Multi-Knowledge Electronic Comprehensive Journal For Education And Science Publications (MECSJ)

ISSUE (26), November (2019)

ISSN: **2616-9185**

www.mecsj.com

A Cloud adoption framework: assessing the factors and determinants of adoption cloud computing technology

Turki ALQarni and Ahmed Barnawi

Faculty of Computing and Information Technology, King Abdulaziz University, Jeddah, Saudi Arabia

Email: turkialqarni@live.com, ambarnawi@kau.edu.sa

Abstract— Decision of adopting cloud paradigm in an organization is influenced by several technical & non-technical factors. Prior literature suggests that, uncertainty about initiating the cloud adoption process, less prior knowledge to cloud domain, unavailability of a standard cloud adoption framework; organizations are not able to complete the cloud adoption process. This research work intends to analyze the factors that impact the cloud adoption process, and to propose an adoption framework based on the identified factors. The factors impacting cloud adoption/migration are identified based on a detailed literature review of previous researches. Further, TOE and DOI adoption models are used to implement the cloud adoption framework.

Quantitative methodology is used as a tool to validate the proposed framework. A web based questionnaire is used as a tool for collecting the data from various government organizations of KSA. Validity and reliability of the observed determinants is computed using statistical methods. Further, to validate the hypothesis t-test is performed. The result of this research highlights the most significant determinants that affect the cloud adoption or migration. While comparing with previous studies, this study is more focused towards technical challenges faced during cloud adoption.

Multi-Knowledge Electronic Comprehensive Journal For Education And Science Publications (MECSJ)
ISSUE (26), November (2019)
ISSN: 2616-9185
www.mecsj.com

In addition, one important contribution of this research is to include the technical determinants such as virtualization management, workload assessment, dependencies & integration, local data storage, resilience, and network bandwidth as the major determinants of cloud adoption.

Keywords- Cloud adoption/migration, Technological readiness, CSP (cloud service provider), TOE-DOI theory

I. INTRODUCTION

Cloud is the latest trendy computing model among users and organizations. This computing model has different offerings compare to other previous computing models. With the time, various requirements such as computing resources, data storage, and computing power among organizations are increasing exponentially. The offerings of cloud computing makes it possible to accommodate these changing requirements with time [1]. The organization needs to select the service delivery and deployment model offered in cloud computing paradigm, while adopting the cloud computing. Previous literature concludes that the adoption of cloud computing has favorable impact on performance of business domain, IT management, and lowering the operational cost for IT infrastructure [2, 3]. Thus, the offerings of cloud computing model are captivating organizations towards cloud computing paradigm [4].

Despite of the cloud computing offerings, it can also be concluded from previous researches that various technical and non-technical challenges are linked with cloud computing paradigm [2, 3, 5, 6]. The migration of organization application, services, and data, into the cloud platform also leads to various risk and challenges including security and privacy. The risk and challenges are the major hurdles during cloud adoption or cloud migration among organizations. Security & privacy, data security & data lock-in, interoperability, availability, reliability, network bandwidth, risk & change management, cloud costing, and service level agreement (SLA) are some well known technical concerns associated with cloud computing observed by previous researchers [3, 7-9]. Previous researches have also raised several other concerns including; lesser knowledge of cloud domain, organization adaptiveness towards latest technologies, and organization ability to handle the change management during cloud adoption or migration process [10]. Besides these technical concerns, organizations are still migrating towards cloud computing technologies.

The intention of an organization for adopting the cloud computing model can be analyzed on the basis of three different perspectives namely: technical, organizational, and environmental. Technical perspective deals with technical challenges in cloud adoption such as cloud integration (how the existing legacy system can be fitted into the cloud computing model), pricing model (how an organization estimate pricing for the required resources), security & privacy (how an organization can be ensured about their assets including organization confidential data), SLA (unavailability of a single standard service level agreement for all CSP's), and interoperability [11-13]. Several security concerns, vulnerabilities, and threat coexist in the cloud computing paradigm, that are identified by researchers in the previous literature [14]. Previous researches in cloud security suggest that, security concern is the major barrier in cloud adoption among organizations. Data is the most important asset to any organization. The three key components of data security namely: confidentiality, integrity, and availability must be maintained beyond the geographical boundaries [3, 15]. This also proves to be a major barrier in cloud computing adoption process.

Organizational perspective dealt with cloud adoption challenges at organizational level; including organization adaptiveness towards new technology, assessment of existing business domain, organization top management support, readiness of the organization human resource, prior knowledge of the cloud domain, and organization culture & size [16]. Prior knowledge of cloud computing domain and organization readiness towards the adoption of latest technology has significant impact on cloud adoption. Organization top management support, decision making capabilities of management, and organization size & culture are some other major contributor of cloud computing adoption [17, 18]. Environmental prospect dealt with local and global challenges during cloud adoption such as; government regulations and regulatory compliances [12].

Clearly, from the available literature it can be infer that besides all the services and offerings provided by cloud computing; organizations are still passive towards cloud adoption. Research focusing cloud computing and its worthiness for the organization is largely available over the Internet. However, it is very important to assess how an organization can integrate cloud computing irrespective of their business domain without any hassle. The research gap from the literature can be summarized as: how an organization can find its best fit to adopt the cloud computing. This best fit includes does cloud computing is suitable for organization business domain, assessment of organization preparedness, organizational capability of cloud handling, and the selection of cloud vendor.

In nutshell, previous researches are unable to propose a standard set of recommendation for the organization that how and why cloud computing is beneficial to their business competitive environment, and a standard cloud strategy for adoption and migration.

The major research problem identified from the literature analysis can be summarized as: organizations have a passive nature towards the cloud adoption, because of unavailability of a standardized cloud adoption framework, and unavailability of checklist of requirements that are necessary before cloud adoption or migration. This research attempts to understand the behavioral intentions of an organization towards the cloud adoption. Initially, this research identifies determinants that affect the cloud adoption; and based on those determinants a cloud adoption framework is also proposed.

