

CITATION ANALYSIS ON THE EMERGING TECHNOLOGIES IN THE FIELDS OF INFORMATION SYSTEMS

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Abstract

Even though information technology is an acceptable innovation for improvement of performance in all sectors, citation studies on associated literature seem to be missing. Furthermore, analysis of citations related to emerging technologies in these fields as cloud computing, virtual reality, mobile computing, e-learning, data mining and internet of things (IoT) seem to have received narrow attention. Citation analysis was carried out with objectives of determining authorship patterns, age distribution as well as keywords co-occurrence of the cited articles. A total of 3,123 citations appended to the reference section of 72 articles covering emerging ICT including cloud computing (10 articles), virtual reality (12 articles), mobile computing (13 articles), e-learning (12 articles), data mining (15 articles), and internet of things (10 articles) were analysed. Collaborative research among ICT scientists was revealed as two or more authors authored 60% of the articles followed by single authors (30%). Most cited sources in ICT systems are between 2010 and 2017 (58.5%). Customer behavior leads keywords in data mining: academic performance in e-learning; energy efficiency in IoT; computing infrastructure in mobile computing; data visualization in virtual reality and data integration in cloud computing.

Key Words: Citation; Cloud computing; Virtual Reality; Internet of Things; E-learning; Data Mining; Mobile Computing

1. Introduction

The value of citation analysis in research cannot be refuted and it reflects on citation practices. It helps study growth and structure of literature of any topic (Kumar & Reddy, 2012). According to (Karen & Dressler, 2018), citation analysis studies is a quantitative aspect of published information and permits researchers to analyze the distribution of knowledge within research areas. (Garfield, 1983) and (Richard, 2010) defined citation analysis as examination of the frequency, patterns, and graphs of citations in articles and books. (Martyn, 1976) describes citation analysis as the investigation of the citations or references or both which forms part of the scholarly publication. According to (Bhaughman, 1974) it is organized enquiry into the structural properties of the literature of the subject. The common use of citation analysis is to determine the impact of a single author on a given field by counting the number of times the author has been cited by others.

Citation information and analysis can be used in searching the literature, which is critical to the development of research questions and the generation of new ideas (Waaiker & Palmblad, 2015). Citation data can also help leading researchers within a field, potential collaborators, or funding opportunities. Citation indicators and information can be used by researchers and proposal developers in grant and project proposals. In addition, using and interpreting journal-level citation indicators is a critical component of the publication process (Leiss & Gregory, 2016).

A study on the impact of citation analysis by (Ellegaard & Wallin, 2015) reports that bibliometric analysis is seen as a valuable method for evaluating scientific production and that an increased demand for this type of analysis is likely. In the context of citation network analysis, articles within a group that strongly connect to each other but weakly link to articles outside the group are compared (Hsiao, Tang, & Liu, 2015). Understanding the latest developments in a given field such as emerging technologies in ICT provides insights into future trends (Huang & Chang, 2014). This could be beneficial to scholars looking for new areas of research; help researchers and technology administrators with policy decisions on funding, patent applications, or collaborations with other institutions. In a recent study, (Mishra, et al., 2016) used citation and network analysis techniques to examine scientific literature to identify influential works and emerging research clusters.

Another area of research that may be of interest to scientists focusing on emerging technology systems is keyword co-occurrence analysis. Besides citation analysis, scientific knowledge is also explored using keyword co-occurrence analysis. While citation analysis focuses on analysing links between citations in literature, keyword co-occurrence analysis focuses on understanding the knowledge components and knowledge structure of a scientific/technical field by examining the links between keywords in the literature (Radhakrishnan, Erbis, Isaacs, & Kamarthi, 2017). The number of times that a pair of words co-occurs constitutes the link connecting these two articles containing the keywords (Chena, Chena, Wua, Xiea, & Li, 2016). The more co-occurrence between two keywords, the closer their relationship is (Ibid). However, keyword co-occurrence analysis carried out by researchers has tended to overlook emerging ICT systems.

