Analysis of In-text Citation Patterns in Local Journals for Ranking Scientific Documents

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ABSTRACT

In-text citations have been put forward as a new way to overcome the bias inherent in bibliographic citation analysis. In-text citation patterns have been used as the basis for citation analysis previously, but all the evidence has come from international journals. However, many countries have more local journals than international journals. This paper uses in-text citation analysis to examine local journals in Indonesia. The paper aims to determine the location-based citation pattern in the text and its effect on the articles' and authors' rankings. We collected articles from seven food science journals and then parsed these articles to detect the citations and their locations within the text. Pre-processing included normalizing section names, developing a database, and matching citation identities. The rankings were based on sections and then evaluated using the Spearman rank correlation in the final step. The results revealed that Indonesian journals did not exhibit the same patterns as international journals. There were differences in the section locations of the highest percentages of citations, the distributions of publication years, and the ranking methods. The correlations between sections indicated that the citations in the results and discussion section should be give the highest weight, followed by those in the method section, while the lowest weight should be assigned to citations in the introduction. These results need to be strengthened with further research using more extensive data and fields. Other findings, such as nonstandard and inconsistent citations, made developing an automatic citation detection system for local journals challenging.

Keywords: Citation analysis; In-text citation; Citation pattern; Document rank; Author rank; Local journal

1. INTRODUCTION

Citation analysis is widely used in library and information science, science and technology, and computer science studies. Some uses of citation analysis include, among others, ranking and mapping scientific discoveries, discovering document similarities, checking for plagiarism, and information retrieval. Traditional citation analysis considers citations in the bibliography only and counts each citation equally. This method is considered to be less valid and biased.[1] Empirical research on journal articles has provided evidence that there are differences in citation frequencies between the bibliography and text.[2] In addition, citations vary in importance within the text according to location and function. In summary, measurements based on the bibliography only will lead to inaccurate results.[3]

The development of information technology created extensive opportunities to investigate citations in all parts of documents (including in-text citations). In-text citation analyses can be divided into syntax (citation location) and semantic (sentence meaning) analyses. Syntax analysis considers the position of the citation and its impact on the quality of the sentence (essential or supporting). A semantic analysis aims to determine the quality of the citation based on the context of the citation sentence.[4]

This paper reports on preliminary research into in-text citations in local Indonesian food science journals. In particular, it focuses on an analysis of citation location. The paper's objective is to determine citation distribution patterns and their impact on publications' rankings. It is urgent to obtain information on citation patterns in national publications. Until now, most of the evidence in this field has come from international journals. That evidence has been widely used in evaluating and researching policy-making in many countries in lieu of local evidence. The characterisation of local journal citation patterns is necessary in order to develop a national research performance evaluation system, citation recommendation system, and a better retrieval system for scientific documents.

The paper is composed of five sections. Section 2 presents previous works related to in-text citation locations. Section 3 describes the methods used to characterise and rank citations based on location frequency. Section 4 outlines the main results and compares them to those of other works including analyses of international journal databases. Finally, Section 5 concludes and discusses future research opportunities.

2. RELATED WORKS

The study of the frequency and location of in-text citations covers several types of analyses. Most analyses aim

to determine the distribution patterns of the citations within the text, their impact on weighting, and trends in various fields.

2.1 Citation Distribution within the Text

A study with a large amount of data from multiple disciplines was conducted by Boyack *et al.*[5] They collected more than 5 million articles and used XML-based extraction techniques and CWTS parsing algorithms in their analysis. The results showed different citation patterns between subjects. The most citations occurred in the introduction, then they decreased in frequency in the next sections.

Other works using smaller datasets are limited to specific fields/journals. For example, Bertin *et al.* analysed 45.000 articles from PLOS journals.[6] Their research found that the citation distribution in the text varies by journal series but that most citations are located in the introduction, followed by the results. Bu *et al.*[7] collected 1.420 articles and Hsiao and Chen[8] collected 4.255 articles to analyse publications in library and information science. They used almost the same techniques and agreed that the introduction and the beginnings of the chapters had the highest number of citations.

