

Assessing the Determinants of Cloud Computing Adoption for Educational Sector

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Abstract

Cloud computing has brought evolution in many sectors like manufacturing, healthcare, governance. Cloud computing is growing interest in education, but the rate of adopting the cloud computing is low for the education sector. Cloud technology can help education field to overcome new challenges. In this context, this paper aims to provide a systematic literature review of cloud computing capabilities, challenges, and usages of the educational sector. The paper presents the systematic analysis of 52 research papers on cloud computing for education. For simplification and better understanding, these papers were divided into four categories namely academic institutes, library, e-learning and adoption. The purpose of the presented work is to clarify the requirements of cloud-based education systems. Authors identified recent research directions, and research challenges and opportunities of cloud computing for education purpose. This article contributes in theorizing cloud computing capabilities in the context of educational sector and provides future direction of research in this field.

Keywords

Cloud Computing, Education, Library, e-Learning, Adoption

1. Introduction

Cloud Computing (CC) has emerged as an exciting paradigm for managing and delivering services over the Internet (Zhang et al., 2010). The impact of CC on IT outsourcing is significant as due to CC there is a paradigm shift in how

organizations pay for and access IT services (Dhar, 2012). CC and SaaS are indeed innovations within ICT, allowing new ways of doing business, connecting with and engaging (Sharif, 2010). ICT fields have to produce in conjunction for the promise of CC are the advancement of parallel programming models and extensive reference software, Cloud access to high-performance computing, Green IT, investment in low-cost access-cum-computing devices and hi-speed networks (Dwivedi and Mustafee, 2010). CC has been cited as ‘the fifth utility’ along with water, electricity, gas, and telephone (Buyya et al., 2009). Among the various definitions, the one by the NIST is broadly accepted, which states as: - “A model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g.- networks, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction” (Mell and Grance, 2009).

Like many other disruptive innovations, CC is expensive and more complicated to use, and before CC adoption, organizations must monitor and investigate also needs to consider global financial crisis (Sultan and Van, 2012). According to Rai et al. (2015) cloud migration research is evolving and maturing, but there is need secure migration model, which can support organization’s trust. CC is adapted widely from manufacturing to services, but its use for the educational sector is limited due to various reasons.

The purpose of this research paper is to provide insight to CC requirements for the education sector. Three central pillars of education sectors considered are academic institutes, library and e applications for education. In this paper, we are motivated to have a thorough literature review to understand CC applications in the education sector, to gain knowledge about recent research, current new trends, and to identify future research directions along with critical issues that need immediate attention.

The rest of the paper has organized as follows. Section 2 gives research methodology and analysis of papers. In section 3 introduces literature survey papers. In section 4, 5 and 6 overviews CC for academic institutes, library, and e- applications respectively. In section 7, adoption of CC for the educational sector has discussed. In section 8 our work is concluded with a summary of challenges.

2. Research Methodology

The research methodology used for conducting the literature review is as follows. This literature review is based on the extensive search of peer-reviewed papers following 09 publishers: ASME, Elsevier, Emerald, IEEE, Inderscience, SAGE, Springer, Taylor and Francis, and Wiley. For above publishers’ conference proceedings, textbooks and whitepapers were excluded, and only journal papers were considered. This literature review is based on the extensive search of 145 papers found on CC and related issues in journals of above mentioned nine publishers. After scrutinizing manually, 52 articles are considered relevant to CC for education. The collected papers are analyzed, categorized; the code is given to each paper.

For simplification and better understanding, these 52 papers were divided various categories and subcategories. These papers were segregated into two broad areas as shown in Table 1.

Table 1 Structured classification of literature review on CC for Educational Sector

Sr. No.	Area	No. of Papers (N)	Percentage (%)
1	CC for Academic Institutes	08	15.38
2	CC for Library	23	44.23
3	CC for e-application for education	05	9.62
4	CC Adoption	16	30.77
Total		52	100

It indicates that CC for education even though in the early stage, number of papers CC for the library is discussed by more number articles (23 papers,44.23%), followed by CC adoption by 16 papers (30.77 %). CC for academic institutes (08 papers, 15.38 %) and CC for re-education (05 papers, 9.62 %) is lesser and needs more attention. Out of 52 papers, five papers are on literature survey and discussed in next section

Further, this section explores analysis of these 52 papers year wise and country wise. Year wise distribution of these papers is given in Table 2 and Figure 1. It shows that even though CC term was coined in 2006, its use for the education sector is started in 2009. A gradual increase in some papers indicates that CC can be a promising solution for the educational sector.

