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# Traditional Citation Indexes and Alternative Metrics of Readership

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## Abstract

The present study aimed to investigate the relationship between traditional citation indexes representing hot papers in the field of "Clinical Medicine" and their bookmarking and readership in "Mendeley software". The citation counts of hot papers were extracted from Essential Science Indicators (ESI) and Web of Science (WoS). As an applied research adopting a descriptive-exploratory method, the present study used the Essential Science Indicators to retrieve hot articles published between 2014 and 2016, indexed in the category "Medical Sciences". Each record was then searched in Mendeley to obtain the number of readership of the paper and the academic status of the users. The results showed a significant positive correlation between Mendeley readership and citation indexes in both ESI and WoS. Moreover, the most frequently-cited articles in both databases attracted more readers in Mendeley than lowly-cited publications and both hypotheses were confirmed. Moreover, the findings revealed that Mendeley users had assigned a total number of 3847 tags to the hot papers, with the tags ranging in frequency from zero to 38 for individual articles. Compared with author keywords and Plus, about 10 percent of users' tags were either meaningless or repetitive. The value of present study shows that "Mendeley Sofware" with the possibility of tagging articles, can be used to create a searchable folksonomy of information and as a source of data in information retrieval studies, help professionals to manage their literatures and make their research life easier.

**Keywords:** Alternative Metrics, Altmetrics, Mendeley, Hot Papers, Citation, Essential Science Endicators (ESI), Web of Science (WOS), Readership, Bookmarking.

## Introduction

Research findings in medical sciences typically address people's lives. Statistics obtained from citation databases such as "Web of Science" and "Scopus" as well as specialized

databases such as "PubMed" suggests that medical sciences are among the most prolific and most cited research areas. Furthermore, the citation score of highly cited, hot papers and top papers in medical sciences often outweigh those of social sciences and humanities (Harzing & Alakangas, 2016). The cause of the great variation in the number of citations per paper is often given as the differing citation culture of the various disciplines (Marx & Bornmann, 2015).

Hot or highly-cited papers are those attracting a certain number of citations within a specific time period, which leads to their indexing in ESI. Having computed the citation score, ESI sets to index the upper limit of top 1percent of scientists and institutions as well as the upper limit of top 50 percent of journals and countries based on citation thresholds in every subject area and all disciplines. A paper is selected as a Hot Paper if it meets a citation-frequency threshold determined for its field in bimonthly group; the fraction is set to retrieve about 0.1% of papers. Hot papers date back to no-longer-than two years, which overtake other publications of the same age in their subject area in attracting a substantial number of citations within a short interval[1].

Twenty-two subject fields are defined broadly in ESI, each of which representing hot papers in their specific fields. (Incites Help[2], 2017). From among these subject fields, "clinical medicine" was selected as the research focus in this study as it was found to have the highest number of indexed articles and citation counts and is followed by social users in social networks. Furthermore, finding show that "clinical medicine" articles had the highest coverage (71.6 percent) in Mendeley. This figure was considerably lower for articles in the social sciences (47 percent), engineering and technology (35 percent), chemistry (34 percent) and physics (31 percent) (Mohammadi, Thelwall, Haustein & Larivière 2015). Further in social networks, medical research is one of the most attractive subject among social users. For example, in 2017 Altmetric which has tracked over 18.5 million mentions of 2.2 million different research outputs, just over half of the list (53%) are papers in medical journals, or aimed at a medical audience[3].

Although, hot papers receive citations in a short time following their publication (measured across two years in bimonthly intervals) while it typically takes 3 to 5 years for other publications to be measured in impact factor calculations as the most important traditional citation index (Victor, 2012), this tends to be a relatively long period comparing with swift and instantaneous changes in social networks so that even hot papers may bear all weaknesses in the field of citation studies.

Citation analyses are based on textual citations in documented sources. However, with the emergence of social networks and development of the digital world, a substantial amount of research communications occurs in the digital environment, and it would not be viable to measure the research impact by using traditional citation indexes. Besides, research has shown that citations may account for only 30% of research impact (MacRoberts & MacRoberts 2010) so that informal impacts of research are consistently overlooked. Emphasizing that citation analysis measures only visible impacts, Priem, Piwowar & Hemminger (2012) stress the need for measuring invisible impacts that may be revealed via researchers' participation in bookmarking, sharing, discussions, and comments.

Flaws and weaknesses in citation-based analysis methods led to the emergence of alternative criteria for measuring scientific impacts and trends in science (Mehraban & Mansourian 2014). Traditional citation indexes need to be complemented with new measures as they are time-consuming and fail to address other aspects of scientific impact such as the amount of download, usage, discussion, storage, comments, etc. (Kousha & Thelwall, 2007). According to Priem and Hemminger (2010), citation-based analytics are no longer the only criteria for measuring scientific impact so that Web 2.0 may also do its part. Collaboration tools and research tracking developed with the emergence of Web 2.0 to compensate for the deficiencies of Web 1.0. Web-based criteria facilitated the faster, more global, and more public measurement and tracking of scientific impact through article downloads, views, comments, and favorites. This measurement includes all users either citing or not citing a given journal article. In fact, the use of data denotes their impact on readers one way or another.

