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Adoption of Cloud Computing By Higher Education Institutions in Maharashtra India: An Investigative Study

Avinash Appasha Chormale[1], Sunanda Arun More[2]

Research Fellow, School of Architecture Science and Technology, Yashwantrao Chavan Maharashtra Open University, Nashik, Maharashtra, India.

Associate Professor, School of Architecture Science and Technology, Yashwantrao Chavan Maharashtra Open University, Nashik, Maharashtra, India.

ABSTRACT: Academic study of cloud computing is an emerging research field in India. India represents the largest economy in the south Asia region, which makes it a potential market of cloud computing technologies. This cross-sectional investigative experiential research is based on technology–organization–environment (TOE) framework, within a Maharashtra state of India targeting higher education institutions. In this study, the factors that affect the cloud adoption by higher education institutions were identified and tested using SPSS software, a powerful statistical analysis tool for structural equation modeling. Three factors were found significant in this context. Relative advantage, complexity and data concern were the most significant factors. The model explained 48.3% of the total adoption difference. The findings offer education institutions and cloud computing service providers with better understanding of factors affecting the adoption of cloud computing.

KEYWORDS: Higher education, Adoption of cloud computing, Technology, organization, environment framework, Maharashtra India.

I. INTRODUCTION

Cloud computing services are expected to be the fastest area of growth [1]. Maharashtra government is investing heavily in e-government solutions to enhance public sector services. One of the initiatives of the second national e-government action plan is building cloud computing delivery model for government agencies [2].

Several vendors in Maharashtra are offering cloud services through partnership with IT industry leaders. In the area of ERP and business intelligence solutions, an agreement was signed between Oracle to host ERP systems and analytical software in the cloud [3].

Customers in Maharashtra have started the adoption of cloud services. For example, Maharashtra Chamber Of Commerce Industries & Agriculture (MCCIA), & Microsoft to help SMBs Adopt IT & Cloud Computing for Growth. Maharashtra is home to thousands of SMBs. Microsoft's partners are gearing up to advice and guide SMBs in the state and help them through their cloud journeys. One Microsoft partner, Genie InfoTech Pvt. Ltd. (GITPL), has registered a 150% growth in business in the last 12 months in the cloud computing area especially Office 365. GITPL aims to extend this success to more SMBs in Maharashtra. Microsoft Office 365 helps SMBs collaborate, communicate, and connect better in their ecosystem and expand to more markets and customers. As per a study by by global consulting firm, Boston Consulting Group (BCG), SMBs that embraced IT solutions grew faster than the ones that lagged in terms of IT adoption. The study also shows that SMBs that decided to take the IT plunge created more new jobs and more revenue growth over the past three years compared to SMBs that trailed in this regard. The BCG study, 'Ahead of the Curve: Lessons on Technology and Growth from Small Business Leaders' found that if more SMBs in India adopt the latest IT tools, there is potential for this sector to grow revenues by $56 billion and create as many as 1.1 million new jobs[4]. There are potential benefits of adopting cloud computing technology in higher education institutions. Some cloud vendors offer programs for educational institutions. Examples of these programs are Microsoft Live@edu, Google Apps and IBM Cloud Academy [5]. Microsoft Live@edu service has been transformed to Microsoft Office 365 recently. It includes Word, Excel, PowerPoint, Outlook, OneNote, Publisher, and Access. The offer includes shared

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collaboration storage in the cloud to allow sharing documents among students in their projects. Google also provides a program for education through its Google Apps for Education Suite. This suite includes productivity applications such as Google Docs. The suite includes email service, classroom management system, shared storage represented by Google Drive, website creation and hosting, and collaboration tools. The case study of the University of Westminster indicated that the benefits and savings were attained by using Google Apps services. The primary purpose of the services is to use email, collaboration and storage services for non sensitive information [6]. IBM Cloud Academy is a community cloud computing program. It provides best practices and consultation services in addition to the cloud solutions offered to higher education institutions. These solutions include collaboration solutions, infrastructure computing, integration solutions and virtual desktops solutions.

