

Cloud Adoption: Linking Business Needs with System Measures

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Abstract

Cloud has become an inevitable utility for organizations to leverage their IT resources and processes. It has reached a level from innovation to diffusion to adoption. Organizations are looking towards cloud adoption as a solution to decrease their IT over budgets and also to concentrate more on their core business activities. The cloud has changed the entire IT usage scenario. It has changed the IT usage from self-owned IT resource utilization to rented pay per use as a utility. Though cloud adoption brings with it lots of opportunities and benefits, there are issues which surface its adoption and the companies which take an informed decision after weighing all the issues surrounding the adoption are able to sustain in a better way than those companies which adopt cloud uninformed. The study attempts to analyze the link between business needs and system measures from three perspectives: Technology, Business Needs and Economic Factors and proposes a theoretical framework based on IT adoption theories.

Keywords: Business Needs, Cloud Adoption, Economic Factors, IT Adoption Theories, System Measures, Technology

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1. Introduction

Cloud computing has transformed the IT landscape as a computing paradigm in terms of its IT usage and ownership. Its benefits like reduction in financial burden its usage and efforts have resulted in rapid growth prospects of the cloud computing market. Companies are looking at cloud adoption as an alternative for their over burdening IT budgets. The seemingly economical model of cloud offerings has made it more attractive for small and medium-sized companies and as a result more and more companies going for it or has started planning towards its adoption. Cloud computing is recognized as the most promising computing paradigm of the last several years¹. 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 market². Its features like economy, elasticity and flexibility of usage most economically viable option. But at the same time as with all other technologies it has its own share of concerns and issues, so in order to establish a well-connected link between business needs and system measures it becomes imperative to understand its strength and weaknesses³. We will analyze the scenario with the exiting theories for technology adoption and establish a theoretical framework based on the theories. We have categorized the relevant theories into these three categories i.e. Technology, Business needs, Economic Factors.

2. Cloud Computing Concept

Various researchers have defined cloud in different ways. The National Institute of Standards and Technology defines the Cloud Computing as:

Cloud computing refers to a model which can be used to enable convenient resource polling feature in a shared environment which can be done on-demand. According to some other authors, cloud is a service model for provisioning IT resources which is based on virtualization and works on distributions environment^{4,5} defines cloud as a set of services which gives infrastructure resources utilizing media and data storage. Cloud Computing can also be defined as online model for services providing hardware and software as per demand of the customer and you have to pay for the usage only⁶.

Cloud computing represents a convergence of two major trends in information technology — (a) IT efficiency, whereby the power of modern computers is utilized more efficiently through highly scalable hardware and software resources and (b) business agility, whereby IT can be used as a competitive tool through rapid deployment, parallel batch processing, use of compute-intensive business analytics and mobile interactive applications that respond in real time to user requirements⁷. Figure 1 depicts the cloud computing architecture.

3. Technology, Organization, and Environment Context of Cloud Adoption

The TOE framework developed in 1990⁸ identifies three aspects technological context, organizational context, and environmental context of an enterprise's context to explain the technological innovation adoption. Technological context describes both the internal and external technologies in terms of practices and equipment etc, relevant or available to the organization⁹⁻¹².

Organizational context is the reference of descriptive measures such as scope, size, and managerial structure about the organization. Environmental context refers to the industry, Industry characteristics, competitors, Technology support infrastructure and dealings with the government; Government regulation⁸. TOE provides a useful analytical framework that can be used for studying the adoption and assimilation of different types of IT innovation. The TOE framework makes Rogers'

innovation diffusion theory better able to explain intra firm innovation diffusion¹³. The study follows TOE framework to establish a theoretical framework for cloud adoption.

4. Theoretical Framework for Cloud Adoption

We conducted a structured literature review of all the important issues pertaining to cloud adoption with the purpose of extracting the most important and prevalent issues of cloud adoption by organizations. For a reliable review we used scientific databases like IEEE Explore, ACM, EBSCO, Web of Science, and Science Direct.