As the newest evolving measures, Altmetrics were first introduced by Priem, Taraborelli, Groth & Neylon (2010) and has since been used as a new, complementary method in the social web. Altmetrics addresses the mentioning of scientific work in social media such as Facebook, Twitter, and Wikipedia as well as citation management tools such as Mendeley, Citeulike, news media, etc. (Moed, 2005; Bornmann & Daniel, 2008). It is a recently-launched method that may be devaluated as a scientific tool if used in isolation as the only tool. Various findings have shown that Altmetrics may well be used to complement citation measures. It seems that migration of researchers to the virtual environments has culminated in changes in the scientific impact measures and the birth of web-based criteria, social networks, and Altmetrics (Mehraban & Mansourian, 2014). Still, any new measure might entail weaknesses to be known over time in the light of new studies. The necessity to study new metrics is consistently emphasized to evaluate their accuracy, advantages, and likely disadvantages (Butler, 2008; Harnad, 2008; Zitt & Bassecoulard, 2008). A line of research tends to explore the correlation between Altmetrics and traditional citation indexes as part of studies that try to examine their validity at least in terms of their alignment with the results obtained by using traditional indexes (Sotoudeh, Mazarei & Mirzabeigi, 2015).

As an Altmetric tool, "Mendeley" is an academic social website and a free citation management program for users to manage their sources. "Mendeley" provides its users with 2 GB of free space for storage. The users may launch open groups and accept members for their subjects of interest and/or search for and join other groups to use their documents. "Mendeley" offers a variety of features to manage, store, cite and share research papers and data. Moreover, it is a big database accommodating over 570 million documents from all disciplines created by over 6.5 million users (Mendeley manual, 2017). Storage of scientific work in "Mendeley" is referred to as 'readership' so that adding any given document to your personal library may by default imply that you are reading the document immediately or in future followed by your citing of the document in your own research work. "Mendeley" users may readily track their unread documents. Once the documents are opened with Mendeley PDF, they are rated as read documents. Thus, the total count of document manipulation by users is referred to as readership. An important feature of "Mendeley" is providing statistics on the number of users storing documents in their libraries. It also releases statistics on the

users' academic status, discipline, and country based on the information they provide while registering into the software. Although this information is restricted to only 3% of the users, it is considered as a rich source of Altmetrics (Li, Thelwall & Giustini, 2012) as it offers data on not only the readership count but also the users' personal profile (Zahedi, 2014). The users may also tag the bookmarked articles in Mendeley for future use when needed – for example, when author keywords and Plus do not fulfill all their needs.

Several studies have already delved into the relationship between citations and "Mendeley" readership counts and users' characteristics, which will be discussed in the literature review section below. However, to the best of the authors' knowledge, there has not yet been a study to investigate the relationship between ESI hot paper citations and their readership in Mendeley. Besides, as it is only the advent of Altmetrics with no longer than a decade of history, more studies are required in different fields on various samples to clarify different aspects of these new metrics. Altmetrics rely on "Web 2.0", and they are essentially user-oriented and variable so that they may not be substituted for traditional metrics altogether. Rather, it seems more reasonable to use Altmetrics in conjunction with scientometric indicators to evaluate research quality.

The present study is innovative in that "hot papers[4]" represent the research that shows the global route of science so that they are immediately identified and cited by peers in a specific discipline. Therefore, a leading question is raised with regard to the high speed of citations in hot papers: is there any relationship between hot paper citations and "Mendeley" readership rates? In other words, do the users – either expert or non-expert – track the latest findings in medical sciences in their convenient ways such as storage, usage, discussion, bookmarking, tagging, reading, and citing in Web 2.0? Who are they and what are their characteristics?

## Literature review

A review of the literature revealed the recency of Altmetrics as it was introduced in 2010. The majority of studies belong to the relationship between citation counts and Altmetrics and reported a correlation between the two variables. In other words, there has been a correlation between the mentioning of scientific work in the social web environment and their citation counts. Further studies are needed to revealvarious aspects of this correlation. However, there is a lack of research on hot papers and the relationship between hot citations and Altmetrics. The available literature will be discussed in two sections below.

### The relationship between citation and readership in Mendeley

The earliest studies on Mendeley dates back to 2007 when the articles published in Nature and Science were examined to find moderate correlations (0.540 and 0.559) between Mendeley bookmarking and citation counts in WoS (Li et al., 2012). Bar-Ilan (2012) studied journal articles, particularly articles published in JASIST, over the period 2001-2010 and found a significant correlation between article citation counts in WoS, Scopus, and Google Scholar and their bookmarking in Mendeley. She concluded that bookmarking may well complement scientometric indexes. In another study entitled 'beyond citations: scholars' visibility on the social Web', Bar-Ilan et al. (2012) detected a significant correlation between Mendeley bookmarks and citation counts in Scopus (r=0.45). Schloegl et al. (2013) reported a

moderate correlation between Mendeley readership counts and citation counts in Scopus. In their presentation entitled 'what is the impact of the publications read by the different Mendeley users? Could they help to identify alternative types of impact?' Zahedi, Costas and Wouters (2013) reported a weak positive correlation between citation counts and article storage in Mendeley, which they announced consistent with the previous findings.