Table 2 Frequency of papers published by the year

Sr. No	Year	No. of Papers
1	2009	2
2	2010	5
3	2011	6
4	2012	6
5	2013	6
6	2014	10
7	2015	9
8	2016	8
	Total	52

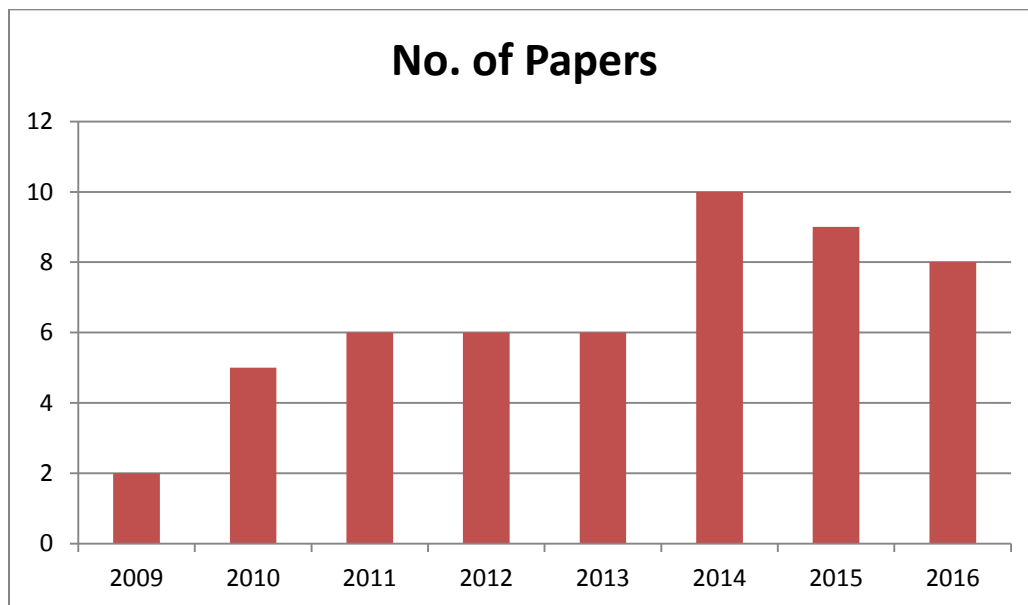


Figure 1 No. of Papers Year wise

Country-wise distribution of these papers is given in Table 3 and Figure 2. For papers having authors from more than one country, country of the first author is taken. It shows that even though CC term was coined in 2006, its use for the education sector is started in 2009. A gradual increase in many papers indicates that CC can be a promising solution for the educational sector.

Table 3 Frequency of papers published by country

Sr. No	Country	No. of Papers
1	Africa	1
2	Australia	1
3	Botswana	1
4	Brazil	1
5	Bulgaria	1

6	China	1
7	France	1
8	Germany	2
9	India	3
10	Israel	1
11	Jamaica	2
12	Kenya	1
13	New Zealand	1
14	Saudi Arabia	1
15	Spain	3
16	Taiwan	4
17	Thailand	1
18	Turkey	2
19	UK	4
20	UAE	1
21	USA	19
	Total	52