II. LITERATURE REVIEW

The cloud computing paradigm is like an *"old wine in new bottle"*. However, several technical aspects that are introduced in cloud computing paradigm are new, which makes it robust and dynamic in nature. In earlier times, it can be found that individual research institutions, military organizations in developed countries were using a similar computing paradigm which is equivalent to cloud computing [19]. According to a latest survey, it is anticipated that global market capitalization of the cloud computing will be around $162 Billion by 2020 [20].

A. Cloud Computing

"*Cloud computing is a pool of computing resources, that are available over Internet*". Cloud offers self configuration and personalization of the cloud services and offerings as per the need of user or organization [21]. Virtualization, multi-tenancy, service oriented architecture, and network capabilities are the key technologies incorporated in cloud computing paradigm [5]. These technologies ensure the availability of computing resources over Internet in anytime and anywhere manner. It means, computing resources can be accessed remotely or locally using any hand-held device. In nutshell, cloud offers a dynamic flexible IT infrastructure where service can be provisioned dynamically and accessed either remotely or locally using Internet. This improves the efficiency of traditional computing paradigm.

In simple words "*Cloud computing is pay per use model with dynamic On-demand service provisioning of computing resources*" [5]. NIST has defined key characteristics associated with cloud domain which are: "*on demand self service, broad network access, resource pooling, rapid elasticity, and measured service*" [21].

Besides these some other key benefits of cloud technologies are: "*multi-tenancy, scalability, dynamic service provisioning, virtualization, elasticity, availability, pay as you go, and lower IT cost"* [5, 21].

Cloud computing paradigm has also empowered the organization with several other offerings such as: self provisioning of resources including hardware, computing capabilities, network, application, and storage as per their requirement. Thus, organizations only need to pay for what they have used either computing resources or services. Pay per use feature of cloud computing paradigm plays a key role during cloud adoption among organizations.

Existing literature suggests cloud computing paradigm put forward many advantages to its end user. Cloud computing paradigm helps organization to minimize their cost while building new IT Infrastructure. It also supports the changing requirements of the organization with the time. However, many research challenges and gaps are identified in the cloud computing model by the researchers in the existing literature.

A dearth research has been conducted by the researchers to point out the major risk and factors that are associated with cloud computing adoption. All the identified factors are classified into three main categories which are: "*technological, organizational, and environmental*". The three classified categories are the part and partial of IS adoption theories such as TOE and DOI. Factors covered under the technological propsect of TOE adoption theory are: *"technology relative advantage, complexity, and compatibility; organizational context are: top management support, complexity, and compatibility, and environmental context are: competitive pressure and trading partner pressure"* [22]. In [23], a cloud adoption framework is proposed by the authors to identify the risk associated with cloud computing model. Data is collected from a service based organization for validating the proposed framework. The result obtained from the research suggests that "*resource availability, reliability, adaptability with existing platform, policy compliance, and security*" are the key barriers impacting cloud computing adoption. However, recommendation based on the framework is not provided by the researchers.

In [24], authors have studied the key issues & challenges in cloud adoption in SME. However, the study is focused only towards organizational context. The outcome of the study concludes that "*firm size, technology readiness, top management support, and relative advantage"* are the key factors which impacts cloud adoption the most. The study only provides a conceptual framework without any validation. A more concentric research on barriers to cloud computing adoption focusing SME with risk analysis is conducted by the researchers [25].

The TOE adoption model is used as the standard model to propose the adoption framework. Research concludes that "*business concerns, IT capability, and perceived benefits"* are the major indicators impacting cloud computing adoption. However, business concern is the only major contributor that plays a vital role while selecting the cloud deployment model [25]. Research hasn't included cloud migration technical challenges in their study. In [26], a cloud adoption framework based on TOE adoption theory is proposed to examine the key determinants that impact the cloud computing adoption. Research concludes that technology context ("*relative advantage, complexity, and compatibility*"), environment context ("*compliance with regulation*"), and organizational context ("*management support, firm size, and partner pressure*") are the most influential indicators while adopting cloud computing. However, the technical concerns of cloud adoption process are not considered and missing in the research. Most of the researchers have used TOE as the adoption model, for proposing the cloud adoption framework. Further, the proposed framework is validated using data collected form specific organizations of the participating country. The major drawback in most of the researches is that, researchers have adopted only TOE framework for their study.

DOI (diffusion of innovation) is another adoption theory which is widely accepted in Information System adoption studies. Several studies are also found in the literature that has adopted DOI as the reference model for their research. In [27], authors have assessed the underlying factors that impacts cloud adoption the most based on DOI adoption theory. The result suggests that "*compatibility and relative advantage"* are the most crucial factors associated to cloud computing adoption. To validate the proposed framework a semi-structured study is performed using qualitative analysis.

Further, several studies are also found in the literature that have included both TOE and DOI adoption theories; to propose a cloud adoption framework. In [28], an integrated framework based on TOE & DOI adoption theories is proposed by the authors.The result suggests that "*firm size, technology readiness, complexity, relative advantage, and management support*" are the key factors having maximum effect on cloud computing adoption. To validate the proposed framework, data was collected from the manufacturing and service domains of Portugal. The major drawback of this research is that, it is a domain specific study. Similarly in [29], authors also have studied the key challenges that impacts cloud ERP adoption in KSA. This study also has included both TOE and DOI adoption theories in their research.

The result suggests that "*management support, firm size, technology readiness, complexity, competitive pressure, relative advantage, peer pressure, and compatibility*" are the key factors that impact cloud adoption the most.

Except these adoption theories, several other research models are also found in the literature which are adopted for cloud adoption modeling such as; *"TAM (Technology Acceptance Model) and UTAUT (Unified theory of acceptance and use of technology)".* The major research gap concluded from the systematic literature review suggests that, limited studies are available that have focused on core technical concerns related to cloud computing paradigm.

.

B. Cloud adoption models

There are several well established information system adoption theories that are used predominantly such as *"TOE (Technical-Organizational-Environmental), DOI (Diffusion of Innovation), TAM (Technology Acceptance Model), Institutional theories"*, and many more. TOE & DOI are the two most dominant theories which are widely accepted in IS adoption research.