The above factors were summarized and grouped into three main categories:

- Technological context
- Organizational context
- Environmental context

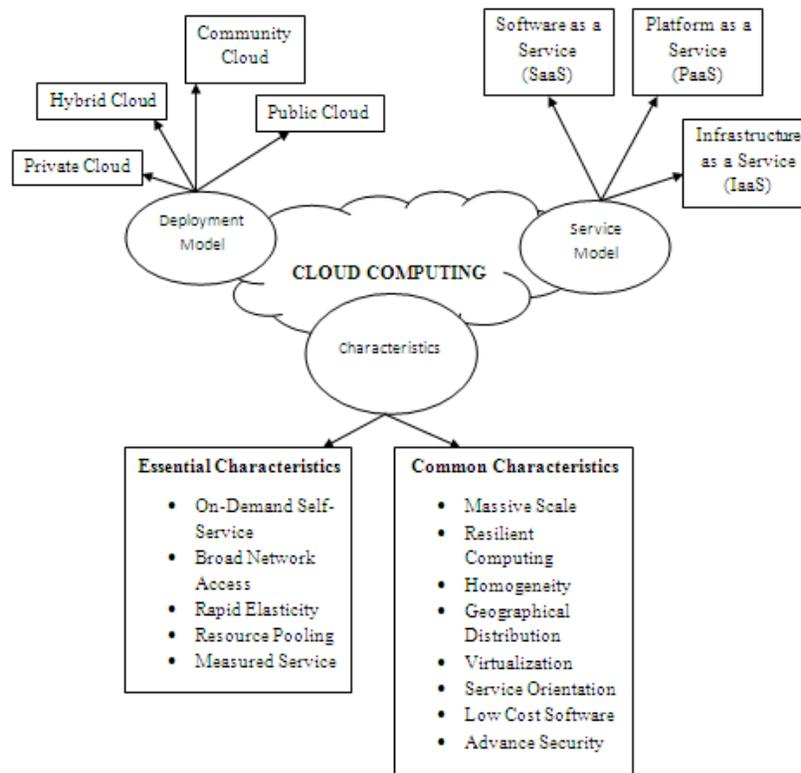


Figure 1. Architecture of Cloud Computing¹⁴.

Table 1. Extracted Issues from Various Databases

| Issues | #S | IEEExplorer | ACM | EBSCO | Web of Science | Science Direct |
|--------------------------------|-----|-------------|-----|-------|----------------|----------------|
| Data Control | 149 | 24 | 30 | 36 | 28 | 31 |
| Data Criticality | 125 | 28 | 26 | 21 | 24 | 26 |
| Trust | 174 | 36 | 38 | 35 | 31 | 34 |
| Risk | 191 | 40 | 36 | 38 | 40 | 37 |
| Performance Assurance | 155 | 38 | 38 | 34 | 21 | 24 |
| Data Security and Privacy | 217 | 48 | 41 | 46 | 42 | 40 |
| Service Environment | 191 | 43 | 34 | 42 | 37 | 35 |
| Cost | 165 | 32 | 35 | 31 | 30 | 37 |
| SLA | 94 | 21 | 20 | 19 | 20 | 14 |
| Reputation of Service Provider | 125 | 22 | 32 | 30 | 21 | 20 |

Table 2 provides the categorization of different issues of cloud adoption into these three categories.

Table 2. Categorization of Different Issues

| Categories | Factors of Adoption |
|------------------------|--------------------------------|
| Technological context | Data Control |
| | Data Criticality |
| | Data Security and Privacy |
| Organizational context | Performance Assurance |
| | Cost |
| | Risk |
| Environmental context | Trust |
| | Service Environment |
| | SLA |
| | Reputation of Service Provider |

4.1 Issues and challenges of adoption

Despite the fact that cost assumes a noteworthy part in choice to receive cloud yet issues like security, execution and so on can't be overlooked¹⁵. It turns out to be critical to consider every one of these parameters alongside adaptability, unwavering quality, security, accessibility, protection, and make them a piece of legally binding understandings while adopting. A relative examination of Growth of IT and development of the organization is a key component towards the choice of cloud adoption alongside different issues.

4.2 Cost of cloud adoption

As always Cost is the main driver for cloud adoption apart from other parameters like scalability, elasticity, agility, availability, cost-efficiency, extensibility¹⁶⁻¹⁹ where small and medium scale companies are mainly attracted towards reduced cost structure

due to no or minimal capital expenditure (CAPEX) and operational expenditure (OPEX) in IT²⁰⁻²⁴. As per^{25,26} 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. As per^{20-22 25,26} cloud computing provides significant cost reductions in areas like capital acquisition, IT infrastructure operations and maintenance costs. The pay-per-use model further decreases the financial burden substantially^{21,27}.

4.3 Perceived cloud adoption risks

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.

4.3.1 Risk of Performance

Performance is an important factor and issue in cloud adoption. Various researchers have mentioned that due to a number of reasons like lack of critical skills or developing wrong skills, inexperienced staff, lack of organizational learning performance of cloud if not as expected can result in potential losses to the company due non availability of data and processes, slow response time, business discontinuity, unavailability of services^{21,28,29}.

