A Systematic Literature Review of Critical Success Factors for Cloud Adoption

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Abstract: Cloud computing has emerged as a new computing paradigm that has fundamentally shaped the business model in terms of how IT services are being developed and delivered. As it moves from being a buzz word and hype into adoption, organizations are faced with question of how to best adopt cloud. Critical success factors (CSFs) refer to specific activities, procedures or areas that a business or concept depends on for its continued survival. Critical success factors for adopting cloud for their business model are particular to each organization. A literature review is necessary to collect and analyse all findings done and CSFs listed by various researchers in their work on this particular concept. In this paper we try to review CSFs pointed by twenty five authors, that may be useful for other researchers that are also working on cloud and to come on a conclusion about all the CSFs that are possible and critical for cloud adoption.

I.   INTRODUCTION

Although cloud computing is widely defined, in business terms, cloud is essentially a flexible, scalable, pay-per-use model for the way IT business applications delivered in the form of services are developed and consumed, typically through short-term contracts. With its pay-as-you go model, cloud moves many IT business costs from capital expenditure to operating expenditure focusing on core business terms rather than infrastructure; its "elastic model" means available IT capability can be flexed to mirror changing business demand up or down; and it enables consumers of IT to have much greater transparency over their costs. Standard definition by The National Institute of Standards and Technology (NIST), Information Technology Laboratory [1], says:

Cloud computing is a pay-per-use model for enabling available, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.

Five key characteristics of cloud said in its definition can be listed as:
1. On-demand self-service- The ability for an end user to sign up and receive services without any human interaction with the service provider.
2. Ubiquitous network access- Ability to access the service via standard platforms (e.g., mobile phones, laptops, and PDAs etc.).
3. Resource pooling- Resources are pooled across multiple customers through physical and virtual servers for which customer has no knowledge of exact location and control.
4. Rapid elasticity- capabilities can scale up and down to cope up with crest and trough of demand curve.
5. Pay per use- Capabilities are metered and charged as per use.

Cloud providers deliver computing resources as a service. It is not computing as a product that is owned but to computing as service that is delivered to consumers over internet from large data centres (clouds) in measured manner. In actual everything (business process, storage, applications, platform, data etc.) can be delivered as service, but in broad view cloud service models are classified as three:

- Infrastructure-as-a-service - It is more like data centre-as-a-service. Not just one interface it is access to the entire machine, to all applications that are running on it.
- Platform-as-a-service - It refers to hosting complete application development environment (including interface development, database development, testing etc.) to subscribers.
- Software/application-as-a-service - It refers to hosting application software over internet. It is typically for the users of the application.

Deployment model states how the strategy impacts by defining the coverage boundaries. Cloud deployment boundaries can be given in following four types:

1. Private Cloud - These are used exclusively for single organization and typically controlled, managed and hosted in private data centres. It is comparable to buying, building and managing your own infrastructure.
2. Public Cloud - These are the cloud infrastructure is owned by an organization selling cloud services to the general public or to a large customer group.
3. Community Cloud - These types of infrastructure are used by group of related organizations that have same policy and compliance consideration for using common cloud environment
4. Hybrid Cloud - These cloud infrastructures are composition of two or more clouds (internal, community, or public) that remain unique entities but are bound together by standardized technology that enables data and application portability mostly for cloud bursting scenario.

Hence, cloud model therefore is composed of five essential characteristics, mainly three service models, and four deployment models.

In January 2015, RightScale conducted its fourth annual State of the Cloud Survey of the latest cloud computing trends. The survey asked 930 IT professionals about their adoption of cloud infrastructure and related technologies. The respondents ranged from technical executives to managers and practitioners and represented organizations of varying sizes across many industries. The margin of error is 3.2 percent [2].
Key findings from the survey are:

5. **Hybrid Cloud Remains the Preferred Strategy**
82 percent of enterprises have a hybrid cloud strategy, up from 74 percent in 2014.
6. **Public Cloud Leads in Breadth of Enterprise Adoption While Private Cloud Leads in Workloads**
88 percent of enterprises are using public cloud while 63 percent are using private cloud.

