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«ΔΙΑΧΕΙΡΙΣΗ ΠΛΗΡΟΦΟΡΙΩΝ ΣΕ ΒΙΒΛΙΟΘΗΚΕΣ, ΑΡΧΕΙΑ, ΜΟΥΣΕΙΑ»**

**ΤΜΗΜΑ ΑΡΧΕΙΟΝΟΜΙΑΣ, ΒΙΒΛΙΟΘΗΚΟΝΟΜΙΑΣ ΚΑΙ ΣΥΣΤΗΜΑΤΩΝ ΠΛΗΡΟΦΟΡΗΣΗΣ  
ΣΧΟΛΗ ΔΙΟΙΚΗΤΙΚΩΝ, ΟΙΚΟΝΟΜΙΚΩΝ ΚΑΙ ΚΟΙΝΩΝΙΚΩΝ ΕΠΙΣΤΗΜΩΝ**

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**Master Thesis**

**Scientometrics 2.0 and Research Impact**

**Author**

**Konstantinos Manikas (AM: 186682019)**

Supervisor: Alexandros Koulouris

Assistant Professor

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## Περίληψη

Η διαδικασία ποσοτικής αξιολόγησης της επιστημονικής απήχησης των παραγόμενων ερευνών (Scientometrics) ήταν και συνεχίζει να είναι ένα πολυεπίπεδο και πολύπλοκο ερευνητικό περιβάλλον για την επιστήμη της πληροφόρησης. Στον πολυεπίπεδο και πολύπλοκο χαρακτήρα των Scientometrics, προστίθεται τα τελευταία χρόνια η ταχύτατη παραγωγή μεγάλου όγκου δεδομένων (big data) ιδανικά για ερευνητικούς σκοπούς, η μεγάλη αύξηση παραγωγής ερευνών σε διεθνές επίπεδο, καθώς και η άνθιση της επιστημονικής ανοιχτής πρόσβασης. Παράλληλα οι ίδιοι οι ερευνητές, έχουν πλέον την δυνατότητα να διευρύνουν την ορατότητα, αναγνωρισιμότητα και απήχηση των ερευνών τους στον παγκόσμιο ιστό, λόγω της ύπαρξης πλήθους διαδικτυακών εργαλείων υπαγόμενα στο πλαίσιο των Altmetrics. Τα Altmetrics ή αλλιώς *Scientometrics 2.0*, αποτελούν ένα νεότερο ερευνητικό πεδίο ποσοτικής αξιολόγησης των παραγόμενων ερευνών.

Πιο συγκεκριμένα, τα Altmetrics, μπορούν να προσθέσουν στην απήχηση των επιστημονικών περιοδικών και των ψηφιακών αποθετηρίων επιστημονικής γνώσης, μετρικές σχετικές με τις προβολές-αναγνώσεις άρθρων (views-reads), τις λήψεις τους (downloads) τις κοινοποιήσεις τους (shares) κ.ά. Από την οπτική γωνία των ερευνητών, τα Altmetrics δίνουν την δυνατότητα σε αυτούς να συμμετέχουν σε πλατφόρμες σχετικών ερευνητικών δικτύων (ResearchGate, Google Scholar, Mendeley, Academia κ.ά.), να προχωρούν σε αυτό-αρχειοθετήσεις των άρθρων τους, να ακολουθούν και να ακολουθούνται (following - followed) από άλλους ερευνητές, ενώ σε γενικότερο πλαίσιο να διαμοιράζονται την ερευνητική τους παραγωγή.

Ωστόσο, για τους ίδιους τους ερευνητές, δεν υπάρχει ακόμα ξεκάθαρη και ποσοτικοποιημένη γνώση σχετικά με την συνεισφορά των Altmetrics στην διεύρυνση της ορατότητας, αναγνωρισιμότητας και της απήχησης των άρθρων τους στην αντίστοιχη επιστημονική θεματική περιοχή που απευθύνονται. Ως εκ τούτου, εγείρονται ερευνητικά ερωτήματα σχετικά με την συνεισφορά των Altmetrics ως προς την αύξηση των ετεροαναφορών (citations) στα τεκμήρια των ερευνητών, τον βαθμό ευκολίας εύρεσης άλλων ερευνητών με κοινά επιστημονικά πεδία γνώσης, καθώς και γενικότερα των βαθμό συνεισφοράς τους στην αύξηση της αναγνωρισιμότητας της επιστημονικής προσπάθειας των ερευνητών.

**Λέξεις Κλειδιά:** Altmetrics, Scientometrics 2.0, Research Impact, Traditional metrics, Citation, Visibility

## Abstract

The quantitative evaluation process of the scientific impact of research (Scientometrics) was and continues to be a multi-layered and complex research field for information science. In recent years, the multilevel and complex character of Scientometrics has been added, the rapid production of big data which assist research purposes, the huge increase of research production globally, as well as the flourishing of open access movement. At the same time, the researchers themselves have the ability to expand the visibility, recognition and impact of their research on the World Wide Web, due to the existence of a number of online tools that are included to Altmetrics. Altmetrics, or Scientometrics 2.0, is a new research field for quantitative evaluation of produced research.

More specifically, Altmetrics can add to the impact of scientific journals and digital repositories of scientific knowledge, metrics related to the views-readings of articles (views-reads), their downloads, their notifications (shares) etc. From the perspective of researchers, Altmetrics enables them to participate in platforms of relevant research networks (ResearchGate, Google Scholar, Mendeley, Academia, etc.), to self-archive their articles, to follow and to be followed by other researchers, and in a more general context to share their research output.

However, for the researchers themselves, there is still no clear and quantified knowledge about Altmetrics' contribution to the increase of visibility, recognizability and impact of their articles in their respective scientific subject area.

Therefore, research questions arise about Altmetrics 'contribution to increasing citations in researchers' work, the level to which other researchers with common scientific knowledge can be found, and their contribution to increasing recognition of the scientific effort of researchers, in general.

**Keywords:** Altmetrics, Scientometrics 2.0, Research Impact, Traditional metrics, Citation, Visibility, Strategy

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# 1. Introduction

As the world is changing and every process in our life is different compared to the past, new options arise. The research field is another domain that could not remain stable. Big data, data sources, research impact, visibility are some terms that are often used in academic environment. Since the research process is different now, measuring research impact has also changed. Nowadays, the people that are related to research process are working in different context. Many scholarly processes are differentiated and as a result research procedure is also affected. New opportunities should be exploited in order to achieve research objectives which can highly impact society. Essentially, research is an integral part of our life because it is beneficial for the scholar environment but also for society in general. Despite the fact that many people do not have a direct relationship with research they are also affected. This effort needs to be recognized by Academia and society.

The ways that research reputation and impact are measured vary. The most important thing during this process is that these measurements must be fair and the impact should be assessed thoroughly. Taking into account that research production is bigger than ever, it is essential to use quantitative data to present the impact of an author. "Research impact is the demonstrable contribution that research makes to the economy, society, environment and culture beyond the contribution to Academic Research" (Australian Research Council, 2017). The growth of literature size is considered as a key problem in scholarship (Rowlands and Nicholas, 2005), so it is necessary to filter the possible impact by using new metrics. The need for new measurement tools is obvious because bibliometrics and scientometrics are common and useful metrics but they also have disadvantages. They are "slow, narrow, secretive, and irreproducible, open to gaming and based on journals, not on the articles they contain" (Priem and Hemminger, 2010). New sources of impact metrics are necessary in order to obtain a concrete view of these aspects. Altmetrics is *"the study and use of scholarly impact measures based on activity in online tools and environments"* (Priem, 2014, p. 266). Alternative metrics are "formulated based on the idea that the Web is not just a mere usage by academics but may serve to provide evidence for the wider impacts" (Bong and Ale Ebrahim, 2017).

This study focuses on the opportunity that arises with the use of Altmetrics (Scientometrics 2.0) for every researcher. Social media and the advent of Web 2.0 affected research process and differentiated the reading audience. Nowadays, many papers are available on Open Access journals and subjects such as medicine, environment and social sciences are very popular and with high readability. In this master thesis, it is examined in what extent research affects not only scholar environment but also society and how the researchers can exploit the strengths of Altmetrics. Researchers' opinion, acceptance and knowledge about Altmetrics are presented. The aim is to clarify if researchers can exploit these new metrics and how this can be achieved.

## **1.1 Topic Justification, Aims and Objectives**

It is beyond any doubt that every researcher aims to impact the community as much as possible, either scholarly or socially. A usual way to show scholar impact is by exploiting citations but this kind of impact cannot be estimated from the same data. The social impact can be estimated quantitatively by observing data sources that are used not only by academics or researchers but also from different audiences. Altmetrics is the kind of metrics that can capture social impact.

Altmetrics offer many opportunities because they are calculated through real-time basis (Bong and Ale Ebrahim, 2017) and allow exploiting various data in order to estimate impact. The aim of the study is to explore if researchers know about altmetrics, if they exploit them and how. Moreover, various ways that researchers can increase their visibility by a using a proper strategy which is based on altmetrics counting is examined. The aim is to use altmetrics as a complementary tool to citations which will be beneficial for researchers. The wider context of the study is the adoption of new ways of measuring impact that are necessary while the research process is changing rapidly. Furthermore, it is important to propose a strategy for a better way to promote the researchers' work. In this work a strategy of adopting more opportunities for better visibility and findability is proposed. In order to achieve the aim of the study I considered the reasons that lead the community to find new ways of measuring impact and the new circumstances that are created. Moreover, it is attempted to discern the involvement of libraries and information organizations at this shift. Every factor that affects the measurement process is taken into consideration in order to answer our research questions. For instance, it is attempted to identify possible

correlations of open access, institutional repositories and academic institutions with researchers' impact and more specifically how these factors can ameliorate researchers' work and promotion.

## 1.2 Research questions

The present master thesis aims to answer the following research questions:

- Do researchers know altmetrics as a way to promote their scientific activity? Are they exploited or not and how?
- How can researchers increase their visibility through altmetrics taking advantage of the social impact they have that is captured through altmetrics?

## 1.3 Methodology

The method that has been followed in order to achieve the aim of this study was the quantitative approach. The master thesis process followed a three-stage analysis. After the construction of the research questions we used the research tools that are described in this chapter. The study was based on primary and secondary data in order to have more reliable and valid results. Three data sources were used in our effort to examine the topic performing various analyses. Secondary data were, initially, collected from *Altmetric.com*. We used the altmetrics values that are available in the list of Top100 most discussed articles for 2019. Specifically, we focused on the following altmetrics: News outlets, Blogs, Tweepers, Facebook pages, Mendeley, Wikipedia and also we added *Researchgate* reads and *Researchgate* interest. Secondly, the software Publish or Perish was used to harvest data about the citations of the same Top100 sample. Finally, primary research data were also collected. We constructed a questionnaire with sixteen items and sent it to 598 recipients. Then, the responses were assessed quantitatively. In this exploratory study, the interpretive method is used to explain our findings. The goal of interpretive research is to "document and interpret as fully as possible the totality of whatever is being studied in particular content from the people's viewpoint of frame of reference" (Leininger, 1985, p. 9). The questionnaires created were based on the literature review in order to correlate with the findings. The sample of participants was created by selecting the Top100 articles for 2019 according to *Altmetric.com*. Moreover, altmetrics stats were gathered by <https://www.altmetric.com/top100/2019/> and more specifically we focused on the following metrics : News outlets, Blogs, Tweepers, Facebook pages, Mendeley, Wikipedia and

also Researchgate reads and Researchgate interest. Additionally, by using the tool PublishOrPerish the citations of the specific articles were also gathered. For the estimation of our possible relationships between the altmetrics and survey variables, we use the Pearson  $\rho$  coefficient. In this way, we estimate the possible linear correlations among them. The closer is the  $\rho$  to 1 or  $-1$ , the greater the correlation is between the metrics. Positive correlation implies that when one variable is increasing the other variable is increasing too. Negative correlation indicates that when the decreases, the other increases.

## **1.4 Limitations**

The field of altmetrics has a great research interest and many outcomes can emerge. However, this study is prone to some limitations. The most common issue is the use of a very specific methodology and sample which means that the results cannot be generalized. Despite the fact that the usefulness and the value of altmetrics is presented by using 3 data sources, it is not directly implied that the results are valid for the whole research community. It was not feasible to show all the aspects of altmetrics, however, in the specific master thesis important results about research impact and altmetrics use are presented. Moreover, an important limitation of this study is that the data were gathered in a specific time period which means that the metrics may now be different. However, this limitation can be used in the future in order to compare the results of two different time periods at a specific year.

## **1.5 Definitions**

### **Scientometrics 2.0 or Altmetrics**

- “is the study and use of scholarly impact measures based on activity in online tools and environments” (Cronin and Sugimoto, 2014).
- “is used as an umbrella term which condenses ideas on how to combine social media with aspects of traditional scholarly practice” (Priem et al., 2010).
- “is a very new term, and can be defined as the creation and study of new indicators for the analysis of academic activity based on Web 2.0” (Priem & al., 2010).

## **Bibliometrics**

“encompasses the measurement of ‘properties of documents, and of document-related processes’. The range of bibliometric techniques includes word frequency analysis, citation analysis, co-word analysis and simple document counting, such as the number of publications by an author, research group or country” (Thelwall, 2008).

## **Institutional Repository**

“is a digital research archive consisting of accessible collections of scholarly work that represent the intellectual capital of an institution. It is a means for institutions to manage the digital scholarship their communities produce, maximise access to research outputs both before and after publication and also to increase the visibility and academic prestige of both the institution and authors” (Oladiran, M.T., Bentley, G., & Jain, P. 2013).

## **Open Access**

“is the free, direct, ongoing, and fee-free internet access to digital academic and scholarly content. Readers are free to use the available material for research, educational and other purposes. Open Access improves the quality of research, accelerates scientific progress and enhances innovation” (openaccess.gr,2020).

## **1.6 Master Thesis structure**

The first chapter is the introduction of this master thesis. The aims and objectives which were defined in a preliminary stage, the research questions set, the topic justification and the scope of the research along with the limitations are presented in this part of the master thesis.

The second chapter consists of the theoretical part of the study. A review of the literature is developed. Literature review conducted on 3 pillars: 1. The study of the transition from the use of traditional metrics to altmetrics. More specifically, the reasons for this change are examined, the correlation of citations with altmetrics and the role they play in measuring the impact of researchers. 2. The study of advantages and disadvantages of Altmetrics. 3. Potential adoption of altmetrics by researchers and the relation of this possibility with information science, information organizations and open access.



Chapter 3 presents the analytical methodology that was followed. The research methods and strategies, the data collection methods, the data analysis process, the quality of research and the ethical considerations are discussed throughout this section.

In chapter 4 the empirical findings and the data analysis of this master thesis are developed. The chapter includes a detailed presentation of results and the main findings of the research are highlighted.

The final chapter includes the discussion of the master thesis. In this part the findings are discussed and are related with the theory and with previous research. Furthermore, future research and its practical utilization are discussed along with some important conclusions from this work. .

## **2. Theoretical part**

### **2.1 Literature review**

This section consists of the review of the literature that I conducted for this master thesis. The theoretical framework of this study is based on the following three topics. First is the study of transition from the use of traditional metrics to new alternative metrics. More specifically, the reasons that lead to this change, the relation of citations with altmetrics and the role they play in measuring the researchers' impact are examined. The second is the presentation of the strengths but also of the weaknesses of altmetrics. The third is the potential adaptation of altmetrics use from researchers and its connection with information science, information organizations and open access.