TOE (Technology-Environment-Organization) theory was proposed by Fleischer & Tornatzky. This theory identifies the influencing factors of adoption and implementation for technological innovation using three different prospects which are: "*technological, organizational, and environments"* [22]. Each context specifies a group of factors that impact the adoption of technological innovation. The technology context refers to, how technology impacts the adoption decision. The main contributors of the technology context are: "*availability and characteristics*. The organization context covers all the aspects of organization structure and communication process that affect the decision making of technological innovation. It focuses on several factors such as: "*organization size, organization policies, market competitiveness, and communication processes"*. The final environmental context emphasizes on how internal and external environmental factors related to organization affects the adoption of technological innovation. The major contributors in this context are "*opportunities and completion in the relative domain, structure of the business, legal rules and government regulations"*.

DOI theory was proposed by Rogers, and supposed to be one of the oldest and widely applied adoption theory in social sciences [30]. The DOI theory has four main components those are important in diffusion are as "*innovation, time, social system, and communication*" [30].

In addition, there exists several characteristics that have a positive influence in decision making of technical innovation are: "*compatibility, trialability, relative advantage, complexity, uncertainty, and observability*" [30].

C. *Empirical analysis of previous studies examining factors affecting cloud adoption*

Table I, summarizes all the factors identifies by the researchers in the existing literature during cloud adoption. It also represents the summary of most widely used cloud adoption factors. Some most common determinants which are used by the researchers in their study are: "*availability, reliability, security, privacy, trust, relative advantage, compatibility, complexity, top management support, organization size, competitive pressure, firm size, and cost*". This analysis is helpful in constructing the variable and framework, discussed in the next section.

Multi-Knowledge Electronic Comprehensive Journal For Education And Science Publications (MECSJ)
ISSUE (26), November (2019)
ISSN: 2616-9185
www.mecsj.com

Table I An Empirical analysis of previous studies examining factors affecting cloud adoption

Authors	Key Determinants	Research Context	Adoption Theory	Research Methodology & Analysis
[9]	"Relative advantage, Competitive pressure, Trading partner pressure , Top management support, Firm size"	Determining determinants of cloud paradigm	TOE and DOI	• Survey based questionnaire (The data is collected from 111, high tech industry firms belongs toTaiwan) • Factor Analysis & Regression Analysis
[16]	"Relative Advantage, Complexity, Compatibility, Top management support, Firm size, Technical readiness, Environment, Competitive pressure, Trading partner pressure"	Analyzing organizational factors in cloud adoption focusing SME's	TOE	• Qualitative Method • Theoretical framework is proposed based on interview
[12]	"Availability, Reliability, Security, Privacy, Trust, Relative Advantage, Compatibility, Complexity, Top management support, Organization size, Compliance with regulation, Competitive pressure, Physical location"	Cloud Adoption in Saudi Organization	TOE, DOI, & Institutional theory	• Semi structured interview (Data collected from Saudi Organizations) • T-Test is used for framework validation.
[28]	"Relative advantage, Complexity, Technical readiness, Top management support, Firm size,"	Cloud computing among service & manufacturing sector	TOE and Innovation characteristics of DOI theory	• Survey questionnaire (Data collected from manufacturing and service sectors firms of Portugal)

				• PLS (partial least squares) & SEM
[13]	"Relative advantage, Compatibility, Complexity, Organizational readiness, Top management commitment, Training & education, Competitive pressure" Mediating variables: " Perceived usefulness, Perceived ease of use"	Cloud computing adoption among organizations	TAM & TOE	• Survey questionnaire (Data collected from 433 organizations adopted cloud computing) • EFA & CFA
[31]	"Relative advantage, Compatibility IT personnel knowledge"	Adoption of Cloud computing focusing private sector of Malaysia	DOI & IT personnel characteristics	• Survey questionnaire • SEM & PLS
[32]	"Relation capability, Managerial capability, Technical capability, Performance"	Impact on cloud computing process	IT based capabilities, Resource theory	• Survey questionnaire (Data collected from 302 organizations) • Cronbach's Alpha reliability test & SEM
[33]	"Soft financial analysis, Relative advantage, Hard financial analysis, Attitude toward change, Business ecosystem partner pressure, Compatibility, Top management support"	Cloud adoption in the Healthcare organizations of KSA	TOE, IS triangle, and HOT-Fit	• Survey questionnaire (Data collected from healthcare organizations of Saudi) • Reliability & Factor analysis (FA)

[17]	"Perceived usefulness, Trust, Job opportunity, self efficacy, Perceived ease of use"	Cloud adoption motivators	Hybrid Model(Extended TAM model with External constructs)	• Survey questionnaire (Data collected from experts of cloud technology) • MLR & Neural Network (NN)
[8]	"Relative advantage, Awareness, Cost, Security, Compatibility, Complexity, Usefulness, Ease of use, Risk, Data security"	Cloud adoption in education	TAM & DOI	• Survey questionnaire (Data collected from lecturers and IS experts of Saharan African universities) • Cronbach's Alpha reliability test & PLS
[34]	"IT Resources"	Cloud Adoption in SME	Extensive Literature Review	• Survey questionnaire (Data collected from service sector of Malaysia) • PLS
[35]	"Security & Privacy, Organizational risk, Sharing and Collaboration, Confidentiality & Integrity, Top management support, Relative advantage, Complexity"	Cloud Adoption in Indian SME	Literature review	• Survey based questionnaire (Data collected from 110 firms belonging to Indian SME) • Analytics hierarchy process approach, EFA, CFA

[36]	"SEM result based factors: Perceived IT security risk, Risk analysis, Technology innovation, Management style, Trust" ANN result based factors: "Perceived IT security risk, Management style, Trust"	Adopting cloud computing	TOE and ANN based Factors	• Survey questionnaire (Data was collected from various 660 professional cloud and IT experts of Indian Private industry) • Two staged hybrid SEM model is used • SEM & Artificial Neural Network(ANN)
[18]	"Quality of service, security, privacy, trust, relative advantage, compatibility, trial-ability, top management support, technology readiness, physical location, Compliance with regulation, & culture"	Cloud computing adoption in private organizations	Integrated model based on literature review	• Survey questionnaire (Data collected from 300 IT professionals of Saudi Arabia) • SEM

III. FRAMEWORK DEVELOPMENT & HYPOTHESIS

This research has adopted an integrated TOE-DOI model approach for proposing the cloud adoption framework. TOE, is supposed to be one of the most widely accepted adoption theory applied to Information System adoption research. In [22], authors have studied and proposed several factors which are associated to adoption of technological innovation. The study is categorized into three different prospects namely: “technological context, organizational context, and environmental context”. Similarly, DOI (Diffusion of Innovation) is another widely accepted adoption theory applied to the field of information system adoption.