4.3.2 Risk of Security and Privacy

Unplanned and uninformed adoption decision can lead to serious losses in terms on security and privacy^{21,30-33}. Security concerns like security incident management and reporting, authorizations and authentications, data backup mechanism proper identity management, auditing, security verifications, System Vulnerability, data transmission protection etc have

to be considered well and planned well during cloud adoption decision along with privacy issues like data protection, confidentiality, copyright and audits, maintaining privacy of data from unwanted disclosure as ignoring these issues can lead to not only financial losses but also loss in goodwill^{34,35}.

4.3.3 Risk of Service Environment

Service environment includes compliance, legal requirements, Rules and regulations pertaining to data storage, confidentiality and disclosure change across local as well as global level as cloud computing spans countries across the globe^{32,35} resulting in compliance and data privacy issues^{17,19,32,35}. Generally companies are not aware of location of their data. Another serious service issue is data portability³⁴.

5. Role of Trust in managing risk in cloud adoption

Trust can be defined as party's willingness to have a vulnerable action that can be a threat to the trustier whether being a organization or human³⁴. When a company takes a decision to adopt cloud trust plays an important role in selecting a particular cloud service provider which becomes all the more important when adoption is for mission critical data¹⁷⁻¹⁸. A well planned contractual agreement can play an important role in generating an initial trust towards service providers^{36,37}.

In light of the arrangement of issues, the following level of variables was set up as appeared in the figure beneath.

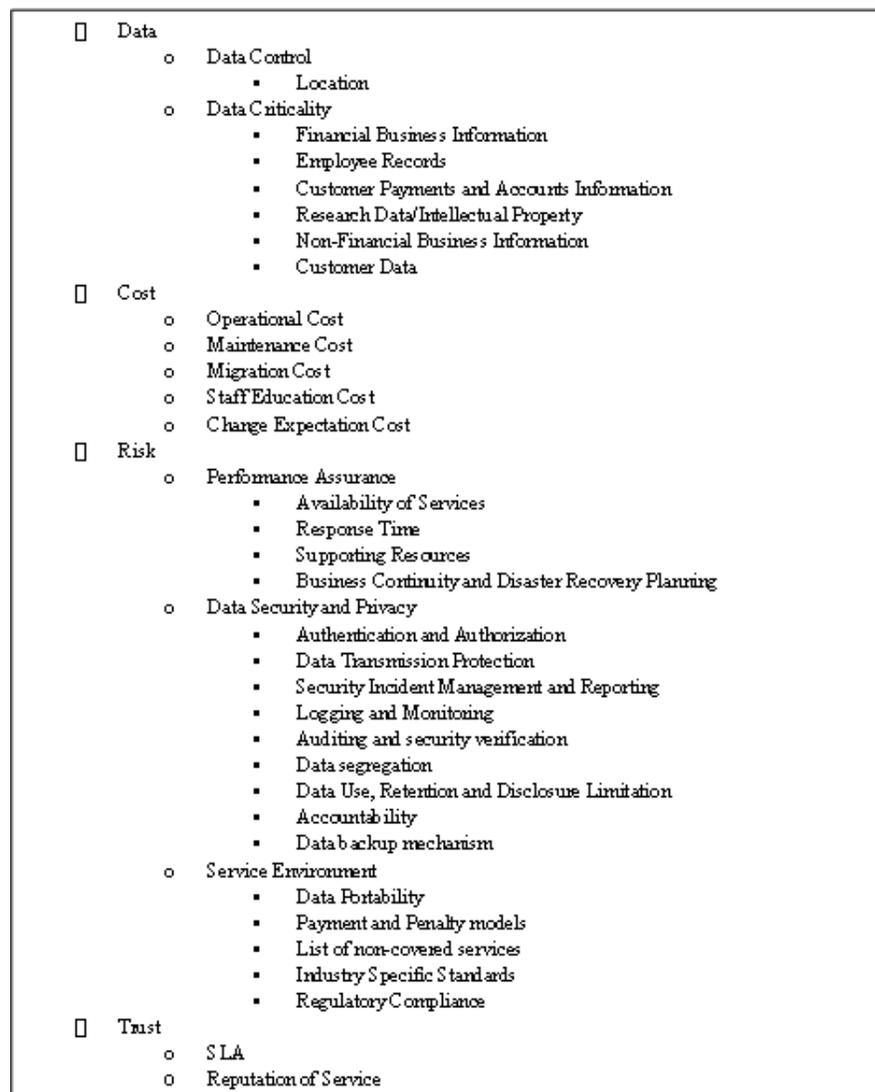


Figure 2. Different factors of cloud adoption framework.

