Towards Risk Managed Cloud Adoption
A Conceptual Framework

Shikha Gupta
School of Engg & Technology, Ansal University
Research Fellow - Department of Computer Applications, TMU, India
shikhagupta@ansaluniversity.edu.in

K B C Saxena
Fortune Institute of International Business, India
kbcsaxena@gmail.com

A K Saini
University School of Management Studies, GGS Indraprasth University, India
aksaini1960@gmail.com

Abstract— Cloud is an economical viable proposition for companies, Small and Medium Scale companies (SMEs) in particular
by facilitating a financial reduction in IT usage encouraging companies to focus and allocate their business funds and
strategies on other major business activities. It offers an innovative and promising vision in the field of Information and
Communications Technology (ICT). But performance issues, data vulnerabilities, security issues, data portability issues and
financial risks involved, make this adoption a risky process. The risks that come with outsourcing software and data to another
party are problematic for many companies which makes trust on cloud service provider as an extremely important factor. This
paper investigates the issues and challenges facing SMEs which are inclined towards cloud benefits. This paper also explores
the role of initial trust based on contractual agreement called Service Level Agreement (SLA) and Cloud Service Provider’s
reputation in managing risk of cloud adoption. On the basis of literature review of all the aspects and then on the basis of
analysis of expert opinion using Delphi technique the paper proposes a risk informed cloud adoption framework based on
trust between service provider and companies.

Keywords— Cloud; SMEs; Adoption; Risks; Trust; SLA; Risk Management Framework

I. INTRODUCTION

Cloud computing is a computing paradigm that has transformed the IT landscape in terms of its usage and ownership. The
cloud computing advantages like reduction in financial burden through outsourcing of IT services and efforts have
resulted in rapid growth prospects of the cloud computing market. Companies big or small are showing an inclination
towards outsourced Cloud offerings that can help them reduce costs and increase enterprise agility. Economical model of
cloud offerings has made it more attractive for small and medium-sized companies (SMEs) with more and more small
businesses opting for it. Cloud computing is recognized as the most promising computing paradigm of the last several
years [1]. Cloud Computing has revolutionized the concept of ICT. By 2011, it had become the top technology priority
for companies worldwide and As per reports year 2020 will see $241 billion cloud computing market [2]. Cloud
computing has become an economically viable proposition for SMEs with other benefits like improved resource utilization
and elasticity of usage. The research aims at providing practical recommendations for SMEs to take a risk informed
decision while migrating to cloud. Understanding and managing risk is challenging for both cloud service providers and
companies which are driven towards cloud adoption.

II. COST: MAIN DRIVER OF CLOUD ADOPTION

Though cloud computing is being associated by different researchers with many attributes like availability, scalability,
availability, cost-efficiency, elasticity, extensibility, the main drivers of cloud adoption are cost-efficiency and flexibility
[3-6]. Highly scalable computing application, storage and platforms provisioned by cloud have completely changed the
business information technology strategy [4]. Reduced cost structure due to no or minimal capital expenditure (CAPEX)
and operational expenditure (OPEX) in IT can prove a boon to SMEs by offering considerable benefits in terms of cost
reduction[7-11]. This key characteristic of cloud computing can reduce the financial burden placed on SME’s in
technology adoption [7] [8].
As per [12][13] the main cloud computing attributes are pay per use, elastic self-provisioning through software, simple scalable services, virtualized physical resources, speed and flexibility to enhanced performance [7-9][14][15] advocate that cloud computing can provide potential for significant cost reductions in, areas like capital acquisition, IT infrastructure operations and maintenance costs. In all the companies are conscious about investing money in core business, e.g. in IT they create software, infrastructure, customize software, provide solutions, from them main asset is human capital, patents so ideally they should invest on people development, technological development, creating operating system etc. as a part of their core business, however they would also require to create and maintain an IT infrastructure. So they would create a space for it as IT infrastructure dedicated space which requires controlled environment like uninterrupted power supply, telecom dependency if possible, business continuity features, data security (access controls), logical security, people as they grow they will have to invest further in terms increasing size of IT infrastructure, space and other related facilities which is not their core business so it makes sense to outsource their infrastructure and pay per use analogical to a cold storage business to IT infrastructure where every facility is created and taken care of. The pay-per-use model decreases the financial burden substantially [8][16]. This pay per use model enables the companies to access storage resources and charge according to the resources access. Third party cloud infrastructure solutions offer new pricing models, which help in managing income for customers, sales and marketing staff [17]. After the decision to adopt cloud is taken the next step is to understand what best suits them in terms models available and offering by cloud providers. There are different cost calculations for cost benefit analysis. Cost of infrastructure, space, people who will manage it versus cloud based solution, plans available.