This proposed cloud adoption framework is modeled by integrating TOE and DOI adoption theories. The proposed framework comprises of four different contexts as depicted in Fig. 1. These four different contexts presented the adoption framework are: Technology Readiness, Organization Readiness, Business Readiness, and Environmental Readiness. Further, Technology Readiness is categorized into three subcategories which are: Infrastructure, Data, and Security. In the proposed framework, a total 33 determinants are included, and categorized into four different contexts.

These 33 independent determinants are as: “virtualization management, workload assessment, compatibility, interoperability & portability, dependencies & integration, network bandwidth, performance, resilience, complexity, local data storage, availability, data backup & recovery, data security & integrity, security architecture, security controls, privacy, trust, organization size, organizational adaptiveness, top management support, prior skills & knowledge, human resource & training, risk and change management, organizational strategies, organizational culture, business domain, relative advantage, business impact, cost estimation & pricing, peer partner pressure, regulatory compliance, SLA, and government support”. These identified factors supposed to be have maximum impact on cloud adoption among organizations. Thus, it can be hypothesized that all these 33 independent variables have a positive impact on cloud computing adoption.

Multi-Knowledge Electronic Comprehensive Journal For Education And Science Publications (MECSJ)

ISSUE (26), November (2019)

ISSN: **2616-9185**

www.mecsj.com

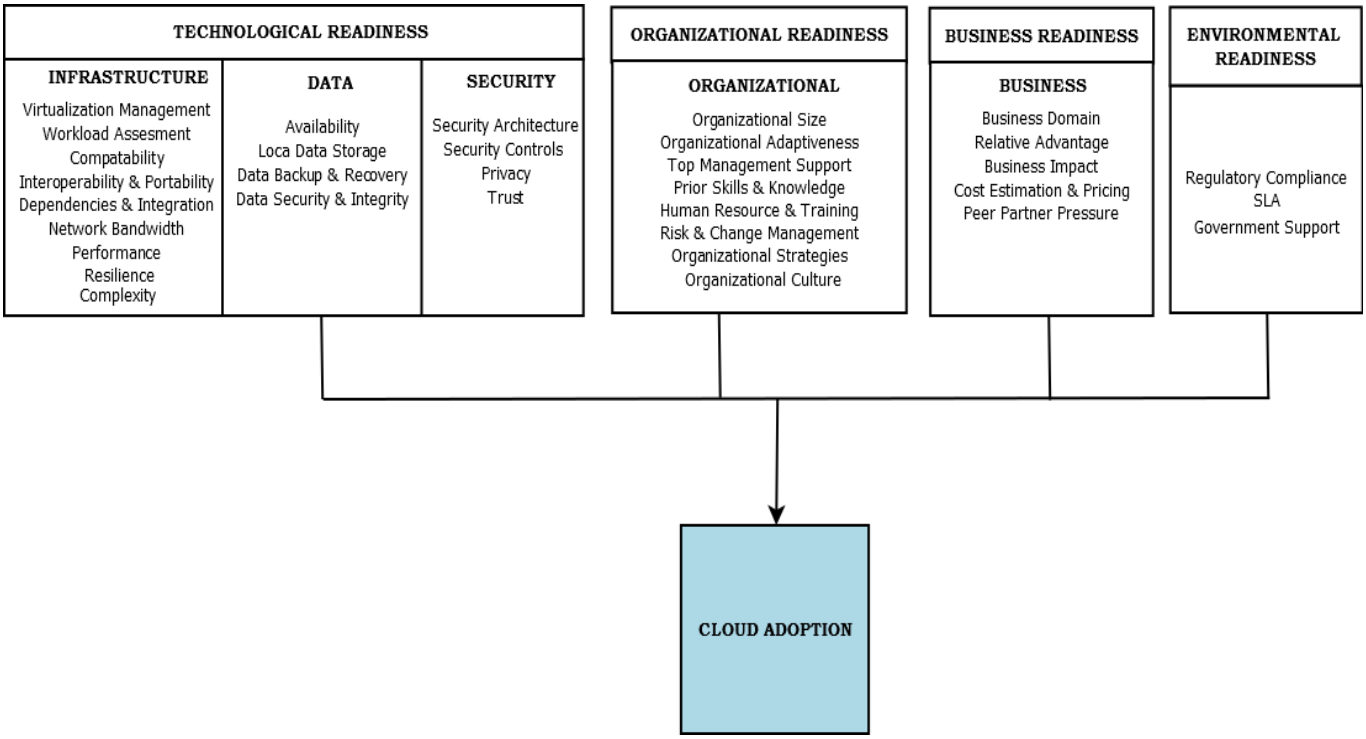

Figure I: Cloud adoption framework

Multi-Knowledge Electronic Comprehensive Journal For Education And Science Publications (MECSJ)
ISSUE (26), November (2019)
ISSN: 2616-9185
www.mecsj.com

IV. RESEARCH METHODOLOGY

Quantitative methodology approach is used in the research to achieve the research objectives. To validate the proposed adoption framework and identified determinants, the data is collected from the targeted population of several organization of Saudi Arabia. A web based questionnaire was prepared for the research based on the framework. Further, the questionnaire is evaluated by a panel of cloud experts. Further, the web based questionnaire was distributed among the various members of Saudi organization to collect their response.