Zahedi (2014) conducted a study entitled 'The use of English language Iranian international publications by Mendeley users'. She reported that Mendeley bookmarked publications had a higher citation rank comparing with unbookmarked articles. The results also showed a weak positive correlation between citations and Mendeley readership bookmarks.

In their study entitled 'Mendeley readership Altmetrics for the social sciences and humanities: research evaluation and knowledge flows', Mohammadi and Thelwall (2014) observed a moderate correlation between Mendeley readership counts and article citation counts. This finding was confirmed in another study by the same authors in 2015. Thelwall and Sud (2016) carried out a study entitled 'Mendeley readership counts: an investigation of temporal and disciplinary differences' and inspected articles across five broad categories (i.e. agriculture, business, decision science, pharmacy, and the social sciences) and fifty subcategories from Scopus during 2004-2014. They found that article citations tended to increase over time while Mendeley readership for articles increased initially but stabilized after 5 years. The correlation between citations and readers was also higher for longer time periods. Although there were considerable differences between broad categories and smaller differences between subcategories, the results endorsed the value of Mendeley readership counts as early scientific impact indicators.

Ebrahimi, Setareh & HosseinChari (2016) examined Citeulike, Mendeley and Figshare and found that sharing scientific publications in social networks such as Mendeley can increase their visibility and future citability. The first and only analysis of Altmetric scores for the top-cited articles was carried out by Barbic, Tubman, Lam & Barbic (2016) who studied the 50 most frequently cited articles published in emergency medicine journals and their Altmetric scores. They reported a mild correlation between citation counts and Altmetric scores for the top papers in emergency medicine and other biomedical journals. Pouladian & Borrego (2016) performed a fifteen-month longitudinal study of the evolution of bookmarks in Mendeley for a set of articles published in Library and Information Science in 2014. Results show that 87.6% of the literature was bookmarked at least once by May 2016 whereas only 55% was cited. The correlation between bookmarks and citations was moderate.

## Mendeley users' characteristics

Zahedi (2014) demonstrated that articles published in 2012 and medical sciences publications were the most instances of storage in Mendeley. She also reported that students were the most frequent users of Mendeley. Mohammadi et al. (2015) undertook a study entitled 'who reads research articles? An Altmetrics analysis of Mendeley user categories.' They found that Master's, Ph.D., and postdoctoral students were the major readers of articles in five disciplines including Clinical Medicine, Engineering and Technology, Social Science, Physics, and Chemistry in 2008 extracted from Clarivate Analytics. Moreover, the majority of

publications in clinical medicine were read by medical professionals. The highest correlations between citations and Mendeley readership counts were found for the users who often authored academic articles, except for associate professors in some sub-disciplines. Pooladian & Borrego (2017) found that "Mendeley" covers 61 per cent of the LIS literature published in the last 20 years. One-quarter of the papers (26 percent) had between one and five users and over half (56 percent) had between one and 15.

The majority of research findings have indicated that Altmetrics often correlate with traditional indicators such as citations. Still, the strength of correlation varies based on the discipline and Altmetric tools. In the case of Mendeley, the correlations between readership and citations have ranged from weak to moderate. Bar-Ilan et al. (2012) report the moderate correlation (r=0.45) between Mendeley bookmarks and citation counts in Scopus, Zahedi, Costas and Wouters (2013) reported a weak positive correlation between citation and article storage in Mendeley (r=0.2). In Pooladian & Borrego (2016) the correlation was moderate throughout the study period, rising slightly from Spearman's rho = 0.52 in March 2015 to 0.56 in May 2016. Ebrahimi et al. (2016) report a high correlation between these two metrics, r=0.6

## Objectives & Research Questions & Hypothesis

This study aims to investigate Mendeley readership counts for clinical medicine publications rated as hot papers in ESI during 2014-2016 as well as the relationship between hot paper citation counts in ESI and WoS and their Mendeley readership. It also seeks to examine the status of user-assigned tags to hot papers. To this end, the following research hypothesis and questions are formulated.

**Research major hypothesis**: There is a significant relationship between citation counts and Mendeley readership for hot papers.

**Research minor hypothesis**: There is a significant relationship between citation counts and Mendeley users' academic status.

## Research Questions

1. What are the citation counts of hot papers in ESI and WoS and what are their readership counts in Mendeley?
2. What is the academic status, discipline, and nationality of the readers of medical sciences hot papers in Mendeley?
3. What is the status of user-assigned tags to hot papers in terms of meaningfulness, repetitiveness, similarity with author keywords, and Plus?
4. Can a study of tags, author keywords, and Plus demonstrate consistency among Mendeley users (tags), author keywords, and article indexers' keywords (keywords Plus) in Clarivate Analytics?