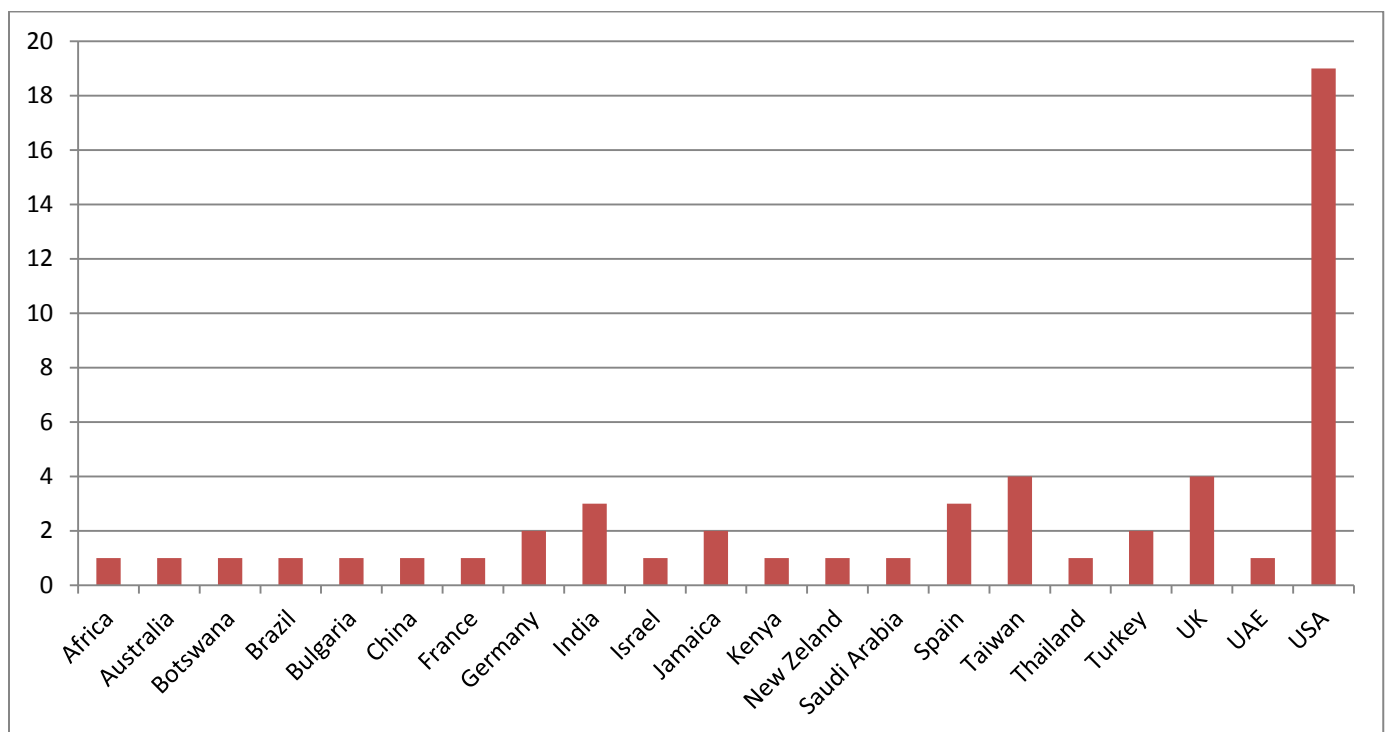


Figure 2: No. of Papers Country wise

These 52 papers are published in 21 countries shows wide spectrum of CC for education. The maximum number of papers (19 papers, 36.54%) is published in USA, whereas Taiwan and UK published 4 articles each (7.69 %). From India, three articles (5.77 %) are published shows that much work needs to be done in CC related issues and adoption in educational sector.

3. Literature Survey Papers- Similar Work

To identifies and analyzes the advantages and risks that the uses of CC in education, González-Martínez et al. (2015) reviewed 112 scientific kinds of literature research CC in education. This survey category and discusses the main technical and domain-specific research challenges, but does not consider library and e-learning papers. Mustafee (2010) identified CC for e-Science applications after reviewing the literature on using grid computing, desktop grids and CC for e-science applications.

Fox (2009) pros and cons of CC for digital libraries by exploring issues of CC technology, current internet business practices and the consequences of providing library services in recent future. Liu and Cai (2013) provided the theoretical approach which provides increasing CC impact on systems librarianship, and to propose strategies to shift to CC adoption. Mavodza (2013) gave the review of current literature about issues involved in navigating the modern information environment and impact of CC on library services. These three papers were an only focused library.

Thus there is the need for literature survey of education sector which will cover academic institutes, library, and re-application. Next three sections discuss these three categories respectively.

4. Cloud Computing and Academic Institutes

Google Apps for Education and Microsoft's SkyDrive are two popularly used cloud tools. Thomas (2011) examined features of these two tools to understand and improve practices in the scholarship of teaching and learning (SoTL) in a higher education context. Ramachandran et al. (2014) and Sultan (2010) used case study approach to understand CC for academic institutes. Premier management institute in the Southern part of India is taken for decision making process of selecting appropriate CC deployment model like private cloud, public cloud, community cloud, hybrid cloud (Ramachandran et al., 2014). Ramachandran et al. (2014) analyzed and compared these CC deployment models based on various factors and perspectives such as elasticity, availability, scalability, etc. using Multi-Criteria Decision Making (MCDM) model – namely, the Analytic Hierarchy Process (AHP). A case study of University of Westminster (UOW), UK was taken by Sultan (2010). In 2007 UOW shifted to Google Apps to provide a whole campus with free email, but in 2008/9 academic year, Google Apps was rolled out after testing and user consultation as many students were in favor of their email systems and shifted to Exchange/Microsoft Outlook, i.e., university's old email system (Sultan, 2010).

