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Research Article

Analyzing the Factors Influencing the Waiting Time to First Citation and Long-Term Impact of Publications

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ABSTRACT
Although citation-based indicators are widely used for impact assessment, time to get the first citation could also be an early indicator of scientific performance. This study examined how factors like number of authors and international collaboration are related to the waiting time (WT) of receiving the first citation. The study further investigates how WT and early citation (EC) could be used as an important indicator for the prediction of long-term scientific impact. For the purpose, we used Web of Science database to collect citation data of the publications from 2008 to 2017 in Robotics and Artificial Intelligence (AI) related research fields. For analysis, we used the bibliometric method to examine the number of cited and uncited publications and to find out publication's frequency distribution as per the waiting period. Further, correlation and regression analysis are performed to check the relationship among variables. The analysis results state that collaboration improves citation speed by reducing WT. Moreover, the result shows that publications which receive their first citation early have more chances to attract future citations.

Keywords: Citation analysis, Collaborative papers, Early citation, Research Impact, Waiting time to first citation.

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INTRODUCTION

Scientific collaboration and citation-based indicators have been given significant attention in recent studies by scientometrics researchers. While collaboration in research improves productivity and academic performance, citation is considered significant for impact assessment and can measure reliability and validity of a publication. Recent studies have examined the effect of collaboration on the scientific impact and has indicated that the citation count rises with the increase in collaboration of any level[1] (number of authors, countries or institutions). Finding shows that collaborated publications obtain a greater number of citations than a single-authored or non-collaborated paper and this increase in citation count is seen more evident in the case of international-collaborated papers.[2-4] Since most of the early studies revealed the relation of collaboration and scientific impact based on citation count, it is relevant to examine whether the effect of collaboration is limited to the number of citations or does collaboration also affect the speed of citations.

Time to receive the first citation is important to evaluate the level of acceptance of a publication in a research community.[5] Time to first citation can be an early-impact indicator that notifies the status change and recognition of a publication by others.[6] As it has been noted that influential or impactful papers receive their first citation in less time following the publication of articles.[7] This implies that waiting time (WT) to receive first citation is less for influential papers. In addition, delay in receiving the first citation could have a negative influence on the long-term scientific impact. From this perspective, WT can be helpful to predict the potential influence and long-term impact of academic papers.

Considering the usefulness of WT in estimating research impact, previous studies have proposed some useful bibliometric indicators like "citation speed index" and "first citation speed index",[8] which could measure the performance and level of recognition of academic papers and can be used as a metric for impact evaluation. These indicators are valuable to indicate that the pace of receiving the first citation and could be useful to determine how fast knowledge is valued in the research field. However, there is lack of understanding how the early valuation of knowledge can be useful to predict long-term citation impact. To better understand the benefits of collaboration and the importance of WT in determining the impact, a more comprehensive study is

needed for how collaboration and WT are related and how WT influences long-term scientific impact. For the purpose, the paper examines how collaboration relates with time aspects of citation data and analyzes how collaborated and non-collaborated papers differ in timing to receive their first citation. The effect of collaboration on WT can be analyzed to check if it has a positive or negative influence in receiving the first citation. In addition, we further explore whether WT for first citation and number of initial/early citations (EC) can act as predictors in finding the long-term impact of papers.

Thus, this paper aims to explore answers to the following research questions:

1. Do co-authored publications have less WT for first citation as compared to single-authored Publications? How does the number of authors affect the WT to get the first citation?

2. What is the effect of degree of international collaboration on the WT of first citation?

3. How does WT correlate with the accumulated citation and the average citation? Does WT of first citation and number of E Care useful to predict the long-term impact of publications?

The remaining of this paper is organized in the following sections: Section "Overview and related work" reviews the related works to present a background of the study and helps us to understand important concepts related to our research topic. "Data and Research Methodology" section describes data source and collection methods and gives details on the research process and methodology used for this study. "Results" section presents the research output and findings of the analytical process. "Discussion" section describes results implication and usefulness in details. Finally, in the "Conclusions" section, the paper concludes and provide suggestions for future work.