Science has been, undoubtedly, developed over the last decades. This development is a consequence of technological developments in general and especially of Web diffusion. The present master thesis focuses on the term altmetrics which has been thoroughly reported in the scientific literature globally. Altmetrics can be considered as the most popular topic in scientometrics research (Bornmann, 2015 p. 123). The continuously growth of Internet use offers a great opportunity for a wider appliance of altmetrics for estimating the impact that a researcher has on scholar environment and society. The dynamic and the development of altmetrics can be observed and comprehended, for instance, in Google Scholar where from 2000 to 2009, 19000 search results are retrieved while from 2010 onwards, the corresponding number has raised up to 21900 search results.

Nowadays, it is beyond any doubt that research has been transferred to its online version. An extensive amount of research is conducted and reported electronically, while hard copies used to be the main way for researchers to communicate their work. Due to this alteration and the new needs that have arisen, the whole research process should adapt to the current situation. New ways of conducting and reporting, demand new ways to measure and present the impact of a scientific journal article. Traditional metrics are well-established measures but new, complementary ways that can accelerate the adaptation process to the new research environment are needed. Moreover, the way of measuring the impact is more complex than it was in the last decades due to the presence of many data sources and factors that should be taken into account. Social media play a crucial role in the present day

as more and more researchers publish their work in the Web. (Barbaro, Gentili & Rebuffi, 2014). Reference management systems, such as Mendeley, tools for online collaboration and social media are now an integral part not only for the research procedure per se but also for the researcher as an individual. Scholarly communication happens in many forms. As a result, the process of estimating the quality of research cannot remain stable; the traditional metrics could be considered obsolete despite the fact that is important. Traditional citation metrics are not capable to measure and illustrate the impact of different types of scholarly outcomes such as datasets and software (Barbaro, Gentili & Rebuffi, 2014). A huge amount of data is produced which renders the demands of the era of high importance nowadays. The evolution speed that altmetrics have and the potential of presenting a better picture of research impact are very important advantages. Altmetrics are thought to be tomorrow's filters (Ayre, 2013). The traditional way to measure the impact and the visibility of an author was related with the number of times that their name was included in the reference list of scientific publications. Scopus and Web of Science as important citation databases present in what extent an author has a significant impact on the scholar society (Bar-Ilan et al., 2012). The difference in these databases was the number of sources used, i.e. WOS is bigger than Scopus (Moed and Visser, 2008). A potential drawback of these types of measurements is that the social impact of an author cannot be exploited (Bar-Ilan et al., 2012). The opportunity for a holistic view is offered with alternative approaches such as altmetrics. As Priem (2010) states, altmetrics could be like an umbrella that encloses the traditional scholarly practice with social media. Altmetrics primary objective is to extend the theory about impact by consolidating new data sources and metrics (Bar-Ilan et al., 2012). Essentially, alternative metrics can be considered as a means of crowd sourcing peer review (Priem, 2010). The rise of altmetrics can be connected with the advent of Web 2.0. The openness of platforms like Mendeley and the offered opportunity for data harvesting, fostered the development of altmetrics. Also, Priem, at the manifesto (2010) proposed to investigate the correlation between altmetrics and existing measures, and also to predict citations from altmetrics with expert evaluation. This urge was followed by researchers and there are many studies that have examined this issue, e.g. whether there is a correlation between altmetrics and peer review processes (Priem, 2010). However, it is still under debate whether one can use these findings as evidence to ensure quality suggestions for particular articles, as the accuracy of citation prediction through altmetrics is not clear yet. Eysenbach (2011) presents important findings about the correlation of tweets with

traditional citation metrics. He presents a significant correlation between tweetations and citations. He examined a sample of 50 articles cited in the Journal of Medical Internet Research. The outcome of his study was that tweets can predict highly cited articles within the first 3 days of publication. Moreover, tweetation and citation from Google Scholar seems to have a narrow correlation compared to Scopus. This can be explained by the fact that Google Scholar uses a wider range of citing sources. It can be hypothesized that the exposure on social media, and especially Twitter, used by scientists and scholars, may predicts accurately the number of given citations. Moreover, some other aspects like the hyperlinks to articles can ameliorate the visibility of scholars through Search Engine Optimization (SEO). Twitter may have an impact on an author's popularity, be it a positive or negative influence. However, authors of research topics that are not popular among the public may not gain a lot by social media effect. Eysenbach (2011) presents a specific case where a topic had more citations than tweetations. This topic addressed to low-income, elderly population, a group that is underrepresented on Twitter. In other words, the citations and tweetations are not an outcome only of article's quality but also of external factors such as the journal popularity or the sample of the population that will read it. Actually, a correlation between tweets and citation prediction exists but it is subject to some limitations. Perfect correlation is not easy to be obtained because of some factors which are alterable and may affect this correlation. Eysenbach (2011) states that highly tweeted articles are 11 times more likely to be consequently highly cited. Passant and colleagues reported that, by observing Twitter use among a sample of participants of a scientific conference, the behavior is related with their disciplines and topics of interest (Passant, Decker and Breslin, 2010). Many studies in the global literature present quantitative results through which correlation of altmetrics and citations can be interpreted. Bar-Ilan et al. (2012) in their study, try to estimate the correlation between traditional metrics and altmetrics. They used Scopus, CiteULike and Mendeley and calculated the highest correlation between Mendeley and Scopus (.448). These findings are in close agreement with Li et al. (2012) who found similar correlation for Natural and Science articles. Bar Ilan et al. (2012) used a sample of 57 researchers among who, the highest percentage were active in Web (70% had LinkedIn profiles while 84% had Institutional pages). He captures a relative strong correlation between Mendeley counts and WoS citation ( $r=.46$ ). Also, it is stated that "as counts of citations and altmetrics grow relationship tightens, perhaps overwhelming sources of noise" (Bar Ilan et al., 2012, p.12). Li and Thelwall (2012) correlate highly Mendeley and

WoS ( $r=.69$ ) by using as sample, a set of articles that F1000 recommends. In accordance with the above, Priem, Piwowar and Hemminger (2012) report an  $r$  of  $.50$ . Bornmann (2015) states that new data sources of altmetrics offer the opportunity to estimate the broad impact of research. In his meta-analysis, an expected outcome is shown; the correlation between altmetrics and traditional metrics depend on how many researchers are active in social media. More specifically, he concluded that traditional metrics and microblogging counts are not correlated ( $r=0.003$ ), correlation with blog counts is relatively low ( $r=0.12$ ) and correlation with various reference management systems is moderate (CiteULike  $r=0.23$ , Mendeley  $r=0.51$ ). In general, a relationship between altmetrics counts and citations can be observed. Mazarei (2013) also reports a positive correlation between citation counts and article's bookmarks. Dorch (2013) states that bibliometrics and citations are not sufficient in areas such as arts and humanities. Also, highlights the need of complementary metrics to traditional metrics. He refers to PLoS in which article level altmetrics were implemented in 2009. Arts and humanities lack of usage data that would show the impact of an article in scholar and social environment. If one reads a scientific article, it is not entirely sure that the author will be quoted or cited, yet, the content may impact the reader's thought. So, "reads" are also important to emphasize because is a factor that means impact (Dorch, 2013). Readership population is consisted not only of researchers but also of non-publishing readers (around one third of the scientific community) (Price and Gurse, 1976). Haustein et al. (2014) use a sample of 166 participants of bibliometric community. One hypothesis of their study was "how many of them use reference management platforms". Between 70 respondents, the majority selected Mendeley as the most heard and used platform, among other such as BibSonomy, Connotea, CiteULike and Delicious. Another important result of the study was the findings about which one of the alternative metrics researchers believe that has the potential to assist in the evaluation of an article or an author. In descending order the results of the answers were: downloads or views of an article (71.8 %), citation in blogs (38%), mentions of or links to your work in Wikipedia (33.8%), bookmarks on reference managers (33.8%), discussions of your work in Web 2.0 platforms (31.0%), article about you on Wikipedia (26.8%), mentions on Twitter (23.9%), invocations on the Web (21.1%), followers on Twitter or other social networking sites (18.3%), other (9.9%). Moreover, an important finding is the respondents' opinion about the way social network and bookmarking systems affect their Professional life and/or work flow. 42.9 % answered that they had no influence, 22.2 % saw their work being improved while 5.6 % identified

increased visibility. Early altmetrics studies, also, investigated the possible correlation between altmetrics and traditional metrics such as citations, and the majority of the results showed that a positive correlation exists. Holmberg and Vainio (2018) list different altmetrics sources examined in the literature, supporting that altmetrics are directly connected with the number of citations that the articles receive later. The most common sources with high correlation are the following: Mendeley (Mohammadi and Thelwall, 2014), Wikipedia references (Evans and Krauthammer, 2011), and tweets mentioning articles with scientific content (Shuai et al., 2012).

Scholar impact is not the only desideratum; social impact is also valuable and measurable. In 1972, the citation data incorporated in the science indicators and now altmetrics are expected to be incorporated in research evaluation (Antelman, 2004). To make things clear, altmetrics are not used with the aim of substituting the traditional bibliometrics, but to complement them in order to exploit all the available sources and readers. Finally, altmetrics can capture impact in a more complete form, thus traditional bibliometrics and altmetrics can be considered as a common research topic. Always in comparison with bibliometrics, altmetrics are vulnerable to manipulation. However, bibliometrics also face similar problems. For instance, some journals are not publishing any articles on purpose for up to two years in order to increase their Impact Factor (Coats and Shewan, 2015). Moreover, self-citing is another way to increase h-index. Concerning altmetrics, problems with fake profiles and fake mentions are usual. For instance, an experiment conducted by Delgado Lopez-Cozar et al. (2014) where they connected false papers to a young researcher named Marco Alberto Pantani-Contador. With malpractices they examined if Google Scholar can detect this. The papers contained citation to articles that have been published by the Lopez-Cozar laboratory and Robinson Garcia. The result was impressive because their h-index and i10-index were increased and proved that Google Scholar citation can be easily manipulated. Karanatsiou et al. (2017) state that both altmetrics and bibliometrics are vulnerable to manipulation and therefore they are weak indicators for assessing performance. Nevertheless, they propose that a combination of the two metrics could be a good way to export safe conclusions. Haustein (2015) and Didegah et al. (2016) concluded in their studies that the factors that lead to citations and those that lead to altmetrics are not the same. As a result, they support that both could be used complementary to each other.

Twitter was initially developed as a means of communication but nowadays can also be regarded as a professional means for scientific purposes. Bar-Ilan et al. (2012) state that one

out of 40 scientists are active on Twitter. Undoubtedly, in 2019 this ratio will be increased. Naturally, the users' behavior is different based on their discipline (Hammarfelt, 2014). Nevertheless, Twitter is used by scientists and this can be shown by the fact that an appropriate terminology for scientific communication has been developed in Twitter. For example, the terms scientific tweet, first order citation, second order citation and external citation are used widely. Bornmann, (2015) in his meta-analysis, shows a somewhat expected outcome; the correlation between altmetrics and traditional metrics depends on how many researchers are active in the social media community. Moreover, in a conducted survey of bibliometricians, 86% of them expressed the opinion that altmetrics had the potential to assist authors' and article evaluation (Bornmann, 2014). An essential aspect of altmetrics that should be ensured is that their use follows the steps of traditional metrics and contributes to the peer review process. This shift is crucial for the researchers because the measurement process passes from journal level metrics to author and article level metrics. Quantitative measures are now a common tool that leads to funding and research evaluation. (Purch, 2013). As Piwowar (2013) states "research evaluation matters". Practically, she says that evaluation is a necessary criterion for being hired getting grants and provides an outstanding asset to get a career in Academia. The significant part of the evaluation process is that the researchers' output should be counted fairly by taking into account alternative outflows that cannot be reflected in citations.

The transformation described above and the necessity of this alternative way to measure scientific impact, urged many researchers to examine altmetrics in order to find out the benefits and drawbacks of this new term. To begin with, Wouters and Costas (2012) present four arguments that enhance the belief that altmetrics offer many advantages in comparison with the traditional bibliometrics. First of all, diversity is an important benefit. The opportunities that altmetrics offer for analyzing, as the visibility and the impact can be tracked easily because of the many sources of useful data, such as blogs, tweets, Facebook posts apart from citation. Altmetrics cover a wide range of ways to analyze impact. For instance, it is easier to measure article impact independently of the written language.

Secondly, speed is another promising argument about altmetrics usefulness and value. A considerable drawback of traditional metrics is the notable time that is necessary to collect citation data. Altmetrics are developed to overcome this obstacle. A citation takes time to be available while altmetrics makes the collection of data faster by using instantly available data from reference management software such as Mendeley. This feature facilitates the

fast analysis of data. Also, Priem and Costello (2010) state that 15% of Twitter citations are shown on the same day an article was published, 39% appear in the same week, and 56% in the same month (Priem & Costello, 2010). On the contrary, the score of h- index is calculated only at the end of the year and sometimes later (Sutton, 2014). Thirdly, the openness of method can be considered as an important advantage. Altmetrics data are usually free and available for researchers as opposed to citation databases such as Scopus and WOS which are relatively expensive. Altmetrics data are open and allow the researchers to assess their impact. However, as Wouters and Costas (2012) state this openness does not mean that we are totally informed about their exact operation while commercial companies such as Mendeley and Twitter exploit the benefits that altmetrics offer. Last but not least, is the broadness of measuring impact. The impact can be estimated as social impact in general, not just scholar impact. Altmetrics are not restricted to the scientific author judgments but as Kurtz and Bollen (2010) imply, altmetrics are addressed to four different readers categories: Researchers, professionals, undergraduates and interested public (Kurtz and Bollen, 2010). Scholar impact is not the only impact that a researcher can achieve with his work, social impact is also important and can be measured only with alternative metrics as it arises from the social web which is also used by readers outside Academia. Facebook, Twitter and Mendeley are some of these platforms that produce data for alternative metrics. Barbaro et al. (2014) in their study highlight the opportunities that occur by the advent of altmetrics. Altmetrics are an immediate way to measure impact while traditional citations are characterized as a slow process. Secondly, altmetrics cover a wider variety of research outputs such as slides and datasets. Moreover, the ultimate aim when using altmetrics is to present not only the scholar impact that an author or an article has but also the social impact that occurs through the dissemination of information on the social web. Also, the data that are produced can be considered reliable, as, for instance, Mendeley data show the activity that occurs from the interest on reading an article. The early impact evidence is also a characteristic of altmetrics potential. This opportunity could be exploited in evaluating researchers, departments, universities and funding programs. It facilitates and supports decision making when publications are too “young” in order to lead to citations. Wider impact evidence also adds value on altmetrics. Altmetrics offer view on different types of impact in contrast with traditional citations. Wider output types are also a unique advantage of altmetrics because through them quantitative data arise that imply impact from non-typical outputs such as YouTube and Grey literature. Another advantage of alternative



metrics is the finer-grained impact context (Thelwall, 2020). Impact that arises from altmetrics indicators offer information about nationalities, occupations and subject areas of interest of the readers (Thelwall and Maflahi, 2015). Collaboration is also affected by altmetrics because many researchers can exploit them and find others that are working on the same topic or project (Bong and Ale Ebrahim, 2017).

On the other hand, observers support that the above can be considered as a disadvantage as well. As far as the speed of data collection is regarded, it can render the quality of data questionable. Furthermore, social media and usage statistics may be easily manipulated through commercial services that increase, for example, likes on Facebook. Facebook is an example through which is easy to understand that data are vulnerable to gaming. Moreover, the impact of a research in social media could be unrelated with scientific reasons. Other potential weaknesses are:

- The absence of a standard context across different metrics.
- Social media platforms change very quickly, so the metrics based on specific platforms should change simultaneously because they may become obsolete if the way of measuring remains stable.