More detailed findings were obtained by extracting frequencies and locations from 32 articles using SciTech Strategies and verifying the results manually.[9] This method confirmed that most citations in older publications had multidisciplinary characteristics and were in the introduction. In more recent publications, there were fewer citations in the method, results, and discussion chapters as well, but there was less evidence of multidisciplinary characteristics. It was concluded that although many citations in the introduction were supportive, it is advisable to give less weight to these citations that those in the method, results, and discussion chapters.

2.2 In-text-based Citation Rankings

Another type of analysis focuses on ranking articles. One study calculated four different variables, i.e., all citations in the bibliography, all appearances of citations in the text, and filtered citation numbers, which were found by removing citations in the introductory chapter and literature review. Evaluation with Spearman correlations found that the section filters gave the best results. Filtering made the citations for the subjects analysed appear in the top rank. This result reinforces the notion that the citations in the introduction and the literature review are less important and can be removed from the ranking of articles.[10]

The most recent analyses have concentrated more deeply on the section and sentence levels. Research carried out by Thelwall[11] studied the sequence of citations in a particular chapter. Using the chapter's geometric mean, the author found that the citations at the beginning of the chapters, with the exception of the method chapter, were from highly cited articles and generally acted as supports (non-essential). Therefore, in citation-based ranking, this finding needs to be considered.

At the citation sentence level, a concept of dependent and independent citations was proposed.[12] In this concept, a single citation supporting one citation context is considered independent, whereas a citation provided in conjunction with the other citation(s) to support a context is considered dependent. An experiment was performed by calculating the full and fractional counts for dependent citations. The two methods were compared using the Spearman correlation. The study found that full counting caused over-counting, so fractional counting was recommended. It was also found that frequently occurring citations were generally independent. Meanwhile, citations appearing once were mostly dependent, allowing them to be categorised as supporting citations.

2.3 Citation Location as a Feature

Citation location patterns are used in many advanced studies to, among other uses, classify citations and determine the relevance of documents. The citations might be divided into important (main/essential) and not important (supporting). The citation classification method uses machine learning and deep learning techniques, where citation frequency and location are considered to be learned features. In one study, classification results using the support vector machine (SVM) algorithm had 89 per cent accuracy, and the long short-term memory (LSTM) algorithm provided 92 per cent accuracy.[13] It may be possible to apply this method to find influential citations at the country level and measure knowledge flow between countries.[14] To rank the relevance of documents, combining citation location extraction with citation analysis, such as an examination of co-citations, did up to 68 per cent better than using just co-citations and 39 per cent better than utilizing proximity citations and has been widely developed to acquire citation-based information.[15] Experiments with other techniques combining citation location calculations and bibliographic couplings provided better results in terms of document similarities than the gold standard content approach methods, such as keyword matching.[16]

Research on using frequencies and citation locations for ranking authors or articles is closest to the present research. The traditional ranking method of examining the citations in the bibliography was compared to the order of articles achieved with the citation frequencies for the entire text.[4] Another approach is to compare the citations in the bibliography with the frequencies and locations of the citations in the text. The citations were more frequent in the method, results, and discussion sections, while the citations in other chapters were near zero and had a negative correlation.[17]

3. METHODS

This study analysed citations in Indonesian journals by combining the state-of-the-art article ranking methods used in the related works.[4,17]

3.1 Data Collection

Indonesian articles from journals accredited at levels 1 and 2 by the Indonesian Ministry of Research and Technology were collected. The criteria included covering food and agriculture, being open access, and having DOI numbers for their articles. Journals at levels 1 and 2 were chosen to find articles written in a standard and consistent manner. The food and agricultural field was chosen because it is one of Indonesia's national research priority programs and one that was rarely discussed in previous works. Analysis required access to the full text,

