

# Scatter of Journals and Literature Obsolescence Reflected in Document Delivery Requests

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In this paper we investigate the scattering of journals and literature obsolescence reflected in more than 137,000 document delivery requests submitted to a national document delivery service. We first summarize the major findings of the study with regards to the performance of the service. We then identify the “core” journals from which article requests were satisfied and address the following research questions: (a) Does the distribution of (core) journals conform to the Bradford’s Law of Scattering? (b) Is there a relationship between usage of journals and impact factors, journals with high impact factors being used more often than the rest? (c) Is there a relationship between usage of journals and total citation counts, journals with high total citation counts being used more often than the rest? (d) What is the median age of use (half-life) of requested articles in general? (e) Do requested articles that appear in core journals get obsolete more slowly? (f) Is there a relationship between obsolescence and journal impact factors, journals with high impact factors being obsolete more slowly? (g) Is there a relationship between obsolescence and total citation counts, journals with high total citation counts being obsolete more slowly? Based on the analysis of findings, we found that the distribution of highly and moderately used journal titles conform to Bradford’s Law. The median age of use was 8 years for all requested articles. Ninety percent of the articles requested were 21 years of age or younger. Articles that appeared in 168 core journal titles seem to get obsolete slightly more slowly than those of all titles. We observed no statistically significant correlations between the frequency of journal use and ISI journal impact factors, and between the frequency of journal use and ISI- (Institute for Scientific Information, Philadelphia, PA) cited half-lives for the most heavily used 168 core journal titles. There was a weak correlation between usage of journals and ISI-reported total citation counts. No statistically significant relationship was found between median age of use and journal impact factors and between median age of use and total citation counts. There was a weak negative correlation between ISI journal impact factors and cited half-lives of 168 core

journals, and a weak correlation between ISI citation half-lives and use half-lives of core journals. No correlation was found between cited half-lives of 168 core journals and their corresponding total citation counts as reported by ISI. Findings of the current study are discussed along with those of other studies.

## Introduction

Millions of articles get published in scientific and scholarly journals every year. Scientists and researchers make use of those articles to carry out their studies. Yet, even large libraries with considerable collection development budgets cannot subscribe to all scientific journals needed by their users. Requests that cannot be fulfilled using in-house resources of a library need to be satisfied through interlibrary borrowing and document delivery services. Large-scale document delivery services are offered by libraries such as the British Library Document Supply Centre (BLDSC) Boston Spa, United Kingdom, and by commercial companies.

Collection development policies of libraries in the past have usually been shaped by in-house use of journals. Libraries would track in-house use and try to identify most frequently used journal titles. Journal titles used most often through document delivery services would also be recorded. Such journal titles would then become prime candidates for subscription in the following years. The “access versus ownership” approach is now changing the premise of collection development policies. More and more libraries tend to subscribe to “core journals” only, while satisfying the need for less frequently requested titles through interlibrary borrowing and document delivery services. This is reflected in the service trends observed in member libraries of Association of Research Libraries (ARL): the number of interlibrary borrowing transactions has almost doubled (97%) between 1991 and 2000 (Kyriillidou & Young, 2001). Moreover, documents are increasingly being delivered electronically to the user’s desktop or personal digital assistant (PDA) as part of personalized information services offered by libraries in cooperation with publishers (Tonta, 2003). The trend towards electronic document delivery is also having an impact on commercial

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Received August 14, 2003; revised January 6, 2004; accepted March 15, 2004

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companies and institutions providing traditional document delivery services. For instance, the British Library (BL) recently signed an agreement with Elsevier Science (Amsterdam/New York) and Adobe (San Jose, CA) to provide print-quality copies of journal articles from over 1700 key Elsevier titles delivered to users' desktops (British Library, 2002).

## Literature Review

Several researchers carried out studies on collection development policies based on document delivery requests. For instance, Cooper and McGregor (1994) studied more than 48,000 journal article photocopy requests submitted to the information services unit of a biotechnology firm by local users between 1987–1989 with a view to find out the unit cost per use, the most frequently requested journal titles as well as the age of requested articles. They provided a detailed review of previous research on reference, citation, and use studies along with those that investigated the relationship between use and citation data that are regularly published in *Journal Citation Reports* of the Institute for Scientific Information (ISI, Philadelphia, PA). Based on findings, the library canceled 45% of its subscriptions. Despite the availability of fewer titles due to cancellations, the number of photocopies increased. Half the photocopy requests were for articles that appeared in only 36 of the 1673 journals used in the study. Cooper and McGregor also found that (a) the median age of use was just over one year, (b) more than 42% of all articles were photocopied in the same year as they were published, and (c) there was a negative random agreement between ISI impact factors and the rankings based on use data (i.e., some journals with higher impact factors scored lower rankings on the basis of the number of photocopy requests). Researchers advised that local use data should be preferred over citation data for collection management purposes.

Wiley and Chrzastowski (2002) also reviewed more than 105,000 document delivery requests for journal articles submitted to the Illinois Consortium Libraries (comprising 26 libraries) in 1999/2000. Some 60,000 requests came from Illinois researchers. Almost 13,000 journal titles (44% of all requests) were used only once while a very few titles (3.4% of all titles) were used more than 20 times. They found that 470 core journals satisfied over 20,000 requests from Illinois researchers (one third of all Illinois requests) and that “the majority of transactions for the most highly requested titles were from the more current years” (p. 29).