Overview and Related Work

To better understand the background and the context of the study, we have divided the literature related work into two parts. First, we elaborate on the importance of scientific collaboration in research areas. In the second part, we focus on the role of WT and the number of early citations in the knowledge diffusion process.

Importance of Scientific Collaboration

Over the past decades, there is rapid growth in the number of collaborative papers among various disciplines. The rise in the number of interdisciplinary fields, complexity in research work, change in the funding environment and new communication sources, all promoted the growth in collaboration across the different research environments. Co-authorship is regarded as an important indicator of scientific collaboration and can effectively measure the collaboration action in research.[9,10] The collaboration supports researchers in solving their research problem and to get new insights through exchanging their knowledge and expertise, which improves the quality of research papers. Moreover, collaboration brings time-saving and cost-sharing benefits, thus increase the productivity of research.

A considerable amount of literature has been published on scientific collaboration. These studies attempted to investigate the different level of collaboration as well as motives and benefits behind the scientific collaboration. Katz and Martin (1997) and Katz (2000), in their seminal work on the scientific collaboration defined collaboration as a process where two or more researchers are working together to bring advancement in existing knowledge or can create new and innovative knowledge.[10,11] Research collaboration affects the quality of work and produces more reliable and valid results than non-collaborated or single-authored papers.[12] Previous studies examined how collaboration influences the productivity and the research results showed that collaborated paper produces a high impact in the term of increasing the number of citations. Bornmann (2017) analyzed the effect of co-authored paper on the citation impact of publications by using publication's quality as a control and found that citation impact increases with the increase in collaboration activities and the effect is independent of the paper's quality.[13] Consequently, collaboration appears to have a positive influence on scientific impact.

Considering previous research and interpreting the relationship between collaboration and citation, a critical question arises whether the collaboration is only related to citation frequency or does it have any benefit on receiving the early first citation? Furthermore, the relation can be established as collaboration is considered to increase the quality and visibility of scientific publications,[13] and there are chances that papers that are more visible receive their first citation early than non-collaborated papers. Therefore, considering the expected benefits, this study will examine the relation and effects of collaboration on time to receive the first citation.

Citation Time and Knowledge Diffusion

Citation distribution over time is a widely recognized indicator for historic as well as prospective analysis of research quality and impact. Several researchers have shown that citation-based indicators can be utilized as a standard measure in the assessment of research performance.[14-16] In general, it is considered that the more the number of citations, the more impactful is the paper. Besides citation counts, WT to get the first citation and early citations (EC) are another parameters in citation analysis. Time to first citation indicates the conversion of uncited documents to a cited one and is related to early or delayed recognition of a publication. Beginning from

Schubert and Glänzel,[1] (1986) paper that introduces "Mean Response Time" to measure citation immediacy, a significant number of studies have been done on first time to receive a citation. Most of the early studies on time to first citation are based on the parametric assumption and modeling of first citation distribution.[17-19] These studies have used various distribution function like exponential, poison or stochastic process to model time to first citation distribution. Further, time to receive first citation is used to measure immediacy but is not same as "[2]immediacy index"[20,21] and it signals about the speed of communication and dissemination of knowledge in research field.

Prior literature has established that citations allow the flow of information from one source (cited paper) to other (citing paper). This allows the flow of concept or ideas included in a document to move forward to other through citations.[22,23] Although most of these empirical studies have analyzed the patent citation data as the sources of knowledge diffusion,[24-26] they have considered that papers serve equally or more important source of knowledge accumulation and paper citations have equal potential to distribute knowledge among sources.[27-29] Furthermore, diffusion of knowledge through citation and potential of knowledge creation is related to WT and time to receive the first citation has a significant effect on the knowledge diffusion process and delay in receiving the first citation can slow down the speed of diffusion of knowledge. On the other hand, Less WT to receive first citation have a faster spillover effect that can improve the potential of knowledge generation and spur innovation. A faster flow of knowledge and information proposed in a publication to the other citing papers brings stimulation in the knowledge creation process and can have a positive impact on future scientific advancement. Yu and Lin (2016) has pointed out that, the shorter waiting time to get the first citation shows the significance and prominence of the articles in the research community.[30] Egghe (2000) has mentioned that the time to first citation can also be seen as an indicator of a paper's quality and impact.[31] Thus, an early-cited paper has early visibility in the scientific community with greater potential in knowledge contribution and can be considered as an early indicator of research impact.