Cloud computing offers a shift from computing as a product that is owned to as a service that is delivered to consumers over the network from large scale data centers or clouds [7]. This shift created an efficient operation for higher education institutions. For example, Washington State University has achieved efficiency by adopting a virtualization environment which is considered an enabler for cloud computing. Saving also was recognized by using email services, CRM Sales-force, GoogleApps and ERP systems [8, 9].

Understanding the position of education institutions with respect to cloud computing adoption is an essential research area. The aim of this research is to explore the factors affecting cloud computing adoption. The results of this research study are expected to help both cloud computing providers and education institutions

The paper is organized as follows. First, the research motivation and objectives, second, the literature review and research hypotheses are proposed, followed by the methodology, the results, and the discussions, and the contribution and implications for practitioners. Third, the paper's limitations are summarized and future research directions are suggested.

II. RESEARCH MOTIVATION AND OBJECTIVES

Cloud computing is one of the top 10 strategic technology trends for 2014 [10]. Current research on the use of cloud computing in education mainly focused on cloud computing frameworks, security, pricing mechanisms, and implementation [11, 9, 12, 13,14, 15, 16, 17, 18] and has not mainly addressed the use and adoption of cloud computing in education. A systematic literature review study found that several universities were interested in using cloud computing in their education systems; however, there is a lack of experimental studies focusing on the adoption of cloud computing by educational institutions [19].

The research objective is to identify and test technological, organizational and environmental factors that directly affect the adoption of cloud computing by higher education institutions in Maharashtra state. The focus of this study is on cloud computing solutions that are hosted outside the premises of higher education institutions (i.e. public cloud). Examples of cloud computing solutions being addressed by this study are institutional level solutions such as library systems, ERP, learning management systems and research solutions. Specifically, we attempt to answer the following research question: what are the technological, organizational and environmental factors affecting cloud computing adoption.

III. LITERATURE REVIEW AND RESEARCH HYPOTHESES

The National Institute of Standards and Technology (NIST) defines cloud computing as "a model for enabling ubiquitous, convenient, ondemand 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. This cloud model is composed of five essential characteristics, three service models, and four deployment models." [33].

Cloud computing model was evolved from several technologies. The model is an evolution of virtualization, grid computing, utility computing, and Internet services. High speed wireless network, low cost broadband and low storage and HW cost have contributed to the development of cloud computing. Cloud computing is more than an outsourcing. According to the definition, there are five essential characteristics that distinguish cloud computing from an outsourcing [11, 21, 22].

The theoretical foundation of this research is based on the technology–organization–environment (TOE) framework. TOE was proposed by Tornatzky and Fleischer [24] and is widely used in studying the adoption of technology innovation adoption [25, 27, 28, 29, 30, 31, 32, 33, 34]. TOE serves as a taxonomy for factors that facilitate

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or inhibit the adoption of technology innovations [31]. TOE has advantage over the Diffusion of Innovation model due to its accommodation of the organizational and environmental factors [27, 35]. According to TOE framework, three sets of technology, organization and environment factors to affect the technology innovation adoption. In this paper, the technology innovation is cloud computing.

A. TECHNOLOGY FACTORS

Technology factors focus on the attributes of technology innovation [14, 36]. Tornatzky and Klein [37] conducted a meta-analysis study and found that relative advantage, com-plexity, and compatibility were the main attributes associated with technology innovation behaviour. Higher education cloud computing was tested under TOE framework in devel-oped countries. A study that was conducted in USA revealed that compatibility, top management support, and relative advantage had the most significant contributions to the vari-ance in IT managers' interest in adopting cloud computing [38].