Table 1. Characteristics of journals in the dataset

Journal title	Number of articles	Citations in the bibliography	Citation occurrences in all text	Citations in introduction	Citations in method section	Citations in result and discussion sections	Citations in conclusion
Jurnal Gizi dan Pangan	21	743	909	336	86	486	1
Jurnal Teknologi dan Industri Pangan	21	784	916	278	140	494	46
Jurnal Aplikasi Teknologi Pangan	24	629	831	294	112	425	0
Jurnal Penelitian Pascapanen Pertanian	12	322	417	181	48	188	0
Jurnal Teknologi & Industri Hasil Pertanian	11	174	179	72	26	81	0
Advances in Food Science, Sustainable Agriculture and Agroindustrial Engineering	10	254	343	159	35	149	0
Warta Industri Hasil Pertanian	14	398	472	210	63	226	11
	113	3.304	4.067	1.530	510	2.049	58

so only open-access journals were selected. The DOI numbers were used as unique identities for citation matching.

Based on the above criteria, seven journals were selected. Articles published in 2019 were downloaded in March and April 2020. The data consisted of 113 articles, 3,188 unique citations, 3,304 citation occurrences in the bibliography, and 4,067 citation occurrences in the text. The journal names and statistics for the research dataset are listed in Table 1. This research was limited to a small amount of data. However, we feel that the amount of data is sufficient for an initial test regarding differentiating between in-text citations and bibliographic citations. With the results of this initial study in hand, the research will be continued with a much larger amount of data representing various fields of science.

3.2 Pre-processing

The selected journal articles were downloaded in PDF files, then references and citation locations in the text were parsed using Grobid.[18] The program was selected due to an Indonesian parsing experiment using four applications, namely, Grobid, PDFx, Parscit, and Cermine.[19] Grobid had the highest accuracy (82 %) compared to the other applications. Grobid's ability to identify citations in the text wad rated at 75 per cent (F-score). Other studies have shown that Grobid has

an F-score of 78 per cent for section heading identification and 87 per cent for in-text citations.[20] To ensure that the data used in the current study were close to 100 per cent accurate, after they were parsed using Grobid, two people manually validated them (researcher and research assistant).

Parsing extracted citations from the text and references, and the detection of citation locations was done in an XML format. The next stage involved the normalisation of the chapter names. All selected journals followed the IMRad structure for article composition. However, the section headings are sometimes different, e.g., "introduction" versus "background," "method" versus "methodology," "results" versus "results and discussion." Hence, the chapter names were standardised as introduction (i), method (m), results and discussion (r), and conclusion (c).

The final stage was citation matching. The matching could not be done directly using DOIs because very few references included DOI numbers. Therefore, it was necessary to first provide the main identification numbers for the references manually, then match the references in the database.

3.3 Experiment

This research focuses on the characterisation of citation patterns and comparing rankings based on different parameters.

The citation patterns were obtained through descriptive statistical analysis. Six different methods were compared:

- Each citation in the bibliography was counted as one citation, regardless of occurrences in the text (W1)
- The frequencies of occurrence within the text, regardless of location, were calculated (Wn).
- Frequencies and positions in the introduction (Wi), method (Wm), results (Wr), and conclusion (Wc) were found.

3.4 Evaluation

The rankings were then based on the Spearman ranking correlation. This correlation's formula is presented in Equation 1 below.

$$Rs = 1 - \frac{6\sum_{i=1}^{n} d_i^2}{n(n^2 - 1)} \quad (1)$$

Rs = Spearman's rank correlation coefficient
d_i = difference between the two ranks of each observation
n = number of observations

The correlation coefficients were then compared with the correlation coefficient interpretation table to make the final rankings.[21] All the stages involved in the methods are presented in Fig. 1.