WT to receive the first citation considerably vary across the research fields or among various academic disciplines.[31] Disciplines with a slow ageing process could have a longer WT for the first citation; however, disciplines with a faster ageing period could get first citation more quickly. For example, a study done by Glänzel *et al*. (2012) compared the graph for cumulative time of first citation for four journals in mathematics (slow ageing discipline) and five journals in cellular biology (fast ageing discipline). Based on graphical representation, first time citation curves are compared with average citation time for all journals. The research results indicated that at the initial stage, journal Cell has faster response time than the response time of cell biology discipline mean, which suggests that journal Cell is more influential and is faster in the diffusion of scientific information as compared to other journals in cell biology field. Comparing the absolute response time for both fields, the result stated that the first-time citation rate is relatively higher in the field of cell biology than the mathematics field. In another study, Hancock (2015) analyzed the rate of first citation data for the articles published in the Journal of Research in Music Education (JRME). The study used Kaplan-Meier estimators to examine the rate of response to citation and determined the first citation probability and failure function. The paper results indicate that time to first citation was faster among the music area than other related disciplines.[21] The paper also examined how co-authored papers affect time to first citation and results presented using two models confirm that citation rate is faster for multi-authored articles than single-authored articles. The above-stated papers indicate that the selection of similar disciplines is important in comparison to response time for first citation in order to avoid biases due to different citation times in various disciplines.

Most of the authors examined the results based on articles published in a few journals. Hancock (2015) only covered data of journal (JRME) articles to examine the effect of co-authored papers on the time to the first citation. However, we used citation data analysis of frequently updated database (WoS) to examine the effect that consists of various relevant journals of related subjects. In addition, citation counts depend on subject or research area; we examined the subject areas, which belongs to multi-disciplinary fields and where the collaboration of researchers from different disciplines can be easily seen. Previous study results[21] considered effects on citation either in case of single-author (coded as 0) and multi authors coded as 1, however, in this studies we analyzed how citation rate changes with the number of authors. In addition, we also considered examining early citations (EC). Because some papers may get only 1 citation in the very first year and some others may get 2 or more citations. In that case, WT is the same but EC is different. The latter group of papers will have more impact. So we include both WT and EC.

1 Schubert and Glänzel (1986) introduced immediacy index is not the same as time to first citation (response time) and defined "immediacy index" as a measure of how quickly the average cited paper in a journal is cited. However, response time is defined as "time between the publication of the article and the first citation"

2 "Time to first citation" is specified as "Response time", "Response speed", "first citation speed" etc. in previous literature. Egghe, Bornmann and Guns's (2011) used the method to calculate the first citation speed (Where, = first citation year and = publication year). In this paper, we considered it as WT (Waiting time).

In addition to time to get the first citation, early citation is considered as a forward indicator of long-term impact.[15,32] Publications with a greater number of early citations signifies the quality and importance of publications and early citation further express the possibility of getting a greater number of citations in the future. Early citations also play a positive role in revealing diffusion of knowledge at the early stage as well as in a shorter citation time window. Previous studies observed that early citations counts are useful for timely monitoring and assessment of funding and investment outcome and allow timely evaluation of the performance of researchers.[33,34] Thus, considering both WT and EC is a comprehensive method for the early assessment of scientific progress in science and technology fields.

Research Data and Methodology

Data for this study was collected from the Web of Science (WoS) database for a period of 10 years, covered from 2008-2017. We selected AI and robotics-related research data as it is a very new and interdisciplinary field of study. For data collection, first, we downloaded research publications data on the subject of "Robots", "Artificial Intelligence" (AI), "Autonomous Robots" (AR) and "Humanoid Robots" (HR). For, the data collection, we used various search keywords for different technology domains using Boolean search operators to find the most relevant article's data (Table 1).