6. IT ADOPTION THEORIES

There are number of theories for IT adoption. As cloud adoption decision requires considering a number of parameters like cost, resources, data, ability and willingness to transition to new technology, we have analyzed the cloud adoption decision from the perspective of four theories of IT adoption namely:

- Diffusion of Innovation Theory
- Resource Based Theory
- Resource Dependence Theory
- Transaction Cost Theory

We have divided these theories on the basis of three categories: Technology, Business Needs and Economic factors.

6.1 Diffusion of Innovation Theory (DOI)

DOI helps in explaining organization’s propensity and decision of technology adoption³⁸. The main thesis of the theory is that innovations are communicated through certain channels over time within a particular social system which affects the rate of adoption^{38, 38-39} suggest three attributes affecting adoption rate as relative advantage, complexity, and compatibility where *Relative Advantage* of an innovation is the measure to which a new idea is said to be better than previous related idea^{38,39}. suggests that relative advantage positively affects adoption. The second attribute is compatibility which is defined as a measure to which the new idea is said to be consistent with existing technology and experience. A lack of compatibility in IT with individual needs may negatively affect the individual’s IT use^{40,41}. So adoption is directly proportional to degree of compatibility. Third attribute is Complexity.⁴² defined complexity as the measure to which the new idea is said to be relatively difficult to use and understand. Rate of adoption is inversely proportional to complexity. Table 3 describes the different attributes along with their definitions.

Table 3. Attributes of Diffusion of Innovation Theory

| Concept Definition - Diffusion of Innovation Theory | |
|---|--|
| Relative advantage | Degree to which an innovation is perceived as being better than the idea it supersedes |
| Compatibility | Degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters |
| Complexity | Degree to which an innovation is perceived as relatively difficult to understand and use |

6.2 Resource Based Theory (RBT)

The resource-based theory is part of the theories that consider the resources as the foundations for a firm’s strateg⁴³. ⁴⁴defines firm resources(physical capital resources, human capital resources

and organizational capital resources) as all assets, capabilities, organizational processes, firm attributes, information, knowledge, etc. As per⁴⁴ value, rareness, imperfect imitability and substitutability are the four attributes of the theory. The thesis of the theory is the competitive advantage the organization should get by technology adoption.

Resource must be valuable and an enabler to the firm conceiving and implementing strategies, this can positively affect the rate of adoption. Second attribute is rareness, the resource should be unique or rare i.e. imperfect imitable and should be sustainable .All the attribute positively affect cloud adoption decision. Table 4 describes the various attributes and their explanations.

Table 4. Attributes of Resource Based Theory

| Concept Definition - Resource Based Theory | |
|--|---|
| Value | Degree of o the Value of IT Resources to the organization for strategic decisions |
| Rareness | Uniqueness of IT resources in comparison to competitors |
| Imperfect Imitability | Inability of competitors to imitate the resources |
| Substitutability | Degree of availability of substitution resources |

6.3 Resource Dependence Theory (RDT)

Resource Dependency theory^{45,46} explains the relation between an organization and its external environment in terms of dependence on resources. Thesis of the theory is that organizations tend to adopt cloud to utilize resources such as virtualization capabilities, higher elasticity, economies of scale, and arguably more expertise in running IT services or software that are not available internally⁴⁵ suggest three factors that determine the degree of dependence of one organization on others which are namely Environmental Concentration, munificence and interconnectedness where concentration is the widely dispersion of power and authority among the environment, munificence refers to the level of availability or scarcity of critical resources. Interconnectedness is about the number and pattern of linkages among organizations⁴⁷. Table 5 describes the various attributes and their definitions.

Table 5. Attributes of Resource Dependence Theory

| Concept Definition - Resource Dependence Theory | |
|---|--|
| Environmental Concentration | Widely dispersion of power and authority among the environment |
| Munificence | Level of availability of Critical Resources |
| Interconnectedness | Number of pattern and linkages among organizations |

6.4 Transaction Cost Theory (TCT)

Transaction Cost Theory is important from the perspective of economic factors affecting cloud adoption. The thesis of the theory is that economic efficiency can be reached through the balance between production costs against transaction costs where transactions is an exchange of services or goods between economical actors, who are technologically independent parts outside or inside an organization⁴⁸. The parameters of theory are specificity, uncertainty and infrequency⁴⁹ where Asset Specificity is the measure to which the item can be reuse with alternative uses without sacrificing productive value⁵⁰, uncertainty is related with the complexity of the product/service to be acquired and infrequency of contracting can also increase transaction costs⁴⁹. The costs of relationship building, formulation of adequate con-

tracts and ensuring consistency of goals between the contracting parties are the main costs generated by infrequency.

