. The data set consists of 1178 IS articles cited altogether 25 K times through 5 K publication venues. Each citation is seen as a contribution to the citing document’s discipline by the cited article, which represents some IS subareas and methodologies, and the author team’s disciplinary composition, which is inferred from the authors’ affiliations.

Findings – The results show that the citation profiles of disciplines vary depending on research topics, methods and author disciplines. Disciplines external to IS are typically cited in IS articles authored by scholars with the same background. Thus, the export of ideas from IS to other disciplines is evidently smaller than the earlier findings claim. IS should not be credited for contributions by other disciplines published in IS literature.

Originality/value – This study is the first to analyze which research topics and methods in the articles of IS are of use in other disciplines as indicated by citations.

Keywords Research methods, Information science, Citation analysis, Author disciplines, Contributions, Research topics

Paper type Article

Introduction

Information science (IS) is an interdisciplinary field of research. It has been influenced by other disciplines at least since 1950s, when scientists like Bradford from mathematics, Farradane from chemistry or Mooers from physics began to work with research problems in IS. Studies indicate that the number of contributions by scholars external to IS have increased significantly in IS publication venues, exceeding in number the contributions by scholars with background in IS (Chang, 2018, Urbano and Ardanuy, 2020; Vakkari et al., 2022a, b, 2023). Studies also show that IS has increasingly spread its influence on other disciplines as indicated by citations to IS research (Odell and Gabbard, 2008; Cronin and Meho, 2008; Lariviere et al., 2012; Si and Guo, 2023). IS is most cited by scholars affiliated with computer science, business and medicine (Cronin and Meho, 2008; Lariviere et al., 2012; Si and Guo, 2023).

Although other disciplines increasingly borrow from IS, little is known about the research topics or methods contributed by IS. Based on highly cited papers in IS 2000–2019, Si and
Guo (2023) observe that sciences like medicine and computer science focus on information technology and information retrieval, while the citations from social sciences like management or education focus on information management or information/user behavior. Cronin and Meho (2008) suggest that the striking increase in the number of external citations to IS literature can be explained by advances in information technology and Internet applications and the expansion of Institute for Scientific Information (ISI) coverage to domains related to IS. They show that between 1997 and 2006, keywords assigned to ISI [currently Web of Science (WoS)] articles imported from IS were related to Internet, information retrieval, information technology, information management and scientometrics. Thus, the scarce findings have identified in IS some broad topics of interest to other disciplines. However, it is an open question what it is in the results of IS that forms a contribution to other disciplines? The aim of this article is to elaborate this question by analyzing systematically which main topics and research strategies in IS articles are cited by other disciplines.

Jarvelin and Vakkari (1990) categorized IS research into a hierarchy of research topics and sub-topics. An updated version (Jarvelin and Vakkari, 2022) consists of six major research topics, which we here divide into five main research topics: library and information science (LIS) context (collapsed with LIS studies), L&I services, information retrieval, information seeking and scientific communication (Appendix 2). Thus, we analyze citations to these five main research topics of IS by the broader scholarly community.

We see IS literature as a mixture of sub-literature based on topics, methodologies, types of contributions, disciplines of the author teams, publication venues and accumulated citations. Likewise, we see the citing literature as a mixture of sub-literature based on publication venues, disciplines of the venues, intensity of citing IS literature and authority (or accumulated citations). The main research question is what gets cited in IS literature and by whom – See Figure 1.

We assume that each citation marks a contribution by the cited article to the discipline of the citing document. By tracing what is cited and by whom we can, therefore, analyze the flow
of ideas (specifically IS contributions) in the broader scholarly community. We use citation profiles – the distribution of citations over variables of interest – in the analysis.

Our research questions are as follows:

**RQ1.** Which disciplines cite contributions in which major topics of IS?

**RQ2.** Is there a connection between the IS article author teams (representing various disciplines) and the citation profiles?

**RQ3.** Are the citation profiles associated with the choice of research topics and methodology?

**Literature review**

*Si and Guo (2023)* analyzed 573 highly cited papers in LIS in 2000–2019. One-third of citations to LIS come from non-LIS disciplines. The disciplines citing most contributions in LIS were medicine, computer science and management and economics covering 72% of all external citations. Topics commonly concerned with multiple disciplines in LIS are more likely to be cited by external disciplines. The citations from sciences, such as medicine and computer science, mainly focused on topics of information technology and information systems, while the citations from social sciences, such as management, economics and education, mainly focused on topics of knowledge management, or information user behavior.

*Odell and Gabbard (2008)* studied which disciplines cited LIS journals in 1996–2004. They found out that 53% were citations by LIS scholars. The citations to LIS journals by non-LIS journals increased from 18% in 1996 to 35% in 2004. The largest proportion of citations to LIS come from computer science (35% of all non-LIS citations) and from business and management (15%) and medicine (9%).

*Cronin and Meho (2008)* analyzed citations to 275 IS periodicals between 1977 and 2006. Self-citations by IS decreased from 65% in 1977–1986 to 35% in 1997–2006, while citations by external disciplines increased respectively from 35% to 65%. Most of the external citations came from computer science and engineering, business and management and medicine. Lariviere (*Lariviere et al., 2012*) showed that the share of citations coming from other disciplines in IS has increased from 20% to 60% between 1990 and 2010. Management and computer science accounted for the largest proportions of citations received representing in 2010 10 and 8% respectively.

Prior studies show that IS is cited by other disciplines increasingly over the years. The pace varies greatly between the studies ranging from 35% in 2004 (*Odell and Gabbard, 2008*) and 65% in 2006 (*Cronin and Meho, 2008*) to 60% in 2010 (*Lariviere et al., 2012*). The studies show unanimously that computer science, business and management and medicine cite most contributions of IS. Computer science is mostly interested in contributions concerning information systems, while business and management in user studies (*Si and Guo, 2023*).

