Performance Measurement and Metrics

A comparative study of the impact of Korean research articles in four academic fields using altmetrics

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Abstract

Purpose – Alternative metrics (altmetrics) are non-traditional metrics to measure the social impact of research results, which were unable to be assessed by the previous methods, by calculating how research results are reflected in various social media. The purpose of this paper is to measure and compare the impact of Korean study results in four fields that were published in international journals using altmetrics.

Design/methodology/approach – This study analysed the impact of 383 Korean research articles published by international journals in the field of medical science, engineering, social science and arts and humanities through altmetrics and compared it with bibliometrics.

Findings – As a result, the frequency of research articles which are "discussed" through social media such as Twitter was shown to be highest in the medical science than in other fields. In addition, the frequency of research articles which were "saved" through reference management tool such as Mendeley was shown to be higher in the social science and the arts and humanities than in other fields. Furthermore, as a result of a correlation analysis between altmetrics and bibliometrics, it is found that there exists a positive correlation between the number of articles which were "saved" in Mendeley and "cited" in follow-up studies.

Originality/value – This study examined the impact of the articles originating in non-English-speaking nations; it could be referred by other non-English-speaking nations that are trying to identify invisible impact of their research output on global society. By finding the academic field which are receiving special attention from global community using altmetrics, researchers could prospect country's overall research impact and utilize it to make a future R&D plan.

Keywords Metrics, Bibliometrics, Citation, Altmetrics, Impactstory, Korean research

Paper type Research paper

1. Introduction

Since journal publication has historically been a major means of academic communication, the impact factor or h-index based on bibliometrics has been mainly used as an indicator to measure the impact. However, in recent days, researchers are using social media such as blogs and Twitter for not only discussing and recommending research issues among researchers but also exploring ideas and collecting research information. In addition, researchers are sharing bibliographic information in their fields of interest by using web-based reference management tools. As these activities are done online, many traces from research are left on online platforms. Therefore, alternative metrics (altmetrics) emerged as a new way to assess the impact of research by using these traces (Lapinski *et al.*, 2013). Altmetrics is a portmanteau of alternative and metrics, meaning a metrics to measure the extent to which academic papers or research data react to new media such as social media (Wikipedia, 2014).

As the potential of altmetrics gains attention, web-based application programmes are being launched. Notable tools are as follows: first, altmetric (altmetric.com) is a measurement tool developed by Euan Adie in 2011 to visualize or calculate the score for the attention that articles and research papers received on social media. Second, ImpactStory is an

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open-source-based assessment tool. After establishing a collection with identifiers such as Google Scholar Profiles, DOIs and PubMed IDs, the score of the data loaded on the web can be calculated directly. Third, PlumX is a web application developed by Plum Analytics Inc., and is used primarily by institutional subscriptions. The Pittsburgh University Library first introduced it, and it is considered to be useful to show the article-level metrics within the repository (Plum Analytics, 2012). The evaluation process of altmetrics can be briefly explained as follows, using Almetrics.com as an example. Altmetrics.com uses social media as source data such as Twitter, Facebook, Google, LinkedIn and blogs; online reference management tools such as Mendeley, CiteULike and Connotea; and other tools including StackExchange Q&A, F1000 Review, NPG journals highlight and YouTube. After collecting the profiles of the person who posted the study results and confirming whether that person tendentiously follows some specific publishers, journals or persons, the score can be counted as follows, assigning weight by each source. For example, if weight 8 is assigned to newspaper article, 5 to blog, 2.5 to Q&A, 1 to Twitter, 2.5 to Google and 0.25 to Facebook, the total score of the research result that was mentioned in a newspaper article once and tweeted three times is 11 (8×1 time $+ 1 \times 3$ times). For the paper once mentioned in a blog and once on Facebook, the total score is 5.25 (5×1 time $+ 0.25 \times 1$ times) (Altmetric.com, 2014).