4. RESULTS AND DISCUSSION

4.1 Characterisation of in-text Citation Patterns

Citation patterns in Indonesian journals, particularly in
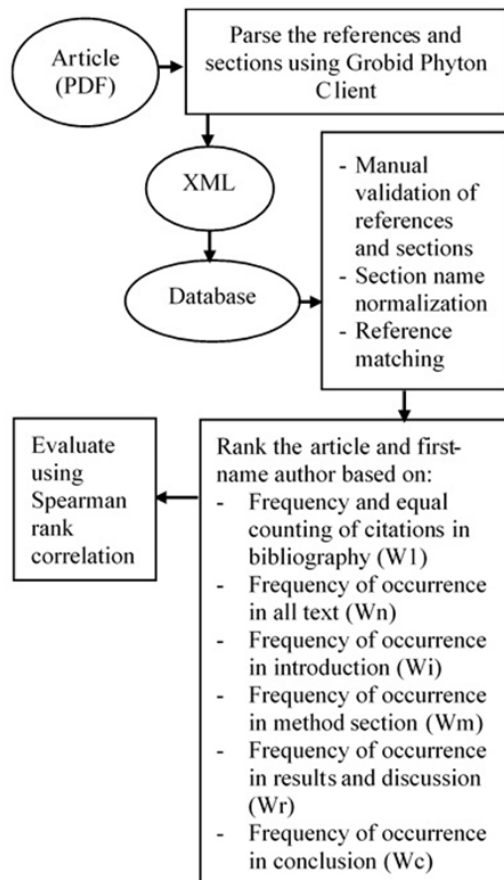

Figure 1. Stages in the research methods.

the food science field, are different from those in international journals. The results demonstrate that citations in Indonesian journals were mostly found in the results and

discussion chapter (50 %), then in the introduction (37 %), method chapter (13 %), and conclusion (0 %). Figure 2 illustrates the citation distribution across sections for all the journals in the dataset. This pattern is different from those found in other studies, which found that the most citations in international journals occur in the introduction.

The articles in Indonesian food journals followed the modification of the IMRaD model consisting of four sections. Differences pattern occurred when compared with the similar structured international journals examined were citations in introduction contained over 40 per cent (higher than the other sections)[22]. Compared to journals with five sections, the total number of citations from the results section and the discussion section was lower than the introduction[22]. In the other literature[6], results are invariant where there were some journals having citations in results and discussion higher than in introduction, similar to the work of this study. These results suggest that the citation distribution pattern varies depending on the field and structure of the article[5].

The second difference was in the distribution of citation publication dates. This paper found that 5 years to 6 years old publications (published in 2015 and 2016) were the most cited in all chapters. This result can serve as an initial estimate of a proper time window for evaluating Indonesia's research performance. The determination of the right window would give accurate results, and vice versa.[23] At present, several key metrics used at the national and international level generally use a shorter time window, such as two years for impact factors and three years for cite score[24] for all fields. Based on these preliminary results, a single span selection of 2 or 3 years for all science domains can be inaccurate and needs further evaluation.

Another characteristic of Indonesian journal citations is the difference between citations in the bibliography and within the text. There are many cases in which the citations in the bibliography are not referenced anywhere in the text. There are also some references in the text that do not show up in the bibliography. In this study, the first type of error affected 117 citations (5.5 per cent of occurrences in the bibliography), while the second type of error encompassed 64 citations (1 per cent of appearances in the text). The in-text citation identification and calculation method in this paper included the citations that appeared in captions and tables, resulting in some citations in bibliographies that were not actually cited in the articles' main texts. Until now, no previous research has remarked upon these types of citation errors in Indonesian journals. The numbers might be higher in a larger dataset. Inconsistent writing is a challenge for automatic citation detection methods.