Several studies have shown that other disciplines than IS contribute most to literature in IS (*Chang, 2018; Urbano and Ardanuy, 2020; Vakkari et al., 2022a, b, 2023*). By analyzing the affiliations of authors in the articles of leading IS journals Vakkari and his colleagues (*Vakkari et al., 2023*) showed that between 1995 and 2015 the contributions by IS decreased essentially from 57% to 27%, while the contributions of external disciplines increased correspondingly from 29% to 53%. However, the disciplinary contributions varied by the topic of research (*Vakkari et al., 2022a*). In 2015 in professionally oriented topics – LIS context and L&I services – IS alone covered two-thirds of the contributions. In information retrieval, computer science dominated in contributions with a share of one-half. In information seeking IS was the dominating contributor followed by business and economics and computer
science. In scientific communication, the contributions were evenly distributed between IS, business and economics, computer science and social sciences.

These results show that most contributions in some topics are products of disciplines external to IS. Therefore, it is plausible that the representants of a discipline authoring a large share of articles in some IS topic also cite contributions by their own discipline when they study the topic. Some findings (Vakkari et al., 2022a, 2023) hint that the representants of a discipline within a main topic may specialize in selected sub-topics using characteristic research strategies of the sub-topics. For example, in information retrieval computer scientists typically study sub-topics with special methodology, which differs from the interests of IS scholars. It is likely that scholars external to IS consider that they contribute to their home discipline despite of publishing on an IS venue. Moreover, they likely find contributions by their own discipline most useful and consequently cite them. Our study seeks to shed light of these conjectures.

It is debatable whether citations indicate acknowledgment of contribution to the citing work. Some argue that citation-related indicators are inappropriate for assessing research influence (MacRoberts and MacRoberts, 2018), while others (Jirschitzka et al., 2017; So, 1998) claim a positive correlation between citation count and expert judgment. In any case, it is difficult to assess the unequal contributions of authors of a multi-author document on the basis of the number and order of authors because (Jarvelin et al., 2023): (1) the total contribution of an article varies from marginal to revolutionary, (2) the order of authors does not systematically indicate authors’ shares of contribution and (3) the contribution types vary from, e.g. formulation of research questions, to arranging the resources, providing methodological consultation, etc. Notwithstanding, we will use citations as contribution indicators since we believe that a statistical result based on large data is valid.

Citation analysis provides a range of metrics for assessing the citation impact of publications, journals, scholars, institutions, (e.g. Waltman, 2016) etc. Since we are interested in the flow of ideas (or contributions) between research areas, publication-based impact metrics are appropriate for the present study. Still, interpreting citation counts requires care due to typically skew distributions and way different datasets sizes. As a correction, various field-weighted, or normalized, versions of citation impact have been proposed (e.g. Waltman, 2016).

The primary cited articles in our data represent a single field, IS and are published in its top journals in a single year, 2015. The citation window is the same for all and fixed, 2015–June 2021, which allows over six years for the earliest citing publications and one year less for the last ones. We are not comparing units that may have different citation windows. Instead, we are analyzing the gross contribution of IS in related scholarly communication. No smoothing of outliers is performed in impact analysis. To make subfield profiles size-wise comparable, we use subfield-based field normalization.

Methodology
We analyze which disciplines cite articles of IS published in IS journals. For defining which contributions belong to the scope of IS, one has to characterize IS as a field of research and then operationalize this notion. Although it is not possible to find a definition of IS, which would be shared by all scholars in the field, it is widely accepted that the unifying characteristic of IS is the study on the provision of access to desired information typically in the form of documents (e.g. Vakkari, 1994; Bates, 1999). However, this brief characterization is challenging to operationalize. A typical way to characterize a field of research is to show what belongs to its study object. We give an ostensive definition of IS study objects by adopting the
hierarchical categorization scheme of research topics in information science by Järvelin and Vakkari (1990, 1993, 2022) (Appendix 2). Their categorization is generic, representative and widely used (e.g. Arman-Keown and Patterson, 2020; Hider and Pymm, 2008; Ma and Lund, 2021) hinting to its validity. Thus, the research topics indicated by the scheme form the scope of IS.

However, defining a particular research topic as belonging to the scope of one discipline does not exclude the option that another discipline considers the same topic belonging to its scope as well. For example, information retrieval is on one hand considered as part of IS, but on the other hand as belonging to computer science as, e.g. the Association for Computing Machinery (ACM) computing classification system (https://dl.acm.org/ccs) indicates. Thus, both disciplines may legitimately count information retrieval as belonging to its scope. An article on information retrieval authored by computer scientists and published in an IS journal is a contribution of computer science, which matches also to the scope of IS. It is unlikely that computer scientists would consider their contribution to belong to information science. Therefore, information science should not be credited for such a contribution. The same applies to contributions of disciplines external to IS which match to the scope of IS and are published in IS journals.

The construction of the data set, the variables used in the analysis of the IS articles, and the methods of analysis are explained in subsequent sections. Table 1 summarizes the terminology.

**Data collection**

The research process is illustrated in Figure 2 and the dimensions of the data set are summarized in Table 2. The data set consists of:

1. Phase 1: an analysis of topics and research strategies of articles published in scholarly IS journals in 2015 (Järvelin and Vakkari, 2022).
2. Phase 2: an analysis of the disciplinary composition of the author teams (Vakkari et al., 2022a, b).

