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To understand the applications of cloud computing adoption in various sectors

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Abstract

Cloud Computing (CC) is capable of on-demand use and sharing of resources. Various sectors like education, manufacturing, service, healthcare have successfully adopted CC. Cloud Computing Adoption (CCA) in these sectors is practically being implemented for real-life applications. Scholarly articles discuss these popular applications. However, there are other applications like governance, insurance, forensic, biomedical etc. which are also using CC services. The purpose of this study is to understand CCA in these diverse applications. The benefits, issues and concerns of CCA for e-Governance, e-Commerce, e-Science, digital forensic, geoscience, a non-profit organisation, biomedicines, health insurance, disaster management and drones are discussed herewith. Conclusion and future scope of the study are presented at the end.

Keywords

Cloud Computing, Governance, e-Science, Industry 4.0, Disaster Management

1. Introduction

CC has already started its impact on businesses. According to Gartner's July 2016 report, in 2016 the total amount of cloud shift is $ 111 billion and estimated to reach $216 billion by 2020. After the introduction of the three popular cloud segments: Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS), a fourth segment namely Business Process a Service (BPaaS) is gaining popularity. Cloud shift rate by 2020 as estimated by Gartner (2016) is BPaaS (43%), SaaS (37%), PaaS (10%), and IaaS (43%). Major drivers of cloud services are that it is accessible from anywhere, energy efficiency, specialisation and customisation applications, and cloud-enabled storage as a ubiquitous service (Rayport and Heyward, 2011).

CCA is prevalent in areas like logistics, education, health care, and manufacturing. Next to the industrial revolution, popularly called as Industry-4.0 is going to play a critical role in mechanisation, digitisation, utilisation of hardware, and data advancement (IT) in manufacturing (Roblek et al., 2016). Li et al. (2017) discussed the layout of Industry 4.0 is having four major components namely, Physical layer, Network layer, Cloud or big data, and Application layer. Health 4.0 is an extension of Industry 4.0 in healthcare.

Through a literature survey, authors have found that many researchers address sectors like services, manufacturing, education, and healthcare in terms of framework, platform, and application. However, very few papers talk about CC for different applications. This has motivated the authors to write the paper. This paper discusses how CC can be useful for applications in e-Governance, e-Commerce, e-Science, digital forensic, geoscience, non-profit organisations, biomedicines, health insurance, disaster management, and drones.

The rest of this paper is organised as follows. Section 2 briefly reviews the literature on CCA in various sectors. Section 3 presents CCA in different applications, like governance, insurance etc. along with issues, benefits of CC. Finally, conclusions and future scope are presented in Section 4.

2. Literature Review

Extensive literature survey of CC was carried out as vast literature was available on this technology. Three phase methodology was adopted in which, in the first phase author identified 750 papers on CC in peered reviewed journals of publishers like Emerald, Elsevier, Taylor and Francis, Springer etc. In phase two, after scrutinising the research paper manually, the author found 289 articles useful. The papers are categorised into categories like CC for manufacturing (144 papers), CC for healthcare (81 papers), CC for education (52 papers), and CC for different applications (11 papers). In phase three, these categories are further divided into sub-categories.

CC for manufacturing offers an advantage in terms of economic benefits (Doherty et al., 2015; Grubisic, 2014), time-saving (Misra and Mondal, 2011) and compatibility (Hsu et al., 2014; Ratten, 2015). CCA in education offers collaborative learning and also addresses issues like

geographical location, shortage of expert faculty, etc. CC in education is being implemented for academic institutes (Aharony, 2014; Behrend et al., 2011; Stantchev et al., 2014), e-learning (Liao et al., 2014), libraries (Luo, 2012; Yuvraj, 2016). CC for manufacturing is prevalent mainly in services (Gangwar et al., 2015; Oliveira et al., 2014), small and medium scale enterprises (Alshamaila et al. 2013; Opara-Martins et al., 2016; Wu et al., 2015). CC in healthcare is popular to maintain electronic health record (Castiglione et al., 2015; Sujansky and Kunz, 2015), personal health record (Chen et al., 2012; Xhafa et al., 2015). With advancement in a smartphone, mobile applications using CC (Paschou et al., 2013; Badawi et al., 2017) are extensively being used to monitor patients more cost-effectively. Next section briefs about CC for different applications.

3. CCA in Various Sectors

After a thorough literature survey, six different CC applications identified are as follows: e-Governance, e-Commerce, e-Science, Digital forensic and Non-profit organisations. Table I summarises these six applications.

Table 1: CCA in various sectors

Sr. No.	Application	References	Critical Success Factor
1	e-Governance	Decman and Vintar (2013)	Digital preservation for the long term, Authenticity, Integrity, Reliability, Legal issues, Collaboration, Sustainability
		Lian (2015)	Security, Effort expectation, Social influence, Trusts, Perceived risk, Behavioral Intention
		Prasad et al. (2014)	Sustainability, Governance structure, Utilization of IT resources, Business agility,
		Tsohou et al. (2014)	Cross country service, Privacy, Data Protection, Compliance, Total Quality (information, system, service)
2	e-Commerce	Guimaraes and Paranjape (2014)	Customer satisfaction, Customer loyalty, Risk, Data quality, Quality of Service (QoS)
3	e-Science	Mustafee (2010)	Complexity, Bandwidth, Data storage, CPU cycle used,
4	Digital Forensic	Pichan et al. (2015)	Trust, Data decentralisation, Legal issues, Data dependency, Encryption
5	Geoscience	Yang et al. (2013)	Interoperability, Availability, Reliability, Security, Global collaboration, Big data
6	Non-profit organization (NPO)	Raman (2015)	CC capabilities, Social missions, Digital divide, Organizational effectiveness
7	Biomedicines	Sobeslav et al. (2015)	Ethics, Lack of resources, QoS, Security, Governance
8	Health Insurance	Abbas et al. (2015)	Co-insurance, Co-pay, Cost, Data heterogeneity, Insurance plan premium, Quality of Experience (QoE)
9	Disaster Management	Qiu et al. (2014)	Wireless intelligent sensor network, smart cloud evacuation system, data