The relationship between frequency of use and journal impact factors, between frequency of use and total citation counts, between frequency of use and obsolescence (half-life) rates, and between journal impact factors and half-lives have been studied in the past by a number of researchers (see, for example, Cooper & McGregor, 1994; Glänzel & Schoepflin, 1994; Line, 1978; Line & Sandison, 1974; McCain & Bobick, 1981; Meadows, 1967; Moed, Van Leeuwen, & Reedijk, 1998; Tsay, 1999a, 1999b). “Citation counts are a formal acknowledgement of intellectual debt to . . . previously-published scientific research papers” (ISI,

2003). The impact factor is defined as “the ratio of the number of citations which a journal receives in the course of a given year to the number of articles published by that journal within the two preceding calendar years” (Rousseau, 1988, p. 249). Rousseau (2002) discussed in detail how journal impact factors are calculated and used in evaluation studies. Garfield (1994) notes that “the impact factor is useful in clarifying the significance of absolute (or total) citation frequencies. It eliminates some of the bias of such counts which favor large journals over small ones, or frequently issued journals over less frequently issued ones, and of older journals over newer ones” (p. 3). Used synonymously with “obsolescence,” the term “half-life” is defined as “the time during which one-half of the currently active literature was published” (Line, 1970, p. 46), or “the median age of items cited or demanded” (Earle & Vickery, 1969, p. 132).

Line and Sandison (1974), Gapen and Milner (1981), and Line (1993) reviewed the literature on obsolescence. Some studied frequency of use as reflected in ISI citation data while others did by gathering data on in-library use of, or document delivery requests satisfied from, journal titles. Glänzel and Schoepflin (1994, cited in Moed et al., 1998, p. 391) concluded that aging and impact factor may be considered as almost independent phenomena. Based on 15 years' worth of citation data for more than 3000 journals covered by Science Citation Index (SCI), Moed et al. (1998) found that correlations between impact factors and aging characteristics were rather weak and that aging characteristics were primarily specific to the individual journal rather than to the subfield.

Earle and Vickery (1969) analyzed a sample of citations in the social science literature in the United Kingdom so as to ascertain their bibliometric characteristics (e.g., subject, bibliographic form, language, and age) and compared them with citations from science and technology literature. Items (i.e., articles, reviews) appeared in both social science and science/technology periodicals exhibited similar aging characteristics while social science books aged more slowly. The actual half-life ages of periodical citations were 6 years as opposed to 3.5 years of those obtained from interlibrary loan requests of the National Lending Library, as “citation does not necessarily reflect *current demand*” (Earle & Vickery, 1969, p. 134, original emphasis). Authors concluded that “neither citation nor loan demand is an adequate measure of literature use by a large community. Each is only an indicator, illuminating some aspects of use but with its own inherent bias. The joint study of several indicators gives a more balanced picture” (Earle & Vickery, 1969, p. 133).

Tsay (1999a, 1999b) studied the in-library use of journal titles in a hospital library and found that the peak in-library use was at age 1 while the maximum citation was at age 3. Based on the same in-library use statistics, the mean average of the median use ages for 835 journal titles was 3.43 years while the mean citation half-life was 6.28 years and the difference was statistically significant. No correlation was found between use and citation age distributions. Earlier, Scales (1976) compared the list of journal titles ranked by the frequency of use with the list of same journals, ranked by citation counts, and found that

the rank-order correlation was low between the two. She concluded that “journal citation rankings are not good indicators of actual use, and as such do not constitute valid guides for journal selection” (p. 23). More recently, Cooper and McGregor (1994) reached a similar conclusion when they found no correlation between obsolescence measured by photocopy demand for journal titles in a biotechnology library and obsolescence measured by citation frequency. They suggested that “median citation age data based on citations was not a reliable predictor of the use of current journals” (p. 403).

In this study we investigate the document delivery requests for journal articles submitted to the document delivery unit of the Turkish Academic Network and Information Center (TANIC). We believe that more than 137,000 document delivery requests for journal articles submitted to a national information center can be used to study the general phenomena of scattering and obsolescence. Several researchers in the past studied if the Bradford Law fits the distribution and obsolescence of articles appearing in journals in a specific and homogeneous subject field, some using much fewer citations. We aim to study if the Bradford Law is equally applicable to the distribution and obsolescence of journals representing more than one subject field. After a brief overview of TANIC’s document delivery services, methodology and findings of the study are summarized along with discussion, conclusions and recommendations.

### **The Turkish Academic Network and Information Center**

The Turkish Academic Network and Information Center (TANIC) was founded in June 1, 1996 in Ankara by the Turkish Scientific and Technical Research Center (TÜBİTAK). In addition to setting up the national academic network, TANIC is also responsible for developing a “vision” of an electronic library to satisfy the information needs of academia and for setting up the organizational structure to implement and maintain this vision. As most Turkish university libraries are not well stocked, TANIC also maintains a serials collection of about 10,000 titles with more than 20 years of backruns inherited from the Higher Education Council Documentation Center. As a national center, TANIC subscribes to journal titles representing a wide variety of subject fields. Journals in science, technology, and medicine (STM) constitute a large percentage of the overall journal collection. Individual users as well as libraries in need of document delivery services send requests to TANIC. TANIC fulfills a request from its collection first. If not successful, the request is forwarded to other libraries taking part in what is called the “Cooperative Document Delivery System” established and run by TANIC. In 1998 and 1999, TANIC satisfied about half of all document delivery requests from its collection. After the introduction of the cooperative system, the fulfillment rate improved to 63% in 2000 and 66% in 2001 (TÜBİTAK, 2000, 2002a, 2002b). The Turkish Academic Network and Information Center document delivery system has been automated since June 26, 2000.

### **Methodology**

The following research questions were addressed:

1. Does the distribution of (core) journals conform to Bradford’s Law of Scattering?
2. Is there a relationship between the usage of journals and their impact factors, journals with high impact factors being used more often than the rest?
3. Is there a relationship between usage of journals and total citation counts, journals with high total citation counts being used more often than the rest?
4. What is the median age of use (half-life) of requested articles in general?
5. Do requested articles that appear in core journals get obsolete more slowly?
6. Is there a relationship between obsolescence and journal impact factors, journals with high impact factors being obsolete more slowly?
7. Is there a relationship between obsolescence and total citation counts, journals with high total citation counts being obsolete more slowly?