<table>
<thead>
<tr>
<th>Term</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Citation</td>
<td>The citing document x cites the cited document y in its reference list</td>
</tr>
<tr>
<td>Citation profile</td>
<td>The distribution of citations, either given or received, over classes of some variable</td>
</tr>
<tr>
<td>Citation profile similarity</td>
<td>The correlation of two citation profiles, measured by the correlation coefficient r</td>
</tr>
<tr>
<td>Author and author team</td>
<td>The authors of a primary article. Each author represents some discipline among business and economics, computer science, engineering, humanities, information science, medicine, natural sciences, other disciplines, social sciences based on their affiliation</td>
</tr>
<tr>
<td>Author team’s disciplinary composition</td>
<td>The union of author disciplines, giving the unique disciplines</td>
</tr>
<tr>
<td>Venue</td>
<td>The journal, conference, book, etc. publishing a cited primary article or a citing secondary document</td>
</tr>
<tr>
<td>Venue’s discipline</td>
<td>Venues represent some discipline among business and economics, computer science, engineering, humanities, information science, medicine, natural sciences, other disciplines, social sciences</td>
</tr>
<tr>
<td>Venue citation count vcc</td>
<td>The total number of citations a venue of secondary documents gives to the set of primary articles. Used as a threshold for sub-setting venues</td>
</tr>
</tbody>
</table>

Table 1. Central terms explained
### Journals
- **Volume**: 2015
- **Unit of observation**: A journal
- **Total number of titles**: 31

### Articles
- **Unit of observation**: An article
- **Total number of articles**: 1,210
- **Content dimensions**: 3
- **Classifiers, equal shares**: 2

### Disciplinary compositions
- **Unit of observation**: The pair (article, discipline)
- **Total number**: 1,533
- **Content dimensions**: 3
- **Classifiers of data**: 1

### Citations
- **Unit of observation**: The pair (cited, citing doc)
- **Total number, of which ...**
  - to scholarly articles: 24,965
  - among which IS pubs: 19,346
- **Content dimensions**: 1
- **Classifiers of data**: 1

**Source(s):** Extended from Järvelin et al. (2023), Courtesy of Järvelin, Vakkari and Chang

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**Table 2.** Dimensions of data

<table>
<thead>
<tr>
<th>vcc</th>
<th>&gt; 501</th>
<th>201 - 500</th>
<th>101 - 200</th>
<th>51 - 100</th>
<th>21 - 50</th>
<th>11 - 20</th>
<th>6 - 10</th>
<th>4 - 5</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>#venues</td>
<td>2</td>
<td>12</td>
<td>12</td>
<td>36</td>
<td>99</td>
<td>170</td>
<td>341</td>
<td>334</td>
<td>370</td>
<td>829</td>
<td>2851</td>
</tr>
</tbody>
</table>

**Note(s):** The top-50 of venues (1%) contribute nearly 10K (~40%) of the citations
Phase 3: an analysis of the ∼25 K citations to the IS article set between 2015 and May 2021 focusing on overall citation quantities in various breakdowns of the primary articles (Järvelin et al., 2023).

Phase 3 extended: For the present paper, this data set was augmented by classifying the citing secondary documents into classes representing the main disciplines of their publication venues.

Journal selection
In journal selection we adopted the criteria in Tuomaala et al. (2014). Their criteria were theoretically oriented consisting of purposive selection of core journals in IS matching the characterization of IS as the provision of access to desired information (Vakkari, 1994; Bates, 1999). We have therefore avoided inclusion of journals belonging to other disciplines, like management information systems, as suggested by Abritzah et al. (2015), Huang et al. (2019). The additional criteria included focusing on scholarly IS journals with wide distribution, international editorial board and publication policy and which had been characterized as core journals earlier (e.g. Aström, 2007; Järvelin and Vakkari, 1990; Koufogiannakis et al., 2004; Zhao and Strotmann, 2008; Tuomaala et al., 2014). We arrived at a set of 31 journals for collecting articles. After removing 29 articles lacking citations, a set of 1,181 primary articles remained. Three articles were removed due to being outliers in citation counts.

Content analysis
Table 3 introduces the content analytical variables of the present study. Appendix II defines them by listing their classes. The classification of research topics was used at the level of five main research topics for analysis: LIS context, L&I institutions and services, information retrieval (IR), information seeking and scientific communication.

To increase the degrees of freedom in the analysis, i.e. to have enough cases in the classes, we merged classes of some variables. In research strategies, historical and evaluation strategies and secondary analysis were merged with other empirical strategies as other empirical strategies; citation analysis was merged with other bibliometric strategy as citation analysis; verbal argumentation, concept analysis, literature review and bibliographic strategy and other strategy were merged as conceptual strategy (Appendix 2).

Each article was classified under one content class for each content variable. Classification reliability was measured by Fleiss’ Kappa (Table 4).

<table>
<thead>
<tr>
<th>Name</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS topic</td>
<td>The focus of an article, e.g. information seeking, expressed as a main topic</td>
</tr>
<tr>
<td>Research strategy</td>
<td>The overall combination of data collection and analysis methods of the study</td>
</tr>
<tr>
<td>Discipline</td>
<td>Each unique discipline name based on an article’s co-authors’ affiliations</td>
</tr>
<tr>
<td>No. of disciplines</td>
<td>The number of unique disciplines contributing to an article</td>
</tr>
<tr>
<td>Discipline (HiCiteSubset)</td>
<td>For each citing document venue in the highly citing subset its (main) discipline name</td>
</tr>
<tr>
<td>Discipline (LoCiteSubset)</td>
<td>For each citing document venue in a sample of the low-citing subset its (main) discipline name</td>
</tr>
</tbody>
</table>

Table 3. Content and discipline analytic variables of the data set

Source(s): Extended from Järvelin et al. (2023), Courtesy of Järvelin & Vakkari and Chang
Encoding of authors’ disciplines

The method by Chang (2018) was used to identify the disciplinary attributes of individual authors based on author affiliation information of articles. Authors who were affiliated with IS-related institutions were coded as IS authors. Most IS-related institutions were departments and institutes that were affiliated with universities and offered IS courses, followed by libraries and library associations. Authors who did not qualify as IS authors were classified as authors in Business and Economics, Computer Science, Engineering, Humanities, Medicine, Natural Sciences and Social Sciences (Appendix III). The disciplinary attributes of multi-affiliated authors were determined by their first affiliations. The share of such authors was negligible (only 6% based on a random sample of 32 articles and among them, the additional affiliations often led to the same discipline as the primary one). In addition to referring to reference sources related to IS institutions mentioned in Chang (2018), the present study employed the Internet to identify some authors’ expertise because of incomplete affiliation information in the analyzed articles.