A standard questionnaire guideline available in previous researches is used for the questionnaire design process. The questionnaire is categorized into two main question categories that are: multiple choice and likert scale based questions like the previous researches. The questionnaire is prepared based on the preliminary literature studies that focus on cloud adoption. The main objective of this research is to identify the core technological factors that impacts cloud computing adoption the most. A total 33 factors are identified and used in the proposed framework. 72 likert based scale questions are designed for these identified factors. Except these likert scale based questions, few other questions were also designed to explore the cloud computing adoption factors, readiness assessment, and general cloud computing summary. The questionnaire is distributed via email and complied using Google forms.

A. Research Data Analysis

A total 50 decision makers were selected as targeted population. The questionnaire was distributed via email to selected participants. The collected data was imported to MS-Excel. Out of 50 participants; 36 responses was received, and 8 responses was found invalid because of incomplete responses and hence discarded. Further IBM SPSS tool is used for basic analysis, reliability & validity test, and t-test to validate the construct and framework.

1) Sample Demographics

Table II represents the participant's job role within the organization. The majority of the participants are team member (25%), technical lead (21.43%), manager (17.9%), project manager (10.71%), and chief technical officer (10.71%). Rest participants of the sample are CEO, managing director and vice president of the organization. As a whole, the majority of the role of the participants is of decision makers which include (CEO, VP, CTO, MD, manager, project manager, and tech lead).

Multi-Knowledge Electronic Comprehensive Journal For Education And Science Publications (MECSJ)
ISSUE (26), November (2019)
ISSN: 2616-9185
www.mecsj.com

Table II Participants based on role, in the Organization

Role in the Organization	Frequency	Percentage
Managing Director	1	3.57%
CEO	1	3.57%
VP	2	7.14%
Chief Technical Officer	3	10.71%
Manager	5	17.86%
Project Manager	3	10.71%
Technical Lead	6	21.43%
Team Member	7	25.00%
Others	0	0.00%

Similarly, table III represents the participants based on the organization sectors. The majority of the participants are related to Healthcare (21.43%), Military & Defense (17.86%), IT (18%), and Education (14.29%).

Table III Participants based on Organization type

Organization	Frequency	Percentage
Healthcare	6	21.43%
Banking & Finance	3	10.71%
Retail & Manufacturing	2	7.14%

Education	4	14.29%
Military & Defense	5	17.86%
Construction & Real State	1	3.57%
Telecommunication	1	3.57%
IT	5	17.86%
Hospitality & Transportation	1	3.57%

V. EMPIRICAL RESEARCH FINDINGS

This section represents the results of participants' perception towards cloud computing technology. The questionnaire set comprises the questions related to cloud computing foundation, cloud computing enablers, and challenges that impact the cloud adoption among organizations. Descriptive analysis and validity measures which include reliability and validity analysis are performed using IBM SPSS tool for reliability of proposed factors. Finally, t-test is executed in IBM SPSS to measure the validity of proposed hypothesis of the framework.

A. Major drivers impacting cloud computing

The results of systematic literature review and preliminary analysis have identified 6 major drivers that influence the decision of an organization to adopt cloud computing. These identified factors provide major benefits of the cloud computing to the organization. Table IV shows the response of the participants corresponds to major cloud adoption drivers among organization in Saudi Arabia. Result shows cost reduction (78.57%) and on demand service (71.43%) are the major drivers for cloud computing adoption. Several other studies also confirm that cost reduction, pay as you go, and on demand service are the key drivers of cloud adoption among organization. Thus the finding of this survey is also found consistent with the existing literature [2, 37, 38].

Multi-Knowledge Electronic Comprehensive Journal For Education And Science Publications (MECSJ)
ISSUE (26), November (2019)
ISSN: 2616-9185
www.mecsj.com

Table IV Cloud computing enablers

Cloud Computing Enabler	Frequency	Percentage
On Demand Service	20	71.43%
Reliability & Mobility	10	35.71%
Pay as you Go Model	15	53.57%
Scalability & Flexibility	11	39.29%
Cost Reduction	22	78.57%
IT Efficiency & Agility	9	32.14%

B. Factors affecting cloud computing adoption

The first objective of the research is to identify the technology factors that impact the cloud computing adoption the most. The outcome of the literature review analysis was the factors that impact cloud adoption. These identified factors are analyzed using the likert based questionnaire. The result of the analysis is summarized in table V. Relative Importance Index (RII) is used to rank the identified factors impacting cloud adoption. Factors having RII value greater than .70 is only considered for the research. The findings suggest that security issues, interoperability, and network bandwidth are the top three factors that hinder cloud adoption the most. This outcome is also consistent with previous research [3, 6, 39]. Result also suggests that workload assessment and virtualization management are also having significant impact on cloud adoption. These factors are added in the research in technology domain and prove to be significant for the research.

C. Validation of the measures

Validity and reliability are the most important elements of the data quality. It is very necessary to assess the internal consistency of each individual determinant of the framework to analyze whether questionnaire items of the corresponding factor is measuring the same factor or not. Well established theories and guidelines are used to assess the validity and reliability of identified factors.

1) Reliability of the measures

Reliability is used to test the internal consistency of the questionnaire set belonging to various factors.

Cronbach's alpha (α) coefficient is the most widely used statistical analysis in the quantitative research to measure the internal consistency and recommended [40]. In [41], author had proposed four different cut-off points for reliability measurement which are:

- 0.90 and above - excellent
- 0.70 to0.89 – high
- 0.50 to 0.69 – moderate
- Below 0.50 – very low

Thus this research has also adopted croanbach's alpha to measure the reliability of identified factors. Based on the established guidelines (α)>0.70 is used as the standard cut off value for identified factors. The value of croanbach's alpha for all proposed 33 factors is summarized in table VII. Most of the factors were found to be reliable and used for the further analysis. However, there are 8 factors having (α) <0.70 so these items are deleted from the framework.