## Materials and Method

As an applied research adopting a descriptive-exploratory method, the present study used the Essential Science Indicators to retrieve hot articles published between 2014 and 2016,

indexed in the category "Medical Sciences" and assumed a correlational design and a citation analysis method. The research population consisted of all hot papers in the field of clinical medicine published during 2014-2016, which were extracted from ESI in November 2016(the first bimonthly period). In order to collect the data, hot papers were sorted by citations, the data on citations, author keywords, and Plus were extracted for each article. Then article titles were entered into and searched in Mendeley one by one. The article titles were delimited inside quotation marks to increase the search accuracy. The retrieved articles were double checked with journal titles, year, and issue. Although the best searching method in Mendeley seems to be a combination of DOI searches with traditional queries (Zahedi, Haustein & Bowman, 2014) which helps identify the maximum number of users, the traditional queries were drawn upon as the majority of ESI retrieved articles lacked DOI.

Following the retrieval of articles in Mendeley, Altmetric data were extracted for all hot papers. Once various titles were retrieved for the same article – as they were variably stored by users in the library due to their various writing forms – the data on all different forms were extracted for the articles. The data were recorded on Mendeley readership counts, user profiles including academic status, discipline, and country as well as user-assigned tags. As the Application Programming Interface (API) was unavailable for Mendeley, the obtained data were first entered into Excel and then analyzed using SPSS. The Spearman correlation test in SPSS was used because of the type of variations (Zahedi, 2014 ; Pooladian & Borego, 2016). The Spearman's rank-order correlation is the nonparametric version of the Pearson product-moment correlation. Spearman's correlation coefficient measures the strength and direction of association between two ranked variables which in this study is number of citations and readership.

## Results

Due to the inconsistency and diversity of titles and punctuations for the same article, a minimum of one and a maximum of 25 different forms were retrieved for any given hot paper. Therefore, a total of 1401 article titles were retrieved in Mendeley for the 531 articles as 187 titles had different written forms. Following the retrieval of all various written forms for a given article title, it was then necessary to homogenize the data due to writing inconsistency, variable readership, readers, etc. for every form. The statistics on the Mendeley users who had read or tagged the articles were provided as percentages. As it was likely for an article to have different written forms, it was necessary to check every article individually and convert user percentages into numbers. Eventually, all numbers for a given article were added and percentages were computed for the same article. Table 1 illustrates a synopsis of the hot papers in clinical medicine, their readership, and citations. The research questions are partly answered in the light of these data.

**Table 1**
*Summary statistics of hot papers in the field of clinical medicine*

| Article status | All papers | | | Bookmarked articles | | |
|---|---|---|---|---|---|---|
| Metric | Frequency | Mean | Max. | Frequency | Mean | Max. |
| Articles | 531 | | | 480 | | |
| Different written forms | 1401 | | 25 | | | |
| Citations in ESI | 52935 | 99.7 | 1960 | 47834 | 99.7 | 1960 |
| Citations in WoS | 67919 | 128 | 2607 | 61610 | 128.4 | 2607 |
| Readership | 101843 | 192 | 2354 | 101843 | 212.2 | 2354 |
| Tags | | | | 3847 | 8 | 38 |

As shown in the table 1, 480 out of the total 531 hot papers were retrieved in Mendeley while the remaining 51 titles were not read by users. The mean scores of article citations (either bookmarked or not) were almost equal in ESI and WoS. On average, every bookmarked article was read 212 times while the average readership for all articles was 192. Every bookmarked article received 8 tags on average and the highest number of tags for an article was 38.

To answer the first research question, the findings showed that a number of 531 hot papers in clinical medicine had received a total of 52935 citations in ESI (with a minimum of 4 and a maximum of 1960 for each) and 67919 citations in WoS (with a minimum of 4 and a maximum of 2607 for each) over 24 months ending in May 2018. The findings revealed that an article releasing statistics on cancer in 2015 attracted the highest number of citations in both ESI and WoS. The Mendeley readership count was 2257 for that article. Due to their variable written formats, the same papers amounted to 1401 titles in Mendeley having a total of 101894 readership counts (with a minimum of 1 and a maximum of 2354 readership).

As social users of Mendeley use different variation for a unique title, it was necessary to match these inconsistency of the written form of article by Doi, authors and other criteria in order to find the correct number of readership. Table 2 illustrates the inconsistency of the written form of article titles, with a maximum of 25 different titles for the same paper while the majority of articles had only one title format.