After the disciplinary attribute of each author was assigned, each article could be described by one or more disciplines. The same discipline was coded once for each article, not for each author. For example, a three-author article written by two IS authors and one computer science author was coded as IS and computer science, indicating the contribution of two disciplines to the article. Thus, each article was coded to represent one or more disciplines. For having enough cases in the classes for the analyses, twelve combinations of disciplines were formed as shown in Table 5. Computer science and engineering was coded as one group of disciplines called computer science. In the same vein social sciences, business and economics were merged as

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Author discipline groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS</td>
<td>Information science</td>
</tr>
<tr>
<td>IS&amp;Soc</td>
<td>Information science &amp; Social sciences &amp; Business &amp; Economics</td>
</tr>
<tr>
<td>IS&amp;Comp</td>
<td>Information science &amp; Computer science &amp; Engineering</td>
</tr>
<tr>
<td>IS&amp;Oth</td>
<td>Information science &amp; Other disciplines</td>
</tr>
<tr>
<td>CompSci</td>
<td>Computer science &amp; Engineering</td>
</tr>
<tr>
<td>Comp&amp;Soc</td>
<td>Computer science &amp; Engineering &amp; Social sciences &amp; Business &amp; Economics</td>
</tr>
<tr>
<td>Comp&amp;Oth</td>
<td>Computer science &amp; Engineering &amp; Other disciplines</td>
</tr>
<tr>
<td>SocSci</td>
<td>Social sciences &amp; Business &amp; Economics</td>
</tr>
<tr>
<td>Soc&amp;Oth</td>
<td>Social sciences &amp; Business &amp; Economics &amp; Other disciplines</td>
</tr>
<tr>
<td>Nat&amp;Med</td>
<td>Natural sciences &amp; Medicine</td>
</tr>
<tr>
<td>Human</td>
<td>Humanities</td>
</tr>
<tr>
<td>Disc 3-</td>
<td>A combination of at least three disciplinary groups</td>
</tr>
</tbody>
</table>

Table 5. Combinations of author disciplines
Thus, these twelve disciplinary groups in articles could be the target of citations from citing venues. The citing venues were categorized into six disciplinary groups: (1) information science, (2) computer science and engineering, (3) social sciences, business and economics, (4) natural sciences and medicine, (5) humanities and (6) other disciplines.

**Venue citation count**

The dataset contained 5,050 publication venues producing ~25 K citations and requiring discipline labeling. The citation count of venues had a skew distribution over the range [1, 1,632], Figure 2. The citing venues were divided into two groups: the HiCiteSubset of 1,000 venues contained at least four citations each to the set of primary articles, whereas the 4,050 LoCiteSubset venues contained at most three citations to the set of primary articles. Altogether, the HiCiteSubset provided 19,346 citations and the LoCiteSubset only 5,619. For research economy, only the HiCiteSubset was fully labeled manually with venue disciplines, using the classification of Appendix 3. A sample of 100 venues within LoCiteSubset was labeled to check the similarity of their citation profiles.

We use *venue citation count*, `vcc` for short, as a threshold in profiling citations to the primary article sets under analysis. `Vcc` indicates the number of citations the venue under consideration, thru all its documents, gives to all the articles in the set of primary articles, or its subset. Setting `vcc` relatively high, say `vcc ≥ 50`, focuses the analysis to the main consumers of IS contributions, while a low threshold takes even stray venues into account.

*Data selection for citation profiles.* Figure 3 shows that the citation profile of the entire IS looks the same, no matter whether it is constructed at the low threshold of `vcc = 4` or the higher threshold of 20. We use maximal data and thus set `vcc` at 4. Figure 4 suggests that the citation profile at `vcc = 4` of the entire IS forms a turning point above which the share of IS internal venues begins to grow. Below `vcc = 4`, the ~5 K citations come from 4,050 venues, which often belong to business/economics and computer science and rarely to humanities and IS. IS venues are drawn from a much smaller pool so their `vcc` tends to be higher.

Figure 5 shows the typical situation across main topics that the choice of `vcc` does not greatly affect the profile shapes. The peaks and valleys do not move by manipulating `vcc` values neither within the absolute value graphs (on the left) nor within the percentual graphs (on the right). Between main topics the peaks and valleys vary. In the findings section we let the percentual `vcc = 4` graph represent each main topic.

**Data analysis**

The data matrix for statistical analysis combines – see Figure 6 – the original content analysis, the authors’ discipline encoding, the citation data and the citing document (venue
based) discipline encoding into one matrix. We report cross tabulations and $\chi^2$ significance test results.

The relationships between author disciplines, citing disciplines, topics and research strategies were visualized by correspondence analysis (CA). CA is a dimension reduction technique for exploring the association between categories of variables (Hair et al., 2010). It resembles factor analysis and can be used with nominal data and nonlinear relationships. This technique uses the $\chi^2$ value as the basis for deriving a similarity measure, which is then used to plot the categories as points on a map (Hair et al., 2010). Proximity indicates the level of association among row and column categories. Points with higher similarities are mapped closer to each other. The distance between points is used for interpreting relative position, rather than for making precise statements on exact point-to-point distance (Hair et al., 2010).

**Results**

Below we discuss frequently citations to IS by the disciplines that the publication venues of the citing article represent. Since this is a rather long expression, we use the phrase *venue*
disciplines as a shorthand. We combined author disciplines with similar characteristics and about similar profiles for not losing degrees of freedom in the analyses.