We collected 22,383 articles on the topic of "AI", 26,579 articles on the topic of "robot", 2,368 articles on "humanoid robots" and a total of 845 articles on subject of "autonomous robots". Our downloaded data has different categories of information such as publications title, author's name, country, institution, funding source and other relevant information related to publications.

We used an additional dataset of citation report data that contains year wise citation counts and average citations per year along with other related information. We downloaded yearly citation information for all the publications collected as above. Since Web of science does not allow citation report available for results sets of over 10,000 records. This issue has been solved by dividing our data into a different set of publication years (like 2008-2010, 2010-2012) so that the result sets should come less than 10,000 records and finally we merged all the dataset together. In addition, WoS citation report does not contain the author's related data such as author's address column with citation data (C1 column). Therefore, after retrieving both publication and citation information separately, we merged both datasets based on the title of the publications. This comprehensive dataset provides citation data with all other information including the author's address with yearly citation information. The final dataset is used for the analysis purpose.

RESULTS

Year-wise Trend of Number of Cited Papers

First, we want to see the year-wise distribution of total papers (TP) both with the citation (CT) and without citation. It is important to consider both cited and uncited documents for examining the distribution of time to first citation, not considering uncited publications could otherwise lead to biases in distribution results. Thus, year-wise cited papers (CT>0) and uncited TP in all the four research areas is presented in Table 2. For all the four areas of research, research output grows every year. The total number of publications in the last 10 years varied significantly over different areas. However, the number of cited papers does not indicate any clear trend in the table.

The result indicates that out of TP, % of papers with one or more citations (CT>0) are almost similar in AI and robot field (73.3%), 74.6 % on humanoid robot articles have at least one citation and around 75.02 % of articles are cited with one or more citations in "autonomous robot" field. In Figure 1, the year-wise percentage of uncited papers are drawn for all the research areas. It is seen that the percentage of uncited paper grows each year. This could be due to the matter that recent papers get lesser time window to receive citations.

WT Distribution of Papers

In Figure 2, WT (in years) distribution is shown for all data sets. WT to get the first citation is calculated as: If a paper is published in a certain year (say 2008) and gets its first citation in the same year as publication (first citation year is 2008), then WT is considered as 0. If the citation period is next year to publication, (2009 for 2008 published papers) then WT is considered as 1 and so on. Similarly, EC is calculated as the number of citations received within one and two years after publication.

The figure shows that among all cited papers above 30% of papers received their first citation in the same year they were published. Around 40% of the papers received their first citation in the very next after the year they were published. The value is less than 10% for the second next year. This means

Table 1: Keywords as per technology domain used for data retrieval.

Humanoid	AI	Autonomous Robot	Robot
Humanoid Robot	**Artificial intelligence**	**Autonomous Robot**	**Robot***
Biped Robot	Deep learning	AI robot	
Anthropoid Robot	Machine learning	Intelligent autonomous robot	
Anthropomorphous Robot	Artificial neural network		

Table 2: Year-wise TP distribution in different areas.

	HR		AI		AR		ROBOTS	
Year	TP	TP(CT>0)	TP	TP(CT>0)	TP	TP(CT>0)	TP	TP(CT>0)
2008	136	129	1713	1532	73	64	1499	1309
2009	167	156	1799	1621	55	49	1743	1550
2010	132	121	1741	1572	72	61	1825	1620
2011	177	164	1781	1592	68	64	2069	1827
2012	212	188	1841	1640	73	64	2232	1971
2013	271	241	2041	1783	78	68	2595	2272
2014	246	208	2134	1837	81	73	2733	2342
2015	311	245	2538	1940	100	77	3334	2569
2016	341	197	3039	1913	118	76	3936	2646
2017	375	117	3756	984	127	37	4613	1394
Total	**2368**	**1766**	**22383**	**16414**	**845**	**633**	**26579**	**19500**

the papers, which do not get citation, at least by the next year after their publication are very unlikely to get citation in the long-run. Table 3 presents the frequency of publications as per WT. So, this table only includes papers that have at least one citation. Last row of the table represents the value of mean time to receive the first citation (MWT) and MWT for the articles lies between 1 to 1.2.