2) Validity of the measures

"*Validity is the extent to which an instrument or variable what it is intended to measure".* Validity can be further categorized into two categories which are: construct validity and content reliability. "*Composite reliability (CR) is used to establish the reliability, whereas average variance extracted (AVE) is used to establish the convergent validity*". The IS adoption research guidelines proposes a composite reliability (CR) having value greater than 0.7 (CR>0.7) and average variance extracted value greater than 0.5 (AVE>0.5) is acceptable [13, 18]. However, there are 6 factors which don't follow the cutoff levels of CR and AVE, thus these items can be excluded from the framework.

3) Hypothesis testing of the framework

One sample t-test is used to test the proposed hypothesis, and to analyze the significance of identified factors of the proposed framework. A P-value<.005will have statistically significant impact on cloud adoption. Table VI summarizes the t-test results for the independent factors/determinants of the framework.

Multi-Knowledge Electronic Comprehensive Journal For Education And Science Publications (MECSJ)
ISSUE (26), November (2019)
ISSN: 2616-9185
www.mecsj.com

Table V Factors affecting cloud adoption

Factors	Very Unlikely	Unlikely	Neutral	Likely	Very Likely	RII	Rank
Availability of Services & Data	3.57%	7.14%	10.71%	57.14%	21.43%	0.772	9
Virtualization Management	3.57%	7.14%	17.86%	25.00%	46.43%	0.808	5
Interoperability	3.57%	3.57%	7.14%	39.29%	46.43%	0.843	**2**
Compatibility	3.57%	14.29%	7.14%	32.14%	42.86%	0.793	6
Security Issues	0.00%	3.57%	0.00%	35.71%	60.71%	0.908	**1**
Privacy	3.57%	7.14%	7.14%	57.14%	25.00%	0.786	7
Dependencies & Integration	10.71%	7.14%	14.29%	25.00%	42.86%	0.765	10
Network Bandwidth	3.57%	10.71%	3.57%	28.57%	53.57%	0.836	**3**
Performance	3.57%	3.57%	17.86%	60.71%	14.29%	0.758	11
Workload Assessment	3.57%	7.14%	10.71%	32.14%	46.43%	0.822	4
Cost Estimation & Pricing	3.57%	10.71%	21.43%	42.86%	21.43%	0.736	12
SLA	7.14%	7.14%	17.86%	25.00%	42.86%	0.779	8
Lack of Prior Skills & Knowledge	21.43%	17.86%	10.71%	28.57%	21.43%	0.622	13

Table VI Hypothesis Testing

	Factors	p-value	Result
Technology Readiness	Virtualization Management	0.000	Significant
	Workload Assessment	0.000	Significant
	Compatibility	0.18	Not-Significant
	Interoperability & Portability	0.001	Significant

	Dependencies & Integration	0.000	Significant
	Network Bandwidth	0.001	Significant
	Performance	0.003	Significant
	Resilience	0.001	Significant
	Availability	0.000	Significant
	Local data storage	0.002	Significant
	Data backup & recovery	0.000	Significant
	Data security & integrity	0.001	Significant
	Security Architecture	0.002	Significant
	Privacy	0.001	Significant
	Trust	0.000	Significant
Organizational Readiness	Organization adaptiveness	0.003	Significant
	Top management support	0.000	Significant

	Prior skills & Knowledge	0.002	Significant
	Risk analysis & change management	0.000	Significant
	Organization strategies	0.287	Not-Significant
Business Readiness	Business Domain	0.002	Significant
	Relative advantage	0.000	Significant
	Cost estimation & pricing	0.000	Significant
	Peer partner pressure	0.156	Not-Significant
Environmental Readiness	SLA	0.004	Significant
	Regulatory compliance	0.003	Significant

VI. DISCUSSION

The proposed framework and construct are validated using statistical methods. Framework consists of 33 independent determinants of cloud adoption. During the reliability test of the determinants 7 factors are found below the cutoff range. Thus, 26 variables are found reliable and valid for the framework.

To test the hypothesis one-sample t-test is performed using IBM SPSS tool. The proposed hypothesis can be summarized as all the proposed independent variables have a positive impact on cloud computing adoption. The proposed framework comprises of four different contexts namely Technology readiness, Organizational readiness, Business readiness, and Environmental readiness.

In the technology readiness context the 17 factors were tested. The result suggests that compatibility doesn't have a positive impact on cloud computing adoption. Several other determinants including

complexity and security controls were not found reliable and valid for the framework. Thus, these factors were removed for hypothesis testing. Determinants such as privacy, trust, network bandwidth, interoperability, portability, and availability having significant impact on cloud computing adoption. Findings of this research also found consistent with previous research [12, 16, 26, 28, 38]. This research has put a significant emphasis on technology readiness context. Thus, the research has identified several new determinants: virtualization management, workload assessment, local data storage, resilience, and dependencies & integration which have significant impact on technology readiness so as on cloud adoption. Though no previous research is found in the literature in which the detail study on technology readiness context is performed. Thus, result concludes that for successful adoption to cloud computing a detailed analysis on technology readiness needs to be performed keeping these determinants in mind. A technology readiness assessment must be performed with these determinants to check the readiness of the organization for cloud adoption or migration.

In the organizational readiness context organization culture, human resource & training, and organization size were not found valid and reliable for the study. Thus these determinants were excluded in the hypothesis testing. The result of the hypothesis testing suggests that organizational strategies don't have a significant impact on cloud adoption.

However determinants such as top management support, prior skill & knowledge, organizational adaptiveness, and top management support have positive impact on cloud computing adoption. Findings of this research are also found consistent with the previous research findings found in the literature [2, 17, 31, 33].

In the business readiness context business impact determinant is not found valid and reliable for the framework. The result of hypothesis testing suggests that determinant peer partner pressure does not impact the cloud computing adoption. However this findings of the research is found inconsistent with some previous researches which suggest that peer partner pressure has significant impact on cloud computing adoption [9, 16]. As expected cost estimation and pricing are found one of the important determinants of cloud adoption. Thus, a detailed cloud cost estimation analysis needs to be performed before cloud adoption & migration.

In the environmental context government support is found not reliable for the framework. However, the results suggest that both the determinant SLA and regulatory compliance are found significant and have positive impact on cloud computing adoption. The outcome of the research is found consistent with previous studies [34]. However, with the determinant regulatory compliance there exist different opinions in different researches.