Which disciplines cite articles in IS
There are significant differences in the profile of citations to IS topics by venue disciplines ($\chi^2 = 2477.8; \text{df } = 20, \ p < 0.001$) (Table 6). Half of the citations from disciplines focus on studies on scientific communication, which are typically scientometric in nature. Other IS topics receive notably less attention in descending order: information retrieval, information seeking, L&I services and LIS context. Thus, library and information services and context are the least cited topics.

**Table 6.** Citation profile of topics by venue disciplines (%)

<table>
<thead>
<tr>
<th>Topics</th>
<th>IS</th>
<th>CompSci</th>
<th>SocSci</th>
<th>Nat&amp;Med</th>
<th>Hum</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIS context</td>
<td>9</td>
<td>4</td>
<td>9</td>
<td>3</td>
<td>23</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>L&amp;I services</td>
<td>15</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>8</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>Inf retrieval</td>
<td>11</td>
<td>42</td>
<td>12</td>
<td>11</td>
<td>13</td>
<td>10</td>
<td>19</td>
</tr>
<tr>
<td>Inf seeking</td>
<td>13</td>
<td>16</td>
<td>21</td>
<td>13</td>
<td>18</td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td>Scientific</td>
<td>52</td>
<td>35</td>
<td>53</td>
<td>70</td>
<td>38</td>
<td>67</td>
<td>50</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

**Note(s):** IS = Information Science; CompSci = Computer Science and Engineering; SocSci = Social Sciences and Business; Nat& Med = Natural Sciences and Medicine; Hum = Humanities; Other = Any other non-fitting or unknown discipline

**Source(s):** Based on Järvelin et al., 2023 (Courtesy of Järvelin, Vakkari and Chang)
In all venue disciplines the most cited studies are on scientific communication except for computer science and engineering, which focus on information retrieval. Scientific communication receives over two-thirds of citations in natural sciences and medicine and other disciplines, about half of citations in IS and social sciences and business, while little over one-third in humanities and computer science and engineering.

About 40% of citations by computer science are directed to information retrieval, while the respective share in other disciplines is around 10%. Information seeking is emphasized in the citation profile of social sciences and business (21%), humanities (18%) and computer science and engineering (16%). LIS context is the second most popular citation target (23%) in humanities, whereas L&I services (15%) has the same position in IS.

**Associations between the disciplines of citing venues and cited author teams**

There are significant differences in the citation profiles in author team disciplines between the venue disciplines ($\chi^2 = 1905.1; df = 55, p < 0.001$) (Table 7). Venues of IS, computer science and engineering and social sciences and business mostly cite contributions by author teams with the same background: 39% of citations to IS contributions is produced by IS venues, and the corresponding shares are in computer science and engineering 36% and in social sciences and business 34%. Computer science and engineering and social sciences and business cite second most frequently contributions by authors in IS (22 and 21% respectively).

Diverging from the previous, venues of natural science and medicine and humanities cite mostly authors of IS (28 and 34%) and second most authors of social sciences and business (21 and 19%). They cite notably less the contributions of authors from their own discipline (8 and 14%). The contributions of authors in computer science are relatively popular in the venues of all other disciplines by the share around 15%.

**Connections between venue and authors’ disciplines by IS topic**

Next, we analyze citations by venue disciplines to contributions of various disciplinary groups in research topics in IS. To keep the analysis simple, we excluded those author disciplines that have a relatively small share (less than 0.5%).

<table>
<thead>
<tr>
<th>Author disciplines</th>
<th>IS</th>
<th>CompSci</th>
<th>SocSci</th>
<th>Nat&amp;Med</th>
<th>Hum</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>IS</td>
<td>39</td>
<td>22</td>
<td>21</td>
<td>28</td>
<td>34</td>
<td>24</td>
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Note(s): IS&Soc = IS and Social Sciences and Business; IS&Comp = IS and Computer Science and Engineering; IS&Oth = IS and Other Disciplines; CompSci = Computer Science and Engineering; Comp&Soc = Computer Science and Engineering, and Social Sciences and Business; Comp&Oth = Computer Science and Engineering, and Other disciplines; SocSci = Social Sciences and Business; Soc&Oth = Social Sciences and Business, and Other disciplines; Nat&Med = Natural Sciences and Medicine; Hum = Humanities; Disc 3- = Author group of at least three disciplines; * = < 0.5%

Table 7. Citation profile of author disciplines by venue disciplines (%)
disciplines, the share of which was insignificant in various venue disciplines. The proportion of included disciplines is indicated in the sum of each column.

**LIS context.** There are significant differences in citation profiles between venue disciplines ($\chi^2 = 266.8; df = 45, p < 0.001$) (Table 8). Unsurprisingly, within LIS context contributions of authors representing IS are most cited. They are most cited by venues belonging to IS (65%), natural sciences and medicine (54%), humanities (52%) and other disciplines (52%). Venues in social sciences and business mostly cite articles representing their own disciplines (59%), but also notably articles belonging to IS (24%).

In all, in LIS context the citation profiles of venue disciplines differ. In IS venues citations focus heavily on authors representing IS and scatter strongly across the rest of disciplines. Venues in social sciences and business use mostly contributions of authors representing their own disciplines, while venues in computer science cite notably authors of social sciences and IS.

**L&I services.** The citation profiles of venue disciplines differ significantly ($\chi^2 = 61.6; df = 40, p = 0.016$) (Table 9). However, at least two-thirds of citations in all venues concentrate to contributions by IS authors. Citations to contributions by authors in IS alone or jointly with authors of social sciences cover about 90% of all contributions regardless of venue discipline.

**Information retrieval.** The citation profiles of venue disciplines differ significantly ($\chi^2 = 642.9; df = 55, p < 0.001$) (Table 10). All disciplines mostly cite contributions by authors in computer science and engineering varying from 30% in IS to 65% in computer science and engineering. If joint contributions of computer science and engineering with other disciplines are considered, the proportion of contributions including computer science and engineering varies from 52% in IS to 85% in computer science. Contributions of computer science and engineering alone and in various disciplinary combinations produce 72% of the citations in all venues.