It is claimed that altmetrics give us “evidence of impact in days instead of years” (Piwowar, 2013a). Also, Piwowar (2013a) highlights the opportunity to include diverse audiences in the measurement process. For instance, an audience of high-quality work is not only academics, but also educators, students and the public in general. According to Priem, altmetrics lack of a theoretical background and as a result, they are vulnerable to gaming and biases. These three limitations can be considered as disadvantages of altmetrics but also as an opportunity for further research. Specifically, commercialization is a usual phenomenon that could affect the metrics in scientific fields. Another matter of controversy is the data quality in relation with different aspects.

- Bias: As social media use is not adopted from everyone, the users’ statistics could be regarded as not highly accurate.
- Target: The lack of specific information about user group renders altmetrics weak.
- Multiple version: Due to many versions of a paper the results of altmetrics could be ambiguous (e.g. double counting).

- Different meanings: The measurement cannot take into account the different meanings.

The difficulty of collection is an obstacle that hinders altmetrics adoption. The combination time that is needed to collect with the persons that are not aware of altmetrics prevent the proper use of altmetrics. However, the increasingly awareness of altmetrics seems to increase knowledge about them (Aung et al., 2019). Low coverage could be assumed as a drawback because it seems to be more applied in large document datasets. Altmetrics also face difficulty with field normalization. Moreover, uncompleted and biased coverage of impact areas are mentioned as weaknesses. The alternative indicators it is not sure that evidence that every type of impact will be captured. For example, indicators of tweet counts are biased to persons that do not use Twitter. Lack of quality control and incomplete coverage of impact types are also identified as weaknesses in the literature (Thelwall, 2020).

Regarding the third pillar of literature review, libraries are an integral part of Research and every information organization aims to assist their researchers and users. The users' needs vary, with some of them in need of bibliographic resources while others are more open to be directed towards the best path to promote their work. Libraries also play an important role in the development of research process. For example, libraries provided supporting services and tools to the researchers such ISI Web of Science and Scopus through which they track citation data and estimate citation metrics like h-index (Ayre, 2013). Librarians are the specialized personnel that are capable of managing, organizing, training and informing researchers about citations and their documented impact. ACRL (2014) declares that academic libraries are staffed with qualified persons that are appropriate for using altmetrics properly and to foster the research that is conducted in the institutions (Gonzalez Fernandez – Villavicencio et al., 2015). Librarians are considered as «assessors, trainers and advocates» as regards alternative metrics. As it is mentioned earlier, despite the fact that the detection and exploitation of traditional metrics are well-known issues for librarians, these may not be enough for estimating the real impact of research. Big data and social media have changed the research landscape dramatically. The wider variety of data sources lead to alternative metrics because citation analysis alone is not enough. Ayre (2012) underlines the relation between altmetrics and Open Access movement. Towards this direction, it is highly recommended that authors deposit their work in the Institutional Repository mainly for information dissemination purposes. Another important factor, which

affects author's impact, is his\her visibility on the Web. One way of achieving higher visibility is the use of high-quality metadata for maximizing Search Engine Optimization (SEO). Ayre also states that London School of Economics (LSE) Research collects statistics which are used in parallel with traditional citation metrics. Essentially, they take into account the broader social context. By using DOIs they assist researchers to pinpoint the level that their works impact society and the scholar environment. As a result, both researchers and libraries profit by this procedure; not only do the researchers use subsidiary tools to promote their work, but also libraries, through the repositories, offer high-quality content to the users. Another opinion of discussion in 2014 was that librarians could conduct more research about altmetrics and especially about defining the quality of altmetrics and its impact in the whole research procedure (Barbaro et al., 2014). «Armed with the knowledge that certain types of measure correlate with citation counts, librarians who are helping people finding recently published research will be able to confidently recommend certain articles over others, given their altmetrics counts» (Konkiel, 2013, p. 14). Also, they propose 3 pillars that librarians should be based for supporting and helping their users: «informing emerging conversations with the latest research, supporting experimentation with emerging altmetrics tools and engaging in early education and outreach» (Barbaro et al., 2014, p 6). For example, in Australia, librarians are actively involved in the process of making users aware of altmetrics (Barnes, 2015). Some initiatives of adopting altmetrics in libraries are listed in Gonzalez Fernandez – Villavicencio's et al. (2015) study. To begin with University of Pittsburgh Library System is collaborating with Plum Analytics in order to exploit new ways of evaluating University's impact. Institutional repositories and social media platforms are two means that assist the process. Another case is that of P. Scott Lapinski in the Harvard Medical School and Harvard School of Public Health for the NIH Public Access Policy who trains users in altmetrics use and demonstrates to the researchers the advantages and disadvantages of offering their work openly accessible. Also, Lisa Palmer, librarian on institutional repository at Lahar Southern Library trains the users at altmetrics practice by promoting Altmetric.com in order to show the impact of the researchers' papers. John Furfey of the MBL WHOI Library, used an API to incorporate altmetrics into the systems of profiles of the researchers (Gonzalez Fernandez – Villavicencio et al., 2015).

The value of altmetrics is a matter of controversy which is highly debated in the global literature. Moreover, as far as the profession of librarianship is concerned, many librarians support that adopting altmetrics may be a useful tool that could assist with the

enhancement of research process by offering the institutions the opportunity to understand and build their own impact (Galligan, 2012). The opportunity for the profession can be substantial; if someone considers that its value is in dispute. Given that, the involved persons should undertake new responsibilities (Lapinski, Piwowar and Priem, 2013). In Gonzalez Fernandez – Villavicencio's et al. work (2015) the authors try to summarize the reasons that librarians should incorporate altmetrics in their daily activity.

- Librarians are consultants who assist researchers to understand, improve and build their own impact by using altmetrics as a complementary method to traditional citations. Through this process, librarian becomes an expert in the scientific communication process (Priem, Piwowar and Hemminger, 2012). The orientation that librarians offer to the researchers could lead to financing of research projects, promotions and granting.
- Librarians who estimated the potential of altmetrics can present to university administrators the advantages and disadvantages of using altmetrics and they can display a comparison of altmetrics with other measures of influence (Brigham, 2014).
- Acting as trainers, librarians should encourage experimentation with emerging altmetrics tools. For example, new ranking symbols appear frequently on repositories and databases, so librarians should be ready to inform researchers about them.
- Library collections are also affected by the advent of altmetrics. During the process of electronic resources purchasing librarians should take into account the altmetrics parameter and the new usage data.
- «As a bridge with the suppliers of altmetrics. Librarians have to be always attentive to the existing metrics of the evaluation of scientific publications and can function as a bridge between the needs of the researchers and institutions and the suppliers of alternative metrics to indicate the errors that exist» (Gonzalez Fernandez – Villavicencio et al., 2015, p. 7).

On the contrary, it is stated that librarians should be cautious with the use of altmetrics and avoid overestimating their value as they are considered an imperfect tool for the prediction of articles performance (Barnes, 2015). Information scientists must be able to identify the opportunities and the limitations of altmetrics. They have to know how to exploit their use

by offering quantitative data to stakeholders such as institution administrators to make the decision-making process easier. It is commonly accepted that in many cases decision-making demands quantitative data (Brigham, 2014).

Repositories are another field that is affected by the exploitation of altmetrics. The first repository that added altmetrics in order to enrich the usage statistics was Digital CSIC (Gonzalez Fernandez – Villavicencio et al., 2015). In January 2014 altmetrics indicators from various sources such as Academia .edu, Facebook, LinkedIn, Mendeley, ResearchGate, SlideShare, Twitter, Wikipedia and Youtube were adopted by the Ranking Web of Repositories (Gonzalez Fernandez – Villavicencio et al., 2015). Rovira I Virgili University in Spain promotes the achievement that among the university's research staff it can be found the second scientific paper of the list with the articles with the bigger impact in the social networks in 2013 according to Altmetric.com (Gonzalez Fernandez – Villavicencio et al., 2015). Dorch (2013) places the open full text repositories in the landscape of factors that affect perceived impact. He proposed an analysis of statistics with two important metrics: views and full text downloads. The important on this measurement is their combined interpretation as by using only "hits" or downloads, the results do not imply impact. Konkiel and Scherer (2013) highlight the opportunities that arise for repositories at the age of altmetrics. To begin with, authors should exploit not only the usage statistics that occur by the altmetrics tracking services but also the information about readers. They can gain a deeper insight about the existing impact of their Open Access content offered in repositories. Secondly, altmetrics in conjunction with citations can work as a tool for documenting authors' impact. Repositories can add value to the researchers' effort to impact the scholar community and society in general. The role of the librarian lies with the objective to help researchers comprehend the deposit of their work in open access repository could be beneficial for their work. It is essential to motivate depositors by promoting the increase of usage statistics when a study is openly accessible. The relationship between altmetrics and open access is inextricable. Open access journals were the first that adopted altmetrics usage in order to provide article level metrics. (JMIR and PLoS by using open data or open source systems such as Mendeley and Institutional Repositories (Sutton, 2014). Openness and accessibility of content are factors that affect the crowd-sourced peer review (Galligan and Dyas-Correia, 2013). New metrics offer the opportunity to take into account new parameters about impact based on open data, speed and diversity of sources (Sutton, 2014). Altmetrics «use mostly publically available data, making the process and

calculations completely transparent» (Galligan and Dyas-Correia, 2013, p. 57). In the contrary, traditional metrics such as Journal Impact Factor are available only after subscription. Moreover, repository managers could exploit statistics in order to communicate them to repository funders. Many university administrators need specific figures to estimate the value of various services. Better planning is also achieved by exploiting altmetrics together with usage statistics. Collection development, resource allocation and marketing outreach could happen more properly. Furthermore, altmetrics work as an additional indicator that universities use to present their impact to external and internal stakeholders. Popularity of content should be used in favor of creator and institution. Last but not least, altmetrics scores can be used as evidence of a researcher's impact for various occasions, e.g. faculty reviews committees, better understanding of an author's scholar and social impact. High scores indicate impact that could lead to promotions or grants (Konkiel, 2013). The common sense among the authors is that librarians should involve in the alternative metrics exploitation. Due to this involvement some steps are reported in the literature: Understanding and training in altmetrics, include this knowledge on their CVs, communication with other universities and proposing projects and collaborations in order to study and hence to implement altmetrics, information literacy competencies of library users, incorporate altmetrics to the collection development process, implement altmetrics to the institutional repositories and finally dissemination of altmetrics use by documenting strengths and weaknesses. Altmetrics could be considered as a natural expansion of libraries and librarians work. Tracking user behavior such as page clicks and downloads was a usual work for a librarian who is working on e-resources department of a library.

It is crucial that librarians inform researchers to understand the potential and advantages of altmetrics. The weaknesses of traditional metrics such as Journal Impact Factor (JIF) and h-index lead to the emergence of new impact indicators. Altmetrics «allow assessment directly at the product level, rather than the publication» (Lapinski, Piwowar and Priem, 2013, p.4).

## **3. Methodology**

### **3.1 Aim of Research and methodology**

The aim of this study is to examine whether researchers perceive altmetrics as a way to promote their scientific activity, whether they use them or not and how. Moreover, this study aims to explore how researchers can increase their visibility by exploiting the social impact of their work through altmetrics.

In this chapter I present the methods used for the analysis of this work. The research strategies, data collection methods, data analysis procedure and ethical considerations are discussed using a quantitative approach. "Quantitative research is a means for testing objective theories by examining the relationship among variables. These variables, in turn can be measured, typically on instruments, so that numbered data can be analyzed using statistical procedures." (Creswell, 2009, p.17). Quantitative research is a type of research that leads to outcomes that are measurable by using statistical analysis procedures. The opportunity that could be said that is provided through this research is that the findings can be replicated. Methodological techniques of this approach are surveys and experiments. The strategy that I followed is the survey, because it is a study in which numerical descriptions of attitudes and opinions are presented in order to examine a specific sample of the whole population. In our study we planned to use not only one but two research tools, and three different data sources. The first research tool is questionnaires and the second is data observation. By applying the first research tool we collected data from the participants' responses by creating a questionnaire which was sent electronically. Regarding the observational data, we selected two sources from which we collected the appropriate data in order to answer our Research Questions. The first data were gathered by Altmetric.com on January 2020. By using this platform, we had data that shows how popular are the Top100 articles according to altmetrics. After that, also in January 2020, we collected data by using the software PublishOrPerish for gathering traditional metrics (cites) in order to collect information about other metrics for the Top100 articles that we choose from Altmetric.com. Essentially, by having 3 different data sources, the data analysis process was more complex but also more valid and valuable.

## 3.2 Sampling and Data Collection

These specific altmetrics were selected based on the prior examination of the literature and hence their stand-alone involvement into the examination of possible intercorrelation between altmetrics and traditional metrics. This kind of selection was further reinforced through the utilization of Altmetrics.com database. More specifically, all the Top100 most influential articles included these metrics plus others. The selection process of altmetrics with multiple metrics that are not included in all articles could cause fragmentation of the retrieved datasets and thus inability to quantitative comparisons and examinations.

Our sampling study has data that derive from primary and secondary research. Primary data arise from the questionnaire that was constructed in accordance with our Research Questions and the literature that was studied. Secondary data were gathered from two different sources. The first was the website of Altmetrics.com. In the beginning of the research we contacted Altmetric.com and applied for and granted no-cost access to Altmetric tools and data explorer. However, during the research we used only the data that are available on their website as presented in Figure 1. Specifically, in the Altmetric.com we focused on the following altmetrics: News outlets, Blogs, Tweeters, Facebook pages, Mendeley, Wikipedia and also we added Researchgate reads and Researchgate interest.