Relative advantage refers to the degree to which an innovation is perceived as providing more benefits than its predecessor [40]. Relative advantage can be used to measure the degree a technology is considered advantageous from an adopter perspective [36]. Relative advantage is associated with cost reduction and responsiveness to business require-ments [6]. Cloud computing should increase the efficiency of educational institutions. Computing information system hosted in house requires capital investment to build data center infrastructure and high availability, train operator staff and so on. In addition to the capital investment, operational cost is required to operate the system [40]. Based on this argument, I propose:

H_1 Relative advantage will positively affect cloud computing adoption.

Compatibility is defined as "the degree to which the innovation fits with the potential adopter's existing values, previous practices, and current needs" [41]. Based on this definition, there are three dimensions of this factor. Cloud Computing is considered a revolution for Information Technology services. It is expected that compatibility with cloud computing will facilitate the adoption process [36,40, 38]. Therefore, I propose:

H_2 Compatibility will positively affect cloud computing adoption.

Complexity is the perceived difficulty by a firm to under-stand and use an innovation [36]. Adoption would be less likely if the innovation is considered as being more challenging to use [41]. It is anticipated that cloud computing is less complex from a technical perspective. One of the objectives
of cloud computing is to simplify the use of IT resources. The complexity may arise when integrating cloud computing with current processes. Complexity factor was found to be significant in previous studies [27]. Thus, I propose: **H_3** Complexity will negatively affect cloud computing adoption.

B. ORGANIZATION FACTORS

Organizational context refers to the resources and characteristics of the firm that facilitate or constrain the adoption and implementation of the innovation [24]. Top management support is considered important organizational factors in cloud computing context [40, 38]. Other important factors in the context of cloud computing is data concerns and vendor lock.

Cloud computing can be influenced by top management support. Top management allocate the required resources to adopt a new technology. If the buying was not achieved for cloud computing, it is expected that management let the innovation die through in force and directing the resources to other initiatives that they support [42]. If the manager is risk adverse or satisfied with the current situation, he is likely not going to support the idea [27 , 40]. Resisting and opposing the idea by top management are considered killers of innovation.

Top management support refers to the attitude of management toward the relevant technology and the level of support devoted for the adoption. Top management support is one of the most critical factors for promoting a supportive climate and for furnishing the resources necessary for adopting new technologies [40, 43]. Top management supports the adoption process by sending signals to the institution staff about the importance of cloud computing. Adopting new disruptive technology, like cloud computing, requires change management to reengineer business processes and align the structure of the institution with the new direction of cloud computing adoption. Therefore, I propose:

H_4 Top management support will positively influence cloud computing adoption.

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Vendor lock-in refers to the difficulty of switching to other cloud vendors due to cost or technical barriers [5, 44,38. When cloud computing services are used, institutions become dependent on the provider services and constrain their ability to revert back to in-house computing because providers mandate the use of specific IT resources (e.g. database, operating system, hardware) and switching cost to another provider is high.

IV. RESEARCH METHODOLOGY

A. DEVELOPMENT OF SURVEY INSTRUMENT

In order to test the research hypotheses, the research variables have to be measured. Measurement items were either developed or adapted from relevant prior research studies [14, 36, 45, 40]. Some measurement items were rephrased or reworded to suit the context of this study. The variables in this study were measured using a five-point Likert scale, ranging from "strongly disagree" (1) to "strongly agree" (5). Additional items were used to collect data on the number of students, faculty and staff members, and position of the IT of the key informant who responded to the survey questions. The last part of the survey included open-ended questions to capture important qualitative data related to the advantages of and concerns with cloud computing adoption.