An increase in the amount of open data available is a prerequisite for the development of altmetrics. Especially in the research evaluation, the advent of reference management tools such as Mendeley (www.mendeley.com) is considered the greatest generated power. According to a study by Bornmann (2014), the number of readers who save bibliographies to Mendeley shows a strong correlation to traditional citation impact. Therefore, this means that Mendeley is a potential tool to represent a citation-based research evaluation system. The Twitter, blog and citation impacts have a weak correlation to each other ($r = 0.003$/ $r = 0.12$), but the reference management tool has a strong correlation with citation impact (Mendeley $r = 0.51$). On the other hand, the huge growth in open-access culture has become a force of altmetrics as well. As the research institutions have exchanged research output quickly by open-access repositories and then performed research evaluation on the article level, the synergy of scholarly communication has been maximized.

2. Problem statement

Altmetrics are non-traditional metrics to measure the impact of research results such as articles and data in an immediate and multidimensional way, or a ceaseless activity that measures the impact of research using this method. Not only can altmetrics expand the possibility of multidimensional and quantitative research evaluation, it can also shift the centre of research evaluation from the journal unit to the article unit (Neylon and Shirley, 2009). The main strengths can be summarized as follows. First, an impact evaluation by an extensive range of experts is possible, that is, it is possible to assess social influence on various groups such as working-level staff, practitioners, educators and the general public, which cannot be assessed using a citation index. Second, the comprehensive impact of the study can be evaluated by measuring various behaviours of researchers such as searching, reading and saving. Therefore, this method can be applied to the research field such as arts and humanities, for which impacts cannot possibly be evaluated by using a citation index. Third, the impact can be evaluated quantitatively right after the paper is published, and the impact can even be predicted. In a method using bibliometrics, citation counts can be figured out after a certain period of time. However, when using altmetrics, it is possible to assess the responses right after a paper is published, and it can help predict trends of scientific technology. Fourth, it is possible to determine the impact of various materials such as data sets, software and videos as well as academic papers (Hayashi, 2013).

As the possibility of altmetrics is garnering attention, not only various web-based application tools for measuring the impact of research by media reports, social media and reference management tools began to be developed but also many studies were instituted to

apply and verify altmetrics in academia. However, most of the studies focus on articles of Anglo-American origin, since English is considered to be the international language for the diffusion of scientific knowledge. Studies focussing on the impact of non-English-speaking nations' research on the global community using altmetrics or identifying which fields draw attention from international society still have not been carried out. Even though Korea is regarded as a highly developed country, scientifically and technologically, its authors sometimes have a lower degree of citation than authors from English-speaking nations. The total number of Korean researchers and amount of R&D investment shows a high ranking among OECD countries, but SCI citation counts shows relatively low ranking of 29th position (ChosunBiz, 2016). When the journal is listed on international citation index, citation rate will naturally increase (Zainab, 2008). However, in case of many Korean journals, even though they were indexed in the international citation index, they could not have attracted foreign readers and authors yet, as seen by the low citation rate (Shin, 2011). The reason why they could not attract international readers is that Korean journals have very few foreign contributors and editors. The number of foreign contributors and editors are major factors that are affecting globalization of domestic journals (Kim, 2012).

Therefore, questions arise as to how much attention Korea's research is attracting from international society, which fields are receiving special attention and what kind of relationship exists between the citation impact and social impact.

The primary focus of this study is to measure and compare the impact of Korean study results in four fields that were published in international journals, using altmetrics, which were not assessed by bibliometrics. In particular, the study investigated the following research questions:

RQ1. How much attention does Korea's research draw from international society in four fields including medical science, engineering, social science and arts and humanities. What difference can be seen between Korean originated research and those of Anglo-American, when measuring the impact by altmetrics?

RQ2. What is the difference between the impact measured by altmetrics and bibliometrics? Could the impact measured by altmetrics complement bibliometrics in the future, especially in the studies regarding non-English-speaking nations?

3. Literature review

As altmetrics is being considered as a new approach to complement the bibliometrics-based evaluation system, various studies to test this new method are being initiated.