Correlation of number of Authors, collaboration degree, average citations and citations with WT

For the initial analysis, the study examines the correlation of number of authors (#AU) and degree of international collaboration (#CU) with WT for first citations shown in Figure 3. The following correlation results have been found from the primary analysis. Correlation between number of authors and WT to get first citation is -0.12. Correlation between degree of international collaboration and WT to get the first citation is -0.068. We further analyzed the relation between WT to get the first citation with average yearly citation (Avg. CT). Correlation between WT to get the first citation and average citation per year is -0.27. The results are obtained using Pearson's correlation and only for the papers which have at least one citation. For a comparative view, the values are drawn in Figure 3. Correlation values follow a similar pattern for total citation (CT).

The correlation result states that as the number of authors increases, the WT for first citation decreases and as the degree of collaboration increases, the WT for first citation decreases but with a lower significance in comparison to the number of authors. The results conclude that for getting quick response and impact, number of authors plays an important role rather than the degree of international collaboration.

Table 3: WT Distribution in different research areas.

WT	HR	AI	AR	ROBOTS
0	548	5589	229	6655
1	767	7111	267	8447
2	275	2288	85	2715
3	91	789	26	911
4	42	319	10	418
5	24	166	9	200
6	12	82	3	75
7	3	43	2	45
8	3	21	2	26
9	1	6	0	8
TP(CT>0)	1766	16414	633	19500
MWT	1.13	1.05	1.02	1.04

*TP=Total Papers/Publications, CT=Total Citation, MWT=Mean WT for First Citation

It is also observed that that the paper which gets response earlier likely to get more citations. Another analysis from our data reveals that, the number of authors has a positive impact on average citation per year.

Regression Analysis of Indicators

We selected Poisson regression (PR) and negative binomial regression (NBR) model as our outcome variables are integer count data with non-negative value.[35,36] PR assumes the Poisson distribution of outcome variable, which represents an equal distribution of conditional mean and variance. NBR considers similar assumptions as PR and suitable to model the over-dispersion when conditional variance of dependent

variable is greater than conditional mean. We applied "dispersion test" function of AER package in R software to check the over dispersion of our data (https://cran.rproject.org/web/packages/AER/AER.pdf).[36] The result showed over dispersion in all the four datasets (with c value not equal to zero and value lied between 1.2–2). This justified our selection of NBR model, which is more flexible in such situation and used to overcome the problem of over-dispersion. We used both models for our analysis and compared the result to check the influence of variables on WT to first citation.

The regression analysis is conducted to check the effect of the number of authors (AU) and degree of international collaboration (DC) on WT for the first citation. The analysis results (Table 4) indicate that AU has a negative and significant relationship ($p<0.001$) to WT in all the four research fields, however, the value of the coefficient is different in each case. The results suggest that the number of author influences positively in receiving the first citation early and co-authored papers receive a quicker response than single-authored papers. In the case of international collaboration, the degree of international collaboration shows the mixed effect as per the research field. DC has a negative and statistically significant relationship with WT in the case of robotics and AI. In field of humanoid, the degree of collaboration has negative coefficient value but in autonomous robot field coefficient value, the results indicate DC has a positive impact on WT, however, in both the research field (HR and AUTO), the value is not statistically significant. The results present AIC value for each model. Although, for each field, Poisson (PR) and NBR have little difference in AIC values, yet all NBR models show lower AIC value, which makes it a better-fit model for analysis.

We further examine how WT for the first citation and early citation (EC) has an effect on average citations per year. For this purpose, we use linear regression analysis where citations average is the dependent variable and WT and EC are independent variables. The regression analysis is shown in Table 5. The result indicates that publications with higher WT have a negative impact on average citations and EC has a positive impact on average citations. This implies that less time in getting first citation as well as number of early citations, both have a positive effect on average citations and this pattern is almost similar for all the four research fields. However, the value of the coefficient varies as per the different research fields. To train the linear regression model, 80% of the data was used from each of the four categories. 20% of the data was used for testing the model. It is seen that the model was able to predict the average citation with an average deviation of 1.46 to 1.96. This model can be used to predict the long-term impact of papers in the very early stage after the research paper published. This model does not require more factors or other complex analysis.