Lin et al. (2014) proposed a cloud-based reflective learning environment to assist instructors and students in developing and strengthening reflection ability during and after actual class sessions. ASP.NET 3.5 (C#) and Microsoft SQL Server 2005 was used to create course website; Motivated Strategies for Learning Questionnaire (MSLQ), which included nine items based on a seven-point Likert scale, was used to understand whether students' learning motivation had improved (Lin et al., 2014). Waddington et al. (2013) proposed a solution for long-term storage and access of research data with the design of a repository framework which uses the hybrid cloud. Repository framework combines internal institutional storage, cloud storage and cloud-based preservation services into a single integrated repository infrastructure; while rule-based approach was used for allocation of content to storage providers (Waddington et al., 2013). Lee et al. (2014) proposed a web-based system to help pre-service teachers to face real-time challenges in school. Lee et al. (2014) demonstrate PRES-on which is dynamic simulation system embedded with levels of scaffolding for learners also can help teachers for problem identification.

CC is becoming popular in education, but many organizations involved face severe budget restrictions. There is a need for cost optimisation mechanisms. Koch et al. (2016) proposed the method to be based on Maximum Likelihood Estimation to propose the context-aware algorithm for allocating computing resources for classrooms. Factors considered for discrete event simulation were security margin, costs, and QoS for school and results shows 30 % cost reductions, compared with conservative resource allocation strategies (Koch et al., 2016).

5. Cloud Computing for Library

Digital library managers often need to choose between virtualization of servers and CC. Cervone (2010) studied both these technology models regarding principles, techniques, differences, and similarities. Cervone (2010) concluded that while choosing between virtualization and CC for digital library applications, system managers must consider security problems and management problems given the outsourced nature of the computing resources. Prince (2012) gives ten inexpensive cloud-based applications (like Doodle, Cacao, Dropbox, Photoshop Express, Survey Monkey, Screencast-O-Matic, YouConvertIt, Ifttt, Cometdocs, AnyMeeting) that medical librarians can use and replace rich desktop applications.

Bordeianu and Kohl (2015), Erlandson and Kuskie (2015), and Han (2013) used case study approach to understand CC for the library. Due to the popularity of CC libraries are shifting from stand-alone integrated library systems (ILS) cloud-based systems. Bordeianu and Kohl (2015) took a case study of University of New Mexico Libraries who undertook the migration to online computer library center (OCLC) cloud-based ILS. WorldShare Management Services (WMS) provided support to OCLC. Bordeianu and Kohl (2015) elaborated each stage of the migration and described the process along the way such as choosing the vendor, preparing the data for migration, and implementing workflows. Erlandson and Kuskie (2015) discussed the case study of University of Nebraska Omaha Library, USA for OCLC cloud-based WMS. Han (2013) integrated cloud storage using Amazon S3 and Google Cloud Storage (GCS). Case study results show integrating cloud storage services, similarities and differences between S3 and GCS, advantages of CC and concerns like content, skills, costs, and security (Han, 2013). Table 4 shows summary of 11 review papers.

Table 4 Review of CC for Library (in alphabetical order)