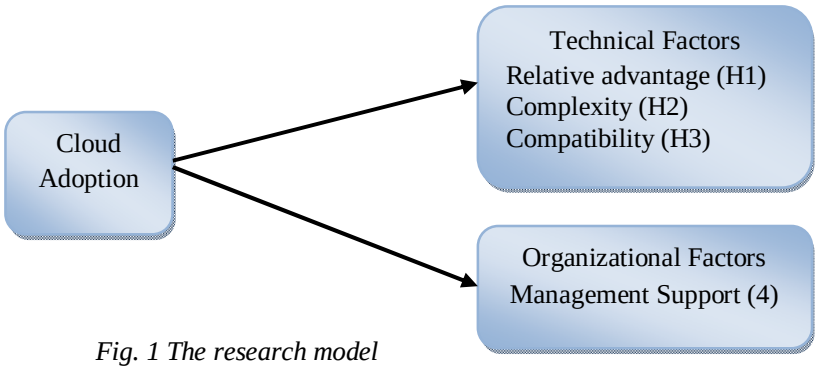

Fig. 1 The research model

The survey instrument was reviewed and validated by a panel of three experts knowledgeable in the area of cloud computing. The panels of experts are one university associate professor and two master degree students. The final items and their corresponding sources are listed in Table 1.

Table 1 Research variables and items of the survey instrument

Relative Advantage (RA)	
RA1	Cloud computing can shorten Information Systems deployment time [46]
RA2	Using cloud computing allows us to perform specific tasks more quickly [40]
RA3	Cloud computing can reduce IT expenses [46]—Dropped
RA4	The use of cloud computing offers new educational and research opportunities [40]—Dropped
Compatibility (CO)	
CO1	Cloud Computing is compatible with our academic institution's operations [40]
CO2	Cloud Computing is compatible with our IT infrastructure [45]
CO3	Using Cloud Computing is compatible with our academic institution's culture and values [40]—Dropped
Complexity (CX)	
CX1	The skills needed to implement cloud computing are too complex for our institution [47]
CX2	The skills necessary to using cloud computing are too complex for our employees [47]
CX3	The use of cloud computing is frustrating [40]
Management Support (MS)	
MS1	Top management provides resources for adopting cloud computing[31]
MS2	Top management supports the implementation of cloud computing [39]

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MS3	Top university/college management understands the benefits of adopting cloud computing [31]—Dropped
Vendor Lock-in (VL)	
VL1	Cloud computing mandates the use of specific IT resources (Authors)
VL2	Cloud computing make us dependent on the provider services (Authors)
VL3	Cloud computing restricts our ability to switch to another provider (Authors)—Dropped
VL4	The switching cost to another cloud computing provider is high (Authors)—Dropped
Data Concern (DC)	
DC1	We are concerned about the leakage of confidential data [23]
DC2	We are concerned that unauthorized people may access our student and research data (Authors)
DC3	We are concerned about storing our data in the cloud (Authors)
Government Regulation (GR)	
GR1	Saudi laws and regulations are sufficient to protect the use of cloud computing (Authors)
GR2	Saudi laws and regulations facilitate the use of cloud computing (Authors)
Peer Pressure (PP)	
PP1	Saudi universities and colleges are currently adopting cloud computing (Authors)
PP2	Saudi universities and colleges will be adopting cloud computing in the near future (Authors)

B. DATA COLLECTION

The target population of the study is all Universities and Colleges that offer 4-year undergraduate or advanced degrees. Community colleges and military or security education institutions are not part of the study population. At the time of the study, there were 41 education Universities operating in Maharashtra. The key informant persons were identified by visiting the official website of the college or the university. The head of IT or his/her delegate was assumed to be the key respondent person. In case the IT position was not available, a higher level person who could make the decision to adopt or not adopt the cloud computing, was invited to respond to the survey. The survey instrument was sent by email to the key informant persons who were responsible for the decision making regarding information technology or their delegates within the institution. The e-mail message included information about the objective of the research study, confidentiality handling, cloud computing definition and contact information of the researchers. After one week, a reminder was sent to all non-respondents. The final reminder was sent after one month of the first e-mail. Data collection took place between November 12, 2015 and December 21, 2014. In total, responses from 34 education institutions were received which represents a response rate of 59.8 %.