Table 4: PR and NBR Analysis Results for WT.

Coefficient value of Regression (Standard Error)					
Regression		Intercept (C)	AU	DC	AIC Value
Poisson Regression	ROBOT	0.374*** (0.021)	-0.066*** (0.004)	-0.075*** (0.016)	52611
	HR	0.451*** (0.070)	-0.067*** (0.014)	-0.067 (0.052)	4965.2
	AI	0.366*** (0.022)	-0.043*** (0.003)	-0.104*** (0.017)	44457
	AUTO	0.151 (0.095)	-0.087*** (0.021)	0.140 (0.068)	1727.8
Negative Binomial	ROBOT	0.374*** (0.023)	-0.0663*** (0.004)	-0.075*** (0.017)	52343
	HR	0.452*** (0.070)	-0.067*** (0.133)	-0.067 (0.052)	4936.6
	AI	0.364*** (0.023)	-0.042*** (0.0029)	-0.103*** (0.017)	44205
	AUTO	0.14831 (0.105)	-0.083*** (0.023)	0.134 (0.076)	1710.1

Significance level *** ($p < 0.001$)

Table 5: Regression Analysis for Average Citations.

	Intercept (C)	WT	EC	Average Deviation
HR	2.052	-0.708	0.299	1.46
AI	0.9197	-0.9434	1.3496	1.82
AUTO	0.4102	-0.788	1.496	1.64
ROBOT	0.9239	-1.007	1.4364	1.96

*WT = WT (for first citation), *EC= number of early citations

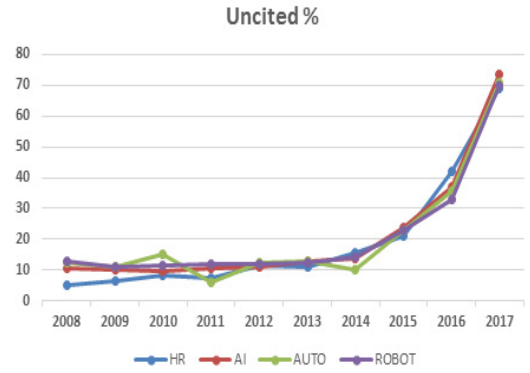


Figure 1: Year-wise percentage of uncited papers in different areas.

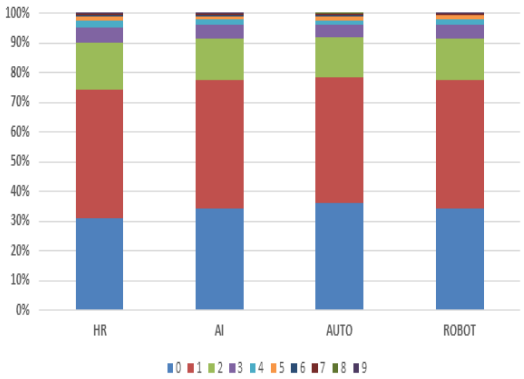
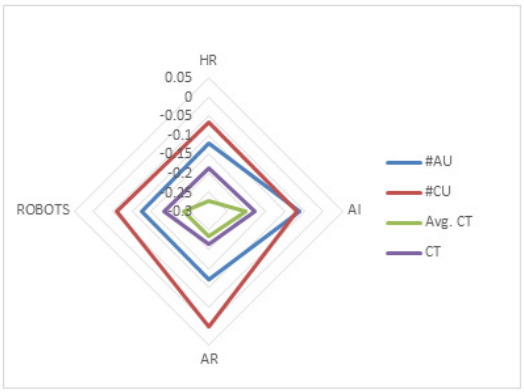


Figure 2: Year-wise WT distribution in Percentage.



#AU = number of authors, #CU=number of countries

Figure 3: Correlation values of Number of Authors, collaboration degree, average citations and total citations with WT.