Sr. No.	Authors	Year	Methodology/ Approach	Remark
1	Goldner and Birch	2012	To provide an overview of the historical development of interlibrary loan (ILL) and identify key milestones, authors conduct an extensive historical review followed by PEST analysis of societal factors affecting present day resource sharing. Analysis provides a global perspective on the challenges of library resource sharing in the digital age. Cloud-based systems will assist in resource sharing as many countries have a national cloud-based resource sharing tool, accessed via a web browser.	Librarians must work with publishers, politicians, and systems developers to ensure resource sharing systems while CC can support sharing and acquiring materials in multiple formats.
2	Hoy	2012	Cloud services used in libraries discussed are Breeding (integrated library system software products), Bibliographic management. Cloud products such as Gmail and Google Docs are becoming popular.	Libraries can benefit from many of the features of CC but one must carefully consider which vendors they choose and ensure that they maintain control of their data and applications.
3	Mitchell	2010	Author reviewed recent technology proliferation and cloud-based solutions for library. Moving from local solutions for our library data and applications to cloud-based solutions has many issues like file storage, archiving and preservation, application hosting, and scalable production environments.	CC adoption for library adds a level of complexity due to new set of tools and services. Advantages offered are faster scale service. In future rather than isolation projects, community-focused applications will allow libraries to build CC service together.
4	Patel et al.	2011	Reviewed GC, CC, UC and SaaS addressing their strategies, functional characteristics and pros and cons, followed by brief comparison between them from several service aspects for public and private libraries.	Google trends of GC, CC, UC and SaaS shows that demand of GC is decreasing while that of CC is increasing significantly because of its beneficial features
5	Romero	2012	Author discussed features of CC, its benefits and drawbacks for professional library. CC ensure quick and easy resource availability because of virtualization and programming techniques (multi-tenancy and/or scalability, load balancing and optimal performance)	CC is not just for large corporate groups but also for small organizations for benefits like cost-saving, improved services and libraries will get benefit with CC adoption.
6	Scale	2009	Reviewed 4 popular CC services used for facilitating Web collaboration: Wikis, Collaborative website development, Collaborative Web documents, and Collaborative customizable search engines.	Today, libraries are going for CC adoption, also new services that libraries are implementing using Web services are significantly social and collaboration allows users to participate in developing the Web product or service. CC and Web collaboration are shaping 21st-century libraries.

7	Sorensen and Glassman	2011	Article throws light on the gray areas of CC and presents CC adoption advantages, challenges to librarians and libraries, scientists, and end users. Due advent of the personal computer and the drop in server costs, MEDLINE and similar databases were hosted locally with products such as Dialog on Disc and CDPlus. Librarians no longer had to rely on slow dial-up and Internet connections. But concerns of security, privacy and access need to be addressed.	CC is here to stay; librarians need to position themselves to take full advantage of this trend and its adoption.
8	Wale	2011	Article reviewed various aspects of proprietary Integrated Library System (ILS), open source ILS and cloud-computing servicing model.	Proprietary ILS- stability and functionality Open Source ILS- flexibility and customizability CC Adoption- Institutional need, financial benefits Cost doesnot play an important role in any of these.
9	Wasike and Njoroge	2015	Reviewed motivating factors for libraries to embrace clouds,library cloud benefits,type of clouds and their descriptions.	Libraries can choose from a wide range of service providers according to their requirements. Libraries need to consider following factors for CC adoption: security, support, scalability, continuity and reliability of library services, reliability, IT knowledge, availability.
10	Yang	2012	Reviewed advantages, disadvantages of CC. CC for libraries. Explained example of Amazon EC2 HaaS pricing.	In 2012 library vendors began to deliver CC tool- integrated library systems (ILS).New generation of ILSs offering more than features mentioned in next generation catalog (NGC).
11	Yuvaraj	2015	Review of literature of CC for libraries. Compared various features of Cloud-Based Operating System Providers (Glide, Joli, Cloudo, Eye) , Cloud-Based Productivity Suites (Google Docs, MS Office 365), Cloud Mailing Service Providers (Gmail, Ymail, Mail, Rediffmail , AOL, Outlook), Cloud-Based Storage Service Providers (Google Drive, Drop box, iCloud ,Skydrive, Mozy ,Spideroak, Box ,Cubby, Live Kive) , Cloud-Based Cataloguing Suite Providers (LibraryThing, Biblios, Bookwhere, Connexion) , Cloud-Based Calendar Service Providers (Google calendar, Yahoo calendar, Zoho)	Librarians are in search of cloud based software and solutions. From set of service providers mentioned librarians need to explore and evaluate these products carefully before switching to CC and their clear understanding of the concept will speed up the process of adoption for library.