These research questions have been addressed in the past with a view to developing collection management policies in libraries. Decisions on identification of core journal titles in a scientific discipline, retention of heavily used materials, deselection, discarding and relegation of less-used or older materials to off-site storage areas were meant to be based on the answers to such questions (e.g., Cooper & McGregor, 1994; Garfield, 1972; Line, 1970, 1978; Line & Sandison, 1974; McCain & Bobick, 1981; Meadows, 1967; Pope, 1975; Tsay, 1999a, 1999b).

Bradford’s Law of Scattering “describes how the literature on a particular subject is scattered or distributed in the journals” (Garfield, 1980, p. 5). Originally formulated in 1934, the Bradford Law states that “if scientific journals are arranged in order of decreasing productivity of articles on a given subject, they may be divided into a nucleus of periodicals more particularly devoted to the subject and several groups or zones containing the same number of articles as the nucleus” (Bradford, 1934; as cited in Hertzfel, 1987, p. 175). Garfield thinks that the Bradford Law derives its universality from the basic unity of science—that is, that every scientific field is related, however remotely, to every other field.” He interprets it as follows:

If you want to compile a bibliography on any subject, you will find that there is always a small group of core journals that account for a substantial percentage (1/3) of the articles on that subject or discipline. Then there is second larger group of journals that account for another third while a much larger group of journals picks up the last third. (Garfield, 1980, p. 6)

“Expressed this way, Bradford’s Law of Scattering can properly be regarded as a law of diminishing returns with respect to the number of titles held in a given subject area” (Buckland, 1983, p. 167). Later, Trueswell’s 80/20 rule drew attention to the same phenomenon when it was shown that

roughly 80% of the books circulated in a library accounted for the 20% of the collection (Trueswell, 1969). The Bradford Law proved useful, *inter alia*, to describe the distribution of in-library use of articles in core journals as well. Journal citation data and impact factors indicating the importance or prestigiousness of scientific journals were usually taken as a basis for comparison. It was thought that journals with high impact factors would be used more heavily in libraries. If this assumption proved to be valid, then relatively fewer number of core journals would satisfy proportionally large number of information needs. However, studies showed that journals with high impact factors do not necessarily get used more often. Usually, no discernable relationship was found between impact factors and the frequency of in-library use of articles appeared in those journals.

Similarly, it was observed that current literature gets cited more often in scientific journal articles. As articles get aged, they get fewer and fewer citations, although the median age of cited articles (obsolescence) varies by scientific fields and by type of material (Earle & Vickery, 1969; Meadows, 1967). This can also be “regarded as a law of diminishing returns with respect to the length of time material is retained in a library’s collections” (Buckland, 1983, p. 167). No meaningful correlation was detected between obsolescence measured by citation frequency of articles and obsolescence measured by the frequency of in-library use of those articles or by the frequency of interlibrary loan demands. Yet, age remains to be an important criterion in collection management decisions.

The possible relationship between scattering and obsolescence was studied in the past. It was pointed out that “[i]t would be of considerable theoretical interest if a relationship could be established and much data collection could be avoided if one could be deduced from the other” and that the Bradford Law and obsolescence can be used together to decide “how large library collections should be” (Buckland, 1972, p. 242). Yet, a study carried out in a university library did not produce conclusive results.

The issues of scattering and obsolescence were studied in the past in regard to citation analysis, impact factors and in-library use of journals in a given subject or a specific collection. Brookes (1968) pointed out that “[t]hrough Bradford’s law holds for compact scientific topics such as vitamins, for example, a question arises about its applicability to very large general collections of documents in which many Bradford-type collections on single compact topics are merged” (p. 256). He raised the following questions:

... if a number of sets of journals, each of which conforms with the Bradford distribution in respect of its particular topic, are merged into one comprehensive set relevant to a wider topic, does the Bradford law apply also to the comprehensive set? Or, in terms of probability theory, does the convolution of correlated and uncorrelated Bradford distributions yield another distribution? (p. 256)

He showed that “. . . as the subject topic widens and [the number of journals] increases, so the papers published

increasingly concentrate (up to saturation) in the most highly ranked journals” (p. 258). However, Brookes did not think that it was possible to answer such questions, as empirical data on both single topics and general collections did not exist at that time. He later explored the Bradford Law theoretically by means of the Poisson model and suggested that the Bradford Law “can be regarded as a particular example of an empirical law of social behaviour” (Brookes, 1977, p. 180). Brookes noted that a Bradford-type distribution can be likened to a Poisson distribution, as the use of journals (however the “use” is defined) can be seen as a random event.<sup>1</sup> Thus, if a collection consists of journals on several subjects and the use of journals in each subject exhibits a Poisson distribution with different means of use, then the use of all journals in the total collection should also exhibit a Poisson distribution (hence a Bradford distribution) (Brookes, 1977, pp. 181–182).

Bulick (1978) showed that the Bradford Law was applicable to book use by library patrons in a major research library. Bulick found that a small number of books were checked out by library users relatively more frequently while a large number of books were rarely used. Cooper and McGregor (1994) reached a similar conclusion when they observed that a small number of core journal titles satisfied the large percentage of photocopy demand in the library of a biotechnology firm.

Such studies are scarce. Moreover, studies on the applicability of the Bradford Law and obsolescence in document delivery services are even scarcer. Usually, interlibrary loan (ILL) or document delivery requests get satisfied from larger, more interdisciplinary and thus less homogeneous library collections. It would be worthwhile to study if scattering and aging of literature apply equally well in the context of document delivery requests that were satisfied from the relatively rich and varied journal collection of a national document delivery service. As mentioned earlier, no correlation was found between impact factors and in-library use of journals, and between median age of use as measured by citation studies and that as measured by the frequency of in-library use of journals. It would be interesting to test if the lack of relationship also holds for the frequency of use of journals for document delivery purposes.