III. CLOUD ADOPTION ISSUES AND CHALLENGES

The case of cloud migration does not generally start with cost benefits, but with security, performance in terms of more uptime, flexibility of services, sharing and ensuring accountability through SLAs and contractual agreements, cost edge technology. From that environment the question is why cloud, why not cloud. The phase of decision making towards transition is very intuitive. Nets logical stage for a company in comparison to companies which are in initial phase of their core activities and also not very big and technology dependent. Growth of IT in comparison to growth of the company and also the threshold of IT expansion are important key factors in decision. Moreover, issues regarding reliability, security, availability, privacy, performance and the management of service level agreements of software services are deeply concerned by the users in the cloud [18-20].

Different cloud adoption solutions which a company can opt for depends on its technological maturity. Adoption of cloud by a company largely depends on its maturity and awareness. We can draw an analogy from conception, awareness, to acceptance of drawing money from ATM which is situated away from banks, to gradually to gradually transitioning to online banking and then mobile banking, which is a journey from user point of view, extending it to companies, what is their IT maturity or which phase of IT evolution they are at or how well IT aware those companies’ KDMs (Key Decision Makers) are to adopt new technology, it also determines their openness to go for solutions available in the market. These KDMs are executive line ups CEOs, CTOs, CFOs. The CTO is the key person who initiates the migration process and creates the case for it whose responsibility is to ensure security, business continuity, performance enhancement etc., the CFO would consider the cost benefit analysis along with CTO who, being head is also responsible for optimization. They jointly will create a case and based on cost and other benefits will present and forward it.

A. Inherent Risks in adoption

Cost and risk are key variables in making a decision to adopt cloud. The most important factor is inclination which comes on awareness. But these variables cannot be compared with each other as no matter how much disproportionate cost v/s risk is one will not go for cloud if risk is very high.

1) Financial Risk

As already discussed the key aspect of Cloud Computing is financial viability and when enterprises opt for cost transparency, scalability and cost variability, a new challenge and opportunity arises [21]. Researches have shown lack of properly planned business strategy and hence poor selection decisions can lead to increased operational costs [22] and sometimes even can cost twice as much as in-house data (McKinsey & Co). Researchers have used the terms hidden costs, hidden service costs, switching costs, cost escalation, contractual amendments costs, litigation cost, service debasement cost, loss of organizational competency, excessive transaction costs, Unexpected transition and management costs to describe the Financial or economic issues in cloud adoption [23-27].

2) Performance Risk

Various researchers have attributed terms like Availability/business continuity, unavailability of services, slow response time. Loss of critical skills or developing wrong skills, inexperienced staff, lack of organizational learning [8][27][28] to performance risks in cloud computing.

As Cloud Computing relies on the quality and availability of the Internet connection and the cloud service itself the performance risks are the major concerns for cloud adoption [25][26][16], giving rise to availability (expressed as the annual uptime percentage) concerns and issues of services and hence business continuity concerns due to Internet
downtime, connection unreliability or CSP outages[8] wherein the term availability can be defined as the property of cloud that users are able to access the service and the data whenever they want to i.e. delivering services right at the time of request without unprecedented and unwanted delays [29]. Availability is also defined as operation time in contracts and SLAs as the ratio or percentage of time in which the system was actually available (i.e., the so-called “operation time”) excluding maintenance periods, non availability being referred to as downtime [30]. Further, latency or the delay incurred in transferring data packets is of concern especially for time-critical applications such as those used in financial markets and international trading [16].

There have been incidences of Cloud Computing service interruptions, service disruptions [31][32]. Downtime can be caused even unintentionally due to technical failures or even natural disasters [33-35]. Service non availability or disruptions might lead to serious business when cloud service provider is attacked. Disaster recovery and business continuity planning become mandatory to deal with cases like service provider filing for bankruptcy or being acquired by a new management When users are no longer able to log on to the service, they end up with no access to their data that are stored on remote servers of the Cloud Computing provider [36][37].

3) Data Security and Privacy Risk
Companies are adopting cloud due to cost considerations but uninformed and unplanned decisions to adopt cloud can lead to insecurity. [38] Enforces the need of quantification of IT security incidents as an important factor of risk management. Various researchers have considered data security and privacy risk as most serious issue for cloud computing [8][13][14][25]. These security concerns include proper identity management, security incident management and reporting, auditing, security verifications, proper authorizations and authentications, data transmission protection, data backup mechanism among various other issues which lead to data security, integrity and confidentiality. Privacy issues include the maintaining privacy of data e of users from unwanted disclosure and also the legalities surrounding data protection, confidentiality, copyright and audits are fundamental concerns [39]. System Vulnerability needs to be handled very carefully in cloud adoption [31]. Data Loss or leakage can lead to heavy financial and goodwill losses to companies.

4) Service Environment Risk
Service environment is one of the important issues in cloud adoption. Rules and regulations pertaining to data storage, confidentiality and disclosure change with boundaries with impact of different country jurisdictions and industries across boundaries [15]. Hence, ensuring compliance with local, regional and global statutory and legal requirements represents a potential barrier to cloud adoption [40]. Data location being one of the issue with cloud computing, vendors’ servers may span multiple countries which result in compliance and data privacy issues [4][6] Some countries have liberal rules and laws whereas some countries have strict limitations on the flow of information beyond the user’s jurisdiction [15][40]. In most cases companies are unaware of location of their data. Another serious service issue is data portability which must be handled very carefully [31].