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**Note(s):** Authors’ disciplines with $n < 15$ excluded

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**Note(s):** Authors’ disciplines with $n < 30$ excluded
Citing behavior in venues of IS and social sciences and business differs from other disciplines, because they also use relatively frequently (30 and 29%) contributions of their own disciplines.

**Information seeking.** Citation profiles of venue disciplines differ significantly ($\chi^2 = 427.5; df = 50, p < 0.001$) (Table 11). The distribution of citations between venue disciplines in information seeking is more even compared to the previous topics. Contributions by scholars in IS receive most citations in all venue disciplines varying from 22% in other sciences to 50% in humanities except those in social sciences and business, where IS is in the third place with the share of 21%. Venues in social sciences and business cite mostly contributions by scholars in social sciences and business as such (24%) and jointly with scholars in computer science and engineering (26%). In information seeking, venues in computer science and engineering cite mostly contributions by authors in IS.

In all, in information seeking IS venues clearly cite mostly authors in IS and to some extent authors in computer sciences and engineering and social sciences and business. Although venues in computer science and engineering and social sciences and business heavily cite contributions by authors in IS, they use more contributions from their own discipline as such and in collaboration with each other. IS, computer science and engineering and social sciences and business are the major contributors in information seeking.

**Scientific communication.** The citation profiles of venues differ significantly ($\chi^2 = 320.2; df = 55, p < 0.001$) (Table 12). The two most cited disciplines are social sciences and business (28%) and IS (24%). The former is the most cited among venues in IS (27%), social sciences

<table>
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<td>8</td>
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<td>4</td>
<td>4</td>
<td>3</td>
<td>–</td>
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Note(s): Authors’ disciplines with $n < 22$ excluded

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Note(s): Authors’ disciplines with $n < 57$ excluded
and business (37%), humanities (23%) and other sciences (32%). Venues in natural sciences and medicine cite evenly contributions in IS and social sciences and business (25% each). Venues in computer science and engineering prefer contributions by scholars in IS (33%) for scholars in social sciences and business (24%).

Thus, the findings of social sciences and business are most used contributions in scientific communication across venue disciplines with IS as an exception, which is most cited in computer science and engineering and natural sciences and medicine.

Taken together, the contributions of IS alone or jointly with computer science are the most utilized sources in scientific communication. Compared to citation profiles in other topics in IS, the scatter of citations in scientific communication resembles that of information seeking. Both vary more across disciplines compared to other topics.

**Correspondence analysis**

Next, we visualize the relationships between the venue disciplines, author disciplines, topics and research strategies by applying CA. Research strategies are analyzed only here due to space limitations. CA is a distinct way to represent complex associations between several variables. The categories of these variables are plotted in a two-dimensional space.

The discrimination values of variables suggest that main topic (mean = 0.741) and research strategy (mean = 0.699) as the best discriminators can be used to name the dimensions. The values of variables author team (mean = 0.421) and citation venue discipline (mean = 0.228) were clearly smaller. The vertical dimension can be called main topics and the horizontal one research strategies (Figure 7).

The map consists of three clusters. In the left center area citing disciplines computer science and engineering (Comp&Eng) are near author team disciplines computer science and engineering (Comp&Eng) and computer science and other disciplines (Comp&Oth). Also, the topic information retrieval (IR) and mathematical (Math), system analytic (SystAn) and experimental (Experim) research strategies belong to this cluster. The visualization suggests that scholars in computer science and engineering cite colleagues of their own disciplines contributing to information retrieval by applying mathematical, system analytic or experimental research strategies.

In the upper right area citing disciplines IS and humanities (Hum) are near author team disciplines IS, IS and social sciences (IS&Soc) and humanities (Hum). Topics LIS context (LIS_Cntx), L&I services (L&I_Serv) and information seeking (ISeek) with qualitative (Qualit), content analytic (ContAn), conceptual (Conc), survey and other empirical (OthEmp)
research strategies belong to this cluster. The cluster represents those disciplines, which study traditional library topics IS context and L&I services and information seeking by methods applied typically by social sciences like qualitative or survey strategy. IS, humanities and IS in collaboration with social sciences cite these results.

In the lower right area are clustered citing disciplines natural sciences and medicine (NatSci&Med) and other disciplines (Other) and social sciences and business (Soc&Bus), which is located between this cluster and the cluster representing library research and information seeking. This third cluster includes author team disciplines social sciences and business (Soc&Bus), IS and computer science (IS&Comp), IS and other sciences (IS&Oth), natural sciences and medicine (NatSci&Med) and teams consisting at least of three disciplines (3Disc-). The topic in this cluster is scientific communication (SciCom), which consist typically of studies on scientometrics. The topic is approached by case study and citation analytic strategies.

The third cluster represents disciplines interested in scientific communication, especially natural science and medicine and social sciences and business which both act as author team and citing disciplines.

Interestingly, the author team disciplines of computer science and social sciences (Comp&Soc) are located between the cluster representing information retrieval and the cluster including information seeking. The collaboration of computer science and social sciences extends to these both topics.

**Discussion**

Our study is the first to analyze which research topics and methods in the articles of IS are of use in other disciplines as indicated by citations. The results show that the citation profiles of
venue disciplines vary depending on research topics, methods and author disciplines. In the
following, we first summarize the major findings and then reflect the implications of our
findings.

**Major findings**
In IS the most cited topic with the share of at least 50% is scientific communication, i.e.
scientometrics in all citing venue disciplines except for computer science. This can be
expected, because scientific communication is notably the most popular topic in IS in general
(Chang et al., 2015; Chang, 2018; Järvelin and Vakkari, 2022) and in various citing disciplines
except for computer science (Vakkari et al., 2022a). Information retrieval is in IS articles the
most popular topic in computer science (Vakkari et al., 2022a) and consequently, it receives
most citations from the venues in computer science. All venue disciplines cite also relative
frequently contributions in information seeking, those in social sciences and humanities, in
particular. IS venues cite mostly contributions in L&I services reflecting the central position it
has in the knowledge production of IS as discipline (Vakkari et al., 2022a). In general, citation
profiles reflect the patterns of knowledge production in IS research topics by various
disciplines.