Hammarfelt (2014) conducted altmetrics analysis in the field of humanities, thinking that bibliometrics is not enough to evaluate the impact of the research. As a result of conducting altmetrics analysis on articles and books, although the research results are not mentioned many times through social media such as Facebook or blogs, they are saved considerably on Mendeley, which is a reference management tool. Therefore, there are many cases in which the research results in humanities are not cited but are referenced at the early stage of research of various professional activities, so the applicability of altmetrics in humanities should be noted (Hammarfelt, 2014).

Mohammadi and Thelwall (2014) conducted a study that compares the citation counts in follow-up studies and saving counts on Mendeley in social science and humanities. As a result, the coefficient of correlation between Mendeley and citation counts appeared higher in social science than in humanities. Therefore, it is verified that many papers in social science saved on Mendeley are cited by follow-up studies whereas citation counts of papers in humanities appeared relatively low. In other words, the impact of the research that is not found by bibliometrics can be evaluated better by using altmetrics in the field of humanities than in social science.

Meanwhile, there is a study that discussed the effectiveness of Mendeley, which is often used as a source of altmetrics. Priem *et al.* (2012) verified that 80 per cent of articles that were published in the Public Library of Science (PLOS) were saved on Mendeley, while only 5 per cent of articles were mentioned on Wikipedia. Li and Thelwall (2012) also noted that there exists a strong relationship between Mendeley and citation rate after conducting a comparison between the citation counts and Mendeley saves regarding articles about genomics and genetics.

There is also a study that deals with the limitations of altmetrics in evaluating academic research results. Hammarfelt (2013) measured various research results in humanities by using various altmetrics tools and pointed out that it was not possible to evaluate the influence on publication, which are published in monograph. Costas *et al.* (2015) also discussed that even though many studies evaluated the potential of altmetrics, it should be used as supportive means for bibliometrics, and Haustein *et al.* (2015) also noted that altmetrics has to be used complementally. In addition, studies that have been performed regarding altmetrics as an evolutionary aspect of impact assessment (Galligan and Dyas-Correia, 2013; Roemer and Borchardt, 2012); discussed altmetrics in the open-access perspective (Konkiel and Scherer, 2013; Mounce, 2013); discussed the relationship between international collaboration and impact (Sud and Thelwall, 2016); and identified the academic area, which has high exposure to the social media platform (Haustein *et al.*, 2015).

In the meantime, the globalization status of Korean research outcomes by the literature review is as follows. In Korea, many research outcomes still have been published in the domestic journals in the Korean language. Articles written in English are only 30 per cent of total article (Shin *et al.*, 2015), meanwhile the rate of foreign articles which Korean researchers have cited are only 50 per cent in general, except in natural, engineering and medical science fields (Choi *et al.*, 2011). Lately, attempt to register some Korean journals into the international citation index database has been carried out. However, citing from international readers has not been received yet. Aviles and Ramirez (2015) said "for globalizing journal: the editorial and advisory boards; peer review boards; peer review evaluation criteria; authorship; database circulation; internationality of citations; and citation; impact" are needed. However, in case of Korean journals, as they have a very low percentage of foreign joint research (about 6 per cent) and very few foreign editors, they could not have attracted foreign readers and authors yet (Kim, 2012).

As was stated above, many studies have been performed regarding altmetrics. However, studies focussing on the impact of non-English-speaking nations' research on the global community using altmetrics or identifying which fields draw attention from international society still have not been carried out.

4. Research method

This study calculated altmetrics of Korean studies published in international journals in medical science, engineering, social science and arts and humanities; compared the evaluation results among the subject fields; and examined if there is a correlation with the citation counts calculated by using bibliometrics. For this, data were extracted by using Scopus, altmetrics were calculated by loading ImpactStory, and the Pearson correlation analysis was conducted using SPSS. The detailed data collection and analysis are as follows.