Keyword analysis has been used to study conceptual work in different domains by many researchers. (Dehdarirad, Villarroja, & Barrios, 2014) selected 959 full text articles included in the journal (Scientometrics) to map the intellectual structure of scientometrics using text-mining and co-word analysis. (Hu & Zhang, 2015) used keyword analysis to study recommendation systems in China. (Chena, Chena, Wua, Xiea, & Li, 2016) employed co-word method based on keywords from funded project to map the research trends in China. The projects of Management Science and Engineering in National Natural Science Foundation of China during 2011-2015 were collected as empirical data. The results show that the focus of researchers were Game Theory, Supply Chain Management, Complex Network, Data Mining, Optimize, Risk Management, and Data Envelopment Analysis. Moreover, Game Theory, Supply Chain Management, and Data Mining are hot topics. The research fields in Management Science and Engineering in China are varied, and the well developed and core research fields are fewer.

For the purposes of this study, citation analysis was used on six emerging technologies in ICT: Cloud computing; virtual reality; mobile computing; Internet of Things; e-learning; and data

mining to determine forms and age of publication, authorship patterns, and keyword co-occurrence in articles focusing on the same.

2. Literature Review

2.1 Emerging Technologies in the fields of Information Systems

Citing 39 articles, (Karen & Dressler, 2018) used readily available open access tools to review current techniques for identifying emerging research fronts in the field of the “Internet of Things” (IoT). Findings discovered terms that are picking up momentum in terms of the frequency of use and implications on research. (Walker & Forbes, 2017) cited 25 articles to consider how peer exchange between online tutors from different institutions may offer a solution to professional isolation. Findings reveal that tutors’ use of synchronous conferencing tools was influential in shaping the relationship between participants on the programme.

(Kakoty, Lal, & Sarma, 2011) cited 28 articles to analyse the current e-learning procedure and importance of e-education system and recent market of e-learning procedure. Equally, citing 16 articles, (Mothibi, 2015) estimated the relationship between e-learning and students’ academic achievement in higher education and found that ICT has a statistically significant positive impact on e-learning based students’ academic achievements. On the other hand, (O’zadowicz, 2017) utilised 96 citations to propose an innovative approach to both physical and logical organization of an active DSM system for future building-integrated prosumer microgrids (BIPMGs), based on standard building automation and control systems (BACS) as well as Internet of Things (IoT) paradigm. New event-triggered control functions with developed universal, logical interfaces for open BACS and IoT network nodes are presented and their implementation in smart metering as well as fully integrated energy management mechanisms is analyzed.

Citing 19 articles, (Singh, Kandah, & Zhang, 2011) assessed the effectiveness of a secured cost-effective multi-cloud storage in cloud computing and proposed a model which holds an economical distribution of data among the available service providers in the market, to provide customers with data availability as well as secure storage.

(Almrot & Andersson, 2013) utilised 26 articles identify advantages and disadvantages associated with running cloud based applications on mobile devices. The results show that migrating all your applications to the cloud will not significantly reduce the power consumption of your mobile device at the moment, but that mobile cloud computing has matured within the last year and will continue doing so with the development of cloud computing.

(Barthelus, 2016) sought to examine the forces that influence the adoption of cloud computing within the healthcare industry with support of 22 citations. The findings indicate that the primary reasons for resistance to cloud adoption within the healthcare industry are security and privacy risks to sensitive patient data, integration challenges, and a firms’ potential to lose control of data to cloud providers.

(Radhakrishnan, Shineraj, & Muhammed, 2013) provided an overview of application of data mining techniques such as decision tree citing 15 articles. Findings revealed that data mining techniques have been used to uncover hidden patterns and predict future trends and behaviors in financial markets. The competitive advantages achieved by data mining include increased revenue, reduced cost, and much improved marketplace responsiveness and awareness.

(Raorane & Kulkarni, 2011) used data mining technique to know consumer behavior, his psychological condition at the time of purchase and how suitable data mining method apply to improve conventional method, citing 23 articles. Moreover, in an experiment, association rule is employed to mine rules for trusted customers using sales data in a super market industry.