The citation profiles of venues can be divided into internally citing and externally citing
venues. Venues in IS, computer science, social sciences and business cite mostly contributions
produced by their own disciplines alone or jointly with other disciplines. Natural sciences and
medicine, humanities and other disciplines cite most external disciplines, IS and social
sciences in particular and less contributions in their own discipline. This difference in citation
patterns is due to the variation of topical interests between the disciplines (Vakkari et al.,
2022a). Next, we proceed into discussing which disciplines cite contributions by various
author discipline combinations in different topics of IS.

In the topic LIS context, the venue disciplines mostly cite IS contributions except for
computer science and social sciences, which mostly cite their own contributions and second
most IS contributions. In the topic L&I services all venue disciplines mostly cite IS
contributions with the share of at least two-thirds. If we also consider joint articles by IS and
collaborating disciplines, the share approaches 90% in all venue disciplines. Thus,
contributions of IS have almost monopoly in knowledge production in the research on L&I
services. This reflects the fact that scholars in IS produce over two-thirds of articles in this
topic (Vakkari et al., 2022a). Evidently the producers and consumers of knowledge in
traditional L&I topics belong to IS community and scholars outside this community have
minor interest in these topics.

In information retrieval computer science receives most of the citations in various venues
varying between 35% in IS to 65% in computer science. Considering joint articles with
collaborating disciplines, the proportion of computer science varies from 52% in IS venues to
81% in the venues of computer science. Thus, other disciplines utilize actively results on
information retrieval created by computer science. This a reflection of the role of computer
science producing half of the contributions in information retrieval in articles published in IS
journals (Vakkari et al., 2022a). Thus, computer science dominates knowledge production in
information retrieval except in IS venues. IS venues cite contributions in IS notably more
often compared to other venue disciplines. This reflects in part the fact that within
information retrieval IS scholars focus on studies on metadata and cataloging, which are not
of great interest to scholars in other disciplines (Vakkari et al., 2022a). Thus, in information
retrieval IS exports only scarcely ideas to other disciplines, while authors in computer science
do this extensively.

In information seeking contributions of IS scholars are most cited in all venues except for
social sciences and business, which cite most social science and business contributions.
Research results produced by social sciences and computer science alone or jointly with each other receive the largest share of citations in all venues except in those of IS and humanities. Thus, contributions to information seeking by social sciences and computer science are favored more among other disciplines compared to IS and humanities. A check in data indicates that venues in IS differ from the venues in social sciences and computer science in their citations to sub-topics on information seeking. The latter venues cite significantly less the contributions of studies concerning the use of L&I services and significantly more results in studies on information management and other types of studies in information seeking like serendipity or presence in social media sites. Thus, the differences in citation profiles between IS and computer science and social sciences may be the result of differing interests in sub-topics of information seeking.

In scientific communication, i.e. scientometrics, the contributions of social sciences and business are most cited in all venues except for computer science, which cite most contributions by IS scholars. The strong position of social sciences and business in the citation profile of various disciplines reflects the fact that they produce the largest share of contributions in scientific communication and IS the second largest one (Vakkari et al., 2022a).

Disciplines typically cite their own contributions in IS articles
The findings suggest that the popularity of topical contribution typically influences most the profile of citations across various venues. The more popular a topic is, the more it is naturally cited in a venue. Scientific communication has typically been the most popular topic in IS research (Jarvelin and Vakkari, 2022) and consequently, it has been cited most in almost all citing disciplines. However, this pattern is transformed by the disciplinary background of authors. If a topic is popular in an author discipline implying voluminous publishing, venues belonging to this discipline tend to cite contributions authored by scholars in the respective discipline relatively more than contributions in other disciplines. For instance, in scientific communication scholars in social sciences and business publish most (Vakkari et al., 2022a), and they also receive most citations in all venue disciplines, except for IS. The venues of social sciences and business cite relatively more contributions of their own discipline compared to the other.

IS, computer science and engineering and social sciences and business contribute most to IS literature (Vakkari et al., 2022a) and the contributions of the two latter are predicted to bypass IS by the year 2025 (Vakkari et al., 2023). The strong position of these two disciplinary groups in the citation profiles in all venues, in all topics excluding L&I services, corroborates the expected decline of IS as discipline shaping the content of its own field of research. Especially in information retrieval and scientific communication scholars representing other disciplines than IS tend to cite more contributions of other disciplines.

Our CA produced three clusters representing information retrieval, scientific communication and traditional library topics with information seeking. Typically, in each cluster the author team disciplines tend to resemble citing disciplines. It seems that certain disciplines study characteristic research topics in IS by research methods and ideals typical to them and that these disciplines cite contributions belonging to these same disciplines with some variation. These findings corroborate findings by Vakkari et al. (2022a). External disciplines may also form specialties within broader IS topics, each with their own research goals, methods and ideals which differ from IS. To assess these conjectures would require intensive studies on the use of information from the cited sources, see further studies below.

Studies (Odell and Gabbard, 2008; Cronin and Meho, 2008; Lariviere et al., 2012; Si and Guo, 2023) claim that the export of results from IS to other disciplines has increased based on citations by other disciplines to IS literature as an indicator. However, our results show that in most cases citations by other disciplines are directed to author disciplines external to IS,
typically to the same discipline that the citing venue represents. Thus, the apparent growth in the influence of IS among other disciplines reflects the growth in the publication activity of these disciplines in IS journals (Chang, 2019; Vakkari et al., 2023). Consequently, other disciplines also cite contributions in IS journals authored by scholars in their own discipline. The authors of citing articles likely do not consider citing an IS contribution, but a contribution produced by colleagues in their own discipline. IS cannot be credited for this influence.