B. Role of Trust in managing risk in cloud adoption
Trust can be defined as “the willingness of a party to be vulnerable to the action of another party based on the expectation that the other will perform a particular action important to the truster, irrespective to the ability to monitor or control that other party” [41]. Trust plays a very important role in transition to cloud – generally IT partners of the companies who manage their IT become driving force towards cloud migration. Take an example of an IT company AAA managing IT of company BBB offers company BBB to outsource its IT infrastructure and upon getting the opportunity of being an outsourcing partner partners with other company CCC, a cloud service provider for some of its operations for example data centers. The companies need to entrust external Cloud Service Providers with their business critical data [8][14][15]. Lack of trust in cloud computing is preventing cloud based technologies from being used widely among users [42]. The need for trust arises as an important factor especially when the organization wants to adopt cloud for its mission critical data [43].

“Trust, but verify” is a good advice for dealing with the relationships between cloud users and cloud service providers [44]. Cloud adoption is based on initial trust which would result in employing a cloud service. Authors have identified the need of an exhaustive and transparent contract [45][44][46] to generate an initial trust between provider and user. This legal contract between a cloud user and a cloud service provider is called service level agreement (SLA). Other important factor in establishing initial trust may be the selection of service provider based on the Reputation/recommendation by present clients of the provider [44].

IV. RESEARCH METHODOLOGY
We conducted a structured literature review of all the important issues pertaining to cloud adoption based on the approach by [47] and [48] with the purpose of extracting the most important and prevalent issues of cloud adoption by SMEs. For a reliable review we used scientific databases like IEEE Explore, ACM, EBSCO, Web of Science, Science Direct. The most important issues were issues were summarized and formed the first level of Adoption. The results were organized and arranged in Table 1. Then a second content analysis was done to establish second level of framework i.e. - find the variables under different issues. A Delphi method was then applied where 6 experts (4 IT experts 2 academicians) were consulted and interviewed with open ended questionnaire to establish and further verify the framework.
The Delphi technique is well suited for analysis based on data from experts within the subject domain. It is based on gathering information and building consensus by taking opinion form a group of experts through series of questionnaires on a specific real-world issue. The technique is well suited as a means and method for consensus-building by using a series of questionnaires to collect data from a panel of selected subjects [50-51]. The opinions from a diverse set of experts is sought and then aggregated to reach a decision which is expected to be accepted by people at large.

### TABLE I. CONTENT ANALYSIS OF CLOUD ADOPTION ISSUES

<table>
<thead>
<tr>
<th>Issues</th>
<th>#S</th>
<th>IEEEExplorer</th>
<th>ACM</th>
<th>EBSCO</th>
<th>Web of Science</th>
<th>Science Direct</th>
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<td>28</td>
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<tr>
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<td>38</td>
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<td>21</td>
<td>24</td>
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<tr>
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<tr>
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<td>32</td>
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V. RISK MANAGEMENT FRAMEWORK

Based on the review of literature of various risk factors involved in cloud adoption and the need of initial trust in the service provider based on its reputation and service level agreements (SLA), we propose a theoretical framework of cloud adoption(Fig.1). The framework is beneficial for SMEs which are already using IT solution and are planning to adopt cloud based solutions after considering a number of benefits that cloud offers, financial implications (Cost) being the major driver among them. Cloud can make their life easy by shifting their focus from IT implementation and maintenance not only in terms of adopting new IT enabled services but also upgrading with time to other mainstream activities and issues.

We establish that though adopting cloud can reduce financial costs its unplanned adoption is risky due to a number of issues like performance, security, privacy, services and hence trust on cloud service provider becomes an important factor, so a company needs to take risk informed decisions and analyze service providers based on trust. The trust, which is initial trust, on the other hand is based on the reputation of cloud service provider. Also contractual agreements (Service Level Agreements) play an important role in establishing trust in Cloud Service Providers.

Data is another issue in cloud adoption which is a factor of two components namely criticality and control. Data control is an important issue as cloud technology is based on storing data at some other location which can again create hesitation in companies to adopt cloud and in this aspect Service Level Agreements play an important role through which the companies can make inclusion of location disclosure mandatory for Cloud Service Provider.

VI. CONCLUSION

Though Cloud Computing is revolution in IT technology which can change the IT usage especially for SMEs which always look for cost reductions, there are issues and challenges in cloud adoption which if addressed properly can lead to a safe, pleasant and economically viable cloud adoption. This research helps the companies to understand these issues by proposing the Cloud Adoption Framework Based on Risk and Trust. This Framework presented here intends to help companies take risk informed decision based on Trust which plays an important role in cloud adoption. The proposed framework needs to be validated which is our future work wherein we intend to validate it through implementation in a company.

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