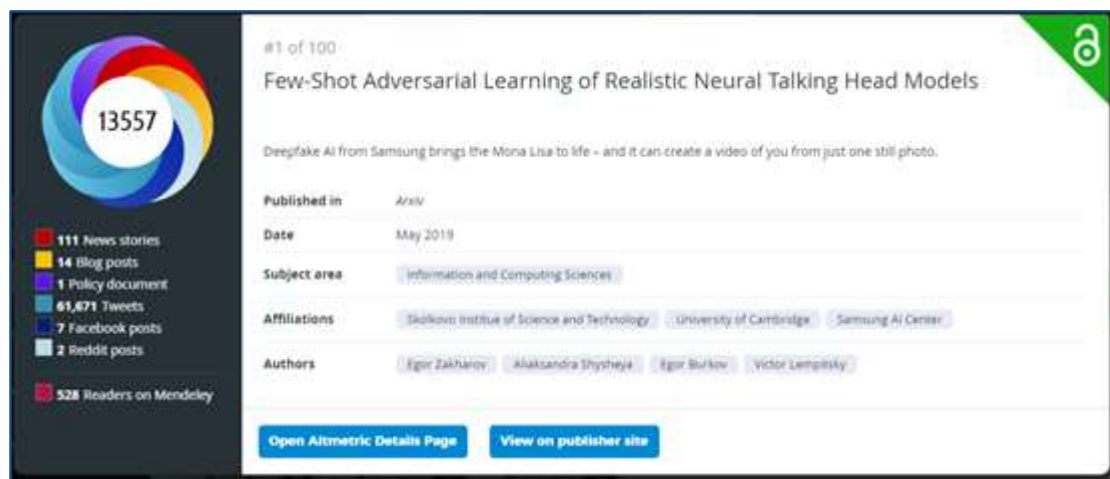


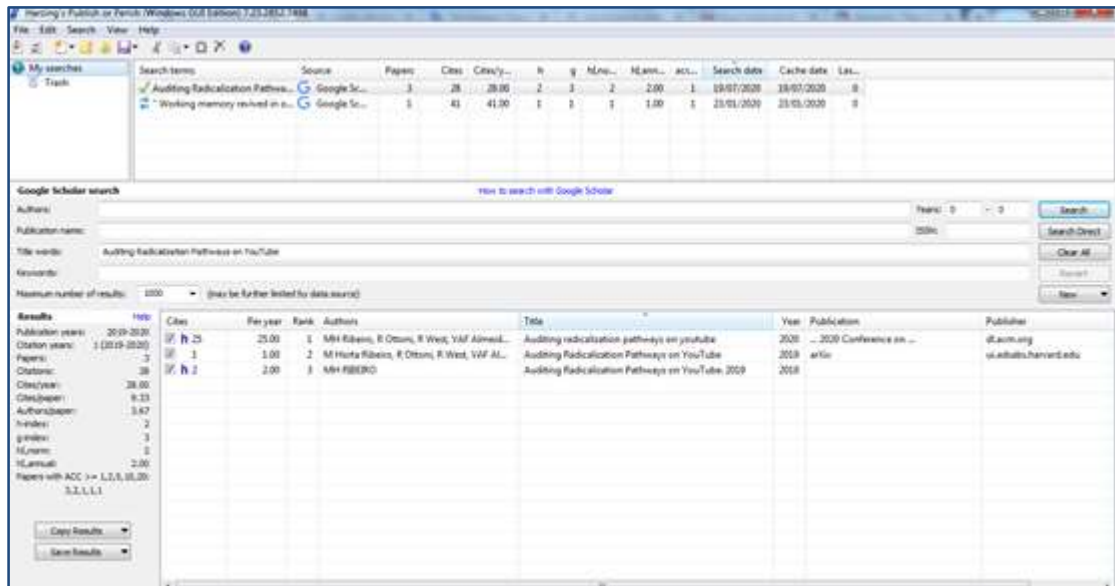
Figure 1. Altmetric.com interface



**Table 1. Altmetrics explanation and examples**

Altmetrics item	Description	URL example	Resource
News outlets	A reference-mention of a paper inside a news website	<a href="https://www.altmetric.com/details/57358237/news">https://www.altmetric.com/details/57358237/news</a>	Altmetric Top 100
Blogs post	A reference-mention of a paper inside a post in a specific thematic informational website, that is, a blog.	<a href="https://www.altmetric.com/details/57358237/blogs">https://www.altmetric.com/details/57358237/blogs</a>	Altmetric Top 100
Tweeters	Indicates numerically how many users of twitter platform mentioned a certain paper	<a href="https://www.altmetric.com/details/57358237/twitter">https://www.altmetric.com/details/57358237/twitter</a>	Altmetric Top 100
Facebook Pages	Indicates numerically how many Facebook Pages mention a paper inside their post	<a href="https://www.altmetric.com/details/57358237/facebook">https://www.altmetric.com/details/57358237/facebook</a>	Altmetric Top 100
Mendeley Readers	Indicates numerically how many readers, read the article inside Mendeley platform	<a href="https://www.altmetric.com/details/57358237#mendeley-demographics">https://www.altmetric.com/details/57358237#mendeley-demographics</a>	Altmetric Top 100
Wikipedia Mentions	The number of mentions that a paper is referred inside Wikipedia articles	<a href="https://www.altmetric.com/details/57358237/wikipedia">https://www.altmetric.com/details/57358237/wikipedia</a>	Altmetric Top 100
ResearchGate Reads	The number of reads that a paper receives inside the Research Gate platform	<a href="https://www.researchgate.net/publication/331908769_Scientists_rise_up_against_statistical_significance">https://www.researchgate.net/publication/331908769_Scientists_rise_up_against_statistical_significance</a>	Research Gate Platform
ResearchGate Interest	It constitutes numerically the total impact of a researcher inside the platform. Its cohesion is composed of multiple underline sub-variables such as citations, recommendations, comments, answers number of articles that the author uploads and so on.	<a href="https://www.researchgate.net/profile/Valentin_Amrhein">https://www.researchgate.net/profile/Valentin_Amrhein</a>	Research Gate Platform

The second source of data was collected by using the Publish or Perish (Figure II) which “*is a software program that retrieves and analyzes academic citations*”. We managed to gather data that presents the traditional metrics/citations of the Top100 most discussed articles according to altmetrics. The aim of this collection was to use the data for correlating Altmetrics with traditional metrics and to examine them in accordance with the opinions of the participants about metrics in general.



**Figure 2. Publish or Perish interface**

**Πίνακας 2. Altmetrics explanation and examples**

Traditional Metrics	Description	Resource
Cites	The number of the total citations that a paper receives from Google Scholar.	Publish or Perish   Harzing.com <a href="https://harzing.com/resources/publish-or-perish/manual/using-query-results/metrics">https://harzing.com/resources/publish-or-perish/manual/using-query-results/metrics</a>
Cites Per Author	The Average number of citations per author in Google Scholar. Based on Harzing.com this is calculated as: <i>For each paper, its citation count is divided by the number of authors for that paper to give the normalized per-author citation count for the paper. The normalized citation counts are then summed across all papers to give the number of citations per author over the result set.</i>	
Cites Per Year	The average number of citations per year for each author in Google Scholar.	
Author Count	The number of authors that each article has.	

The selection of primary research sample was a crucial decision. At a first thought we considered choosing a random sample with researchers that are working in different research fields. However, we decided to select a specific sample of people. Specifically, we chose the authors of the Top100 most discussed articles of 2019 according to the Altmetric.com. (<https://www.altmetric.com/top100/2019/>). Altmetric.com is considered as one of the most important altmetric data providers currently used. Altmetric.com is a

service that tracks a range of sources to capture and collate conversations that happens online about scholarly content and helps users to monitor and report on the attention surrounding the work they care about. The specific sample allowed us to evaluate and examine opinions of persons that are benefited from altmetrics but without been necessary that they use a strategy in order to promote their work through altmetrics. Moreover, the fact that they was in this Top100 list does not mean that they are supporters of altmetrics in evaluating research and measure impact. After that, we gathered 598 email addresses from the Web, in order to deliver them electronically the questionnaire. This judgment sample was useful because we believed that would give us useful answers about the hot issue of altmetrics.

After the collection of the secondary data and the contact details of the authors of the Top100 articles, we sent 598 personalized emails. We chose to personally contact the authors because we wanted to highlight the importance of their participation in the study. We avoided bulk messaging and we considered potential problems because of the large number of emails. Furthermore, in our research we do not have demographic characteristics because our sample was selected based on the Top100 list. During the delivery process 27 emails were not delivered and one week later of the first message we sent a kind reminder to 571 persons. Finally, the responses that we got were 74.

An issue of utmost importance for us was the ethical considerations of our study. Ethics holds an important place in the global literature. As Hart (2005) states, "Ethics is concerned with the attempt to formulate codes and principle of moral behavior." (Hart, 2005, p.279). It was necessary for us to secure ethical issues that arise during a research. Firstly, avoiding plagiarism and referencing persons that have also done important work on the topic were our main objectives. Moreover, as regards our primary research we focused on respecting the rights of the participants and on gathering valid and reliable data. As Creswell (2009) states, "in order to have an ethical research the researcher is obliged to respect the participants' values and rights" (Creswell, 2009). According to the literature, we tried to avoid moral errors. We considered every ethical issue that could arise due to the fact that we have to do with persons and data. We focused on the protection of the participants by ensuring that their responses would be used only for the specific master thesis. We also tried to develop trust and a personal relationship with them by sending personalized emails and by searching their work in order to understand what they are doing in their research.

We guaranteed for the authenticity and credibility of our research, tried to make them understand the aim of the research and finally we explained the benefits that this study should offer. Moreover, we tried to follow the stages that Hart (2005) introduces about the research. In the stage of implementation, we kept a respectful position to the participants, we tried to avoid mistakes and we have been self-reflective. Furthermore, the ethical issues when using questionnaires that Cresswell (2009) refers to were also considered carefully. We tried to secure the following by providing specific details about the study in the cover letter:

- Identification of the researcher
- Identification of the sponsoring Institution
- Indication about the process that we selected the participants
- Identification of the aim of study
- Guarantee of the confidentiality of the participants
- Provision of contact persons in order to contact if any questions arise during the participation process

Regarding reporting, we respected every effort of previous researchers and we gave credit to them, we obtained the integrity of the collected data.

### **3.3 Research Tool Construction and Reliability**

To collect primary data on researchers' opinion for altmetrics and their scientific and societal impact, a questionnaire with sixteen items was constructed. The development of the survey is composed both by prior research implications and findings of the related research community, and novel items derived from the literature review examination. In the next table (Table III) all the questionnaire items are presented. On the second column of the table, the questionnaire item is presented, while on the right the resource is provided, i.e. where the question was derived from. Subsequently, reliability analysis was performed with the purpose to show quantitatively the cohesion and consistency of the survey. We describe more for this issue on the next chapter (3.4 Statistical Analysis Method). Finally, the results of the reliability analysis are described in Table 9.

**Table 3. Items of Questionnaire**

<b>Q. Number</b>	<b>Questionnaire Items</b>	<b>Resource</b>
Q.1	Are you aware of altmetrics as a mean of measuring your impact?	Developed
Q.2	Do you use altmetrics in order to disseminate and promote your research?	Developed
Q.3	Do you believe that there is a connection between altmetrics and citations?	<a href="#">Bar-Ilan, J., Haustein, S., Peters, I., Priem, J., Shema, H., &amp; Terliesner, J. (2012).</a>  <a href="#">Eysenbach, G. (2011)</a>
Q.4	Are you interested in the social impact of your research?	<a href="#">Eysenbach, G. (2011)</a>
Q.5	In descending order, I upload my research papers at: <ul style="list-style-type: none"> <li>✓ Academic/ Institutional Repository</li> <li>✓ Mendeley</li> <li>✓ Academia.edu</li> <li>✓ ResearchGate</li> <li>✓ Orchid</li> <li>✓ Other</li> <li>✓ None of them</li> </ul>	<a href="#">Haustein, S., Peters, I., Bar-Ilan, J. et al. (2014)</a>
Q.6	In descending order, I share my research papers at: <ul style="list-style-type: none"> <li>✓ LinkedIn</li> <li>✓ Facebook</li> <li>✓ Twitter</li> <li>✓ Other</li> <li>✓ <input type="checkbox"/> None of them</li> </ul>	<a href="#">Haustein, S., Peters, I., Bar-Ilan, J. et al. (2014)</a>
Q.7	In descending order, I would prefer my research papers to make the most societal impact thought their citation in: <ul style="list-style-type: none"> <li>✓ News websites</li> <li>✓ Blogs</li> <li>✓ Wikipedia articles</li> <li>✓ LinkedIn</li> <li>✓ Policy document</li> <li>✓ Facebook post/share</li> <li>✓ Twitter</li> <li>✓ Social Video Platform (Youtube, Vimeo etc).</li> <li>✓ Other</li> <li>✓ <input type="checkbox"/> None of them</li> </ul>	Developed
Q.8	In what ways do altmetrics affect your professional life and/or work flow? <ul style="list-style-type: none"> <li>✓ no influence</li> <li>✓ improving working process</li> <li>✓ expecting future influence</li> <li>✓ increasing workload</li> <li>✓ improving contact management and collaboration</li> <li>✓ increasing visibility and findability</li> <li>✓ Increasing reputation</li> <li>✓ other influence</li> </ul>	<a href="#">Haustein, S., Peters, I., Bar-Ilan, J. et al. (2014)</a>
Q.9	Do you know the strategic techniques for increasing visibility and findability your research through the	<a href="#">Bar-Ilan, J., Haustein, S., Peters, I., Priem, J., Shema, H., &amp;</a>

	World Wide Web?	<a href="#">Terliesner, J. (2012).</a>
Q.10	Do you prefer to publish your papers in open access journals?	Developed
Q.11	Do you believe that your scholarly impact will be increased if you publish in open access journals?	<a href="#">Repanovici, A. (2011)</a>
Q.12	Do you believe that open access is connected with the increase of your visibility and your impact?	<a href="#">Antelman, K. (2004)</a> <a href="#">Holmberg, K., &amp; Vainio, J. (2018)</a>
Q.13	Do you believe that your societal impact will be increased if your papers published in open access journals?	Developed
Q.14	In your organization is there any relevant service (e.g. a library) that provides information about how to promote your research?	<a href="#">González-Fernández-Villavicencio, N., Domínguez-Aroca, M. I., Calderón-Rehecho, A., &amp; García-Hernández, P. (2015)</a>
Q.15	Do you believe that this kind of service will be useful?	Developed
Q.16	Do you believe that libraries are able to offer this kind of services?	<a href="#">González-Fernández-Villavicencio, N., Domínguez-Aroca, M. I., Calderón-Rehecho, A., &amp; García-Hernández, P. (2015)</a>  <a href="#">Rathemacher, A. (2014)</a>

### 3.4 Statistical Analysis Methods

At the initial stage of data analysis, descriptive statistics were calculated for exploratory purposes. Furthermore, statistical reliability analysis was performed with the purpose to measure the cohesion and consistency of the survey and the involved items in each factor. Descriptive statistics include measures such as Mean, Frequencies, Standard Deviation, Skewness and Shapiro-Wilk values as a test of normality for each item.

Skewness metric was selected as an effective way to quantitatively understand the tendency of respondents to answer positively or negatively along the choices of the likert scale (Von Hippel, 2005). For example, a negative Skewness value means that the majority of the respondents answer to the positive choices of the likert scale. Oppositely, a positive one Skewness value indicates that most of the respondents tend to answer to the negative choices of the likert scale. Shapiro-Wilk test was selected to test the normality of the gathered data in each item. That is, the closer the metric to 0.999 and its p value to  $< 0.001$ , the higher the likelihood to have a dataset with items that follow a normal distribution (Shapiro, 1965).