4.2 Comparison of in-text Based Ranking with Bibliographic-based Methods

Most citation-based rankings employ traditional calculations in which each citation in the bibliography is given the same weight (W1). This study revealed that the W1
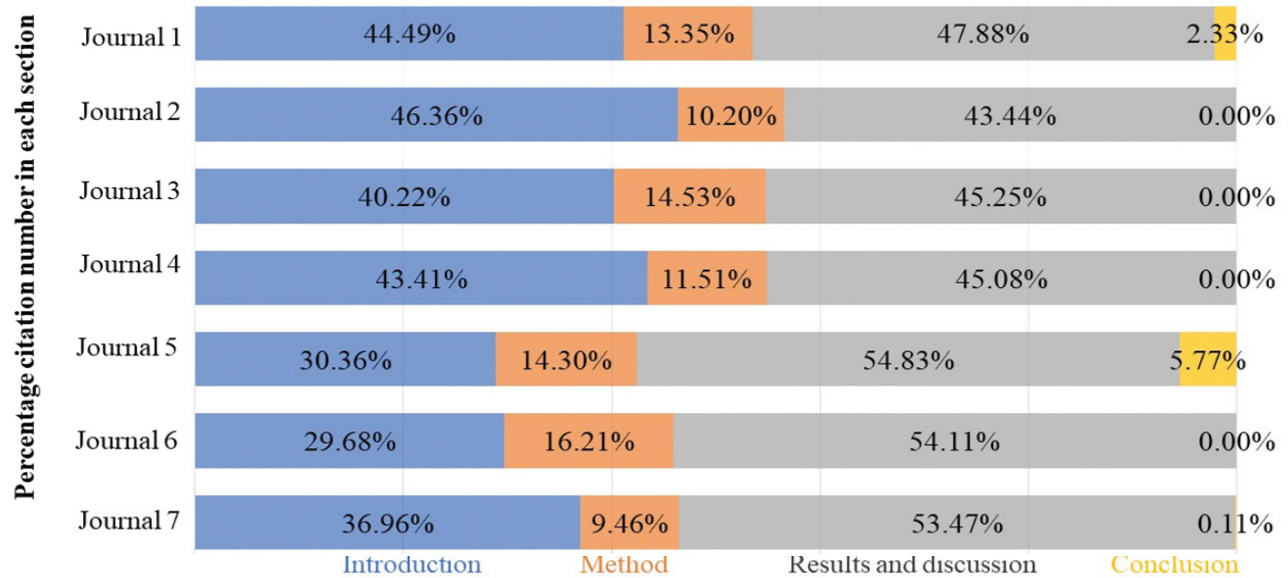
Figure 2. Citation distributions in text.

Table 2. Ranking of articles based on the number of citations in the bibliography (W1) and their occurrence in all text (Wn)

W1 rank	Title	Wn rank	Title
1	*Indonesian basic health research 2013	1	*Indonesian basic health research 2013
2	*Official method of analysis 2005	2	*Kimia pangan dan gizi
3	*Kimia pangan dan gizi	3	*Official method of analysis 2005
4	Official methods of analysis 1995	4	Neck circumference as a simple tool for identifying metabolic syndrome
5	Methods of analysis of the association of official agricultural chemists international	5	The effect of different drying methods on the phytochemicals and radical scavenging activity of Ceylon cinnamon plant parts
6	Official method of analysis 2012	6	Neck circumference may be a better alternative to standard anthropometric measures
7	Antimicrobial and antioxidant activities of plants from northeast of Mexico	7	The microbiology of Ghanaian cocoa fermentations analysed using culture dependent and culture-independent methods
8	Chemical composition of tempeh from soybean cultivars	8	Simple and rapid purification of pediocin pa-1 from pediococcus pentosaceous ncdc 273 suitable for industrial application
9	SNI syarat mutu sereal	9	Difusivitas panas dan umur simpan pempek lenjer
10	Ilmu pangan	10	Yeasts are essential for cocoa bean fermentation

* indicates articles ranked using both methods.

method produced a different ranking than the in-text citation calculation method (Wn). Examining the top 100 lists, the differences amounted to 85 per cent of articles and 29 per cent of authors.

This rate was far higher than that in the research conducted by Ding et al.[4] (30 %) for international journal articles. When raking articles, only the top three ranks were the same. When ranking authors, although many of the same authors were listed for both grades, the orderings were very different. Lists of the top 10 articles and 20 authors based on the W1 and Wn methods are presented in Table 2 and Table 3.

The differences in citation rankings between W1 and Wn confirm that it is necessary to develop an in-text based citation ranking for retrieval and research evaluation metrics. Using only the citations in the bibliography can lead to bias in retrieval results and unfair author rankings. Experiments using more extensive data covering various scientific fields are needed to obtain a clearer picture as to the appropriate method to use, particularly in the Indonesian case.