WT or Collaboration

We also did a comparative study to see the independent effect of WT and Collaboration (in terms of numbers of authors) on average citations. For this purpose, we used AI dataset. To see the impact of WT, we took papers that have only one or two authors (less collaboration) which left us with 3,497 papers. The correlation between WT and the average citation was found to be -0.2163. On the other hand, to see the impact of collaboration, we excluded the papers, which have less than 2 years of WT (excluded papers those have good response time) which left us with 3,714 papers. The correlation between number of authors and the average citation was found to be 0.0872 which very insignificant. We also took papers that have more than two authors and less than 2 years of WT. The result shows that WT has much more correlation (0.17) with average citations in comparison to the correlation between the number of authors and average citations (0.065). This study reveals that WT has more effect on the future impact of papers (citations) in comparison to collaboration

DISCUSSION

The research considered to explore WT to get the first citation, which is related to the change in status and recognition of publications and indicates how fast knowledge is valued in the research field. First, the research uses the bibliometric method to examine the number and trend of cited and uncited papers. The study also found the pattern of WT to get first citations in different research fields. WT distribution of published articles indicate that most of the papers received their citations in the initial years after publications (1–2 years) and papers that do not get citation in initial years have less chance to receive citations in later periods. Less WT of papers specifies the speed of diffusion of knowledge that can determine the pace of research impact in the scientific community. Further, WT to receive the first citation reflects on the paper's quality, as it has been believed that high-quality papers have a strong ability to diffusion knowledge within few years (5 years ageing) after publications.[37,38] Besides, delay in getting the first citation suggests the slow speed of knowledge transfer.

In the next step of our analysis, we investigated the relationship between collaboration and WT to first citation. Most of the studies investigated that there is a relationship between co-authorship (measure for collaboration) and citation impact, as collaboration improves the transfer of knowledge and affects the quality of research. It is also evident that collaborated papers get more citations especially in case of international collaborated papers. However, there are a few evidence that indicate the relationship between collaboration and WT to first citation, thus we tried to investigate this relation. The result suggests that as the number of authors increases, the

WT for the first citation decreases. In the case of international collaboration, degree of collaboration is also negatively related to the WT for the first citation, but the value indicates the weak relation between both variables.

The results of the analysis support the idea that collaboration does not only increases citation but also improves the speed of citation impact by reducing the time to get the first citation. The improved visibility and quality of collaborated papers could be the reason of getting an early first citation. Moreover, the trend shows that the receiving of the first citation in a short period is important to get recognition for a paper and less WT indicates early recognition of the paper in the research community. Otherwise, there is a high chance to perish.

Recently, various attempts were made to improve the prediction of long term impact at an early stage. In the second step, we analyzed the correlation between WT to first citation with average citation and the total number of citations. In addition, we have tried to predict whether WT and EC can be used as an early indicators to predict long-term impact based on our regression models. Studies have indicated that citation gathered in one and two years after publication (calculated as EC) can be used as a forward indicator of the long-term impact of publication.[32] Our result shows there is a high chance that a publication accumulates their citation in one or two years of waiting period after publication and papers, which get early attention, continue to get more citation in the future. Consideration of WT and EC in our model to predict long-term impact is done by testing these indicators with other (number of authors) and results proved the suitability of these (WT and EC) over others. This makes our model a better fit for the prediction of long-term impact.

However, in the future with the development of a web-based database (which is not sufficient at current), the use of new techniques such as altimetry's on web-based data and social media, tweeters, etc. can be considered to predict the publication impact and performance at a very early stage.

CONCLUSION

This paper examined the effect of different factors on the long-term impact of scientific publications. The factors include the number of authors, degree of collaboration, waiting time and early citations against the long-term impact of papers. The result suggests that considered factors could be used for the prediction of long-term impact of papers. This study results help us to understand the role of different factors in recognition of papers in terms of average citation and total citation. The WT of first citation can be used as an early indicator in the evaluation of research performance and impact. Because the citation pattern and time of getting the first citation can differ as per the research fields, the selection of publications is restricted to specific technological subjects. The future work will be to study the citation trend of the early period to predict the long-term impact of papers.

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CONFLICT OF INTEREST

The authors declare no conflict of Interest.

ABBREVIATIONS

WT: Waiting time, **CT:** Total citation; **DC:** Degree of International Collaboration; **EC:** Early Citations; **AI:** Artificial Intelligence.

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