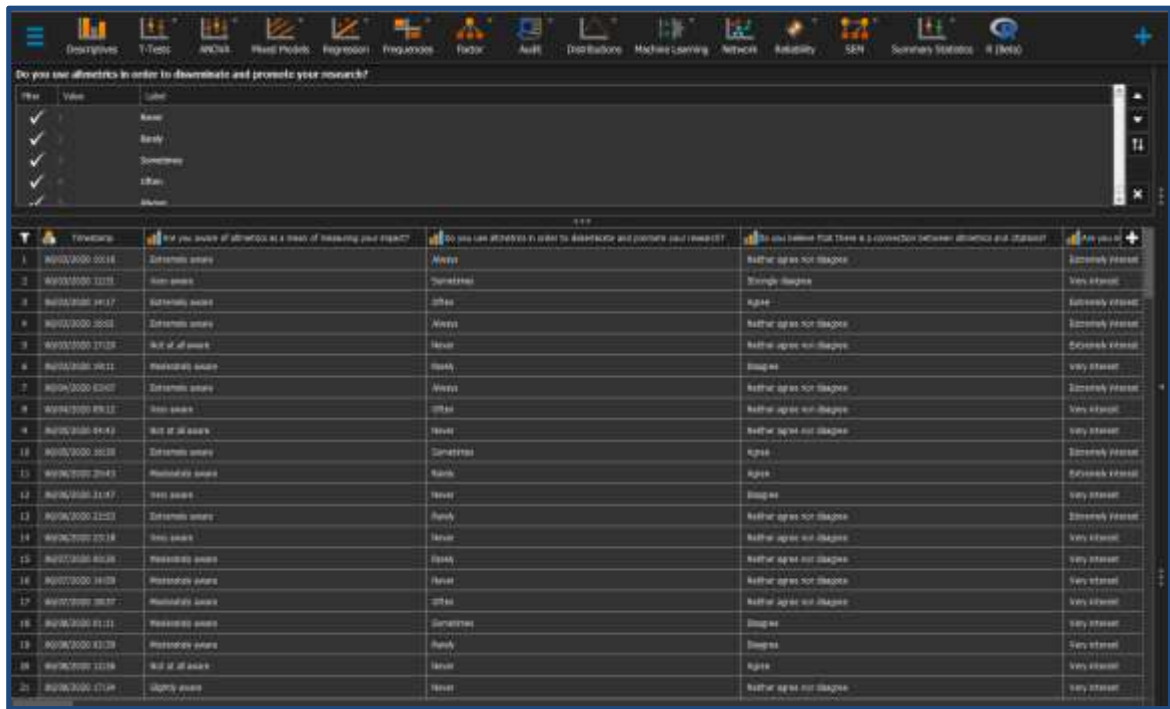
For testing the reliability, cohesion and consistency of the questionnaire and its involved metrics Cronbach's Alpha ( $\alpha$ ), McDonald's  $\omega$  and Guttman  $\lambda$ -2 were used. For Cronbach's, a range of 0.550 up to 0.750 indicates an acceptable level of reliability and 0.800 or higher an excellent level (Ursachi, Horodnic and Zait, 2015). McDonald's  $\omega$  indicator has the advantage to measure the strength of association between the proposed variables. More specifically, the closer to 0.999 the higher the strength of the association between the variables (Şimşek and Noyan, 2013). Guttman's  $\lambda$ -2 works similarly to Cronbach's  $\alpha$  and estimates the variance trustworthiness of the answers that respondents submitted. Values less than 0.500 indicate high bias among respondents' answers, while values higher than 0.650, increase the reliability of the sample (Callender and Osburn, 1979).

Kaiser–Meyer–Olkin (KMO) and Bartlett's Test of Sphericity were used for measuring the cohesion of the selected altmetrics. KMO and Bartlett's test indicate that the closer the value to 0.999 amongst the involved items, the higher the cohesion and consistency of the items for potential categorization (Dziuban and Shirkey, 1974).

Subsequently, correlation analysis was performed in order to answer the second research question regarding the extent to which altmetrics affect the visibility, scientific and societal impact of researchers. For the estimation of our possible relationships between the altmetrics, traditional metrics and the rest of the survey variables, Pearson's  $\rho$  correlation coefficient was used to estimate the potential linear relationships among them. The closer the  $\rho$  to 0.999 or  $-0.999$ , the greater the correlation between the metrics.

For the statistical analysis of the extracted datasets from the survey, the altmetrics database and the Publish or Perish, the JASP software Version 0.13.1 was used (JASP Team, 2020).

JASP (Figures 3 and 4) has an easy-to-use interface, usable to deploy statistical tests with clear visualization of the results. In addition, the parameterization of the selected variables for each test is much easier, while the tests results are re-deployed and updated automatically when including or excluding variables, without multiple stand-alone runs.



**Figure 3. Interface.** In this figure, some variables of the dataset are presented. JASP software uses csv files to load the dataset itself. It also has the capability to click on the dataset, open the csv file and include more values, or excluding some.



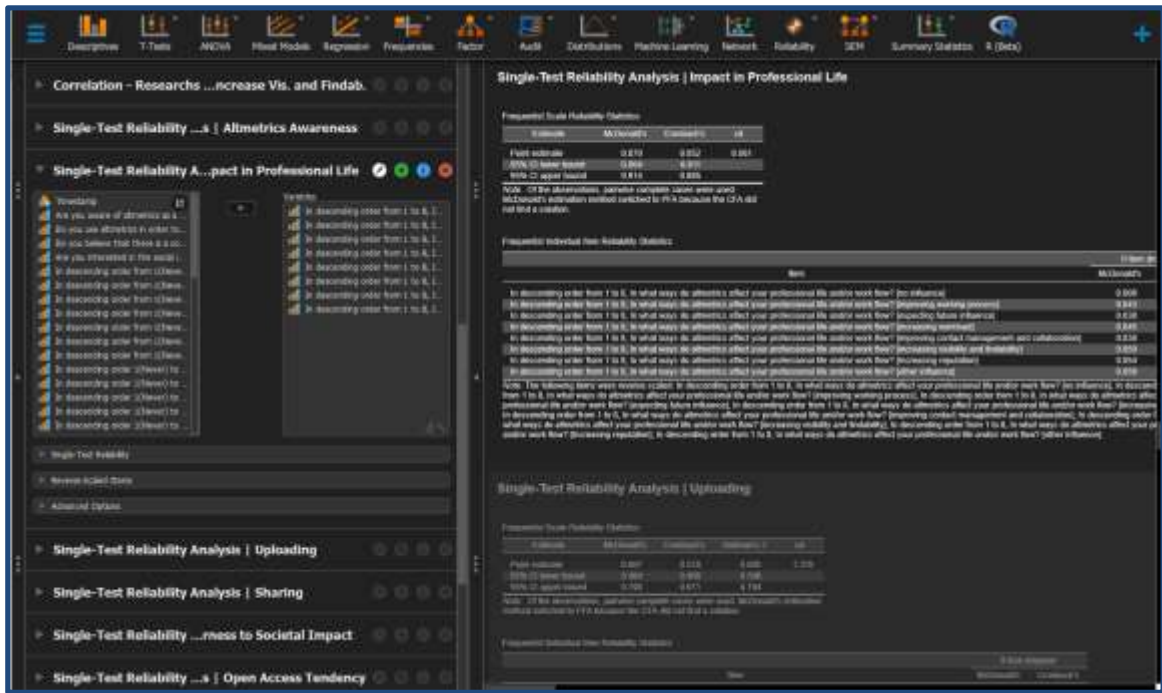


Figure 4. JASP Interface. Implemented statistical tests. On the left the name of the test is depicted. On the right side, the results of the tests are demonstrated

## 4. Research part – Empirical Findings

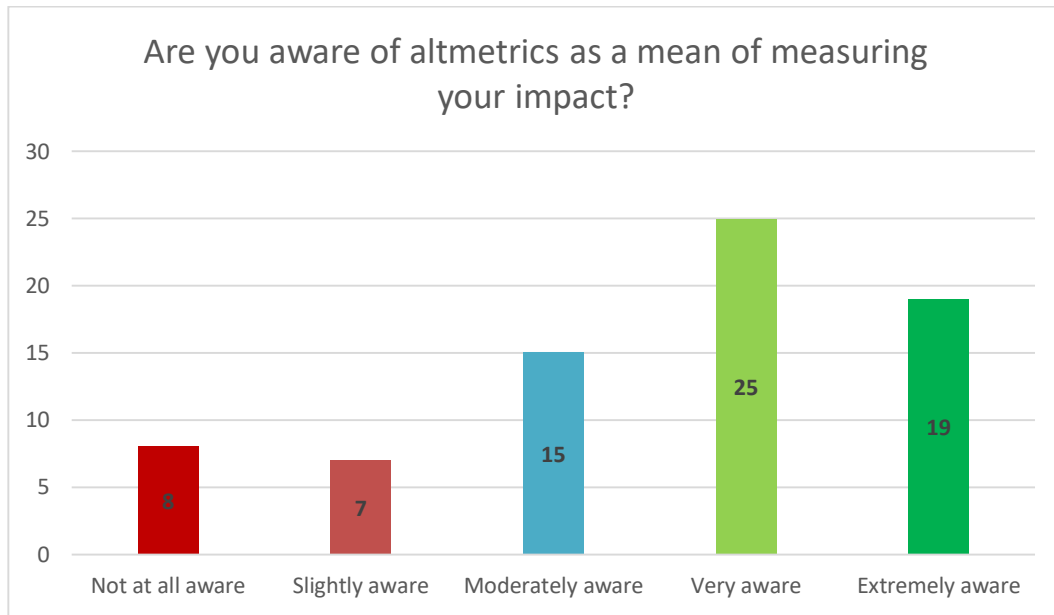
### 4.1 Results

In this chapter an analytical presentation of results takes place. In chapter 4.2 descriptive statistics from the research questionnaire are unfolded. In chapter 4.3 altmetrics and traditional metrics descriptives are presented. Thereafter, in chapter 4.4 reliability and correlation analyses take place with the purpose to examine the possible interrelationships between altmetrics, traditional metrics and researchers' opinions.

**Table 4. Descriptive Statistics. Measuring items regarding researchers' awareness for altmetrics**

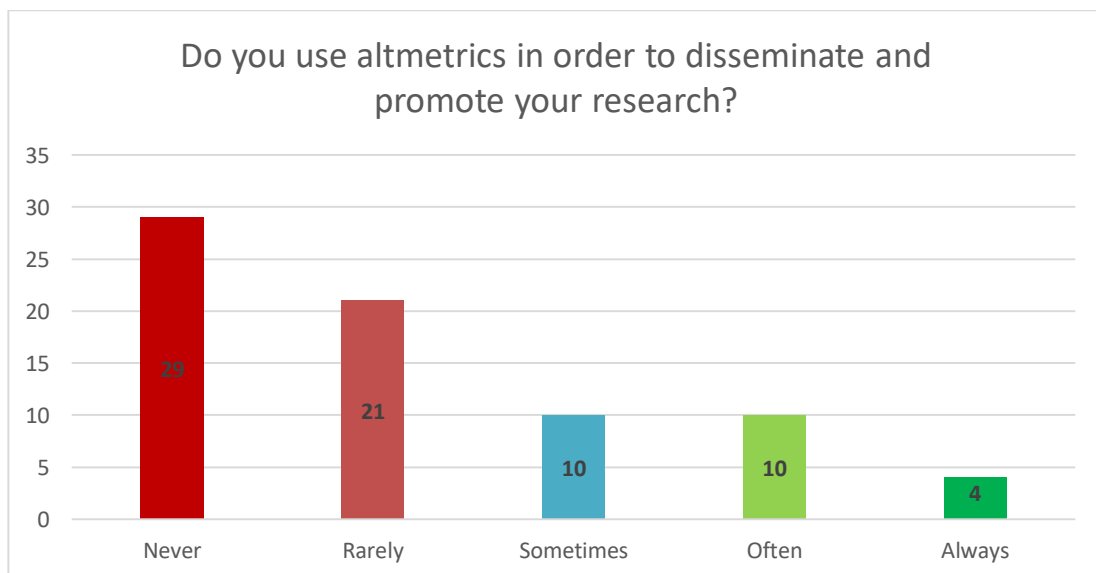
	Are you aware of altmetrics as a mean of measuring your impact?	Do you use altmetrics in order to disseminate and promote your research?	Do you believe that there is a connection between altmetrics and citations?	Do you know techniques and strategies for increasing visibility and findability your research through the World Wide Web?
Mean	3,541	2,176	3,149	2,608
Std, Deviation	1,273	1,243	0,855	1,108
Skewness	-0,666	0,801	-0,294	0,091
Std, Error of Skewness	0,279	0,279	0,279	0,279
Shapiro-Wilk	0,867	0,830	0,873	0,902
P-value of Shapiro-Wilk	< ,001	< ,001	< ,001	< ,001
Valid(N)=74				

In Table 4, the descriptive statistics of specific questions (items) are presented with the purpose to depict researchers' awareness for Altmetrics. Normal distribution is followed in all the items. This can be seen through the Shapiro-Wilk test and its p-value which is < ,001. A five-point Likert scale was used in all the items as it can be seen in figure 1, 2, 3 and 4. Regarding the first one question, participants indicated a positive awareness of altmetrics as a way of measuring their impact highlighting a mean of 3,541 out of 5. Taking into consideration the negative skewness value (-,666) most of the participants tended to select *Moderately Aware*, the *Very Aware* and the *Extremely Aware* options rather than the *Slightly Aware* and the *Not at All Aware* of the proposed Likert scale (Figure 5).



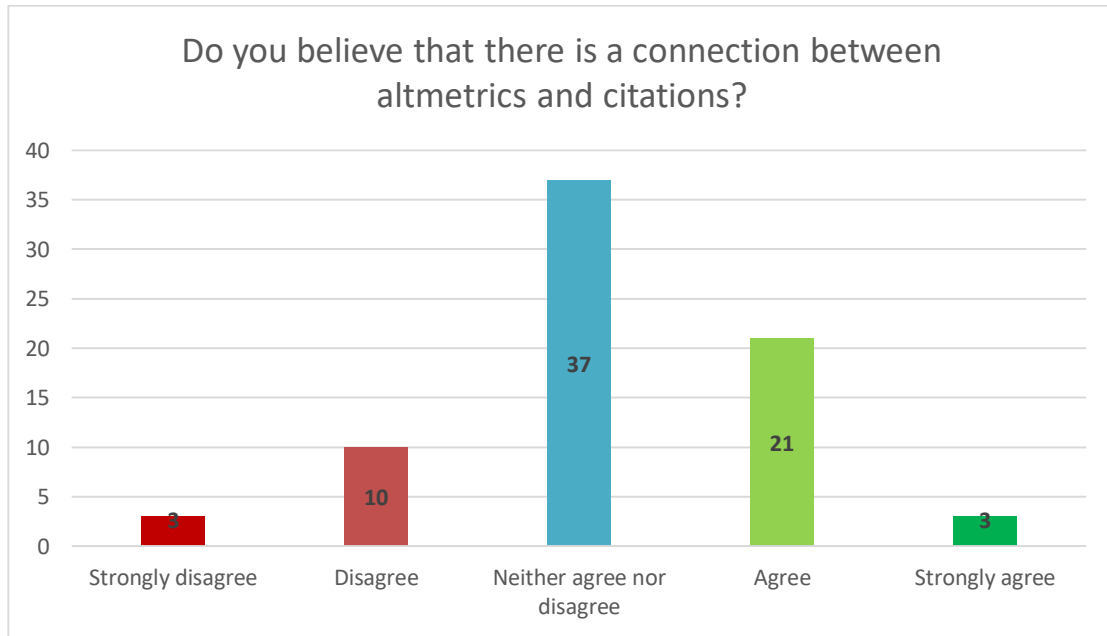
**Figure 5. Respondents' answers at a five-point Likert Scale regarding the awareness of Altmetrics as a way of measuring their impact**

Controversially, the usage of Altmetrics tends to be at a significantly lower level with a mean of 2,176 when respondents asked if they use altmetrics in order to disseminate and promote their research. One step further, the positive skewness value up to 0,801 indicated that most of the answers tended to be negative in the five-point Likert scale with the choices of *Never* and *Rarely*. This is depicted in a clear manner in Figure 6.