C. SAMPLE CHARACTERISTICS

The management positions of respondents and the number of faculty and staff members, and students and the adoption stage of cloud computing are shown in Table 2. The majority of respondents holds a position of IT manager/director (44.1 %). The institutions covered in this study vary from small to large. About 53 % employed 500 or less faculty and staff members, and 38 % had 10,000 or more students. Thirtyeight percent of the institutions were evaluating cloud computing and 26.5 % have already adopted cloud computing. The cloud services that have been adopted includes e-mail, learning management systems, library systems and website portals.

V. RESULTS

The research hypotheses were tested using the partial least square (PLS) method and used the software application Statistical Package for the Social Sciences (**SPSS**). The evaluation of the research model follows a two-stage process. The first stage is the evaluation of the measurement model by calculating the reliability and the convergent and discriminate validity of the research variables. The second stage is the evaluation of the structural model by testing the significance of the path coefficients between the model variables.

A. THE MEASUREMENT MODEL

Table 3 presents the factor loading, mean, standard deviation (SD), composite reliability (CR), and average variance extracted (AVE) for all research model variables. All CR scores exceeded the recommended value of 0.70 [50], indicating that all variables had good reliability.

Convergent validity “involves the degree to which individual items reflecting a construct converge in comparison to items

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measuring different constructs" [51]. A commonly applied criterion of convergent validity is the AVE, as pro-posed by Fornell and Larcker [52]. A variable with an AVE value of 0.500 or more indicates that it explains more than half of the variance of its individual items and, thus, demonstrates sufficient convergent validity. All AVEs, shown in Table 3, ranged from 0.620 to 0.802, much higher than the cut-off value of 0.500. The items with factor loadings and their corresponding t-values exceeded 0.7 and 1.96 ($P < 0.05$), respectively, thereby demonstrating adequate convergent validity. Six items, marked with italic fonts (see Table 1) violated this rule and hence they were dropped.

To assess discriminate validity, Fornell and Larcker [52] suggested the use of AVE, the average variance shared between a variable and its measures. The AVE should be greater than the variance shared between the variable and other variables in the model (i.e., the squared correlation between two variables). For adequate discriminate validity, the square root of AVEs should be greater than the intercorrelations in the corresponding rows and columns. In Table 4, the square root of all AVEs were greater than the corresponding inter-variable correlations.

B. THE STRUCTURAL MODEL

Goodness of fit (GoF) was used to evaluate the overall research model. GoF is SQRT (average communality of variables multiplied by average R-Square for endogenous variables). According to Wetzels and Odekerken-Schorder [53], the GoF for a model with large effect sizes should be greater than or equal 0.36. The GoF score for our research model was 0.604, indicating that the model had an acceptable fit.

The proposed research model explained 48.3% of the variance in cloud computing adoption, providing good explanatory power. The results of the structural model, as shown in Table 5, indicate that relative advantage (H1), complexity (H3) and data concern (H4) were supported at the 0.05 level. The hypotheses related to compatibility (H2), management support (H4). The negative signs of b-coefficients mean that there were negative impacts of complexity and data concern on the adoption of cloud computing.

Table 2 Education institutions profile

Variable	Category	N	%
Position	IT Director	12	41.3
	IT Strategist	1	2.29
	Others	2	4.9
No. of faculty and staff members	300 or less	18	52.9
	301 - 500	6	18.3
	More than 300	10	29.4
No. of Students	5000 or less	8	25.8
	5001-10000	14	39.3
	More than 10000	14	37.8
Adoption stage	Not considering	4	11.8
	Have evaluated but not planning to adopt cloud computing	3	8.8
	Currently evaluating cloud computing	11	36.2
	Have evaluated and planning to adopt cloud computing	5	14.7
	Have already adopted cloud computing	9	26.5

The hypotheses related to compatibility (H_2), management support (H_4), The negative signs of b-coefficients mean that there were negative impacts of complexity and data concern on the adoption of cloud computing.