6. Cloud Computing for e-Applications for Education

This part of the paper focuses on e-Applications, which for education are either e-Learning or e-Science. Fernández et al. (2014) reviewed e-learning approaches for CC, followed by the suitability of this environment for educational data mining. Evaluating individual learning in e-learning program is a complicated job and to address this issue, Stantchev et al. (2015) proposed a cloud-computing-based service. The model was composed of two main technologies Artificial Immune Systems and an abstract global knowledge representation model based on ontologies, along with other data-mining and machine learning techniques (Stantchev et al., 2015). The efficiency of a cloud e-learning service is must to achieve the desired performance and long-term development of service. Su et al. (2015) proposed hybrid fuzzy MADM using decision-making trial and evaluation laboratory (DEMATEL), and fuzzy DEMATEL based analytic network process (DANP). DEMATEL was used to construct the fuzzy scope influential network relationship map while DANP was used to determine the relative weights of the criteria (Su et al., 2015).

Performance of e-Science applications on commercial clouds can be improved. Chard et al. (2016) achieved this through detailed examination, and characterization, of the underlying cloud network using network tomography. Chard et al. (2016) proposed a model for describing the overall network health of an e-Science application by means of health indicators, markers, metrics, and score; two Amazon Web Services (AWS) test beds introduced and deployed the health system over a test-bed of 100 AWS instances and explore its ability to scale.

7. Cloud Computing Adoption for Educational Sector

Opportunities for CC in education are more. As shown in Table 2, 52 papers identified are from 21 different countries. Developed and developing countries are keen to use CC for education. Out of 52 papers selected, sixteen papers are on CH adoption, which is further categorized into three categories as shown in Figure 3. Table 5 gives summary of sixteen papers in these categories

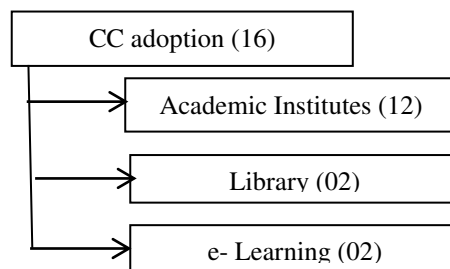


Figure 3 Classification of CC Adoption

Out of 16, twelve adoption papers are academic institutes. Only 2 papers each are for library and e-Learning, shows more adoption study of CC needed for these categories.

Commonly used theories in adoption are as follows

- Technology acceptance model (TAM)
- Technology-organization-environment (TOE)
- Diffusion of innovation (DOI)
- Theory of planned behavior (TPB)
- Innovation diffusion theory (IDT)

Table 5 CC Adoption for Educational Sector (in alphabetical order)

Sr. No.	Authors	Year	Type of Educational Sector/Person	Country	Adoption Model/ Tool
1	Aharony	2014	Educational technology experts.	Israel	TAM
2	Arpaciet al.	2015	Pre-service teachers (n=200)	Turkey	TPB

3	Arpaci	2016	Undergraduate students (n=262)	Turkey	TAM
4	Behrendet al.	2011	Two Community Colleges (one rural, n = 142 and one urban, n= 618).	USA	TAM
5	Bhatiasevi and Naglis	2016	Leading University	Thailand	TAM
6	Chao et al.	2015	Trainers (n=170)	Bulgaria, France, Germany, Italy, Romania, and UK	Theoretical model - CLEM (Cloud E-learning for Mechatronics)
7	Jou and Wang	2013	College students (n=132)	Taiwan	TAM
8	Kim et al.	2014	Undergraduate students (n=150)	USA	TAM
9	Liao et al.	2014	e-learning students (n=257)	China	Theoretical model
10	Luo	2012	Library users (n=62)	USA	No specific theory is used
11	Sabi et al.	2016	Expert users and decision makers at universities	Africa	DOI ,TAM
12	Schneckenberg	2014	Classroom learning (n=82)	France	No specific theory is used
13	Shiauand Chau	2016	Classroom (n=478)	Taiwan	TAM, TPB, and IDT
14	Stantchev et al.	2014	Higher education Students (n= 121)	Germany	TAM
15	Tashkandi and. Al-Jabri	2015	Education institutes (n=34)	Saudi Arabia	TOE
16	Yuvaraj	2016	Librarian (n=339)	India	No specific theory is used

Majority of above studies are quantitative in which through a questionnaire the responses had collected from students, faculties and higher management of an educational institute. Findings of these studies areas:

- Perceived ease of use (PEOU), perceived usefulness has a statistically positive relationship towards the adoption of CC (Aharony, 2014; Bhatiaseviand Naglis, 2016).
- Collaborative learning cloud solves the problem of instructor-student imbalance (Liao et al., 2014; Kim et al., 2014; Schneckenberg, 2014).
- E-Learning helps students in lateral thinking and problem-solving (Chao et al., 2015; Schnackenberg, 2014).
- Current Learning Management Systems (LMS) have many limitations, and CC overcomes it (Schneckenberg, 2014).
- SaaS tools like YouTube, Dropbox, Google Forms, Google Calendar, Ning, and VoiceThread are potentially useful for librarians (Luo, 2012).
- Top management and administrators need to take the initiative (Arpaci, 2016; Yuvraj, 2016)
- CC is cost-effective as many educational institutes have the limited budget (Behrend et al., 2011; Sabi et al.,2016; Tashkandi and. Al-Jabri, 2015, Yuvraj, 2016).