## Data Sources

A total of 137,692 document delivery requests were submitted to TANIC between June 26, 2000 and June 30, 2002.<sup>2</sup> The raw data on document delivery requests as well as their outcome (satisfied or not satisfied, supplying libraries, reasons for failure, etc.) were obtained from TANIC in electronic form. The whole data file was divided into two subfiles, each containing roughly one year’s worth of data. The first one contained 57,802 requests (submitted between June 26, 2000 and June 30, 2001) while the second contained

<sup>1</sup>Brookes used the term *sources* for journals (Brookes, 1977, p. 180).

<sup>2</sup>The grand total was 138,141. There were 449 document delivery requests (or 0.3%) for books, standards and patents excluded.

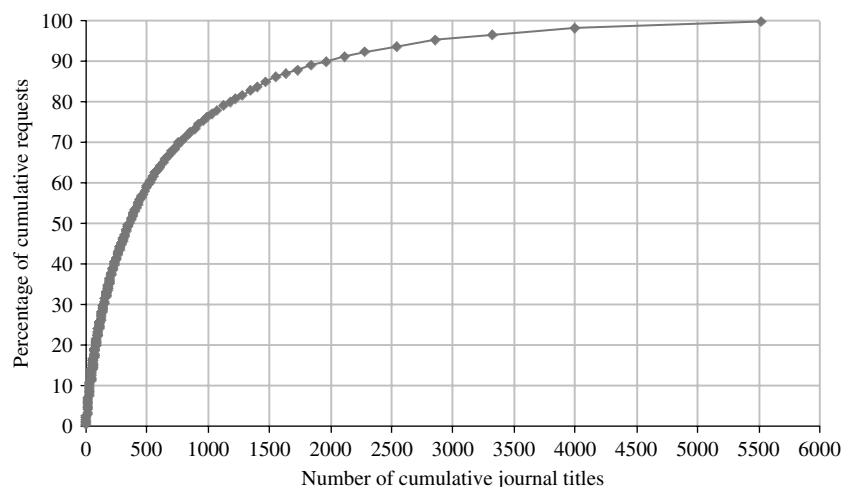


FIG. 1. Cumulative usage of journal titles and percentage of requests satisfied.

79,890 requests (submitted between July 1, 2001 and June 30, 2002).<sup>3</sup> Then, requests in each file were compared in regard to, among others, satisfaction rate, core journals, distribution of requests to journal titles, obsolescence, and impact factors.

Findings on journal usage patterns (scatter and age of use of journal titles) are given below. Discussion and conclusions follow the findings.

## Findings

A total of 91,314 document delivery requests fulfilled were satisfied from 5521 different journal titles.<sup>4</sup> The cumulative usage of all journal titles is given in Figure 1. As can be seen from Figure 1, highly used journal titles satisfied the majority of document delivery requests whereas overwhelming majority of titles were used very infrequently. For instance, 168 core journals (a mere 3.0% of all journal titles) satisfied one third of all fulfilled requests. More than three quarters of 168 core journals (129 to be exact) were on the subject of biomedicine.<sup>5</sup> The remaining journals were mainly on chemistry, biotechnology, agriculture, biology, and plant science. The core journal list contained no titles in the social sciences or humanities. A total of 354 journals (6.4% of all journal titles) satisfied half while 667 titles (12.1%) did almost two thirds of all fulfilled requests. Some 1519 journals (27.5% of all titles) were used only once, satisfying only 1.7% of all document delivery requests. Data on journals and document delivery requests also conform to Trueswell's 80/20 rule in that 80.3% of the total number of

document delivery requests accounted for only 21.4% of all journals (Trueswell, 1969).

Journal titles that appeared in both 2000 and 2001 lists were compared to see if highly used titles overlap. A total of 3904 journal titles satisfied all requests in 2000 while 4608 titles were used for the requests in 2001. As all requests for both 2000 and 2001 were met by a total of 5521 unique journal titles, it appears that 2991 journal titles were commonly used to satisfy requests in both years.<sup>6</sup> This represents a 54% overlap between the two lists of journal titles, which is similar to the overlap rates (52%) obtained in the Illinois Interlibrary Loan Assessment Project for two different journal lists used in 1995 and 1999 (Wiley & Chrzastowski, 2002).

A similar overlap study for only core journal titles of both 2000 and 2001 was carried out separately. Of the 3904 titles, 159 highly used core journal titles satisfied one third of all requests in 2000. The number of core journal titles that satisfied one third of all requests in 2001 was 163 (out of 4608). Some 118 journals' titles appeared in both 2000 and 2001 core journal title lists. The overlap between the two most highly requested journal titles (72%) was much higher than the general overlap (54%) for two lists of all journal titles. Moreover, the correlation between the number of article requests (frequency of use) satisfied from a given journal and its being listed among highly requested journal titles in both years was statistically significant (Pearson's  $r = .474, p < .01$ ). The null hypothesis that "there is no relationship between the frequency of use of journals and their being listed in core journals list" is therefore rejected. The rank-order correlation between the 2000 and 2001 journal lists was also statistically significant (Spearman's  $R = .473, p < .01$ ). The null hypothesis that "no relationship exists between the two core journal lists of 2000 and 2001" is also rejected. In other words, a significant percentage of document delivery requests was filled consistently through the same or highly overlapping set of core journal titles.

<sup>3</sup>For convenience, data containing the first set will be labeled "2000" and the second set "2001."

<sup>4</sup>The discrepancy between total requests fulfilled as given in Table 1 (92,574) and that of 91,314 is due to the lack of journal data for 1260 article requests.

<sup>5</sup>We used the subject categories given in *SCI Journal Citation Reports* (2001) to classify journal titles under each subject category. The first subject category given for each journal title was taken into account.

<sup>6</sup>Obtained by summing 3904 and 4608 and subtracting the result (8512) from 5521.

TABLE 1. Distribution of journal titles and requests satisfied by regions.