Table 3 Factor loadings, reliability, and descriptive statistics

Construct	Item	Loading	SE	T value	Mean	SD	CR	AVE

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Relative advantage (RA)	RA1	0.852	0.151	5.627	4.265	0.554	0.773	0.631
	RA2	0.733	0.211	3.473				
Compatibility (CO)	CO1	0.909	0.167	5.457	3.897	0.726	0.903	0.823
	CO2	0.905	0.286	3.164				
Complexity (CX)	CX1	0.865	0.064	13.563	2.441	0.607	0.890	0.620
	CX2	0.840	0.073	11.513				
	CX3	0.711	0.107	6.640				
Management support (MS)	MS1	0.931	0.212	4.393	3.471	0.843	0.907	0.830
	MS2	0.890	0.152	5.872				
Vendor lock-in (VL)	VL1	0.829	0.347	2.385	3.221	0.947	0.809	0.679
	VL2	0.819	0.326	2.509				
Data concern (DC)	DC1	0.956	0.057	16.671	3.765	0.997	0.962	0.894
	DC2	0.965	0.079	12.156				
	DC3	0.913	0.198	4.606				
Gov. regulation (GR)	GR1	0.904	0.217	4.170	2.853	0.857	0.949	0.903
	GR2	0.995	0.069	14.368				
Peer pressure (PP)	PP1	0.683	0.334	2.044	3.485	0.691	0.815	0.693
	PP2	0.959	0.250	3.829				

SE standard error, *CR* composite reliability, *SD* standard deviation, *AVE* average variance extracted

Table 4. Correlation coefficients and square root of AVEs

	RA	CO	CX	VL	DC	MS	GR	PP
RA	**0.795**							
CO	0.214	**0.907**						
CX	−0.158	−0.170	**0.808**					
VL	−0.147	−0.250	0.262	**0.824**				
DC	0.056	−0.434	0.092	0.361	**0.945**			
MS	0.317	0.278	−0.193	−0.257	0.167	**0.911**		
GR	0.053	0.306	−0.046	−0.086	−0.030	0.443	**0.950**	
PP	0.309	−0.081	0.682	0.658	−0.302	0.144	0.080	**0.833**

Diagonal elements are the Square Root of AVEs.

Table 5. Results of research hypotheses testing

Hypothesis	Path	Coefficient	SE	|T value|	P value	Support

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H_1	RA —> Cloud adoption	0.2986	0.1279	2.3344	0.0260	Yes
H_2	CO —> Cloud adoption	−0.0583	0.1870	0.3120	0.7571	No
H_3	CX —> Cloud adoption	−0.4281	0.1675	2.5560	0.0155	Yes
H_4	MS —> Cloud adoption	0.2310	0.2035	1.1351	0.2648	No

VI. CONCLUSION AND SUGGESTED FUTURE RESEARCH WORK

This paper presents a cross-sectional exploratory study. Longitudinal studies, which examine the same population at recurring intervals, can be carried out to better understand the shift in the cloud adoption and the change in the significance of the determining factors. This study can be repeated in different time periods and evaluate the progress and change of the significant factors. It is also recommended to include additional factors related to the bandwidth availability and reliability of the technology. Many of the respondents echoed their concerns on the issue of network connectivity to the cloud service provider.

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BIOGRAPHY

Avinash Appash Chormale[1] is a Research fellow in the Architecture Science and Technology department, Yashawantrao Chavan Maharashtra Open University. He had completed his M. Tech in computer science engineering from Jawaharlal Nehru Technical University, Hyderabad, AP, India. His research interest in DMDW, cloud computing, Web Technology.

Dr. Sunanda Arun More[2] is a Associate professor in the Architecture Science and Technology department, Yashawantrao Chavan Maharashtra Open University. She had completed her M. Sc. in electronics.