(Hussein, Khalid, & Khanfar, 2016) cited 40 articles in surveying existing literature for cryptographic storage techniques, benefits and drawbacks in cloud computing. They established that the common issue and challenge for cloud computing is the security of the cloud environment.

Based on the aforementioned literature, it is clear that citations among articles focusing on emerging technologies in ICT systems have varying authorship patterns, age distribution patterns and inconsistent keywords co-occurrence. It was therefore interesting to these varying patterns through critical analyses of articles on the emerging technologies in the selected field of information systems.

Objectives of the study

The present study analysed citations on the emerging technologies in the field of information systems, focusing on cloud computing, virtual reality, internet of things, mobile computing, data mining, and e-learning. The specific objectives of the study were to:

- i. Determine authorship patterns of cited articles on the emerging technologies in the field of information systems
- ii. Assess age distribution of cited articles on the emerging technologies in the field of information systems
- iii. Establish distribution of keywords co-occurrence in cited articles on the emerging technologies in the field of information systems

3 Methods and Data Analysis

3.1 Methodology

The analysis adopted descriptive design of citations in articles covering six types of emerging technologies. The articles covered were those published before 2010 and after 2010 to 2018. The articles were accessed in the month of March to April 2018 from internet sources using Google search engine. The details of each article published, such as number of articles covered for each type of ICT system, number of citations in the article, form of authorship, form or source and age of citations for each article and keywords co-occurrence have been recorded and analysed for making observations. The sampling procedure for the study was purposive since data was being

collected specifying the target six types of ICT systems. Table 1 presents the distribution of articles which were analysed for citations.

Table 1: Distribution of Sampled Articles

Publications	Emerging Technology Systems						Total
	Cloud Computing	Internet of Things	Virtual Reality	Data Mining	E-Learning	Mobile Computing	
Journal Articles	5	6	5	6	4	5	31
Books	2	0	2	2	3	2	11
Web Sources	1	2	1	1	2	2	9
Conference	2	1	2	4	3	3	15
Technical Reports	0	1	2	2	0	1	6
Total	10	10	12	15	12	13	72

3.2 Data Analysis

The assembled data was carefully edited, tabulated and analyzed. To make the data analysis statistically sound, Statistical Package for the Social Science (SPSS) as well as necessary statistical techniques such as tables and diagrams were used.

4 Findings and Discussions

4.1 Findings

4.1.1 Distribution of Citations by Authorship Patterns

The first section under objective one assessed the authorship patterns among the cited articles. Co-authorship in research articles is considered a reliable proxy of research collaborations (Kumar, 2015). Table 2 presents the distribution of citations by authorship patterns.

Table 2: Distribution of citations by Authorship Patterns

Authors	No of Citations	Percent
1 Author	937	30
2 Authors	781	25
3 Authors	469	15
4 Authors	250	8
5 Authors	125	4
6 Authors	156	5
More than 6 Authors	406	13
Total	3123	100

Table 2 illustrates that most researchers in ICT systems prefer to work in collaboration as more than 70% (2186) of citations are multi – authored. However, 30% (937) of those cited are single authors. The table reveals that 25% (781) of citations in the sampled articles were of two authors; 15% (469) three authors; eight percent (250) involved 4 authors; four percent (125) involved 5 authors; five percent (156) were of six authors; and 13% involved more than six authors. This finding concurs with that of (Kamini & Rattan, 2013) who established in a citation analysis of articles appearing in an international electronic journal (IR) during the period 2008-2012 that more than half of the citations (51.44%) were multi-authored. This implies that the cited authors have high impact in emerging ICT systems as explained by (Chen, et al., 2017). According to (Chen, et al., 2017), co-authorship aids in examining the scientific impact of an individual scholar: an author can be evaluated by simply looking at citations of her published papers. Similar findings were also established in a study by (Pradhan, Solanki, & Patel, 2016) in an analysis of papers that were presented in the last nine PLANNER conventions held during the period 2003 to 2014 in North East Indian Universities. They found that all the papers presented in PLANNER conventions were mostly collaborative in nature with an average of 1.86 authors per paper.