4.1 Data collection

Journal articles published after 2010 in Scopus were retrieved by using the following method in order to extract the Korean research results published in international journals in medical science, engineering, social science and arts and humanities. First, the keyword was set as "South Korea" and the research conducting country was limited to Korea, and a total of 6,009 research results were extracted in October 2014. As a result, 2,930 cases in medical science,

398 cases in engineering, 630 cases in social science and 100 cases in humanities were searched. Second, 100 cases with a high rank in each field were selected, and DOI was extracted. In the process of extraction, data without DOI were excluded. Because many altmetrics tools are using the DOI information as a parameter, including the Impactstory, therefore this study excluded bibliographic data without DOI. If this study does not exclude data without DOI, figures would be different. But the result would not have a big difference, because it has been compared between academic fields, and relationship has been analysed using inferential statistics. As a result, a total of 383 cases including 98 cases in medical science, 94 cases in engineering, 96 cases in social science and 97 cases in humanities were selected as the final materials for analysis.

4.2 Data processing and analysis

The data of selected cases were processed and analysed in the following method.

First, DOI and citation counts were extracted from bibliographical data and DOI was loaded in ImpactStory. The citation counts were separately organized in order to use correlation analysis with the altmetrics index. The reason why this study chooses ImpactStory from a variety of tools to measure the altmetrics is as follows. ImpactStory covers diverse information sources such as Facebook, Twitter, Mendeley and so on. Moreover, with DOI of analysed data, researchers can easily extract data from the measurement results and then easily import the data into an analysing tool such as SPSS. In addition, ImpactStory was already certified for efficiency by the fact that it was used in the study of Zahedi *et al.* (2014), which analysed the relationship between altmetrics and citation impact.

Second, data were divided into four categories including "discussed", "saved", "viewed" and "mentioned". The category of "discussed" means the extent to which the research results were exposed to social media such as Twitter and blogs and explains the extensive social impact of the research. The category of "saved" means the number of papers saved in a reference management tool such as Mendeley and read or referred to in various stages of the research cycle or professional activities. Meanwhile, the category of "viewed" indicates the number of papers read through PLOS, and the category of "mentioned" indicates the number of papers mentioned on Wikipedia. In this study, these two categories are found only in medical science. To be specific, the altmetrics index used in analysis appears in Table I.

Third, this study analysed the number of "discussed", "saved", "viewed" and "mentioned" papers in each field of medical science, engineering, social science and arts and humanities, and it was examined and compared how much social influence Korean research has, and how much it is read, referred to and cited. Furthermore, the country of readers accumulated on Mendeley was processed and examined in order to figure out which countries are referring to Korean studies. Meanwhile, the correlation among each influence

Index		Source	Description
Altmetrics	Discussed	Blog posts	Number of blog posts mentioning
		Twitter tweets	Number of times the product has been tweeted
		Facebook public posts	Number of posts mentioning
		Google+ posts	Number of posts mentioning
	Saved	Delicious	Number of bookmarks
		Mendeley	Number of people who have added this item
	Viewed	Plosalm	The number of views and download
	Mentioned	Wikipedia	The number of Wikipedia articles that mentioned
Citation	Pubmed	The number of citations by papers in PubMed Central	
	Scopus	Number of times the item has been cited	

Table I.
Altmetrics index

is represented through the Pearson correlation coefficient, what kind of correlation is present among each index of altmetrics is determined and the correlation between altmetrics index and citation index was examined.

5. Analysis results

5.1 Impact by four academic fields

The main results of altmetrics analysis in four fields including medical science, engineering, social science and arts and humanities are as follows.

First, the 98 ranks of citation in medical science were extracted and the impacts by specific categories of altmetrics are shown in Table II. The number of "mentioned" results in social media was 235; the number of "saved" in a reference management tool, Mendeley, was 1,416; and the number of citations by PubMed and Scopus was 4,645. For each paper, the average number of "mentioned" in social media is 2.39, and there was also a case in which the paper was mentioned on Wikipedia. In medical science, the indicator "saved", which means the number of times "saved" on Mendeley, averaged 14, while "cited by" was high at 47. Therefore, it was found that the papers were actively cited by a follow-up study rather than just "saved" on Mendeley for medical science.