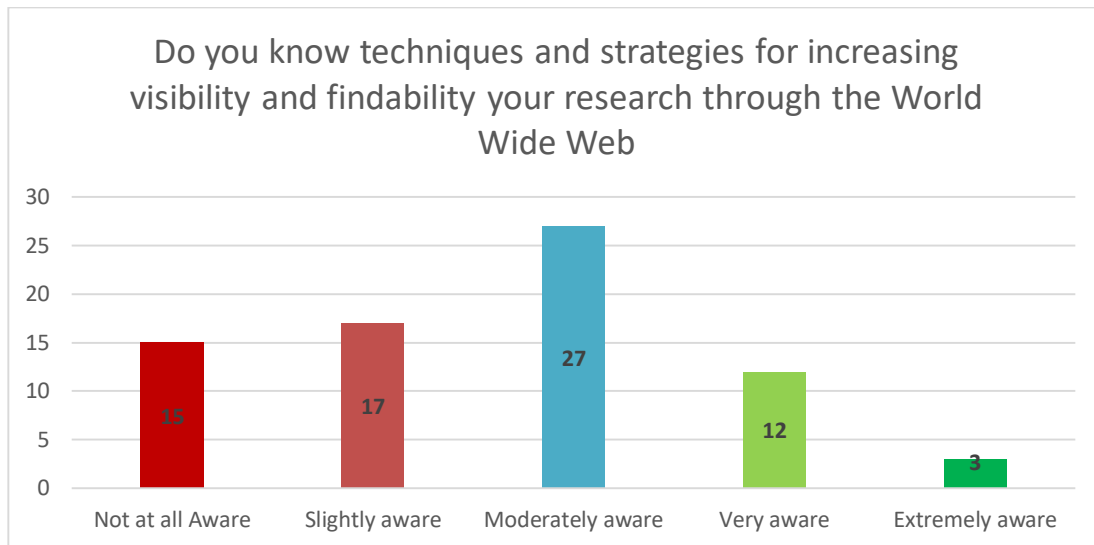
**Figure 6. Clustered bar chart as regards respondents' tendency to use altmetrics for disseminating and promoting their research**

Furthermore, respondents seemed mostly indecisive with the choice of Neither Agree nor Disagree to the belief that altmetrics have a connection with citations with a mean of 3,149 (Figure 7). However, there is a promising negative skewness value up to -0,294 extracted from the Likert scale, indicating that respondents tended to Agree or even Strongly Agree to the matter of connection between altmetrics and citations.



**Figure 7. Respondents belief about the possible connection between altmetrics and citations**

Lastly, a moderate awareness was extracted when respondents asked if they know techniques and strategies to increase their visibility and findability on the web. The mean value reached almost the middle of the five-point Likert scale with a mean of 2,608 out of 5 (Figure 8).



**Figure 8. Clustered bar chart regarding respondents' awareness about techniques and strategies for increasing the visibility and findability of their research in www.**

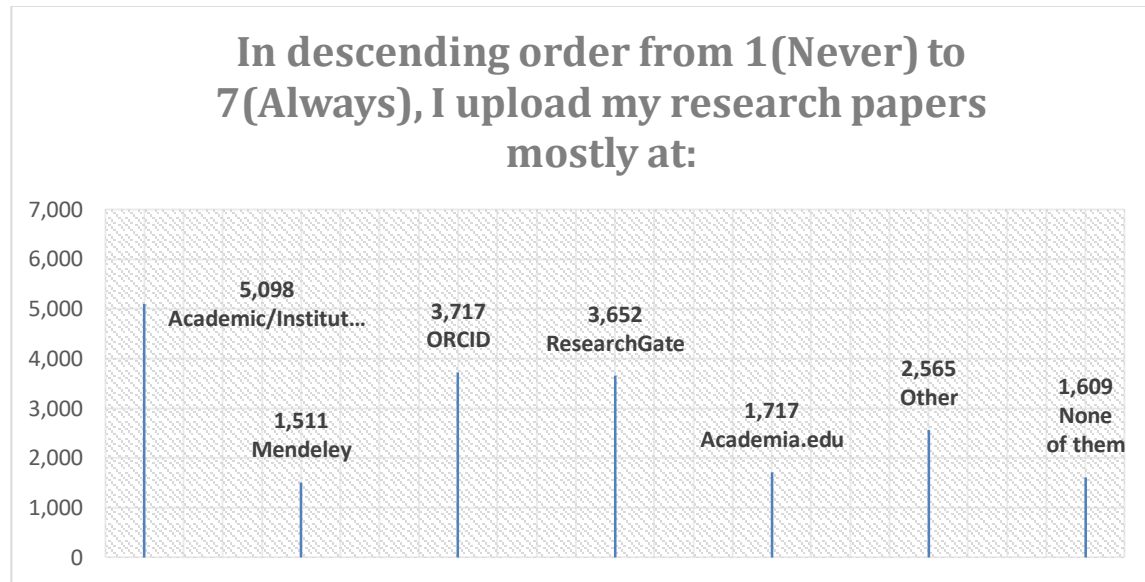
For the next one Table the choices of respondents are presented regarding the platforms in which they upload their research papers. Normal distribution is followed in all the selected, while the Shapiro-Wilk values ranged from 0,452 up to 0,859.

**Table 5. Descriptive Statistics. In descending order from 1(Never) to 7(Always), I upload my research papers mostly at:**

	Academic/Institutional Repository	Mendeley	ORCID	Research Gate	Academia.edu	Other	None of them
Valid	74	74	74	74	74	74	74
Mean	5.098	1.511	3.717	3.652	1.717	2.565	1.609
Std. Deviation	2.224	1.297	2.573	2.289	1.477	2.298	1.437
Shapiro-Wilk	0.774	0.452	0.785	0.859	0.554	0.677	0.488
P-value of Shapiro-Wilk	< .001	< .001	< .001	< .001	< .001	< .001	< .001
Minimum	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Maximum	7.000	7.000	7.000	7.000	7.000	7.000	7.000

Taking into consideration the available seven choices, most of the researchers indicated the Academic/Institutional repositories are the first one choice to upload their papers with a mean of 5,098 out of 7. ORCID and ResearchGate follow up with mean values of 3,717 and 3,652. Moreover the platforms of Academia.edu and Mendeley were lower at the choices of

respondents with 1,717 and 1,511 respectively. Lastly, the choice of Other indicates a mean of 2,565, while the choice of None of them reaches a mean of 1,609. In the next figure (Figure 9.) a line chart depicts clearly respondents' choices to upload their papers in the available platforms.



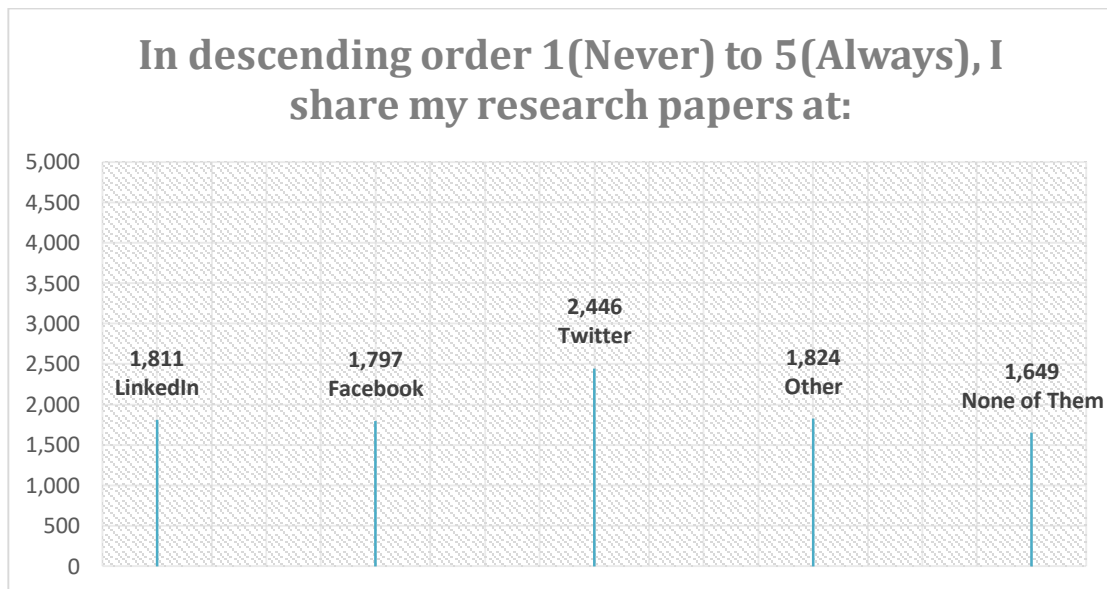
**Figure 9.** Line Chart of researchers' priority to upload their papers to the possible available platforms

**Table 6. Descriptive Statistics.** In descending order 1(Never) to 5(Always), I share my research papers at:

	LinkedIn	Facebook	Twitter	Other	None of them
Valid	74	74	74	74	74
Mean	1.870	1.761	2.478	1.924	1.717
Std. Deviation	1.328	1.152	1.614	1.361	1.295
Shapiro-Wilk	0.684	0.695	0.782	0.697	0.601
P-value of Shapiro-Wilk	< .001	< .001	< .001	< .001	< .001
Minimum	1.000	1.000	1.000	1.000	1.000
Maximum	5.000	5.000	5.000	5.000	5.000

Following the presentation of descriptive statistics, respondents' affinity to share their research papers is depicted in Table 6 and Figure 10. All the five-point Likert Scale items

follow normal distribution with Shapiro-Wilk values ranging from 0,570 to 0,776. Most of the respondents indicated that they share their research papers at Twitter with a mean value up to 2,446. LinkedIn and Facebook are following up with mean values of 1,811 and 1,797 respectively. Lastly, the choice of Other reaches a mean value of 1,824 and the choice of None of them up to 1,649 accordingly.

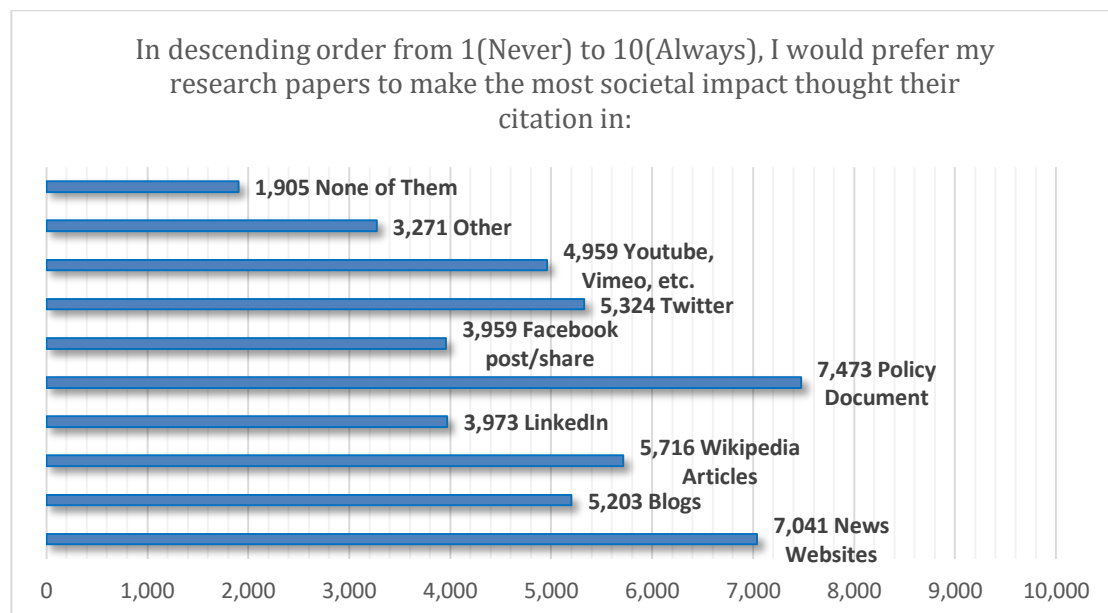


**Figure 10. Respondents’ willingness to share their research papers in specific choices throughout the utilization of social media platforms**

The next table (Table 7) participants were asked where they would prefer mostly their papers to have the most societal impact through citations-references. This constitutes the bridge on how research efforts and accomplishments are disseminated and shared for the better prosperity of each society and its interest parties. More specifically, respondents mentioned that they would prefer to have the most societal impact through their papers within a policy document (Mean of 7,473 out of 8) and News Websites (Mean of 7,041 out of 8). In addition, researchers expressed high mean rates for Wikipedia Articles (Mean: 5,716), Twitter (Mean: 5,324) and Blogs as well (Mean: 5,203). It is also noted that Social Video Platform choice indicated a promising mean value up to 4,959 out of 8 for sharing research papers knowledge through open video platforms. Lastly, an unexpected result is raised while the well-known social platforms of LinkedIn and Facebook resulted in lower mean rates of 3,973 and 3,959 respectively. Making the results more comprehensible to the readers of this study, respondents’ choices are depicted through a clustered bar chart at Figure 11.

**Table 7. Descriptive Statistics, In descending order from 1(Never) to 10(Always), I would prefer my research papers to make the most societal impact thought their citation in:**

	News websites	Blogs	Wikipedia articles	LinkedIn	Policy document	Facebook post/share	Twitter	Social Video Platform (Youtube, Vimeo etc.)	Other	None of them
Valid(N)	74	74	74	74	74	74	74	74	74	74
Mean	7,041	5,203	5,716	3,973	7,473	3,959	5,324	4,959	3,270	1,905
Std, Deviation	2,435	2,455	2,218	2,612	2,394	2,540	2,664	2,811	3,133	1,939
Shapiro-Wilk	0,900	0,958	0,968	0,904	0,850	0,908	0,939	0,929	0,728	0,543
P-value of Shapiro-Wilk	< ,001	0,015	0,061	< ,001	< ,001	< ,001	0,001	< ,001	< ,001	< ,001
Minimum	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Maximum	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000



**Figure 11. Clustered bar chart as regards respondents' opinion on where they would prefer their research papers to make the most societal impact through a variety of choices**

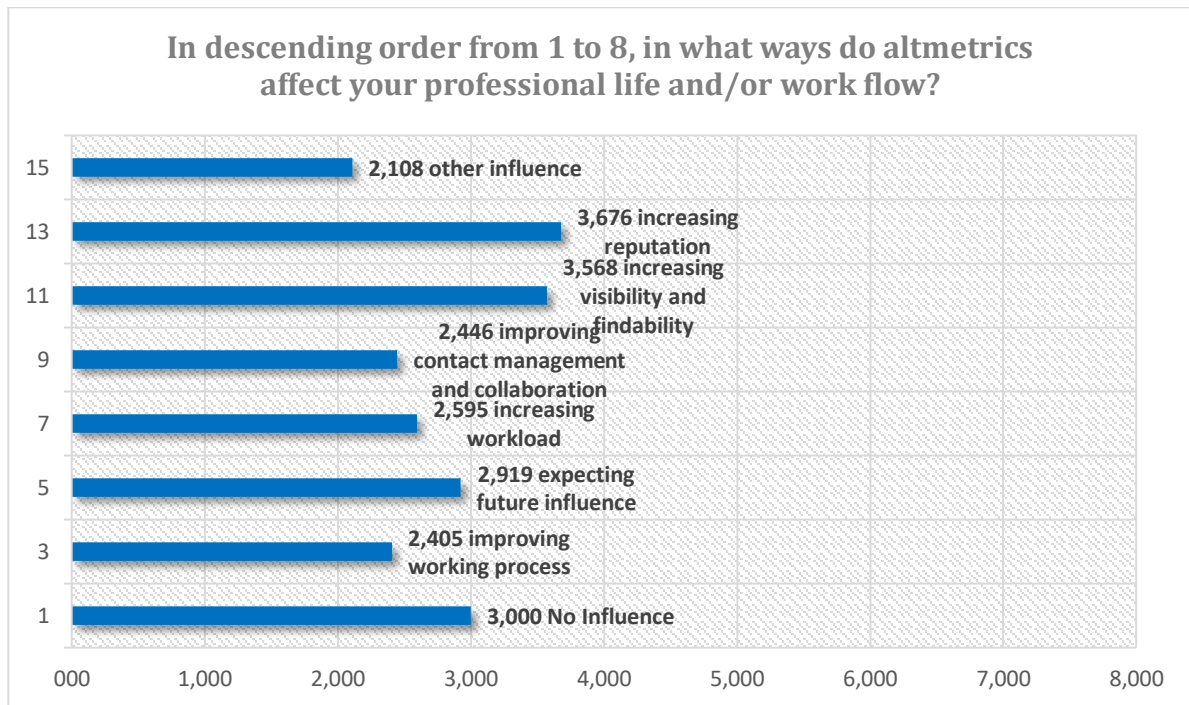
In the next Table (Table 8), participants were asked in what ways do altmetrics affect their professional life and workflow. Their opinions indicated significant results. More specifically, respondents mentioned that altmetrics are capable of increasing their visibility and findability and reputation as well with mean values of 3,676 and 3,568 out of 8. Furthermore, results indicate that researchers think that altmetrics are very promising for their future influence reaching a mean value of 2,919.