Table 2
*Inconsistency of article titles and No. of articles*

| Title inconsistency | No. of articles | Title inconsistency | No. of articles | Title inconsistency | No. of articles |
|---|---|---|---|---|---|
| 25 | 1 | 14 | 5 | 7 | 12 |
| 20 | 1 | 13 | 3 | 6 | 10 |
| 19 | 1 | 12 | 1 | 5 | 16 |
| 18 | 1 | 11 | 4 | 4 | 17 |
| 17 | 1 | 10 | 6 | 3 | 33 |
| 16 | 3 | 9 | 16 | 2 | 50 |
| 15 | 1 | 8 | 6 | 1 | 292 |

A number of 51 articles were not retrieved in Mendeley in any likely format. Table 3 illustrates Mendeley readership counts for articles.

Table 3
*Mendeley readership counts for hot papers in clinical medicine*

| Mendeley readership counts | No of article titles for readership range |
|---|---|
| 1-99 | 179 |
| 100-199 | 130 |
| 200-299 | 71 |
| 300-399 | 36 |
| 400-499 | 20 |
| 500-999 | 37 |
| 1000-1499 | 3 |
| 1500-1999 | 2 |
| 2000-2500 | 2 |
| Total readership count | 480 |

Table 4 illustrates the publication year of the hot papers.

Table 4
*Number of Hot papers frequency distribution based on publication year*

| Year | No. of articles |
|---|---|
| 2014 | 145 |
| 2015 | 268 |
| 2016 | 118 |
| Total | 531 |

The results of the first hypothesis of this research demonstrated that, statistically, there is a positive significant relationship between citations and Mendeley readership counts and the hypothesis is confirmed. The results of Spearman correlation test in SPSS showed a moderate positive correlation between article citation counts in ESI (r=0.487) and WoS (r=0.533) and Mendeley readership counts for articles with 95% certainty (see Table 5 & 6). Therefore, these two variables are correlated so that a change in one leads to a change in another.

Table 5
*Relationship between ESI citations and Mendeley readership for articles*

| | | | ESI Citation | Readership |
|---|---|---|---|---|
| Spearman's rho | ESI Citation | Correlation Coefficient | 1.000 | .487** |
| | | Sig. (2-tailed) | . | .000 |
| | | | | |
| | Readership | Correlation Coefficient | .487** | 1.000 |
| | | Sig. (2-tailed) | .000 | . |
| **. Correlation is significant at the 0.01 level (2-tailed). | | | | |

Table 6
*Relationship between WoS citations and Mendeley readership for articles*

| | | | WoS Citation | Readership |
|---|---|---|---|---|
| Spearman's rho | WoS Citation | Correlation Coefficient | 1.000 | .533** |
| | | Sig. (2-tailed) | . | .000 |
| | Readership | Correlation Coefficient | .533** | 1.000 |
| | | Sig. (2-tailed) | .000 | . |
| | | | | |
| **. Correlation is significant at the 0.01 level (2-tailed). | | | | |

With regard to question that who had read the articles in Mendeley, the findings showed that a number of 59283 readers (out of the total 101894 readers) had identifiable academic credentials, which accounts for 58% of the readers (see Table 7). Ignoring students as a single group due to differences in their academic levels, the majority of readers were researchers (n=21869) who read and saved hot papers in their library. The readership counts for PhD and Master's students were 14335 and 8402, respectively.

In the literature, students are often considered collectively as a single group so that they are over-reported as the main Mendeley readers. However, they feature a range from undergraduate to PhD and even postdoctoral levels. It does not seem reasonable to integrate students in one group, though. Thus, they were clustered in different groups in the present study based on their academic level. Having retrieved the data on Mendeley users' academic status via the software API.

The fact that articles in medical sciences are highly specialized may account for why researchers and postgraduate students are the Mendeley core readers. Associate professors had the lowest readership frequency (n=9). One should note, however, that the data is obtained from Mendeley Public Profile page. Thus, the accuracy of data depends on how accurate the users have been in completing their profiles.

Table 7
*Mendeley users' academic status*

| Academic status | Student > Postgraduate | Student > PhD Student | Student > Master | Student > Doctoral Student | Student > Bachelor | Researcher | Associate Professor | Professor | Other | Librarian | Lecturer > Senior Lecturer | Lecturer | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. of readers | 2229 | 14335 | 8402 | 837 | 3201 | 21869 | 487 | 152 | 7708 | 13 | 9 | 41 | 59283 |