Region	# of Journal titles		# of Requests	
	N	%	N	%
1	168	3.0	30,164	33.0
2	499	9.1	30,699	33.7
3	4854	87.9	30,451	33.3
Total	5521	100.0	91,314	100.0

A test was conducted to see if the Bradford Law holds for more than 137,000 document delivery requests representing various subject fields submitted to TANIC. The total number of journal titles (5521) were divided into three equal regions on the basis of total requests that journal titles in each region satisfied (in our case, one third of all requests for each region). Table 1 gives the number of journal titles and approximate percentages of transactions satisfied. As we indicated earlier, 168 core journals satisfied one third of all requests while 667 titles (499 plus 168) satisfied two thirds of all requests. The great majority of journal titles (4854 titles or 88% of all titles) satisfied only one third of all requests. We found that the frequencies of use of journal titles in the first two regions (highly and moderately used titles) conform to the frequencies that are expected according to Bradford's Law of Scattering. Yet, the frequencies of use for less frequently used journal titles seem to be higher than expected, which may be due to the fact that large numbers of transactions tend to produce what is called a "comet tail" (Garfield, 1980, p. 6). This reinforces the fact that, regardless of their subjects, core journal titles consistently satisfy a significant amount of document delivery requests as is to be expected, while most journal titles are rarely used.

The mean and median impact factors of 168 highly used journal titles were 3.588 and 2.489, respectively. No statistically significant relationship was found between the usage of 168 core journals and their journal impact factors (Pearson's  $r = .074$ ,  $p = .34$ ). The mean and median impact factors of 159 and 163 highly used journal titles that appeared in 2000 and 2001 lists, respectively, were similar to those of 168 journals. The overlapping set of 118 core journal titles that appeared in both lists had slightly higher mean and median impact factors (4.003 and 2.714, respectively). No statistically significant correlation was observed between the frequency of use and journal impact factors for 159 and 163 journal titles, either ( $r = -.011$ ,  $p = .88$ ;  $r = .080$ ,  $p = .31$ ). Therefore, the null hypothesis that "no relationship exists between the frequency of use of core journal titles and their journal impact factors" is accepted.

The mean total citation counts of 168 highly used journal titles was 25,722. The mean total citation counts of 159 and 163 highly used journal titles that appeared in 2000 and 2001 lists, respectively, were similar to that of 168 journals. The mean total citation counts for the overlapping set of 118 core journal titles that appeared in both lists was higher (31,079). The null hypothesis that "no relationship

exists between the frequency of use of 168 core journal titles and their ISI-reported total citation counts" is rejected, although the correlation was rather weak (Pearson's  $r = .164$ ,  $p < .05$ ). The correlation coefficient was somewhat larger than that between the usage and journal impact factors. This might be due to the fact that total citation counts include citations to older articles whereas the impact factor takes into account citations to articles published in the previous 2 years only. Yet, no statistically significant correlation was observed between the frequency of use and total citation counts for 159 and 163 journal titles ( $r = .140$ ,  $p = .081$ ;  $r = .110$ ,  $p = .163$ ). The associated null hypothesis that "no relationship exists between the frequency of use of 159 (and 163) core journal titles and their ISI-reported total citation counts" is accepted.

Both the impact factor and total citation counts are used to measure the influence of a given journal. Yet, our findings suggest that they cannot be used as reliable indicators to predict the frequency of local use of journal titles for document delivery purposes, which confirms findings of previous studies that we reported earlier (e.g., Cooper & McGregor, 1994; Scales, 1976).

As journal articles become aged, they get requested or cited less frequently. This is known as "obsolescence." "Median use age of a journal is a measure of the age at which half the journal's usage has taken place" (Cooper & McGregor, 1994, p. 402). To measure the obsolescence rate of all the requested articles (fulfilled and not fulfilled), they were ranked by publication year and the median age was found as 8 years (see Figure 2).<sup>7</sup> In other words, half the requests were made to articles that were 8 years old or younger. Almost 30% of all requests were made to articles that appeared within the last 4 years, 70% within the last 11 years, and 90% within the last 21 years. Journal articles that appeared in 2000 (i.e., 3 years old) received the peak use with 11% of the total requests. As is to be expected, requests to older journal articles gradually declined (Figure 3). A similar trend was also observed in article requests from core journal titles in Wiley and Chrzastowski's study (2002, Figure 4, p. 30).

A total of 11 most heavily used journal titles satisfied 4.4% of all document delivery requests. The number of requests for those titles along with their median age, 90% obsolescence, and journal impact factors and cited half-lives taken from ISI's *Journal Citation Reports* (2001) are given in Table 2. As was indicated earlier, biomedical journals constituted the overwhelming majority of core journal titles in our study. All but two (*Journal of Food Protection* and *Journal of Agricultural and Food Chemistry*) of the most heavily used 11 journal titles fulfilling more than 300 document delivery requests publish articles on the subject of biomedicine. It is interesting to note that such relatively inexpensive

<sup>7</sup>However, only 1% of all requests were made for articles that appeared in 2002, as the data collection period ended in mid-2002. Thus, median age can be taken as 7 years. Similarly, one year can be subtracted from 30%, 70%, and 90% obsolescence rates.