In nut shell, out of 26 proposed hypotheses, only 3 hypotheses are found insignificant. Based on the empirical analysis the research is capable of identifying the key enablers and determinants that impact the cloud computing adoption the most. The proposed framework can play a significant role for any organization who wants to adopt or migrate to the cloud computing platform.

VII. CONCLUSION & FUTURE WORK

The primary objective of this research is to identify the key determinants that impact the cloud computing adoption. Further research wants to propose a cloud adoption framework that has ease of use to the organization. The research analyzes previous literature in more significant manner with various constraints of TOE and DOI framework to identify the technical and non-technical factors that impacts the cloud computing adoption.

The identified determinants are classified into four categories as technical, organizational, business, and environmental readiness context. In compare to previous researches, in this research technical context is studied in more detail and several new factors are identified and added in the framework.

Virtualization management, workload assessment, dependencies & integration, compatibility, resilience, network bandwidth, local data storage, security architecture, security controls, and availability are analyzed in more detail and adopted as most pre-dominant factors in cloud migration. Further, based on these key determinants a cloud strategy framework is proposed for the organizations. This proposed framework can act as a guideline for any organization either to create the checklist, or to identify the key challenges that impact cloud adoption the most. The framework also provides better understanding of technological factors that needs to be assessed before migrating to cloud platform.

However, the study has certain limitations too. Because of limited timeframe and resources the research is conducted with comparatively smaller population and in specific country. The research can be extended with larger population sample across the geopolitical boundaries. Further, a cloud readiness

assessment needs to be performed within several organizations as a case study, to find out the impact of proposed framework. These are some proposed future direction of this research.

Table VII Reliability of the factors

Factors	No. of Items	Item for deletion	Croanbach's Alpha
Virtualization Management	4	None	0.83
Workload Assessment	3	None	0.86
Compatibility	3	None	0.80
Interoperability & Portability	2	None	0.89
Dependencies & Integration	2	None	0.71
Network Bandwidth	2	None	0.86
Performance	3	None	0.73
Resilience	2	None	0.72
Complexity	2	None	0.56
Availability	2	None	0.72
Local data storage	2	None	0.78
Data backup & recovery	2	None	0.75
Data Security & Integrity	3	None	0.87
Security Architecture	3	None	0.77
Security Controls	2	None	0.70
Privacy	2	None	0.83
Trust	2	None	0.78
Organization size	2	None	0.66
Organization adaptiveness	3	None	0.75
Top management support	2	None	0.80
Prior skills & Knowledge	3	None	0.73
Human resource & training	2	None	0.62
Risk analysis & change management	1	None	0.73
Organization strategies	2	None	0.74

Organization culture	3	None	0.42
Business Domain	2	None	0.78
Relative advantage	2	None	0.81
Business Impact	2	None	0.68
Cost estimation & pricing	3	None	0.81
Peer partner pressure	2	None	0.78
SLA	3	None	0.83
Regulatory compliance	2	None	0.71
Government support	2	None	0.60

VIII. REFERENCES

[1] S. Schneider and A. Sunyaev, "Determinant factors of cloud-sourcing decisions: reflecting on the IT outsourcing literature in the era of cloud computing," *Journal of Information Technology,* vol. 31, no. 1, pp. 1-31, 2016.

[2] M.-G. Avram, "Advantages and challenges of adopting cloud computing from an enterprise perspective," *Procedia Technology,* vol. 12, pp. 529-534, 2014.

[3] B. B. Rad, T. Diaby, and M. E. Rana, "Cloud computing adoption: a short review of issues and challenges," in *Proceedings of the 2017 International Conference on E-commerce, E-Business and E-Government*, 2017, pp. 51-55: ACM.

[4] P. Géczy, N. Izumi, and K. Hasida, "Cloudsourcing: managing cloud adoption," *Global Journal of Business Research,* vol. 6, no. 2, pp. 57-70, 2012.

[5] Q. Zhang, L. Cheng, and R. Boutaba, "Cloud computing: state-of-the-art and research challenges," *Journal of internet services and applications,* vol. 1, no. 1, pp. 7-18, 2010.

[6] T. Dillon, C. Wu, and E. Chang, "Cloud computing: issues and challenges," in *2010 24th IEEE international conference on advanced information networking and applications*, 2010, pp. 27-33: Ieee.

[7] A. Alharthi, M. O. Alassafi, R. J. Walters, and G. B. Wills, "Towards a framework to enable the migration process to educational clouds in Saudi higher education," in *Information Society (i-Society), 2016 International Conference on*, 2016, pp. 73-76: IEEE.

[8] H. M. Sabi, F.-M. E. Uzoka, K. Langmia, and F. N. Njeh, "Conceptualizing a model for adoption of cloud computing in education," *International Journal of Information Management,* vol. 36, no. 2, pp. 183-191, 2016.

[9] C. Low, Y. Chen, and M. Wu, "Understanding the determinants of cloud computing adoption," *Industrial management & data systems,* vol. 111, no. 7, pp. 1006-1023, 2011.

[10] D. Smith, "Cloud computing deployments should begin with service definition. Gartner Report," ed, 2016.

[11] D. Zissis and D. Lekkas, "Addressing cloud computing security issues," *Future Generation computer systems,* vol. 28, no. 3, pp. 583-592, 2012.

[12] N. Alkhater, G. Wills, and R. Walters, "Factors influencing an organisation's intention to adopt cloud computing in Saudi Arabia," in *2014 IEEE 6th international conference on cloud computing technology and science,* 2014, pp. 1040-1044: IEEE.

[13] H. Gangwar, H. Date, and R. Ramaswamy, "Understanding determinants of cloud computing adoption using an integrated TAM-TOE model," *Journal of Enterprise Information Management,* vol. 28, no. 1, pp. 107-130, 2015.

[14] H. Takabi, J. B. Joshi, and G.-J. Ahn, "Security and privacy challenges in cloud computing environments," *IEEE Security & Privacy,* vol. 8, no. 6, pp. 24-31, 2010.