4.1.2 Distribution of Emerging ICT Systems citations Vs Authorship Patterns

Citations according to authorship patterns in each of the selected articles per ICT system were also analysed. Table 3 presents the distribution of ICT systems citations verses authorship patterns.

Table 3: Distribution by ICT System Citations Vs Authorship Patterns

	Cloud Computing	Virtual Reality	Data Mining	E-Learning	Mobile Computing	Internet of Things	Total
1 Author	158	143	129	214	143	150	937
2 Authors	127	130	128	163	118	114	781
3 Authors	69	71	82	78	98	71	469
4 Authors	51	42	41	27	43	46	250
5 Authors	28	25	20	11	22	19	125
6 Authors	27	29	26	18	30	26	156
More than 6 Authors	58	68	69	46	89	76	406
Total	518	508	495	557	543	502	3123

Table 3 illustrates that 23% of single author citations were in articles for E-learning, while 21% were of double authors. Additionally, 21% of triple author citations were in articles under mobile computing while the highest number (20.4%) of articles done by 4 authors was under cloud computing while 18.4% was under internet of things. The emerging ICT system with the highest number of authors cited was mobile computing (2.8%; n=89) followed by internet of things (2.4%; n=76) and data mining (2.2%; n=69). On the other hand, the ICT system with the lowest number of authors cited was E-learning (1.5%; n=46). It is imperative, however, to note that most authors cited in e-learning technology involved articles authored by students and, partly, in collaboration

with their lecturers (e.g (Mothibi, 2015); (Mutendwahothe, 2013); Walker & Forbes, 2017). It also worth to note that co-authorship has been largely adopted by scientists in emerging ICT systems as a mechanism that shapes the scientific community as enthused by Kumar (2015). Being new technologies whose adoption has not been entirely embraced, co-authorship is a key mechanism that links different sets of talent to produce a research output.

4.1.3 Forms and Age Distribution of Citations

Part of the citation analysis also covered forms or sources and age of the citations revealed in the sampled articles. Citations were traced in the reference section of the sampled articles to determine their sources and forms as well as the year of publication (age). Table 4 presents the distribution of forma and age of citations.

Table 4: Form (Source) and Age Distribution of Citations

Form /Source of Citation	Before 2010	2011	2012	2013	2014	2015	2016	2017	2018	Total	% age
Journals	45	56	95	89	86	73	61	62	57	624	20
Books	54	59	45	39	37	42	42	40	36	394	12.5
Web	30	47	41	45	49	47	45	45	21	345	11
Conference	42	52	56	50	57	58	56	48	38	457	14.5
Speech	23	35	32	31	20	21	30	20	17	239	7.6
Reports	24	31	30	23	30	31	23	21	14	237	7.5
Thesis/Dissertations	28	35	21	23	26	26	22	23	19	223	7.1
Manuals	10	15	21	22	25	27	23	20	18	181	5.8
Handbooks	20	30	22	21	32	32	21	21	20	219	7
Magazines	21	33	20	30	31	30	20	20	17	222	7
Total	296	358	394	373	393	387	343	322	257	3123	100

Table 4 illustrates that most citations (20%) covering emerging technologies in ICT systems are in articles found in journals followed by conferences and workshops (14.5%), and books (12.5%; n=394). (Kamini & Rattan, 2013) also found that journals were the most preferred form of citations by international research scholars while writing their papers. Similarly, the table also illustrates that most (n=394; 12.5%) were published in 2012 and (n=393; 12.5%) were published in 2014. Additionally, 12.4% (n=387) of the citations were extracted from articles published in 2015 while 11.9% were in 2013 publications. This implies that the technologies are rather new and their adoption continues to evolve. This finding however tends to partly contradict (Kamini & Rattan, 2013) who found that maximum number of articles (57) as well as maximum number of citations (2324) was published in 2008 in a citation analysis of articles appearing in the online journal during the period 2008-2012. This would nevertheless imply that a large number of articles analysed by Kamini and Rattan were done in 2008.