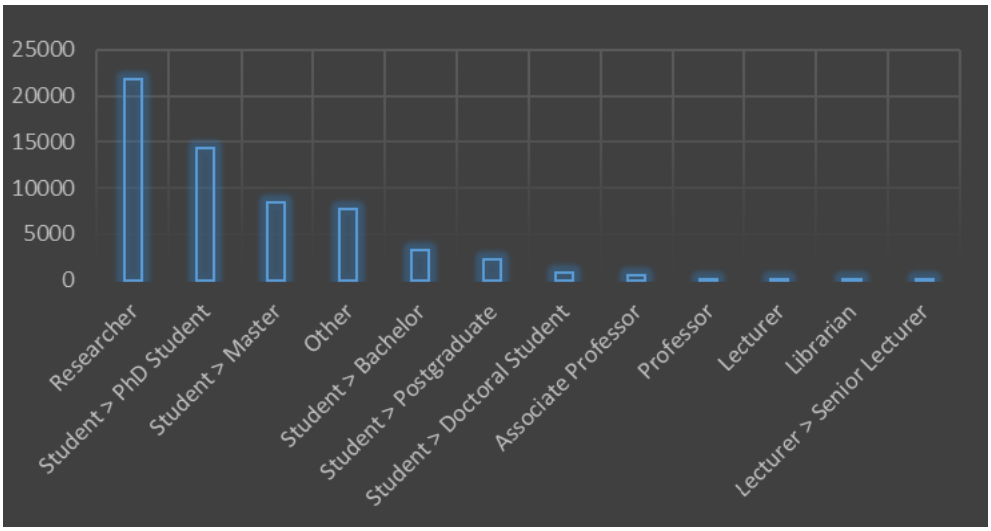


*Figure 1***.** Hot paper readers by academic status

Mendeley users may identify their academic disciplines from among 28 broad categories. Of the users who read, tagged and/or bookmarked hot papers, only did one user belong to the disciplines of design and linguistics while the readership statistics was two for chemical engineering, three for earth sciences, and seven for material science. The readership count was zero for decision sciences. Quite logically, the readership count for medicine and dentistry disciplines was 57773. Table 8 illustrates the readership counts by academic disciplines.

Table 8

*Mendeley users' readership counts for hot papers by academic discipline*

| No. | Discipline | No. of tags | No. | Discipline | No. of tags |
|---|---|---|---|---|---|
| 1 | Medicine and Dentistry | 57773 | 15 | Environmental Science | 88 |
| 2 | Agricultural and Biological Sciences | 22288 | 16 | Chemistry | 87 |
| 3 | Biochemistry, Genetics and Molecular Biology | 3792 | 17 | Sports and Recreations | 66 |
| 4 | Social Sciences | 1531 | 18 | Computer Science | 63 |
| 5 | Nursing and Health Professions | 544 | 19 | Mathematics | 25 |
| 6 | Engineering | 501 | 20 | Veterinary Science and Veterinary Medicine | 21 |
| 7 | Pharmacology, Toxicology and Pharmaceutical Science | 492 | 21 | Business, Management and Accounting | 13 |
| 8 | Psychology | 243 | 22 | Materials Science | 7 |
| 9 | Immunology and Microbiology | 147 | 23 | Earth and Planetary Science | 3 |
| 10 | Neuroscience | 123 | 24 | Energy | 2 |
| 11 | Arts and Humanities | 122 | 25 | Chemical Engineering | 2 |
| 12 | Philosophy | 105 | 26 | Design | 1 |
| 13 | Physics and Astronomy | 104 | 27 | linguistics | 1 |
| 14 | Economics, Econometrics and Finance | 94 | 28 | Decision Sciences | 0 |

With regard to users' nationalities, the findings demonstrated that the users were from 64 countries with American and English nationals ranking first and second as the top readers.
The results of the minor hypothesis of this research demonstrated that, statistically, there is a positive significant relationship between citation counts and Mendeley users' academic status and the minor hypothesis is confirmed too. Chi-square test was run to examine the relationship between these two variables. Considering the categorization of academic credentials in Mendeley, the citations were categorized such that they were divided into high and low groups based on citation medians in ESI and WoS. The results of Chi-square test showed a significant correlation between users' academic credentials and citations in ESI and WoS (Sig=0.000).

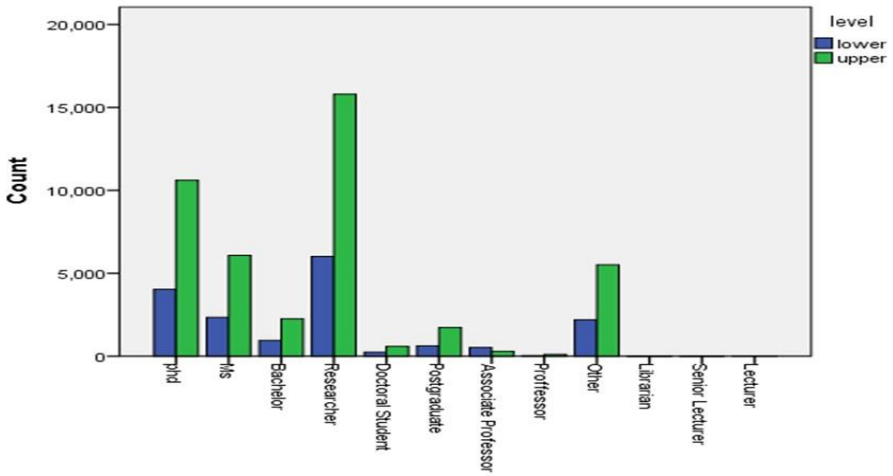


*Figure 2.* Reader frequency by academic status in both highly (green) and lowly-cited (blue) articles in ESI

As shown in Figures 2 and 3, readers with different academic status, except for associate professors in Figure 2, tended to read highly-cited articles. In other words, there were greater readership counts for the top-cited articles. The majority of hot paper readers included researchers, PhD, and Master's students.