Source: RightScale 2015 State of the Cloud Report
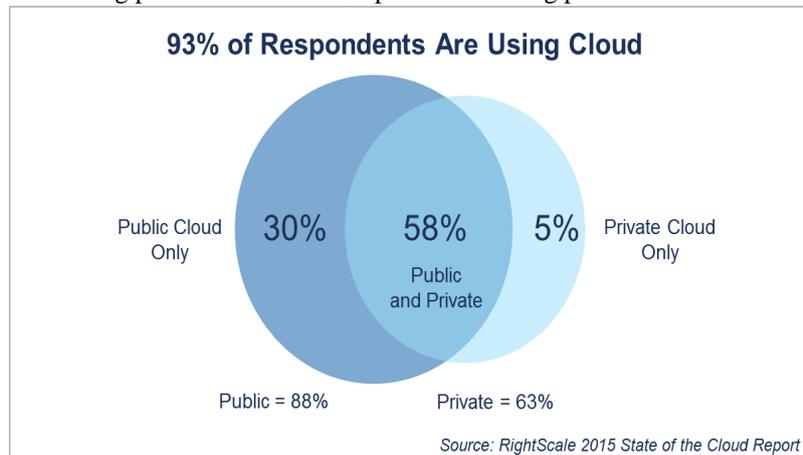
Cloud adoption seems to be a strategic decision as opposed to a tactical response. In a downward economy strategy is key to looking forward, but when in a growing economy like emerging and developing markets, organizations can afford to make short term tactical decisions to respond to immediate issues and needs. This drives up initial cloud usage but only from tactical standpoint. All in all adopting cloud is not only a trend but businesses need to remain in race of IT business world.
Critical success factors (CSFs) refer to specific activities, procedures or areas that a business or concept depends on for its continued survival. Critical success factors for adopting cloud for their business model are particular to each organization. In this paper we review 9 critical successs factors given by 25 researchers and try to come on conclusion about most widely accepted factor for adoption by criticality in general and those that are specific for particular organization or for the achievement of particular goal. Review is as:

II.   LITERATURE REVIEW
Susan K. Lippert et al. [3], 2006 state the need of TOE framework for internet based services. It list technological factors (security concerns; reliability; deploy ability), organizational factors (firm size; firm scope; technological knowledge; perceived benefits); and environmental factors (competitive pressure; regulatory influence; dependent partner readiness; trust in the web service provider).
David S. Linthicum et al. [4] 2009, give idea that cloud computing and service oriented architecture (SOA) is going to become need for business, without these it would not be possible to remain in market. To take advantage of this new sharable resource environment it require stepwise approach from understanding present business critical factors to taking move accordingly to final move that ensure greater chances of success and less failure risk.
Bhaskar Prasad Rimal et at. [5], 2009 give idea that rapidly growing span of internet technologies, computational world is becoming more complex and large than ever it was. With this issue cloud computing come as a model to support processing large volumetric data using clusters of commodity computers. For adopting this model he address the need to work on its architecture, security, fault tolerance and interoperability as critical factors for success.

Buyya et al. [6], 2009 proposed that with advancement in Information and Communication Technology (ICT) cloud computing has emerged as a 5th utility which will rise as essential to meet everyday need. For making cloud with market-oriented resource allocation he focus on the need of architecture supporting virtualization, internetworking and meta negotiation infrastructure to establish global cloud exchange and markets for bringing cloud providers and consumers, market registry for publishing and discovering Cloud service providers and their services; clearing houses and brokers for mapping service requests to providers who can meet QoS expectations; and payment management and accounting infrastructure for trading services, storage cloud for high performance content delivery, need for convergence so as to produce unified and interoperable platforms for delivering IT services as the 5th utility to individuals, organizations, and corporations.. He also points the need to address regulatory and legal issues, which go beyond technical issues. Some of these issues are explored in related paradigms such as Grids and service-oriented computing systems.

Geoffrey Rains et al[7], 2009 state significant change cloud computing bring to industry providing IT services, service oriented architecture(SOA) and cloud computing are complementary for each other and can be pursued independently or concurrently.

Michael Armbrust et at. [8] 2010 proposed cloud computing as utility computing that has tremendous potential to transform a large part of IT industry by making software as service and reshaping the way IT hardware is designed and purchased. With cloud innovative and great IT people need not to worry about arranging infrastructure for deploying their developed business with major threat of overprovisioning when for a service whose actual business does not meet predictions and underprovisioning when business go far from their predicted crowd. To take benefit of such a powerful model Michael address the need for technological advancement for application software that are capable for handling scale up and scale down needs, infrastructure and hardware up gradation to support virtualization as critical success factors for successfully adopting cloud computing.

Leimeister et al.[9], 2010 propose ubiquitous computing as major reason for cloud establishment. He focus on not only considering technical aspects for its success we also need to consider its business aspects, hence understand cloud actor, their roles for business opportunities and business values.

David C. Wyld et at. [10] 2010 states cloud computing as a revolution in way IT used and perceived by industry and people. To adopt this new model for computing he address the need for stepwise migration in order for getting successes.

Sean Marston et al. [11] 2010, state cloud computing as major advancement in computing field, to take benefit of it business perspective is the critical factor, need to identify strength, weakness, opportunities provided by cloud to take advantage for the business.

Market Connection et al. [12] 2010, state security as critical factor in cloud adoption in government sector but awareness play deciding role. Those who are aware growing more in cloud by handling security issues than those who are unaware of all these. Hence awareness is crucial to deal with security threats.

Anthony Bisong et al. [13], 2011 state security concern a significant factor in cloud adoption, proper planning and understanding of emerging threats, risks, vulnerabilities can make success in cloud adoption.

Kuyoro S. O. et al. [14], 2011 Vaishali Singh et al. [27], 2013 state cloud computing as innovative business model to deliver IT services with great elasticity, but to adopt this security issues need to be addresses since storing crucial business data at others location is always troublesome. Both conclude security as prime challenge in success of cloud adoption.