Second, the impact analysis results of 94 research cases in the engineering field are shown in Table III. They are mentioned 21 times through social media, a total of 1,261 cases were saved on Mendeley, and citation counts were 748. Unlike medical science, one paper was "discussed" in social media an average of 0.22 times, so the social impact was not relatively high. Meanwhile, the number of "saved" papers on Mendeley, which is used across the cycle from the stage of coming up with ideas to publishing, was an average of 13. This was about twice the citation count of 7.95.

Third, the results of impact analysis of 96 cases in social science ranked by citation counts are shown in Table IV. The Korean social science research outputs published in international journals were tweeted 36 times and a total of 2,130 cases were saved on Delicious and Mendeley. In addition, the sum of citation counts in PubMed and Scopus was 1,117. In other words, one article was mentioned through social media an average

Indicator	Number	Average
Altmetrics		
altmetric_com:blog_posts	12	0.12
altmetric_com:facebook_posts	11	0.11
altmetric_com:gplus_posts	1	0.01
altmetric_com:tweets	211	2.15
discussed	235	2.40
mendeley:readers	1,416	14.45
saved	1,416	14.45
plosalm:html_views	10,944	111.67
plosalm:pdf_views	2,318	23.65
viewed	2,318	23.65
wikipedia:mentions	2	0.02
mentioned	2	0.02
Citation		
pubmed:pmc_citations	959	9.79
pubmed:pmc_citations_editorials	10	0.10
pubmed:pmc_citations_reviews	122	1.24
Scopus	3,554	36.27
Cited by	4,645	47.40

Table II. Analysis result of medicine

Indicator	Number	Average
Altmetrics		
altmetric_com:tweets	21	0.22
discussed	21	0.22
mendeley:readers	1,261	13.41
saved	1,261	13.41
Citation		
pubmed:pmc_citations	10	0.10
pubmed:pmc_citations_reviews	1	0.01
Scopus	737	7.84
Cited by	748	7.95

Table III.
Analysis result of engineering

Indicator	Number	Average
Altmetrics		
altmetric_com:tweets	36	0.37
discussed	36	0.37
delicious:bookmarks	1	0.01
mendeley:readers	2,129	22.17
saved	2,130	22.18
wikipedia:mentions	1	0.01
mentions	1	0.01
Citation		
pubmed:pmc_citations	60	0.62
pubmed:pmc_citations_reviews	6	0.062
Scopus	1,051	10.94
Cited by	1,117	11.63

Table IV.
Analysis result of social science

of 0.375 times, so the social impact was not high. However, the number of "saved" in the reference management tool was an average of 22 times, indicating that they were used in professional activities many times. Considering that the number of citations averaged 11.63, it indicates that there were many cases in which research results were not cited but were viewed and used in professional activities.

Fourth, the results of impact analysis of 97 cases in arts and humanities ranked by citation counts are shown in Table V. They were tweeted 42 times, and 2,118 cases were saved on Delicious and Mendeley. In addition, the sum of citation counts in PubMed and Scopus totalled 1.146. In other words, one article was mentioned an average of 0.432 times through social media, so the social impact was not high. However, the number of times "saved" in a reference management tool was an average of 21 times, which indicates that they were used in professional activities many times. Considering the number of citations was an average of 11.18, it was found that there were many cases in which results were not cited but were viewed and used in professional activities like in the engineering and social science fields.

When comparing the impact in the four fields, the results are shown in Table VI.