Sr. No.	Application	References	Critical Success Factor
			collection from multimedia analysis
10	Drones	Koubaa et al. (2019)	Wireless Communication Range, Offered heavy computation, real-time control and monitoring

After investigating the public sector of Slovenia with a detailed literature review, Decman and Vintar (2013) proposed a 3-level Cloud-based framework which is interoperable and scalable. Community Cloud makes documenting, preserving and archiving of public document relatively easy (Decman and Vintar, 2013). Lian (2015) conducted an empirical study to find critical factors for CCA for e-invoice service in Taiwan using UTAUT2 (Unified Theory of Acceptance and Use of Technology 2) adoption model. The study received 251 valid responses through a questionnaire survey, in which the 5-point and 7-point Likert scale were used; SmartPLS was employed to verify the research hypothesis (Lian, 2015). Prasad et al. (2014) developed a conceptual model of CC based governance, followed by validation through a survey (n=120) in Australia. The Governance structure consists of CC officer, CC management committee, CC service facilitation centre, and CC relationship centre. An adequate relationship with behavioural intention was found, indicating that CC can be useful for all ages and gender (Prasad et al., 2014). Tsohou et al. (2014) proposed CC based e-government services with a focus on technical, social, behavioural and business perspective. Tsohou et al. (2014) conducted group interviews of e-government services in two countries Italy (5 users) and France (6 users) to test the conceptual analysis.

Guimaraes and Paranjape (2014) tested CC for trustworthiness and customer satisfaction of e-Commerce firms in the USA. Managers must consider several factors before investing in significant CC resources (Guimaraes and Paranjape, 2014). Mustafee (2010) carried out a literature review of CC for e-science applications and its future. As Digital forensics in the cloud is an emerging area, Pichan et al. (2015) reviewed the same and proposed DFaaS (digital forensics-as-a-service) which focuses on gathering forensic data unceasingly. Yang et al. (2013) reviewed research conducted using CC application for Geoscience and Digital Earth. CC, Big Data and event will be the key technologies for enabling and geosciences (Yang et al., 2013). Raman (2015) used mixed method designs to investigate the factors which help in SMAC (Social Mobile Analytics and Cloud) adoption. Raman (2015) employed a quantitative phase followed by a qualitative phase; quantitative online data collection (sample size 111) followed by analysis and testing through SEM. Raman (2015) shortlisted 2 NPOs out of the 111 NGOs for the qualitative data collection and analysis. Organisational effectiveness and bridging digital divide are positive outcomes of SMAC adoption (Raman, 2015). Cloud is only apt for large grants NPOs.

Sobeslav et al. (2015) reviewed key features of commercial IaaS platforms and open Source IaaS platforms. Sobeslav et al. (2015) surveyed relevant CC applications in biomedicine. Though CCA is a striking solution in the field of biomedicine, however, it is a complex process that challenges ethical and security aspects (Sobeslav et al., 2015). CC can be used in drug discovery if ethical and security challenges are overcome (Sobeslav et al., 2015).

Personalised recommendations are necessary for today's health insurance plans; however current web tools fail to do the same. Abbas et al. (2015) proposed a cloud-based framework for personalised insurance. Multi-Attribute Utility Theory (MAUT) was used which considers cost and coverage criteria. Data as a Service (DaaS) was used for retrieving information of each provider while Software as a Service (SaaS) gives customised recommendations according to the user-specified criteria (Abbas et al., 2015). A cloud-based management system is proposed, called the Drone map Planner, for drones and robots over the Internet of Things (IoT), for applications such as real-time tracking, controlling, and monitoring (Koubaa et al., 2019). Qiu et al. (2014) constructed a smart cloud evacuation system using smartphones, data centres, sensors, and cloud computing for energy saving and timely, efficient disaster management.

4. Conclusion and Future Scope

Key benefits of CCA include (but not limited to): overall cost-cutting, ease of scalability and increase in productivity. Literature survey shows that CC is prevalent in education, manufacturing, healthcare and services. Voluminous research articles are there on CCA for the above mentioned popular applications. However, some papers on CCA for identified multifarious applications are less. This shows that issues of CCA for such kind of applications need to be addressed.

CCA factors can be broadly classified into three categories namely mental, legal and technical. Mental factors are more noticeable in applications like governance, forensic etc. Mental factors include trust, concerns about data accessibility, evaluation of usefulness, institutional readiness etc. Legal factors include legal jurisdiction, service level agreement (SLA), regulation and standardization. Technical factors include security, interoperability, connectivity, reliability, privacy, and lack of understanding. CC security is one of the most critical concerns in CCA. QoS is major concern for applications in e-commerce and biomedicine. CC for health insurance will help in designing a personalized insurance plan. Issues of the complexity of data, data formats, and network must be addressed to make CC popular in Geoscience and e-science application. NPO can be benefited with the use of CC.

Mental factors are more prominent for CCA in various applications. The challenges can be overcome through education and involvement, institutional assessment, security and risk assessment, universal connectivity and cloud piloting. Future work of this paper includes identifying key performance index of CCA in multifarious applications, identifying drivers and barriers of CCA, and understanding role of top management.

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