4.3 Ranking Correlations between Locations in the Text

There is a weak relationship between W1 and the ranking

based on the citations within the text (Wn). This correlation coefficient (Rs) was 0.1699. A weak correlation was also seen between W1 and the ranking based on citation locations within the conclusion (Wc) (Rs = 0.1663). The relationships between W1 and citation ranking in the introduction (Wi) as well as

results and discussion (Wr) were weakly negative, with Rs values of -0.01048 and -0.0247. Negative correlations indicate that when an article in a ranking goes up, in another, it goes down. The only strong correlation with W1 was obtained with ranking in the method chapter (Wm) (Rs = 0.5125). A weak or inverse relationship indicates a big difference between rankings.

The determination of which chapters have a close relationship with the in-text citation ranking is based on the correlations of the chapter's locations with Wn. The only strong correlation was between Wn and Wr (Rs = 0.2414), while the correlation with other chapters were very weak.

The correlations of Wr with the other chapters were all negative, except that with the Wm, which was strong (Rs = 0.6641). Apart from these two chapters, the relationships between the other chapters were all negative. These results raise several points. The first point concerns the fact that food science articles in Indonesia rarely referenced citations several times in different chapters, with the exception being the method and discussion chapters. Second, the method and discussion chapters are strongly related when it comes to citations, so a closed weight is advisable for in-text citation-based metrics.

This preliminary conclusion needs to be strengthened by citation function analyses for the two chapters and other chapters. Third, the highest weight in the metric is assigned to the citations in the results and discussion chapter. The correlation matrix between all locations is shown in Table 4.

5. CONCLUSION

The in-text citation analysis method is an attempt to overcome the weaknesses inherent in traditional citation analysis. Initial research on Indonesian food science journals showed that many citations in the references are not referred to in the text and that there are significant differences between the two ranking methods. These results reinforce the importance of studying and developing an in-text citation method, particularly in Indonesia.

The characterisation of in-text citations in local journals needs to be highlighted. The citation patterns in Indonesian food science journals are not entirely similar to the patterns in international journals. In Indonesian journals with four sections structure, the highest rate occurs in the results and discussion

Table 3. Ranking of authors based on W1 and Wn

W1 rank	First author name	Wn rank	First author name
1	*BSN	1	*AOAC
2	*AOAC	2	*BSN
3	*Kemenkes	3	*Kemenkes
4	*Zhang	4	*Zhang
5	*Wang	5	*Wang
6	*Lee	6	*Lee
7	*Li	7	*Li
8	*Liu	8	*Winarno
9	*Chen	9	*Liu
10	*WHO	10	*Chen
11	*Winarno	11	Ho
12	*Kim	12	*Kumar
13	BPS	13	Muhandri
14	*Agustia	14	*WHO
15	Aini	15	Zakaria
16	*Kumar	16	Silva
17	Singh	17	Suryowati
18	Ahmad	18	*Kim
19	Barus	19	Diniyah
20	Chan	20	*Agustia

* indicates authors ranked using both methods.

Table 4. Matrix of Spearman rank correlation coefficients (Rs) between sections

Rs	W1	Wi	Wm	Wr	Wc	Wn
W1		-0.1048	0.5125	-0.0247	0.1663	0.1699
Wi	-0.1048		-0.1839	-0.4135	0	0.0664
Wm	0.5125	-0.1839		0.6641	-0.0263	0.1383
Wr	-0.0247	-0.4135	0.6641		-0.0877	0.2414
Wc	0.1663	0	-0.0263	-0.0877		0.0147
Wn	0.1699	0.0664	0.1383	0.2414	0.0147	

chapters, whereas it occurs in the introduction in the same structured international journal. The distribution of citation in section level varied concerning field and article structure. Furthermore, the publication year's distribution stretches to five and six years, longer than the established global metric time window.

The location ranking correlations provided an initial conclusion that the results and discussion chapter had the most substantial relationship with the citations in the entire text, indicating that it should be given the highest weight compared to other sections.

This study was limited to a small dataset and investigated one subject only. As the patterns were very journal dependent, these preliminary results need to be strengthened with extensive and multi-discipline data.

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In this study, she designs the research concept, methodology, and analysis.

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His contribution to the current study is conceptualizing, reviewing, editing, and validating.