A check in data indicates that the absolute export of ideas from IS is largest in scientific communication with 1,361 citations received from other disciplines to contributions by IS. IS with collaborating disciplines received 3,826 citations by external disciplines in total. The export of ideas descends in information retrieval (463/2,101), information seeking (398/1,305), L&I services (298/322) and in LIS context (188/445). The share of citations from external disciplines to IS of all external citations to articles in IS journals varies by topic. It is smallest (22%) in information retrieval followed by, in ascending order: information seeking (30%), scientific communication (36%), LIS context (42%) and L&I services as largest (93%). Thus, other disciplines have a varying interest in the contributions of IS depending on the topic. The interest is smallest in information retrieval, where there are plenty of contributions in external disciplines to use and largest in L&I services, where scholars in IS have almost a monopoly in knowledge production.

**Limitations**

There are some limitations in our study that may be used to challenge the findings.

1. Our primary document set contains IS journal articles for a single year, 2015. Different document sets based on venue types, venue selection, or temporal windows might yield different results. For example, information retrieval would likely look even more computer science oriented, if the primary articles included conference papers. The boundary between IS and computer science is difficult to set.

2. Although including important journals of IS, our sample does not include journals representing other disciplines where information scientists may publish articles on research topics of IS. Our findings do not reflect this export of ideas from IS.

3. The classifications of article contents (Appendix II) and author and venue disciplines (Appendix III) greatly affect the findings. While both classifications have been used on several data sets, they may be redesigned. More fine-grained results could be achieved by multi-valued encoding of article content variables and venue disciplines. This concern is relieved by the multi-dimensional content classification and by analyzing the data at the level of main topics.

4. We have supposed that articles published in a disciplinary venue represent this discipline. However, our results indicate otherwise. The disciplinary variation of articles in a disciplinary venue limits the validity of our findings.

5. We had to assume all author positions and their associated disciplines equally significant attributes of a paper, while experience tells otherwise. However, there is no simple way for mitigating this – see (Järvelin et al., 2023) in the literature review.

6. We noticed that the name of a research organization in author metadata may be vague, not clearly indicating the discipline of an author. Some authors had multiple affiliations, begging for an appropriate choice. However, only about 6% of authors had more than one affiliation and even these frequently indicating the same discipline.
Further studies
In further studies, some of the limitations discussed above can be turned into research questions. Most obvious would be the analysis of comparable data sets representing different temporal windows. Going beyond the boundaries of the present study design, looking at the references of the set of primary articles, instead of their citations, would complete the description of the flow and development of ideas in/through IS. A deeper picture of the flow might be constructed, if we had data on the other citations the secondary documents made—citing outside the present journal article set. An even more intensive description would involve examination of the role of the cited literature in the citing publications—whether a cited document provides theoretical, methodological, empirical information to the citing document and whether this contribution is essential or just marginal. Such an analysis would require collecting the anchor texts around the in-text citations to literature.

Conclusion
Our results show that disciplines external to IS favor to cite contributions by their own colleagues published in IS journals. Certain disciplines focus on topics characteristic to them, applying specific research methods which differ from those favored by IS scholars, and consequently, their contributions are used by the scholars of respective disciplines. It is a self-perpetuating circle. This suggests that within some main topics of IS research goals and methods are differentiated between disciplines and thus forming specialties, which focus on specific sub-topics and methods. This development corroborates the idea that IS as a discipline is fragmenting due to the differing interest of other disciplines in its research topics, which diverge from those of IS scholars.

References


Appendix 1

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Table A1. Journal titles in the data set
Appendix 2
Content classes

Research topics by main topic

I Research on LIS context
010 the professions
020 history of L&I institutions
030 publishing
100 education in LIS
200 methodology
300 analysis of LIS
800 other aspects

II Research on L&I services
410 document delivery
420 collections
430 Information service
440 user education or literacy
450 L&I buildings
460 administration
470 digital libraries
480 other services
490 several interconnected activities

III Research on information retrieval
510 metadata/cataloguing
520 classification and indexing
531 text retrieval
532 retrieval methods in other media
533 web retrieval methods
534 social media retrieval
540 digital resources
550 interactive IR
560 other aspects

IV Research on information seeking
610 information dissemination
620 use/users of information channels
630 use of L&I services
641 task-based information seeking
642 other information seeking
650 information use
660 information management

V Research on scientific and professional comm
710 scientific/professional publishing
720 citation patterns
730 web-metrics
740 other aspects of communication
900 study in another discipline

Research strategy

Empirical
11 historical
12 survey
13 qualitative
14 evaluation
15 case study or action research
16 content analysis
17 citation analysis
18 other bibliometric
21 secondary analysis
22 experiment
29 other other empirical

Conceptual
31 verbal argumentation
32 concept analysis

Other non-empirical
40 mathematical-logical
50 system analysis
60 literature review
80 bibliographic
90 other strategy
00 non-applicable
Appendix 3
Affiliation-based discipline classes

Main class and sample subclasses (Chang, 2018)

**Business and economics**
- Business
- Economics
- Management

**Computer sciences**
- Computer science and engineering
- Information systems and human–computer interaction (HCI)

**Engineering**
- Engineering
- Architecture
- Energy

**Humanities**
- Humanities
- Literature
- Arts
- Anthropology
- Linguistics
- Philosophy
- History

**Library and information Science (LIS)**
- Documentation
- Information science
- Library science

**Medicine**
- Medicine
- Nursing
- Health science

**Natural sciences**
- General science
- Physics
- Mathematics
- Biology
- Agriculture
Chemistry
Zoology
Botany
Social sciences
Education
General social science
Communication
Law
Psychology
Sociology
Political science
Tourism
Other
Any other non-fitting or unknown discipline

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