Distribution of requests by publication year

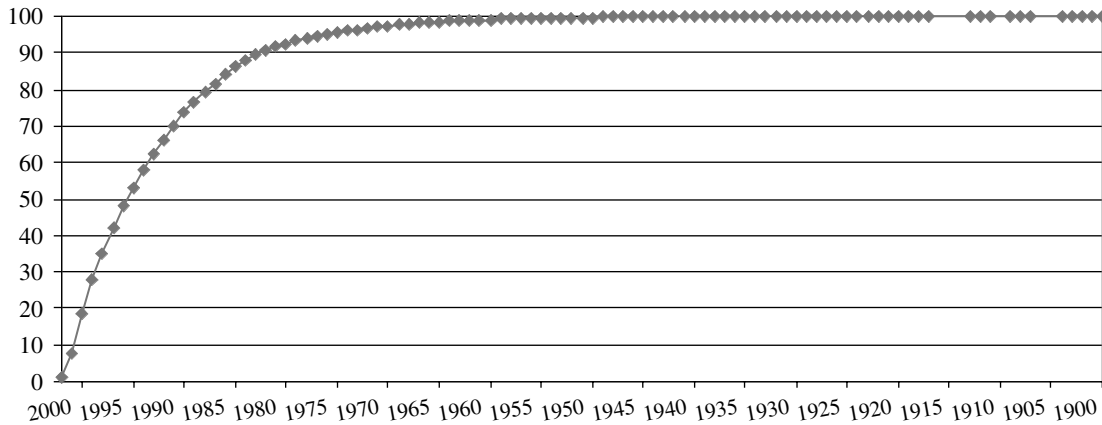


FIG. 2. Cumulative demand (as percentage) met by publication year.

medical journals as the *Lancet* and the *New England Journal of Medicine* (NEJM) were among the most frequently requested journals. This is due to the fact that what is core to a medical library is fringe to many nonmedical libraries or vice versa. Also, it is plausible that libraries of some newly established medical schools in Turkey apparently lack back runs of those journals. The fact that such popular journals as *Nature*, *Science*, and *NEJM* get requested heavily for interlibrary loans and photocopying has also been observed in the past (see, for example, Cooper & McGregor, 1994, Table 3, p. 401; Scales, 1976, Table 2, p. 19).

The median use ages for the most heavily used 11 titles ranged between 4 years (*Journal of Rheumatology*) and 14 years (*Clinical Orthopaedics and Related Research*), the average median age being 8.4 years. The average was almost the same as that for all titles (8 years). Ninety percent obsolescence rates ranged between 14 years (*Spine*) and 28 years (*Plastic and Reconstructive Surgery*), the average being 20.1 years (as opposed to 21 years for all journals).

The median use ages for 168 core journal titles ranged between 3 years (*Journal of Clinical Psychiatry*) and 20 years (*Journal of the American Chemical Society*), the average being 9 years, which was slightly longer than that for all titles (8 years). The average 90% obsolescence rate for 168 core journal titles was 20 years, which is slightly shorter than that for all years (21).

In the current study, the mean usage half-life of 168 core journals was 8.6 years. The mean citation half-life of 168 core journals was found as 7.5 years, about half a year less than that for all requested articles.<sup>8</sup> The null hypothesis that “no relationship exists between the total citation counts and cited half-lives (as reported in *SCI Journal Citation Reports-2001*) of 168 core journal titles” is rejected (Pearson’s  $r = -.106, p = .171$ ). The null hypothesis that “no relationship exists between journal impact factors and cited half-lives of 168 core journal titles” is accepted, although the (negative) correlation was rather weak ( $r = -.214, p < .01$ ). The null hypothesis that “no relationship exists between frequency of use (measured by the number of document delivery requests) and cited half-life of 168 core journals” is rejected ( $r = .141, p = .069$ ). The null hypothesis that “no relationship exists between the median age of use for the most heavily used journal titles and their journal impact factors” is accepted ( $r = .114, p = .14$ ). Statistical tests suggest that cited half-life figures as reported in *SCI JCR (Science Citation Index Journal Citation Reports, ISI)* are not good indicators to predict the level of document delivery demand for journal titles.

<sup>8</sup>It should be noted, though, that SCI records the cited half-lives that are 10 years or longer as greater than or equal to 10 years. There were 28 out of 168 journal titles as such. It is likely that the real mean cited half-life is somewhat higher than what we reported here (7.5 years).

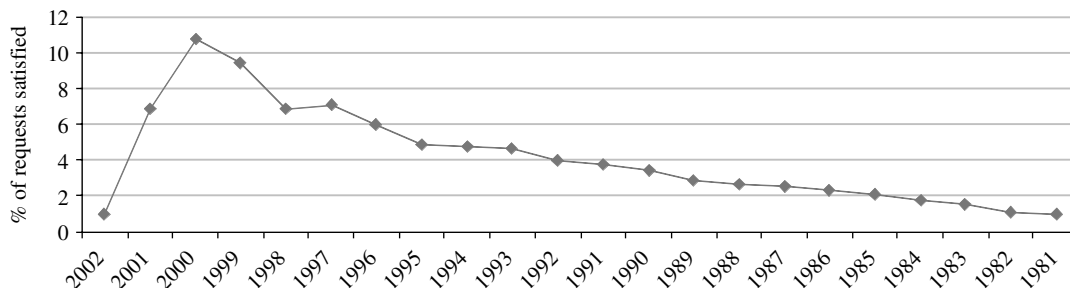


FIG. 3. Age distribution of all journal articles: 2002–1900 (not all years shown).

TABLE 2. The most frequently used 11 journal titles fulfilling more than 300 document delivery requests at TANIC (2000–2002).

Journal title	# of Total use	% of Total requests satisfied	Median use age	90% Obsolescence	Impact factor (2001)	Cited half-life (2001)
<i>Clinical Orthopaedics and Related Research</i>	433	0.5	14	24	1.166	>10
<i>Plastic and Reconstructive Surgery</i>	415	0.5	10	28	1.436	9.3
<i>Lancet</i>	407	0.4	9	25	13.251	7.0
<i>Journal of Food Protection</i>	406	0.4	8	20	1.808	6.5
<i>Journal of Agricultural and Food Chemistry</i>	386	0.4	6	17	1.576	6.4
<i>Applied and Environmental Microbiology</i>	362	0.4	13	21	3.688	6.7
<i>New England Journal of Medicine</i>	352	0.4	9	21	29.065	7.2
<i>Spine</i>	324	0.4	6	14	1.853	7.5
<i>Journal of Trauma</i>	316	0.3	6	16	3.190	8.3
<i>Journal of Urology</i>	316	0.3	8	20	1.531	7.1
<i>Journal of Rheumatology</i>	309	0.3	4	15	2.591	6.4
<i>Total/average</i>	4026	4.4	8.4	20.1		

Core journal titles with higher impact factors or higher total citation counts do not necessarily have older median use ages compared to those with lower impact factors. The null hypothesis that “no relationship exists between citation half-lives and usage half-lives of core journals” is rejected ( $r = .279, p < .01$ ), suggesting that journals with higher citation half-lives tend to get requested over longer periods of time.