Distribution of papers as per adoption model is shown in Figure 4.

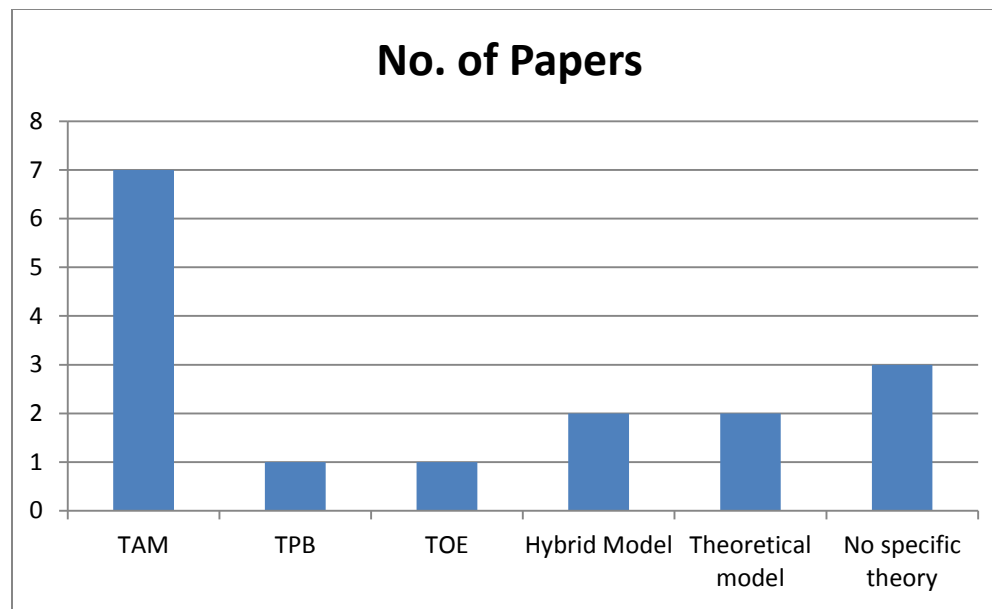


Figure 4 No. of Papers –Adoption Model wise

The TAM is an information systems theory that models how users come to accept and use a technology. Two factors are- Perceived usefulness: degree to which a person believes that the use of a system will improve his performance, Perceived ease of use: degree to which a person believes that the use of a system will be effortless.

8. Conclusion

Use of CC in the educational sector is in its initial stage. CC offers flexibility and scalability. CC is the excellent option for libraries as faculty and students can access information around-the-clock. CC platform can bring positive change in academic institutes. CC through collaborative learning can solve faculty-student imbalance in current e-learning. Developing countries like India schools/colleges have a shortage of resources regarding experienced teachers, money. Irrespective of geographical locations of teacher CC based learning tools will help students to improve their performance. Top management like higher authorities and administrators should be aware of CC benefits, and their support is very crucial. Human users are always reluctant to change, and managers of educational institutes need to support faculty and students for this paradigm shift. Careful planning will ensure that investment does not go waste.

Adoption of CC for education is well taken by developed countries like USA, Spain, UK, China etc. However its adoption is in nascent stage for developing and undeveloped countries. Issues of network, internet band width, computer literacy of people are major concerns in developing and undeveloped countries. Amongst various adoption models, TAM model is most popular as TAM is widely accepted model for understanding IT adoption and usage processes.

Major concerns for the adoption of CC for education are security, privacy as it involves university records, students' data, intellectual property (IP). Concerns about reliability, portability, skills, cost, and culture are also prominent. Legal implications must be understood particularly many clouds may be hosted in foreign countries. Future directions building CC services for group of libraries, mobile CC, intelligent scheduling, further service for teachers and learners, meeting the demands, community-focused applications

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