**Table 8. Descriptive Statistics. In descending order from 1 to 8, in what ways do altmetrics affect your professional life and/or work flow?**

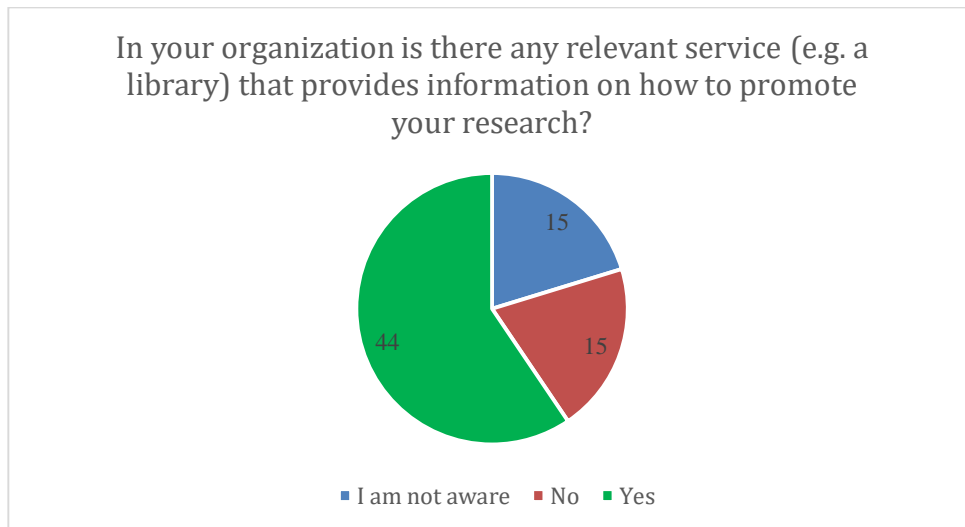
	<b>no influence</b>	<b>improving working process</b>	<b>expecting future influence</b>	<b>increasing workload</b>	<b>improving contact management and collaboration</b>	<b>increasing visibility and findability</b>	<b>Increasing reputation</b>	<b>other influence</b>
Valid(N)	74	74	74	74	74	74	74	74
Mean	3,000	2,405	2,919	2,595	2,446	3,568	3,676	2,108
Std, Deviation	2,580	2,067	2,072	2,113	1,924	2,439	2,324	1,869
Shapiro-Wilk	0,749	0,710	0,840	0,746	0,766	0,867	0,890	0,656
P-value of Shapiro-Wilk	< ,001	< ,001	< ,001	< ,001	< ,001	< ,001	< ,001	< ,001
Minimum	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Maximum	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000

Other opinions regarding altmetrics impact in respondents professional life and work flow ranged from 2,405 up to 2,595, that is increasing workload (Mean: 2,595), improving contact management and collaboration (Mean: 2,446) and working process (Mean: 2,405). It is noted that there is a high mean value of 3 with researchers pointing out that altmetrics have no influence in personal life and workflow. This constitutes a contradictory result while the selected participants have already been favored from altmetrics, nevertheless they still believe that there is no influence. A clustered bar chart is following (Figure 12), visualizing the choices of respondents regarding their beliefs in the ways that altmetrics affect professional life and workflow.



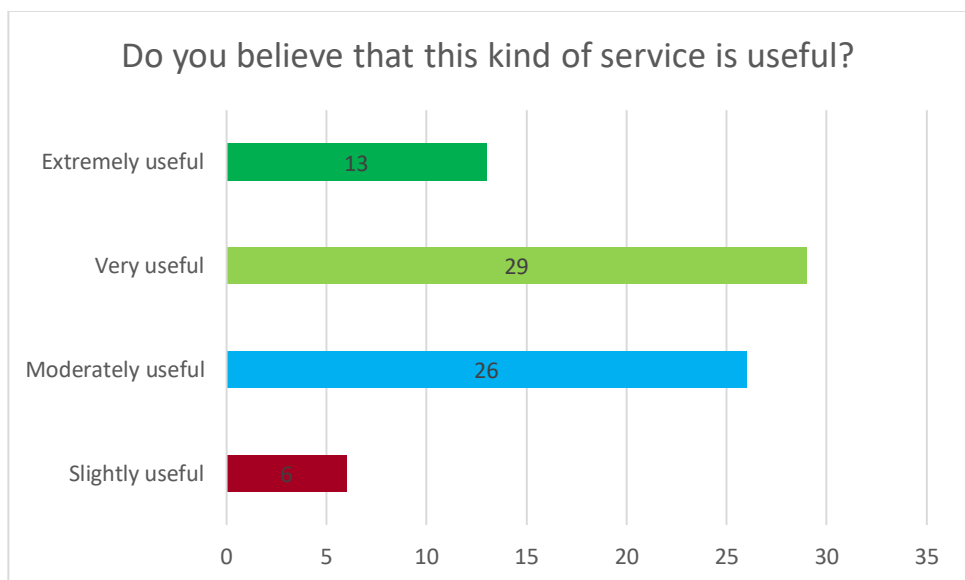
**Figure 12. Respondents' opinion about the possible ways that altmetrics affect their professional life and/or workflow**

Another one interesting result is related with respondents' level of awareness regarding the existence of a service within their organization that is responsible to improve their visibility and findability of their research papers (Figure 13). More specifically, 44 respondents out of 74 stated that there is a relevant service provided by their organization with the purpose to promote their research. Equally, 15 respondents pointed out that either they do not know or there is no such service.



**Figure 13. Respondents' awareness about the existence of a relevant service within their organization that provides information on how to promote their research publications**

One step further, the questionnaire included another one item regarding the level of usefulness of such a kind of that service based on respondents' opinion (Figure 14).



**Figure 14. Respondents' opinion about the usefulness of a service that is capable to promote their research efforts**

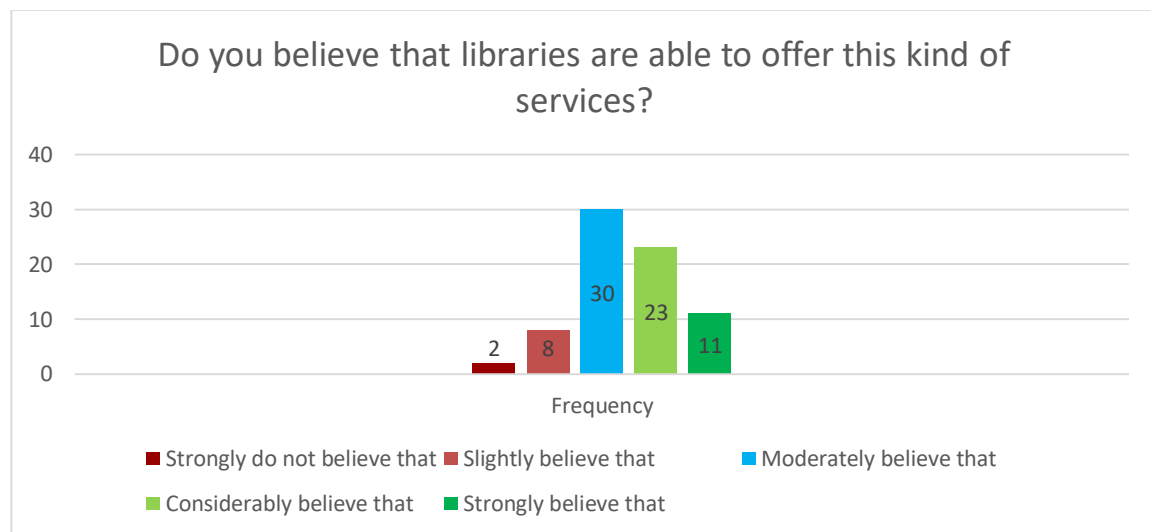
Based on the figure, up to 42 respondents refer that this kind of service will be *extremely useful* (13) or *very useful* (29). Furthermore, there are quite a few participants stated that such a kind of service will be moderately useful (26) shaping the mean value of that item at 3.662. This fact is further reinforced as skewness indicator points out a negative value of -

0.062 but remarkably close to neutral-mid point (Table 9.) Apart from others, respondents were asked if a service that promote their research could be offered by libraries.

**Table 9. Descriptive Statistics. Respondents opinion about the usefulness of a service to promote research and if libraries could be able to offer such an endeavor**

	Do you believe that this kind of service will be useful?	Do you believe that libraries are able to offer this kind of services?
Valid	74	74
Mean	3.662	3.446
Std. Deviation	0.864	0.967
Skewness	-0.062	-0.170
Shapiro-Wilk	0.872	0.896
P-value of Shapiro-Wilk	< .001	< .001
Minimum	2.000	1.000
Maximum	5.000	5.000

This kind of question ranged with a mean value up to 3.446 out of 5 while the negative skweness value -0.170 indicated that more participants tended to choices of *strongly believe that* and *considerably believe that*. In the next figure (Figure 15) the respondents answers are depicted clearly.



**Figure 15. Researchers' opinion about the capability of libraries to offer a service for promoting their research efforts**

#### 4.1.1 Descriptive Statistics of Altmetrics and Traditional Metrics.

In the next table (Table 10) the descriptive values of the selected altmetrics are presented. Among the selected Top100 papers each one of them collected in average 182,99 mentions in new outlets websites, 18,33 mentions in blogs and about 3,02 mentions in Wikipedia.

**Table 10. Descriptive Statistics, Altmetrics values from the Top100 most influential paper of 2019 based on altmetrics.com database**

	News outlets	Blogs	Tweeters	Facebook Pages	Mendeley Readers	Wikipedia Mentions	ResearchGate Reads	ResearchGate Interest
Valid	100	100	100	100	100	100	100	100
Mean	182,990	18,330	4643,350	19,870	329,459	3,020	763,541	31,397
Std, Deviation	98,199	12,221	6739,735	17,960	382,907	2,846	1094,063	45,731
Shapiro-Wilk	0,975	0,844	0,492	0,800	0,687	0,726	0,652	0,594
P-value of Shapiro-Wilk	0,056	< ,001	< ,001	< ,001	< ,001	< ,001	< ,001	< ,001
Minimum	3,000	1,000	160,000	1,000	3,000	1,000	0,000	0,900
Maximum	536,000	72,000	58602,000	120,000	1921,000	14,000	6861,000	289,900

Furthermore, altmetrics impact through social media indicated on average 4643,35 tweeters and 19,87 Facebook Pages that mentioned each one of the papers. The average Mendeley Readers for every selected paper ranged at 329,45. Research Gate Reads and Interest values depicted on average 763,54 and 31,39 respectively.

**Table 11. Descriptive Statistics. Traditional metrics extracted from the Top100 most influential papers of 2019 based on Publish or Perish.**

	Cites	CitesPerYear	CitesPerAuthor	Author Count
Valid	100	100	100	100
Mean	63,939	60,097	16,143	4,408
Std, Deviation	106,878	100,881	30,361	1,234
Shapiro-Wilk	0,566	0,565	0,497	0,909
P-value of Shapiro-Wilk	< ,001	< ,001	< ,001	< ,001
Minimum	0,000	0,000	0,000	2,000
Maximum	629,000	629,000	167,000	7,000

In Table 11, the descriptive statistics of the traditional scientific metrics are presented. Among the Top100 research articles the mean value of their citations reached up to 63,93 with a maximum value of 629. The Cites Per Year metric resulted on average a value of 60,09, while the Cites Per Author indicated a mean value of 16,14. Lastly, most of the papers were written up collaboratively by teams composed on average from 4,4 writers per paper.

#### 4.1.2 Correlation Analysis

Pearson correlation analysis extracted significant research results (Table 12). More specifically, in several cases, there is a positive correlation between altmetrics and traditional metrics. That is, some altmetrics are capable of improving the Cites, Cites per Author and the Cites per Year. This practically means that when altmetrics are increased, traditional metrics are increased as well.

**Table 12. Pearson's Correlations. Identification of intercorrelations between Altmetrics and Traditional Metrics**

Altmetrics Variables		Cites	Cites Per Author	Cites Per Year
1. Cites	Pearson's r	—		
	p-value	—		
2. Cites Per Author	Pearson's r	0.926 ***	—	
	p-value	< .001	—	
3. Cites Per Year	Pearson's r	0.976 ***	0.926 ***	—
	p-value	< .001	< .001	—
4. News outlets	Pearson's r	0.048	-0.002	0.077
	p-value	0.638	0.983	0.452
5. Blogs	Pearson's r	0.372 ***	0.437 ***	0.408 ***
	p-value	< .001	< .001	< .001
6. Tweepers	Pearson's r	0.076	0.125	0.088
	p-value	0.455	0.218	0.386
7. Facebook Pages	Pearson's r	0.324 **	0.331 ***	0.317 **
	p-value	0.001	< .001	0.001
8. Mendeley Readers	Pearson's r	0.784 ***	0.755 ***	0.780 ***
	p-value	< .001	< .001	< .001
9. Wikipedia Mentions	Pearson's r	-0.112	-0.106	-0.109
	p-value	0.443	0.467	0.456
10. ResearchGate Reads	Pearson's r	0.496 ***	0.461 ***	0.521 ***
	p-value	< .001	< .001	< .001
11. ResearchGate Interest	Pearson's r	0.901 ***	0.872 ***	0.899 ***
	p-value	< .001	< .001	< .001
Shapiro-Wilk Test for Multivariate Normality: 0.418 / p-value < .001				
* $p < .05$ , ** $p < .01$ , *** $p < .001$				

For example, posting papers and their content inside blogs is related to the increase of all the traditional metrics with a positive  $\rho(r)$  values of ,372 for Cites, ,437 for Cites per Author and ,408 for Cites per Year with highly statistical significant p-values of  $< .001$ . Mentioning papers inside Facebook Pages is also correlated positively with the increase of all the involved traditional metrics with  $\rho(r)$  values ranging from ,317 up to ,331 and statistically significant p-values of  $< ,001$ . Moreover, Mendeley Readers metric articulates a highly significant positive correlation with all the traditional metrics, namely with Cites (,784) with Cites per Author (,755) and Cites per Year (,780). Furthermore, it is noted that ResearchGate metrics, namely the Reads and the Research Interest indicated a high level of correlation with all the traditional metrics. That is, the higher the numbers of Reads and Research Interest, the higher the Cites, the Cites per Author and the Cites per Year.

In contrast, there are other altmetrics that although prior research efforts indicated a significant correlation with the traditional metrics such as citations, in this case they proved exactly the opposite result. For example, prior research investigations indicated that twitter metrics are correlated with the increase of citations. Nevertheless, in this sample, twitter altmetric value articulates a very weak positive correlation with all the traditional metrics ranged from ,076 up to ,125. In addition, another one remarkable result is the slightly negative correlation between wikipedia and all the traditional metrics ranging from - ,106 up to - ,112. That is, someone would expect that if an article is mentioned inside a wikipedia entry, this will increase the citations of it. However, the negative Pearson correlation results indicate that traditional metrics are decreased as wikipedia mentions are increased.