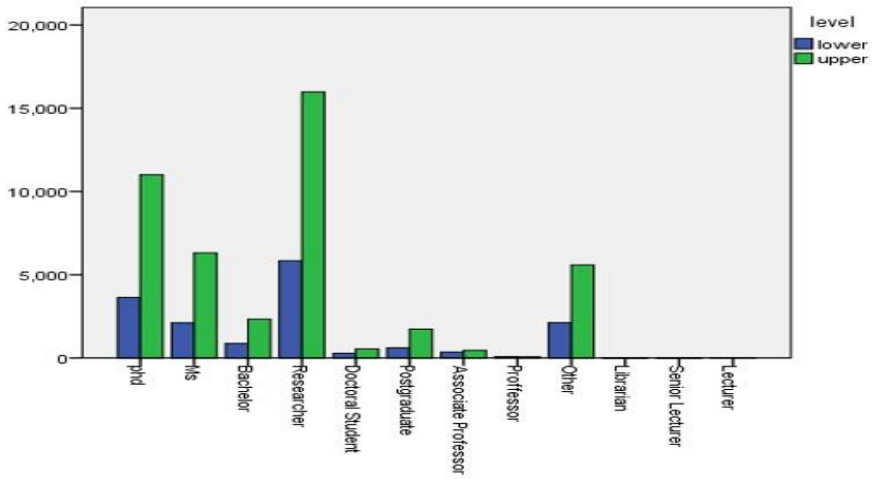


*Figure 3.* Reader frequency by academic credentials in both highly- and lowly-cited articles in WoS

With regard to the third research question, the results showed that Mendeley users had assigned a total of 3847 tags to the hot papers. The tags ranged in frequency from zero to 38 for each paper. A number of 203 papers had received 8 – 10 tags while the tag frequency was zero for 120 papers. Table 9 illustrates the tag frequency of hot papers.

Table 9
*Tags assigned to the hot papers by Mendeley users*

| No. of tags | No. of articles | No. of tags | No. of articles | No. of tags | No. of articles |
|---|---|---|---|---|---|
| 0 | 120 | 13 | 9 | 26 | 2 |
| 1 | 15 | 14 | 2 | 27 | 3 |
| 2 | 15 | 15 | 6 | 28 | 2 |
| 3 | 18 | 16 | 2 | 29 | 3 |
| 4 | 20 | 17 | 3 | 30 | 0 |
| 5 | 17 | 18 | 3 | 31 | 0 |
| 6 | 19 | 19 | 5 | 32 | 1 |
| 7 | 36 | 20 | 5 | 33 | 0 |
| 8 | 55 | 21 | 1 | 34 | 0 |
| 9 | 51 | 22 | 1 | 35 | 0 |
| 10 | 97 | 23 | 4 | 36 | 1 |
| 11 | 6 | 24 | 2 | 37 | 0 |
| 12 | 2 | 25 | 2 | 38 | 3 |
| Total: 531 | 471 | | 45 | | 15 |

It should be noted that around 5% of tags (n=188) were repetitive and 5% were meaningless. In other words, about 10% of the user-assigned tags were either repetitive or meaningless (e.g. a number, different symbols, etc.). This may result from the users' information seeking behaviors, motivations and their interaction with the software. For example, they might have tagged an article leisurely to test the system or as suited their purpose regardless of the article keywords. Tags may be considered as Folksonomy, and that is why they usually prove inconsistent with author keywords and Plus. To further clarify this issue, more studies are needed in the form of interviews with the users of scientific bookmarking websites as well as field research to identify users' motivations.

The results showed a total of 5338 author keywords and Plus in the articles versus 3847 user tags. Omitting repetitive and meaningless tags, the total number of tags decreased to 3463 which is equivalent to 65% of the author keywords and Plus.

In order to answer the forth research question, a comparison of users' tags with author keywords or Plus showed that only were a small number of tags (4.1%) similar to keywords, which may have various reasons. For example, the author keywords might have been informative enough to fulfill users' needs so that they did not assign tags to articles. Or the readers might have not followed the articles as professionals. They might as well have marked the articles one way or another such as highlighting or using other tools in Readers.

The similarity among users' tags, author keywords, and article indexers' keywords was examined in the present study to test the consistency among users, authors, and indexers. In other words, it was to examine if the users' information needs were well understood. Once

such needs are understood, the users may fulfill their information needs more conveniently. This would dramatically reduce the need for users to tag articles and research documents in Mendeley.