In the category of "discussed", the average was 2.39 per article in the medical field, which is the highest. Next, the averages were 0.43 in humanities, 0.37 in social science and 0.22 in engineering. Unlike other fields that show averages between 0.2 and 0.5, the average of "discussed" in social media was four to ten times higher in medical science, and there was even a case that was "mentioned" on Wikipedia. Thus, the social impact of medical science evaluated

Indicator	Number	Average
Altmetrics		
altmetric_com:tweets	42	0.43
discussed	42	0.43
delicious:bookmarks	1	0.01
mendeley:readers	551	5.68
saved	2,118	21.83
wikipedia:mentions	2	0.02
mentioned	2	0.02
Citation		
pubmed:pmc_citations	20	0.20
pubmed:pmc_citations_reviews	4	0.04
Scopus	325	3.35
Cited by	1,146	11.81

Table V.
Analysis result of arts and humanities

	Medical science		Engineering		Social science		Arts and humanities	
Indicator	Number	Average	Number	Average	Number	Average	Number	Average
Discussed	235	2.39	21	0.22	36	0.37	42	0.43
Saved	1,416	14.44	1,261	13.41	2,130	22.18	2,118	21.83
Viewed	2,318	23.65	–	–	–	–	–	–
Mentioned	2	0.02	–	–	1	0.01	–	–
Cited	4,645	47.39	748	7.95	1,117	11.63	1146	11.81

Table VI.
Comparison results about altmetrics analysis of four academic fields

by social media was higher than that of other fields. However, it required further analysis, because this was opposite of the previous finding of Haustein *et al.* (2015). Haustein *et al.* (2015) found that the result were different between academic fields as shown in Table VII by analysing the citation data in Thomson Reuters' Web of Science and social media counts.

To quote them "Twitter density is higher in social sciences (1.33), than in biomedical and health sciences (1.28), and natural sciences and engineering (0.34), with discussion that disciplines that have stronger ties to society or deal with specific concerns of people's everyday lives have a higher probability of appearing on social media platforms than publications from more technical and applied disciplines or with a higher technical and complexity component. Therefore, it is articles in the social sciences and humanities that are most often found on social media platforms" (Haustein *et al.*, 2015, pp. 5-6). However, in this study, articles in medical science were the more often found on social media platforms than articles in the social sciences and humanities. The reason for the difference between two studies might be inferred that the articles in this study covered were dealing with issues about certain country, Korea. Korea is not only a specific country but also a country that does not use English as its official language, thereby academic communication in English on social media is also not common. Therefore, this is a natural deduction that human and

Density (mean and SD)	Tweet	Facebook
Biology and health science	1.28	0.14
Natural science and engineering	0.34	0.03
Social science and humanities	1.33	0.10

Source: Haustein *et al.* (2015)

Table VII.
Density and coverage per field in WoS

social subjects about a certain country would not attract particular attention from the global community. However, in the case of the medical science field in Korea, English is widely used in scholarly communication, because researchers and doctors about medical science learn and improve their specialities and exchange the medical information in English.

In addition, international academic exchange and research outcome in medical science is outstanding compared to other areas. The average citation count was 47.39 per article in the medical field, which is four times higher than other fields. Biotechnology and medical fields where research funding and researchers have been rapidly increasing, there is a large number of published research papers, accordingly citation rate is relatively high, but other area is showing a relatively small number of papers and shows low citation rate. For example, in case of cell biology, the number of SCI indexed journal title is 137 and median impact factor shows 3.181; on the other hand, psychology field shows 13 SCI indexed journal titles and median impact factor shows 0.375 (JCR, 2016).

Meanwhile, the number of "saved" cases was higher in social science and arts and humanities than in medical science and engineering. While the averages were 14.44 and 13.41 in medical science and engineering, respectively, the averages were 22.18 and 21.83 in social science and humanities, respectively, which indicates that these are widely used by experts for formulating ideas and professional activities.

5.2 Analysis of readers by country

This study examined the countries that viewed Korean studies and analysed the differences among academic fields using the information about bookmarking readers' nationalities on Mendeley. The value presented the highest in the USA in every field, and Korea, Spain, Brazil and Germany commonly used the results of Korean studies as well. Meanwhile, in social science and humanities, the rank and proportion of reference in the USA, Spain, Brazil, Germany and Japan were identical, which indicates that the extent of impact and influenced countries are similar.