[15] R. El-Gazzar, E. Hustad, and D. H. Olsen, "Understanding cloud computing adoption issues: A Delphi study approach," *Journal of Systems and Software,* vol. 118, pp. 64-84, 2016.

[16] A. Abdollahzadegan, C. Hussin, A. Razak, M. Moshfegh Gohary, and M. Amini, "The organizational critical success factors for adopting cloud computing in SMEs," *Journal of Information Systems Research and Innovation (JISRI),* vol. 4, no. 1, pp. 67-74, 2013.

[17] S. K. Sharma, A. H. Al-Badi, S. M. Govindaluri, and M. H. Al-Kharusi, "Predicting motivators of cloud computing adoption: A developing country perspective," *Computers in Human Behavior,* vol. 62, pp. 61-69, 2016.

[18] N. Alkhater, R. Walters, and G. Wills, "An empirical study of factors influencing cloud adoption among private sector organisations," *Telematics and Informatics,* vol. 35, no. 1, pp. 38-54, 2018.

[19] G. Bell, "Toward a history of (personal) workstations," in *Proceedings of the ACM Conference on the History of Personal Workstations,* 1986, pp. 1-17: ACM.

[20] Rightscale, "State of the Cloud Report 2019: Data for Driving Your Multi-Cloud Strategy," 2019, Available: https://www.rightscale.com/lp/state-of-the-cloud?campaign=RS-HP-SOTC2019, Accessed on: 21/4/2019.

[21] P. Mell and T. Grance, "The NIST definition of cloud computing," 2011.

[22] J. Baker, "The technology–organization–environment framework," in *Information systems theory*: Springer, 2012, pp. 231-245.

[23] M. Z. Nkhoma, D. P. Dang, and A. De Souza-Daw, "Contributing factors of cloud computing adoption: a technology-organisation-environment framework approach," in *Proceedings of the European Conference on Information Management & Evaluation*, 2013, pp. 180-189.

[24] A. Abdollahzadegan, C. Hussin, A. Razak, M. Moshfegh Gohary, and M. Amini, "The organizational critical success factors for adopting cloud computing in SMEs," 2013.

[25] P.-F. Hsu, S. Ray, and Y.-Y. Li-Hsieh, "Examining cloud computing adoption intention, pricing mechanism, and deployment model," *International Journal of Information Management*, vol. 34, no. 4, pp. 474-488, 2014.

[26] H. P. Borgman, B. Bahli, H. Heier, and F. Schewski, "Cloudrise: exploring cloud computing adoption and governance with the TOE framework," in *System Sciences (HICSS), 2013 46th Hawaii International Conference on*, 2013, pp. 4425-4435: IEEE.

[27] A. Lin and N.-C. Chen, "Cloud computing as an innovation: Percepetion, attitude, and adoption," *International Journal of Information Management*, vol. 32, no. 6, pp. 533-540, 2012.

[28] T. Oliveira, M. Thomas, and M. Espadanal, "Assessing the determinants of cloud computing adoption: An analysis of the manufacturing and services sectors," *Information & Management*, vol. 51, no. 5, pp. 497-510, 2014.

[29] A. M. AlBar and M. R. Hoque, "Determinants of cloud ERP adoption in Saudi Arabia: an empirical study," in *Cloud Computing (ICCC), 2015 International Conference on*, 2015, pp. 1-4: IEEE.

[30] E. M. Rogers, *Diffusion of innovations*. Simon and Schuster, 2010.

[31] H. Sallehudin, R. C. Razak, and M. Ismail, "Factors influencing cloud computing adoption in the public sector: an empirical analysis," *Journal of Entrepreneurship and Business*, vol. 3, no. 1, pp. 30-45, 2015.

[32] G. Garrison, R. L. Wakefield, and S. Kim, "The effects of IT capabilities and delivery model on cloud computing success and firm performance for cloud supported processes and operations," *International Journal of Information Management*, vol. 35, no. 4, pp. 377-393, 2015.

[33] F. Alharbi, A. Atkins, and C. Stanier, "Understanding the determinants of Cloud Computing adoption in Saudi healthcare organisations," *Complex & Intelligent Systems*, vol. 2, no. 3, pp. 155-171, 2016.

[34] H. Hassan, "Organisational factors affecting cloud computing adoption in small and medium enterprises (SMEs) in service sector," *Procedia computer science*, vol. 121, pp. 976-981, 2017.

[35] P. Priyadarshinee, R. D. Raut, M. K. Jha, and S. S. Kamble, "A cloud computing adoption in Indian SMEs: Scale development and validation approach," *The Journal of High Technology Management Research*, vol. 28, no. 2, pp. 221-245, 2017.

[36] P. Priyadarshinee, R. D. Raut, M. K. Jha, and B. B. Gardas, "Understanding and predicting the determinants of cloud computing adoption: A two staged hybrid SEM-Neural networks approach," *Computers in Human Behavior*, vol. 76, pp. 341-362, 2017.

[37] B. M. R. Wilson, B. Khazaei, and L. Hirsch, "Enablers and barriers of cloud adoption among Small and Medium Enterprises in Tamil Nadu," in *2015 IEEE International Conference on Cloud Computing in Emerging Markets (CCEM)*, 2015, pp. 140-145: IEEE.

[38] F. Alharbi, A. Atkins, and C. Stanier, "Decision makers views of factors affecting cloud computing adoption in saudi healthcare organisations," in *2017 International Conference on Informatics, Health & Technology (ICIHT)*, 2017, pp. 1-8: IEEE.

[39] M. Al-Ruithe, E. Benkhelifa, and K. Hameed, "Current State of Cloud Computing Adoption–An Empirical Study in Major Public Sector Organizations of Saudi Arabia (KSA)," *Procedia Computer Science*, vol. 110, pp. 378-385, 2017.

[40] S. R. Tehrani and F. Shirazi, "Factors influencing the adoption of cloud computing by small and medium size enterprises (SMEs)," in *International Conference on Human Interface and the Management of Information*, 2014, pp. 631-642: Springer.

[41] P. R. Hinton, *Statistics explained*. Routledge, 2014.