4.1.4 Distribution of Keywords Co-occurrence

Keywords appearing in each article from which cited works were derived for analyses were also scrutinized by the study. Table 5 presents the distribution of keywords according to the technologies under study.

Table 5: Keywords Distribution

Keywords	Cloud Computing	Virtual Reality	Data Mining	E-Learning	Mobile Computing	Internet of Things	Total
Academic Performance	00	00	00	15	00	00	15
Big Data	12	4	3	00	10	8	37
Blended Learning	00	00	2	16	00	1	19
Building automation	1	10	00	00	1	8	20
Building design	2	13	00	00	1	5	21
Building energy management	1	11	00	00	2	8	22
Clouding	12	6	2	2	10	9	41
Cloud service provider	11	8	00	00	10	9	38
Cloud Storage	12	7	2	00	10	10	51
Competences	2	5	4	8	2	5	26
Consumer behaviour	1	3	11	1	00	3	19
Data mining	2	00	15	2	00	2	21
Decision Tree	3	1	16	1	3	2	26
E-Learning	1	00	1	16	00	2	20
Energy consumption	2	12	1	00	1	11	27
Energy Efficiency	1	10	00	00	1	11	23
Information systems	10	11	9	10	8	10	58
Internet based	10	12	9	10	11	15	67
Internet of Things	2	4	1	00	5	16	28
Knowledge management	9	7	15	14	8	6	59
Marketing	1	1	16	2	6	1	27
Mobile application	7	6	4	00	15	13	45
Mobile Computing	8	5	1	1	16	15	46
Mobility	4	2	1	1	16	14	38

Mobile Solutions	7	5	1	00	15	15	43
Pedagogy	00	00	1	9	00	1	11
Platform	9	10	8	1	12	15	55
Portable devices	10	7	1	1	16	16	51
Smart Building	3	16	00	00	5	3	27
Urban Planning	3	15	1	00	4	4	27
Virtual Reality	3	16	00	00	5	4	28
Total	149	207	125	110	193	242	1026

Table 5 illustrates that internet of things (23.6%); virtual reality (20.2%); and mobile computing (18.8%) had the highest keyword co-occurrence. Equally, five keywords (internet based; knowledge management; information systems; cloud storage; portable devices, and platform) co-occurred most in citations among articles under the selected emerging ICT systems under study, particularly cloud computing, mobile clouding, virtual reality, and internet of things. According to (Radhakrishnan, Erbis, Isaacs, & Kamarthi, 2017), these points at knowledge expansion within this field (emerging ICT systems). It also indicates the interrelationship of these technologies. In similar view point, (Liu, Dong, Guo, Yang, & Peng, 2015.) analyzed the application of cloud computing and the Internet of Things on the field of medical environment. The simulation results showed that the proposed scheme can improve the efficiency of about 50%. This has the implication that there is critical connectedness between the emerging ICT systems that can be beneficial to every player in all sectors.

5. Conclusion and Recommendation

The study concludes that there is collaborative authorship pattern among citations in articles covering the selected emerging ICT Technologies. The study revealed that 70% of citations involved more than one author.

Mobile computing, cloud computing and internet of things led with citations involving more than three authors.

It is also concluded that most citations were extracted from journal sources followed by conferences/workshops and books. Additionally, most citations were from articles published in 2012 up to 2018, signifying the fact that the themes under study were emerging technologies whose adoption continues to evolve.

The study also reveals that internet of things; virtual reality; and mobile computing had the highest keyword co-occurrence. It also revealed that five keywords: internet based; knowledge management; information systems; cloud storage; portable devices, and platform had the highest co-occurrence of citations among articles under the selected emerging ICT Technologies.

The researcher feels that this exercise in bibliographic analysis can be very important in examination of the new emerging technologies. This model of research analysis can also be used with other research topics.

It is recommended that other researchers can carry out the same analysis with other emerging technologies to compare the results.

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