Meanwhile, in the engineering field, Malaysia and Pakistan use many study results of Korea. In medical science, Ecuador and Taiwan have much interest in Korean medical studies, but do not use many results in other fields. Ecuador and Taiwan are the countries that are expected to revitalize their health care networks and become a new market frontier for the health care field, so it is estimated that the statistics reflect their interest in the medical field (Table VIII).

5.3 Correlation comparison by indicators in four fields

The correlation analysis on the five categories of "discussed", "saved", "viewed", "mentioned" and "cited" was conducted in order to examine the correlation among the indicators by field. The results of the correlation analysis are shown in Table IX.

Table VIII. Main reading country for four academic fields

Medical science	Engineering	Social science	Arts and humanities
USA	USA	USA	USA
Korea	Korea	Spain	Spain
Germany	Brazil	Brazil	Brazil
Japan	Malaysia	Germany	Germany
Ecuador	Reunion	Japan	Japan
Brazil	Portugal	Portugal	Portugal
Spain	Japan	Korea	Korea
France	Pakistan	Canada	South Africa
Italy	Austria	Australia	Australia
Thailand	Germany	South Africa	Canada

Table IX. Comparison results about correlation among indicators on the four academic fields

	Discussed	Saved	Viewed	Cited	Mentioned	Discussed	Saved	Cited	Mentioned
Indicator			Medical science				Engineering		
Discussed	1	0.525**	0.041	0.198	.(a)	1	−1.000**	−1.000**	–
Saved	0.525**	1	0.251*	0.504**	.(a)	−1.000**	1	0.705**	–
Viewed	0.041	0.251*	1	0.003	.(a)	.(a)	.(a)	.(a)	–
Cited	0.198	0.504**	0.003	1	.(a)	−1.000**	0.705**	1	–
Mentioned	.(a)	.(a)	.(a)	.(a)	.(a)	.(a)	.(a)	.(a)	–
			Social science				Arts and humanities		
Discussed	1	−0.099	–	−0.073	.(a)	1	−0.161	−0.025	.(a)
Saved	−0.099	1	–	0.465**	.(a)	−0.161	1	0.451**	.(a)
Cited	−0.073	0.465**	–	1	.(a)	−0.025	0.451**	1	.(a)
Mentioned	.(a)	.(a)	–	.(a)	.(a)	.(a)	.(a)	.(a)	.(a)

Notes: (a), One or more variables are constants and can not be calculated. *,**Correlation coefficient is at 0.01 and 0.05 levels, respectively

As a result, there was a statistically significant and positive correlation (0.4-0.7) between "saved" and "cited" in every academic field. Therefore, the more the papers cited in journal, the more papers saved on Mendeley, and used in diverse stage of experts' activities. Meanwhile, in medical science, the average of "mentioned" in social media was 2.39, and there is a positive correlation of 0.525 between "discussed" and "saved" unlike in the other fields. This shows that medical study results that were widely used by experts were also discussed frequently through social media, showing a high social impact. According to the Cancer Registry Statistics of Korea, five-year survival rate of cancer patients shows 69.4 per cent in Korea, 66.5 per cent in the USA, 58.6 per cent in Japan (National Cancer Center, 2016). Korea shows high-level cancer treatment, therefore the number of foreign patients visit are increasing by an annual average of 34.7 per cent, in addition, the clinical medical field and health care education system is also world class, so medical system has actively been exported to China, USA, Mongolia and so on (Jungangilbo, 2015). With this effect, it shows a higher social impact than other areas in the international community.

Meanwhile, the coefficient between "saved" and "cited" in engineering was 0.7, which was higher than in the other fields. This means that the study results evaluated as high by bibliometrics were also saved on a reference management tool many times as well. In other words, articles used for idea exploring or initial stages of a study might be smaller than other fields, otherwise the proportion of professionals with practical activity on Mendeley might be lower. In any case, this phenomenon in which many articles saved on Mendeley were already cited and reflected in bibliometrics indicates that the effectiveness of applying altmetrics is assumed to be relatively "not high" compared to other fields.