Diving deeper into correlation analysis, a descimination of respondents was performed while selecting those who use often and always altmetrics with the purpose to promote their research (Survey Item: Do you use altmetrics in order to disseminate and promote your research?). One step further, a correlation analysis was performed to those respondents examining if their belief about increasing visibility and findability is correlated with the increase in Cites Per Author and Cites Per Year (Table13).

**Table 13. Correlations between the belief that altmetrics increase visibility and findability and the possible increase in traditional metrics of Cites Per Year and Cites Per Author**

Variable		increasing visibility and findability
1. In descending order from 1 to 8, In what ways do altmetrics affect your professional life and/or work flow? [increasing visibility and findability]	Pearson's r	—
	p-value	—
2. CitesPerYear	Pearson's r	0.648*
	p-value	0.023
3. CitesPerAuthor	Pearson's r	0.708**
	p-value	0.010

\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$

In other words, results shown that those who believe that altmetrics increase their visibility and findability finally they receive an increase into the traditional metrics of the Cites Per Year ( $p = 0.023$  and  $\rho(r) = 0.648$ ) and the Cites per Year ( $p = 0.010$  and  $\rho(r) = 0.708$ ). This constitutes a verification as those who believe that altmetrics increase their scientific visibility and findability, they finally benefited as Cites Per Year and Cites per Author are increased.

#### 4.1.3 Reliability Analysis

In Table 14 the internal consistency among the survey items is presented. There are five dimensions that could be used by other researches and practitioners. The purpose is to quantitatively measure respondents' awareness and tendency to use altmetrics, plus also their actions to improve the findability and visibility of their research content.



**Table 14. Internal Consistency and Discriminant Validity**

<b>Dimension</b>	<b>Number of Items</b>	<b>Cronbach's a</b>	<b>McDonald's <math>\omega</math></b>	<b>Guttman's <math>\lambda</math>-2</b>
Altmetrics Awareness	4	0.642	0.706	0.683
Uploading Preference	6	0.578	0.607	0.605
Sharing Preference	5	0.615	0.670	0.659
Impact in Professional Life	8	0.793	0.807	0.812
Open Access Tendency	4	0.906	0.911	0.909

All the involved indicators to measure reliability through a statistically significant way, extracted sufficient values. Cronbach's a ranged from 0.578(Uploading Preference) up to 0.906 (Open Access Tendency). McDonald's omega values resulted values from 0.607(Uploading Preference) up to 0.911 (Open Access Tendency). Lastly,  $\lambda$ -2 values indicated statistical significance of trustworthiness and cohesion among the involved variables in each dimension with values ranged from 0.605(Uploading Preference) up to 0.909 (Open Access Tendency).

In Table 15 the results of an Exploratory Factor Analysis took place with the purpose to measure the sampling adequacy of the involved altmetrics. Factor loadings for each item ranged from 0.635 up to 0.971. In addition, Bartlett's and Chi-squared tests extracted significant p-values < .001 which is an indication that the involved altmetrics express cohesion and consistency in order to be used for measuring purposes.

**Table 15. Exploratory Factor Analysis Indications and Cohesion Testing**

	<b>MSA*</b>	<b>Factor Loadings</b>
Kaiser-Mayer-Olkin Test -MSA	0.640	
News outlets	0.413	0.971
Blogs	0.654	0.635
Tweeters	0.374	0.991

Facebook Pages	0.636	0.803
Mendeley	0.722	0.783
ResearchGate_Reads	0.716	0.729
ResearchGate_interest	0.644	0.901

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Bartlett's test  $p < .001$  | Chi-squared test  $p < .001$   
 \*Measure of Sampling Adequacy

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#### 4.1.4 Regression Results

As can be seen in Tables 16, 17 the implementation of linear regression indicated significant results. Prior pre-processing and analysis was performed in order to exclude possible outliers that probably will cause perturbations into the prediction interpretation. No changes were observed when performed hierarchical technique among variables. That is, both R2 and F remained in the same values. The R2 value indicated a high model fit level at 0.874 with statistically significant p-value  $< .001$ .

**Table 16. Model Summary – Altmetrics Impact on Cites Per Year**

Model	R	R <sup>2</sup>	Adjusted R <sup>2</sup>	RMSE	R <sup>2</sup> Change	F Change	df1	df2	p
H <sub>0</sub>	0.000	0.000	0.000	101.318	0.000		0	96	
H <sub>1</sub>	0.935	0.874	0.867	37.002	0.874	125.756	5	91	$< .001$

**Table 17. Regression coefficients and altmetrics potential change in their values.**

Model		Unstandardized	Standard Error	Standardized	F	p
H <sub>1</sub>	(Intercept)	60.097	10.191		5.897	$< .001^{**}$
	Blogs	3.383	0.773	0.408	19.137	$< .001^{**}$
	Facebook Pages	1.760	0.538	0.317	10.689	$< .001^{**}$
	Mendeley	0.206	0.017	0.780	149.381	$< .001^{**}$

Readers					
ResearchGate Reads	0.048	0.008	0.521	35.455	< .033*
ResearchGate Interest	1.967	0.098	0.899	403.579	< .001**

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\*  $p < .05$ , \*\*  $p < .001$

This means that the model explains sufficiently and without redundancies, the extent to which the variance of the dependent variable (CitesPerYear) is capable to explain the variance of the other independent variables (Blogs, Facebook Pages, Mendeley Readers, ResearchGate Reads and ResearchGate Interest). In other words, the higher the R2 , the greater the model to predict how much will be the change of Cites per Year for every one unit increase into these specific altmetrics.

In this respect, for each one new mention of a paper into a Blog, the Cites per Year could be increased by up to 3.383. That is from 60.097(unstandardized) up to 63.48. Furthermore, for each one new mention in Facebook Pages the Cites per Year could be increased by 1.760. Mendeley Readers indicated lower contribution to the increase of Cites per Year. More specifically, for each new one Mendeley Reader the Cites per Year could be increased by up to 0.206. ResearchGate Reads contribute even less in comparison with Mendeley Readers. That is, for everyone new reader in Research Gate about the specific articles the Cites per year could be increased up to 0.048. Lastly, The altmetric of ResearchGate Interest indicates a significant change, as for everyone unit that the ResearchGate Interest is changed, the Cites per Year could be increased by up to 1.967.

## 5. Discussion - Conclusions - Future extensions

### 5.1 Summary

In the last chapter of the study, various findings of our research are discussed and compared with previous research. This exploratory master thesis used three data sources in order to achieve the aim that was set in the beginning. To begin with, the initial stage of the study was constructed by identifying the reason that motivated us to deal with the hot topic of altmetrics. Every research effort must get the credits they deserve. Every researcher needs to be recognized. A fair method or a combination of methods that would include every available resource is the desideratum. The modern era differentiated the situation in comparison with the past because the citations are not the only way to recognize someone's work and measure the impact that a study has on the scientific community and society in general. The Web diffusion has changed the circumstances and included in the measurement process different metrics that assist for a holistic approach, in order to gain a fast and real assessment about someone's impact. Measuring impact procedure needed a complementary tool to citations, so altmetrics appeared. Altmetrics "is used as an umbrella term which condenses ideas on how to combine social media with aspects of traditional scholarly practice" (Priem et al., 2010). In the early stages of the master thesis, we set two research questions and we tried to answer them in favor of researchers and of research community as a whole.

- 1) Do researchers know altmetrics as a way to promote their scientific activity? Are they exploited or not and how?
- 2) How can researchers increase their visibility through altmetrics taking advantage of the social impact they have that is captured through altmetrics?

The entire writing procedure of this master thesis aimed to answer these questions by collecting primary and secondary data and by comparing them with previous research in the global literature. The study targeted to explore the topic by collecting real data and by examining them for acquiring a better view about the topic. The aim of the study is to use the available tools in order to benefit all the stakeholders and if possible, to create a strategy that would benefit implicitly libraries and the researchers directly. Library and information

science is correlated with the research process and it is crucial to be present in the various changes that take place because of technology's development and Web diffusion.

## 5.2 Discussion

This research effort tried to add value to the scientific community by examining the data sources mentioned before. To begin with, we followed a methodology that would offer a different approach to the topic research. Controversially with other valuable and valid research approaches that examined individually altmetrics such as Twitter solely and its impact in citations increase or the existing correlation, we propose a novel method that is capable of highlighting which of the Altmetrics could be considered reliable in the process of increasing visibility of authors, and hence, the traditional metrics, such as citations. Of course, our effort was not only to detect which one of altmetrics offers advantages to the authors but to discern those that probably do not offer anything based on the retrieved and examined dataset. This choice adds value to the research because it can be considered as a flexible methodology that can be adopted independently in other sets of articles that might have different altmetrics values. Another significant asset of our study was the three stage effort in order to collect data that would allow conducting a reliable data analysis. However, despite the fact that we strived to involve multiple reliability tests in order to understand the cohesion and consistency of the survey variables and the altmetrics values, further effort is needed in order to increase the consistency and cohesion including additional variables and metrics that express even better Cronbach's McDonald's  $\omega$  and Guttman's  $\lambda$ -2 values.

Aiming to achieve the goal of the study, we examined the topic by asking for basic issues about altmetrics and research impact. It was important to examine if the researchers that were selected are aware of altmetrics. As it is rational, someone could believe that every respondent should know about altmetrics, taking into consideration that their work is among the Top100 most discussed articles according to this kind of metrics. However, despite the fact that in the sample we meet persons that are high in altmetrics scores, we have responses that show us that they are not aware at all. Following the above, we also see that persons with awareness of altmetrics, and probably with knowledge about their position in this Top100 list, indicated that they do not use them. Those people, as it is rational, seem to have a moderate opinion in the question whether altmetrics are correlated with increase in citations. As shown in the findings, we have a contradictory result

where Facebook choice in sharing papers ranged at a low level indicated up to 1.761/5. Nevertheless, Altmetrics indicated that Facebook has a positive correlation with all the traditional metrics. On the other hand, Twitter indicated a higher selection value of the available choices, however, Pearson correlations indicated very weak correlation values with the increase of traditional metrics. The researchers that responded that they use altmetrics *Often* and *Always* seem to have a strong belief that altmetrics are capable of increasing the Cites per Year and the Cites per Author. Based on the Pearson results, they are confirmed about that. That is, those who believe that altmetrics have an impact of increasing visibility and findability, these have also a strong positive correlation with the increase in Cites per Year .643\* (p-value 0.023) and Cites per Author .708\*\* (p-value .010). By examining the sample and the literature, it is obvious that every researcher tries to promote her/his work by exploiting every mean. To be more specific, about the topic of altmetrics, it is observed that researchers are suspicious about which is their real value. Due to this suspiciousness, libraries have to be careful and accurate about altmetrics strengths and weaknesses. There is no need for overestimation and depreciation (Barnes, 2015). As regards the relationship between altmetrics and citations, we identified that the speed factor plays an important role. The correlation results indicated that if altmetrics are increased, then cites per year are increased to, so we encourage researchers to utilize altmetrics due to the fact that as altmetrics usage is increased, citations per year are increased as well. As it is rational, every researcher needs different metrics because the demands are not the same as were in the past. Time is an attribute that is necessary to highlight. The long time that takes for citations to show impact can be decreased due to altmetrics. On the other hand, this need of researchers does not mean that they could disregard the parameter of quality. According to the global literature, another thing related to altmetrics is the open access movement (Ayre, 2012). It has underlined the recommendation of depositing works in Institutional repositories for dissemination purposes. However, our research did not verify these findings.

### **5.3 Utilization / Practical implications of research**

By observing the new opportunities that arise with the evolution of the research process, libraries and information organizations should be ready to meet the needs of the new era. It is necessary for them to exploit the current situation in order to continue being part of the research procedure and to strengthen its position. Their role nowadays is different from

what it was in the past. The role of libraries was to assist researchers and authors by offering them opportunities to rank up through JIF and the monitoring of citations. The notable difference now is that there are many supportive things that could affect authors' visibility, findability and their recognition in general. As the library is capable of managing information and knowledge, it should also be capable of managing the users' research impact. Every potential action in this direction should be taken. For instance, the Institutional Repositories should be exploited by libraries and the universities in general. Altmetrics and webometrics are a usual way for institutions to publicize the impact that their researchers have. Taking into account that repositories were from the early systems that adopted altmetrics as a way to measure usage or impact. Many repositories provide data to the readers or to the authors about downloads and hits. Probably, a service in Academic libraries would be a useful tool for every researcher that seeks to increase his visibility and aims to exploit every possible mean in order to benefit her/his work. According to the global literature, libraries are considered as a capable organization to offer services that aim to help the researcher find new ways to capture her/his impact (Galligan, 2012) (Gonzalez Fernandez – Villavicencio et al., 2015, p. 7). In accordance with the literature that has been studied, our findings indicate the need of researchers for help regarding techniques that measure impact. For instance, we observe that in the questions 14, 15 that are about services and organizations in regards to providing relevant information about strategies in order to increase visibility and the captured impact, the answers tend to indicate that researchers do need this kind of services and maybe libraries are the appropriate certifier to offer this. Consequently with the above, in the study we tried to examine the involvement of Institutional Repositories to the research impact and if researchers prefer to use them. Our sample mostly choose the institutional repository as a choice to upload their research papers. Taking into consideration the literature review, the institutional repositories strategy is something that has to do mostly with Academic Libraries. (Gonzalez Fernandez – Villavicencio et al., 2015). Nevertheless, they express an almost moderate opinion if the libraries are able to offer a service for improving visibility and findability of their research efforts. At a first glance, the mean value indicated a positive stance with 3.446/5 promising that indeed libraries are able to do a service like that. However, the very low negative skewness value -.170 indicates that most of the respondents selected the third choice of the likert scale which was a moderate opinion between 1 (strongly do not believe that) and 5 (strongly believe that). To develop such a service, reliable and consistent tools are needed with the purpose of quantitatively

measuring researchers' awareness about altmetrics, the way of usage and the potential utilization of them. For this reason, reliability analysis took place to measure the consistency and the cohesion of the proposed tool that could be used inside the service as an initial numerical indicator. Cronbach's  $\alpha$ , McDonald's  $\omega$  and Guttman's  $\lambda$ -2 indicators were used for that reason.

## 5.4 Future Research

As it is rational, every research has limitations that arise from various factors. The selection of methodology is a usual factor that affects a study, the time period that the research is conducted is another and the selected sample is also important for a master thesis outcome. In our point of view, the specific master thesis offers a different approach to altmetrics utilization from researchers, as regards the strengths and weaknesses of them according to the research impact process. However, more tools could be used for future research. A potential future research is the usage of a sample that would not be based on a Top100 list but would include researchers from various fields in order to estimate the situation under other circumstances. It is likely to have different results for fields like Mathematics or Informatics and different in Social Sciences.

Moreover, deeper research can be done by continuing this study. Taking into account that the articles selected were at the top of the list for 2019, and given that, we collected the data in January of 2020, if collecting the same metrics after 8-10 months, our results would be different. An interesting direction to explore would be the comparison of data from two - not so distant periods- because we could examine some characteristics of altmetrics in a more analytical way and the correlation of altmetrics with traditional metrics could be interpreted under different circumstances. Furthermore, a case study where we would test a strategy about altmetrics and traditional metrics could be interesting in order to show if and how social usage of works affects the route of researchers during their effort.



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