Table 6. Attributes of Transaction Cost Theory

| Concept Definition - Transaction Cost Theory | |
|--|---|
| Asset Specificity | Degree of necessity of an asset for production of a product |
| Uncertainty | Aspects like actual costs of production, uncertainties in market, economic scenarios, contractual complexities etc. |
| Infrequency | costs to increase consistency which include contracts adequacy, long term relationship |

Figure 3 below shows the impact of all the theories discussed above on technology adoption.

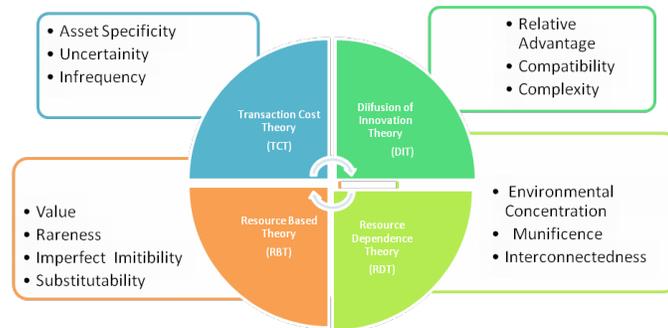


Figure 3. Impact of theories on Technology Adoption.

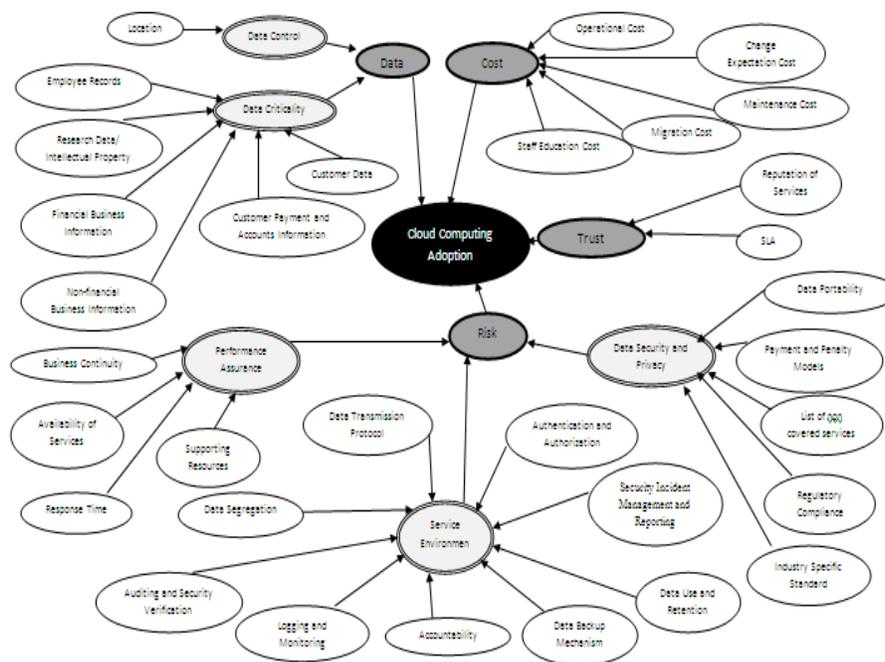


Figure 4. Cloud adoption Theoretical Framework based on TOE Framework.

Table 7. Dimensions of Cloud Adoption and Adoptive Theories

| | | |
|-------------------------|---------------------------|-----|
| Data | Asset Specificity | TCT |
| | Value | RBT |
| | Rareness | RBT |
| | Munificence | RDT |
| Cost | Relative Advantage | DIT |
| | Infrequency | TCT |
| Performance Assurance | Compatibility | DIT |
| Service Environment | Environment Concentration | RDT |
| | Interconnectedness | RDT |
| Data Security & Privacy | Uncertainty | TCT |
| | Complexity | DIT |
| Trust | Infrequency | TCT |
| | Imperfect Imitability | RBT |
| | Substitutability | RBT |

Mapping of different dimensions of cloud adoption with Technology adoption Theories is done in Table 7.

Finally a theoretical Cloud Adoption framework based on TOE Framework is proposed as shown in Figure 4.

7. Conclusion

The study shows that companies are adopting cloud but its adoption has some issues attached with it which should be taken care of and an informed decision should be taken while going for cloud adoption. The study attempts to list and categorize these factors and develop a framework of cloud adoption. Various Technology adoption theories were studied, the factors were analyzed and mapped against these theories and after mapping the factors and establishing them against theories finally the study proposes a framework for cloud adoption which is based on TOE (Technology, Organization, and Environment) framework and which spins around various issues of adoption

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