## Discussion

We found that article requests to journals representing various subject fields seem to exhibit Bradfordian distributions for all journal titles (i.e., requests placed in both 2000 and 2001). The distribution of requests placed to journals in 2000 and 2001 separately also showed similar characteristics. Some 168 core journal titles (3.0% of all titles) satisfied one third of all requests while 159 and 163 heavily used titles fulfilled one third of requests placed in 2000 and 2001, respectively. The overlap between heavily used titles in both years was 72%, suggesting that the same set of core journal titles consistently satisfy a significant percentage of document delivery requests. The overwhelming majority of journal titles (4854 or 88%) were used rather infrequently, satisfying one third of all requests only. The general pattern of use of journal titles in this study was similar to the findings obtained in previous studies of in-library use (see, for example, Cooper & McGregor, 1994, p. 396 for comparison). Half the photocopy requests were satisfied by 36 core journals in a biotechnology firm library (Cooper & McGregor, 1994). Some 470 core journals satisfied one third of all document delivery requests received by the 26-member Illinois Libraries Consortium whereas approximately 13,000 journal titles (44% of all titles) were used only once (Wiley & Chrzastowski, 2002). Compared to findings of in-library use studies, the number of core journal titles satisfying a significant

percentage of document delivery requests in our study was relatively higher, as was in Wiley and Chrzastowski's study (2002). This may be due to the fact that users, or the library personnel on their behalf, would first check their own libraries for the availability of journal titles before submitting their requests to a national or statewide document delivery system as a last resort.

No correlation was found between journal impact factors and the frequency of use measured by the number of document delivery requests. The correlation between total citation counts and the frequency of use was rather weak, although it was statistically significant. This confirms the findings of previous studies to a certain extent. Cooper and McGregor (1994) found a negative random agreement between ISI impact factors and use data while Scales (1976) found a low correlation between the two. This suggests that journals with high impact factors and total citation counts are not necessarily used more often than the rest and that ISI impact factors and total citation counts cannot be used as reliable indicators to predict the frequency of local use of journal titles for document delivery purposes.

The median age of use in our study was 8 years for all journals and 9 years for 168 core journals. Requested articles that appeared in core journals seem to get obsolete in a slightly longer period of time. No correlation was found between median use age and impact factors of core journals. Journal articles of 3 years of age received the highest percentage of requests (11%) in our study while the demand for older articles gradually declined. This is echoed in Price's principle which states that “use will be relatively low for very recent publications, but will increase dramatically for those which are a few years old before falling into the expected exponential decay curve” (cited in Tsay, 1999a, pp. 548–550).

The median age of use of 8 years and the peak use of 3 years that we obtained in the current study are relatively



higher than those reported in other studies. For instance, Cooper and McGregor (1994) found the median age of usage just over one year while Tsay (1999b) reported 3.4 years. Some 42% of articles were xeroxed in the same year in Cooper and McGregor's study. Tsay's finding was similar: The peak in-library use of journal articles was at age one. Wiley and Chrzastowski (2002) found that most current years of journals received the majority of requests. The difference may be attributed to a number of reasons. First, as indicated earlier, our data was based on document delivery requests while Cooper and McGregor's and Tsay's data was based on in-library use of a biotechnology company and an hospital library, respectively. The demand for in-library use of articles by local users may be more immediate whereas document delivery requests used in our study came from off-site users. Second, as alluded earlier, off-site users requested articles from TANIC after they exhausted local resources that were available to them and failed to satisfy their needs. Third, a national document delivery system would receive article requests on all subjects while in-library use of journals in a hospital and a biothechnology firm would primarily concentrate on respective subjects. Findings of various studies consistently confirm the fact that literature in the medical and technical fields becomes aged faster compared to literature in the social sciences and humanities.

The mean average of the median use ages for core journals based on use data was 8.6 years. The mean average of the median use ages based on citation data was 7.5 years. Use data based on document delivery requests and citation data based on ISI cited half-life statistics of core journals were weakly correlated. This may be interpreted as core journals with higher citation half-lives becoming aged more slowly, although the test statistic explains only a small percentage of the variance. Hence, the relationship between half-life based on use and citation data should be tested on all journal titles to reach a more meaningful conclusion. Cooper and McGregor (1994) found no correlation between use and aging.

While we found the mean average of the median use ages (8.6 years) slightly longer than the mean average of the median citation ages (7.5 years) for 168 core journals, Tsay (1999b) obtained the opposite: She found the mean average of the median use ages for 835 journals as 3.4 years, which was significantly shorter than the mean average of median citation ages of 6.3 years. It is likely that core journals differ from all journal titles with respect to their use and citation ages. Or, the nature of in-library use of journals by local users may be different from off-site use of journals by the clientele of a national document delivery service.

Cited half-life figures of core journals based on ISI data cannot be used to predict the potential level of use of those titles as there was no correlation between the two. A weak (negative) random agreement was observed between cited-half lives and impact factors of core journal titles. In both cases, the test statistics explain only small percentages of variance observed in cited half-lives and total citation counts of journals and their corresponding levels of use. No correlation was observed between cited half-lives and total cita-

tion counts. That no strong correlation was found in this study between use and aging, between use and total citation counts, between aging and impact factors, and between aging and total citation counts confirms the findings of earlier studies (e.g., Cooper & McGregor, 1994; Glänzel & Schoepflin, 1994; Moed et al., 1998). As Line (1974) pointed out some years ago, age seems to be a rather poor criterion to predict future use of journals. Moreover, findings of previous studies and that of our own further reinforce Line's hypothesis that "[n]o measure of journal use other than one derived from local-use study is of any significant practical value to libraries" (Line, 1978, p. 313 cited in Cooper & McGregor, 1994, p. 402).