6. Limitation

Altmetrics is not a stable model yet, and the fact that the evaluation results are likely to differ according to the sources and weights. In addition, as altmetrics uses social media as an indicator, there are the following vulnerabilities. The responses appear high only to the materials accessible online, data in social media are likely to be manipulated and the reliability and effectiveness are not yet verified. However, it is noteworthy to pay attention to its development, as it is a new attempt to find influence in various aspects, especially in articles originating in non-English-speaking nations, which have a relatively lower degree of citation than those from English-speaking nations.

7. Conclusion

The evaluation of research results has been conducted depending on the journal impact factor, which indicates how many times an article in a specific journal was cited on average, although the impact evaluation now can be conducted by using the number of accesses to or downloads of a paper in recent days. However, citation impact can be presented only after a certain period of time, which makes it difficult to measure the impact of recent studies and evaluate the impact of individual articles or study using the impact factor since articles in one journal have various and different characteristics (Hayashi, 2013).

Meanwhile, as an OA repository that can gather papers of various fields began to be activated by an open-access culture, the evaluation and impact assessment by paper became important, rather than by journal using an impact factor method. Therefore, researchers are finding ways to verify the outcome of their studies, and evaluation methods using multidimensional facets are being pursued in libraries, research institutes and publishing companies, not the traditional methods such as h-index or journal impact factor.

Altmetrics, which emerged against this backdrop, can evaluate various social impacts that were not accessible by using a bibliometrics-based evaluation method. In a study to verify the usefulness, 77 per cent of researchers said that altmetrics raised the value of journals, and 50 per cent of researchers responded that they will publish their articles in a

journal providing altmetrics (Warne, 2014), which shows that altmetrics is complementing the bibliometrics-based evaluation system.

This study evaluated the impact of study results of Korea in medical science, engineering, social science and arts and humanities that were published in international journals and compared this with the evaluation results assessed by the bibliometrics-based method. Korean authors sometimes have a lower degree of citation than authors from English-speaking nations, in spite of publishing in international journals in English. Therefore, this study that analysed Korea's research impact on international society, using not by bibliometrics but by altmetrics, is valuable. In addition, since the study focussing on the impact of non-English-speaking nations' research on the global community using altmetrics still have not been carried out, the result of this study has originality.

In this study, the citation counts of medical research in Korea were much higher than that of other fields, and they are frequently discussed in social media, showing high social impacts. This is the opposite result of a preceding study which found that articles in the social sciences and humanities are the most often found on social media platforms. The reason that this study obtained a different result from the preceding study can be inferred that the subjects in this study were limited to articles of a certain non-English-speaking country origin. Though it is hard to generalize the result, unless country's official language is English, it is supposed that the academic fields like social science which reflect society and humanity do not have a higher probability of appearing on social media platforms. Like the case of Korea where medical science appeared most high, it could be supposed that the academic fields that have active international exchange or use English for academic communication have a relatively higher probability of appearing on social media platforms. Meanwhile, engineering, social science and arts and humanities fields of Korea showed more than twice the "saving" count of reference management tools than that of citations. So, it can be inferred that even though they are not cited by follow-up studies, they are extensively used in various professional activities or in the initial stages of studies.

In the comparison between the impact measured by altmetrics and citation rate, it appeared that the correlation between the Mendeley saving index and the citation rate is positive among all fields. Therefore, it proves that studies conducted in Korea that have a high citation rate are also used in expert activities many times. This can explain the possibility of altmetrics to supplement the bibliometrics-based evaluation system because Mendeley showed a correlation with bibliometrics in in articles originating in non-English-speaking nations.

Because this study examined the impact of the articles originating in a non-English-speaking nation, it could be referred by other non-English-speaking nations which are trying to identify invisible impact of their research output on global society. By finding the academic field which are receiving special attention from global community using altmetrics, researchers could prospect country's overall research impact and utilize it to make a future R&D plan.

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Further reading

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