## Discussion and conclusion

The present study was carried out to explore the feasibility of Altmetrics. The findings showed a moderately significant positive correlation between citation counts and Mendeley readership for articles and the major hypothesis of the research was confirmed. This is consistent with the findings of Bar-Ilan (2012), Li et al. (2012), Mohammadi and Thelwall (2014), Zahedi (2014), Mohammadi et al. (2015), Thelwall and Sud (2016) and Pooladin and Borrego (2016) who also reported a significant positive correlation between these two measures. Specially this correlation were moderate and higher in clinical medicine (r=0.463) than in chemistry (r=0.369), engineering and technology (r=0.327), and physics (r=0.308) (Thelwall and Wilson 2016). Moreover, articles in medical sciences were bookmarked in Mendeley twice as much as articles in engineering, chemistry, and physics. About 30% of WoS articles in engineering, chemistry, and physics published in 2008 had at least one Mendeley bookmark comparing with 60% for clinical medicine (Mohammadi et al., 2015). However, one should note that the coefficients neither in this study nor in previous studies are so strong to conclude that citation counts and number of readership both reflect a similar image of research efficacy. Thus, readership may only work as a supplement and an alternative to citations. In fact, citation and readership are representations of two different activities in two different environments.

Altmetrics would measure scientific impacts as do traditional citation indexes but in another way. Ibid reported that Mendeley readership may reflect article usage as does citation impact providing if it is limited to readers who are authors as well, so that they can represent the scientific impact of the article in Mendeley without typical delays in citation analyses. They also indicated that Mendeley readership counts may reflect hidden effects of research articles – e.g. impacts on non-author readers and their performance.

While citation counts for an article tend to compute its direct (formal) impact on research output, article tagging counts address its indirect (informal) impact on users. By tagging or reading an article, the user uses the common knowledge in the web environment, and the article itself may help change or boost his knowledge of a subject. Still, this personal knowledge is not measurable by scientometric indexes unless it is released through a scientific output into the realm of common knowledge. Tagging or readership counts may imply that the article has affected the users' personal knowledge.

The rationale behind using Mendeley bookmark counts as a research indicator is that the users most likely use and cite the articles in their research works or represent them in their academic activities one way or another such as teaching and presentations. This is supported by evidence from a study of Mendeley users showing that, except in the arts and humanities, most users had already read or stated that they would read most of the bookmarked articles (Mohammadi, Thelwall & Kousha, 2016).

Other findings showed that researchers and PhD and Master's students were the major Mendeley readers of hot papers in clinical medicine which is consistent with the findings of

Zahedi (2014), Mohammadi et al. (2015) and Pooladian and Borrego (2017). They tended to read highly-cited articles. This may indicate the strength of Altmetrics in measuring article credibility in that social network, users show greater interest in reading and tagging quality articles. The minor hypothesis of the research was confirmed as there is a positive significant relationship between citation counts and Mendeley users' academic status. Other finding about user profile showed that the majority of users were from the U.S., England, and Japan. This is consistent with previous findings.

3848 user's tags to the hot medical articles which was less than 5 percent similar to author keywords, may can be used to create a searchable folksonomy of information within the social networks (Social Citations[5], 2018) and help users better retrieved their information needs. Besides, it should be noted that the user roles have changed from information consumer and web surfer to content producer with the development of Web 2.0 (Ashuri & Tarokh, 2012). Thus, information distortion is part of the content change which requires due attention. In the present study, such distortion may be reflected in the tags. It agitates the accuracy of these metrics when users assign repetitive or meaningless tags but the software fails to communicate an error message to them. Such criticisms may also be leveled against peer-reviewed articles and citations despite robust filtering measures as well as against author and journal self-citations, citation gives-and-takes, and biases in authors' citation behaviors. The main point in using the tagged data is their quality control.

However, criticisms of Altmetrics do not imply questioning them; rather, it is an effort to resolve the likely issues. The world is changing rapidly, and face-to-face scientific relations have moved into the virtual world where people follow, like, and comment on the activities of their peers, friends, and favorite people day and night. In return, they would like to be followed back and commented on; the more the better.

The value of present study shows that "Mendeley Sofware" with the possibility of tagging articles, can be used to create a searchable folksonomy of information and as a source of data in information retrieval studies. Also as the result showed, Mendeley users are almost PhD students which tend to read highly-cited articles and show greater interest in reading and tagging quality articles. Therefore, this reference management software can be employed by professionals to manage the literature, help better retrieve information and make their research life easier.

In addition to the fact that Mendeley ask their users to complete the profile form, as a suggestion it seems logic to upgrade it for better understanding. Publishing the exact number for each category statistics, users and documents may increase its value more and more.

## Endnotes

1. http://archive.sciencewatch.com/about/met/core-hp/
2. http://ipscience-help.thomsonreuters.com/incitesLiveESI/ESIGroup/glossaryAZgroup/g2/8078-TRS.html
3. https://www.altmetric.com/top100/2017/#list
4. Hot papers are papers that receive a large number of citations soon after publication, relative to other papers of the same field and age. More precisely, they are papers published in the past two years that received a number of citations in the most recent two-month period that places them in the top 0.1% of papers in the same field. Retrieved from: http://ipscience-

help.thomsonreuters.com/incitesLiveESI/ESIGroup/indicatorsGroup/citationThresholds/thresholdHot.html

5. http://citt.ufl.edu/tools/social-citations/

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