## Conclusions

We reported the preliminary findings of a study on a scattering of journals and obsolescence based on 2-years' worth of empirical data obtained from a national document delivery service. The distribution of article requests to journal titles confirmed the findings of earlier studies: Heavily used core journal titles satisfied large numbers of document delivery requests while large numbers of infrequently used titles satisfied relatively fewer numbers of requests. Half the requests were made to articles of 8 years of age or younger. It takes slightly longer for core journal titles to get obsolete. The frequency of journal use for document delivery purposes was not related to ISI journal impact factors or citation half-lives, although a weak negative correlation was found between impact factors and citation half-lives. Median use age of journals was not related to impact factors either. A weak correlation was observed between frequency of use and total citation counts, and between citation half-life and use half-life of core journals. Findings obtained in this study have some policy implications for library administrators and collection managers in general, and for the Turkish Academic Network and Information Center (TANIC) in particular.

Our findings seem to indicate that the Bradford Law is equally applicable to article delivery requests placed for journal titles representing heterogeneous subject fields, although further research replicating our findings is needed to make firm generalizations. A journal collection comprising several hundred core titles seems to be enough to satisfy the majority of document delivery requests while a little over 1000 titles can cater for 80% of the total demand. Median age as measured by the frequency of use of journals for document delivery services is longer compared to that of in-library use. While median age for in-library use ranged between 1 and 4 years in specific libraries, it was much higher (8 years) in the current study. Core journal titles become aged more slowly. This indicates that libraries providing document delivery services on a national scale are well advised to keep longer runs of their periodical collections including the core titles. This may well be due to the fact that a national document delivery service usually caters to a large group of users from various scientific disciplines with a wide variety of information needs.

Our findings also indicate that journal impact factors and total citation counts cannot be used solely to select the core journal titles as journals with high impact factors or total citation counts do not necessarily satisfy a higher number of document delivery requests. The average citation half-life of core journal titles being shorter than that of use half-life shows that use tends to outlive citation. Yet, the relationship between the two is inconclusive as the correlation was weak and conflicting findings have been obtained in other studies.

The weak correlation between impact factors and citation half-lives shows that one cannot easily be “deduced from the other.” Moreover, median age of use of journals for document delivery purposes does not correlate with impact factors and total citation counts either. As neither the median use age nor citation half-lives of journals correlate with impact factors, this can be taken as an indication of impact factors and half-lives measuring different things.

The Bradfordian distribution of journal titles satisfying document delivery requests and median use age of journals have some consequences for TANIC as well. As we pointed out earlier, TANIC’s fulfillment rate was 66%. Although not reported in this paper, journal titles that received the remaining—albeit unfulfilled—33% of the document delivery requests also exhibited a Bradfordian distribution. In other words, TANIC can easily improve its success rate by providing access to core journal titles that it did not own but for which they received large numbers of requests. The methods of access to those titles may vary. The Turkish Academic Network and Information Center can subscribe to highly requested journal titles, including back runs of a limited number of journal titles. Or it can purchase access to their electronic versions, if available, starting with the most important ones (Davis, 2002).

The Turkish Academic Network and Information Center can also develop collection management policies for infrequently used or non-used journal titles. Currently, TANIC has subscriptions to or a license for 10,000 journal titles (including electronic ones). They are used both in the library and for document delivery services. If findings of other in-library use studies are to be used, one can safely predict that journal titles used within the library should also exhibit a Bradfordian distribution. That is to say, significant numbers of those titles in the library do not get used at all in any given year. Journal titles that have consistently been used infrequently or have not been utilized at all are prime candidates for cancellation. Occasional requests for such infrequently used journal titles can perhaps be satisfied through electronic journal services on a “pay-per-view” basis. As median use age of TANIC journals is longer than those recorded in other studies, collection managers should be more conservative in making decisions about journal titles to be discontinued. A “break-even” analysis can be carried out to determine which printed journal titles should be discontinued and which titles should be considered for pay-per-view. It should be noted that the viability of housing printed materials in the virtual age has been questioned: “Does it actually matter very much what is discarded if it can be quickly and cheaply obtained from elsewhere? Does even cheapness matter very much,

since occasional access is cheaper than holding materials locally, except when uses exceed some seven or eight a year for the average book or twenty or more for the average serial?” (Line, 1993, p. 678).

The Turkish Academic Network and Information Center has not only secured access to electronic versions of thousands of scientific journals in recent years but also licensed archival copies of certain electronic journals (e.g., Elsevier). (It also acts as a local mirror site for certain bibliographic databases such as Web of Science.) This means that TANIC has access to both printed and electronic copies of more journal titles. The demand for printed titles of TANIC—and hence the demand for physical space to house them—will gradually decline as more electronic journals are added to the collection. It will be much cheaper to use electronic copies directly for document delivery purposes. Moreover, the use of print journals and document delivery services will decrease due to the availability of electronic journals as users prefer to get access to journals online (De Groote & Dorsch, 2001). In fact, the number of monthly document delivery requests submitted to TANIC has already decreased in the first half of 2003, although it remains to be seen if this is the beginning of a new trend. The reason behind this decrease may well be the increase in the number of university libraries getting access to full-text electronic journals through consortial agreements over the last few years (Tonta & Ünal, 2003).

In conclusion, TANIC should review its collection management policies, procedures, and practices with regards to selection, deselection, retention, and housing of its journals and be ready for a gradual and complete transformation of its services in the very near future.

## Acknowledgments

We thank the Turkish Academic Network and Information Center for providing document delivery data used in this study. We would also like to thank Professors Michael D. Cooper and Ronald Rousseau for their most valuable feedback on an earlier draft of this paper. We gratefully acknowledge the comments of two anonymous referees.

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