F. A. Alvi, et al. [15], 2011propose cloud as on-demand computing with benefits of scalability, high performance but major issue in cloud adoption is security since customer is not aware of where data get actually stored. Hence there is need to work on privacy and security issues.

Gianmario Motta et at[16], 2011 state quality of service (QoS) as a critical factor for cloud adoption, and give a requirement for verifying QoS, dynamic service level agreement (SLA) negotiation in order to select from all cloud providers to choose one that is acceptable for your business specific needs and hence ensure success.

Garrison et at. [17], 2012 proposed cloud computing as a transformation in the way business is done in IT industry as now cloud provider is not like traditional software company that give product in one time by single purchase but it is responsible for a range of business activities including hardware and software installation, upgrades, maintenance, backup, data storage and security. It results in overall reduction of capital expenditure and operating cost by on demand service characteristic of cloud of cloud that give access to costly software's, technology and platform which otherwise are difficult to afford. For success of such a model Garrison emphasis on trust between client organization and cloud provider as a strong predictor of how long and good this model will go for business. He points on IT- related capabilities by client organization along with management and market factors as critical factor for cloud adoption success.

Enterprise Management Associate, ASG [18], 2012 state enterprise architecture as a critical factor for cloud adoption because enterprise architects are skilled in complex, cross functional analysis and thinking from whole system point when taking decisions.

Vanessa Alvarez et al. [19] 2012 states that organizations have their virtualization maturity to efficiently and consistently adopt cloud computing. Hence enterprises need to understand the maturity and follow right adoption strategy according to that.

Sitalakshmi Venkatraman et al. [20] 2012, state cloud computing with its on demand provisioning of a shared pool of configurable computing resources giving elastic scalability

and network service accessibility as revolution in IT business world but it lacks for user-centric architecture SOA, emphasize on need of SOA to better adopt cloud.

Vinay et al. [21] 2012, focus on architecture based approach as a best way to adopt IT advancement such as cloud computing.

Venkata Ramana Adari et al. [22] 2012, focus on service oriented architecture (SOA) as an essential architecture style to successes in adopting cloud. It states Without SOA it would not be possible to take cloud as business model.

Susan Sutherland et al. [23], 2013 focuses on convergence of interoperability of Cloud Computing (CC), Service Oriented Architecture (SOA) and Enterprise Architecture (EA). He proposed a logical model for linking cloud computing and service oriented architecture.

Vaishali Singh et al. [24], 2013 also state cloud computing innovative business model to deliver IT services with great elasticity and scalability, but to adopt this security issues need to be addresses as prime challenge in success of cloud adoption.

Aiim et al. [25], 2014, state security as major concern for adopting cloud in government sector despite of its benefit of cost reduction and less administration. Also need of security standards, SLA and regulation for adoption in public sector, lead in will to place less secure data in cloud and hence come on conclusion of adopting hybrid approach as a possible solution.

Azam Abdollahzadehgan et at. [26], 2013 state cloud computing as most discussed concept in IT world. He emphasize on its most advantage for small and mid size enterprises which does not have strong capital power to fulfil their business requirements and face problem in competition. To take benefits of cloud he focuses on need to working on Technology-Organization- Environment (TOE) framework to adopt cloud. It divides in three organizational factors such as top management support, firm size and technology readiness based on TOE framework as critical factors

Gerard Conway et at. [27], 2014 state cloud computing as a transformation in the way IT services are delivered that results in benefit of agility, efficiency and flexibility at growing business time. To take these advantages he focuses on IT-CMF framework that enable enterprise to handle risks and get maximum benefit by working in planned and controlled way.

III.   RESULTS

In this paper we have reviewed 25 authors suggesting 9 factors as Business Perspective; Technology Business oriented Architecture, Security, Trust, Awareness, Maturity, Quality of Service QoS and Service Level Agreement SLA, Technology-Organization-Environment TOE framework, Service Oriented Architecture SOA.

For these factors 7 authors consider security as most critical, 6 authors emphasize on service oriented architecture SOA for cloud adoption success, 4 authors point the need to work on technology business oriented architecture for success, 3 authors consider Maturity in cloud adoption as critical factor to ensure win, 2 authors vote for trust, 2 authors focus on the need for business perspective, 2 other for QoS and SLA, 2 for TOE framework, 1 points need for awareness. In summary

Table1. CSF with author contributing for them.

Critical Success Factor	Author
Security	Aiim, Anthony Bisong, F. A. Alvi, Kuyoro, Amit, M. Conn., Buyya
SOA	Geoffrey Rains, Susan Sutherland, David S. Linthicum, SitaLakshmi Venkatraman, Vinay, Venkata Raman Adari
Tech. Advance.	Buyya, Bhaskar, Ambrust, ASG
Maturity	Vanessa, Gerard, David
Business Pers.	Sean Marston, Leimeister
Trust	Garrison, M. Conn.
QoS, SLA	Gianmario, Buyya
TOE	Susan, Azam
Awarness	M. Conn.

In graph, when we plot critical success factor versus number of author contribute for that factor we get

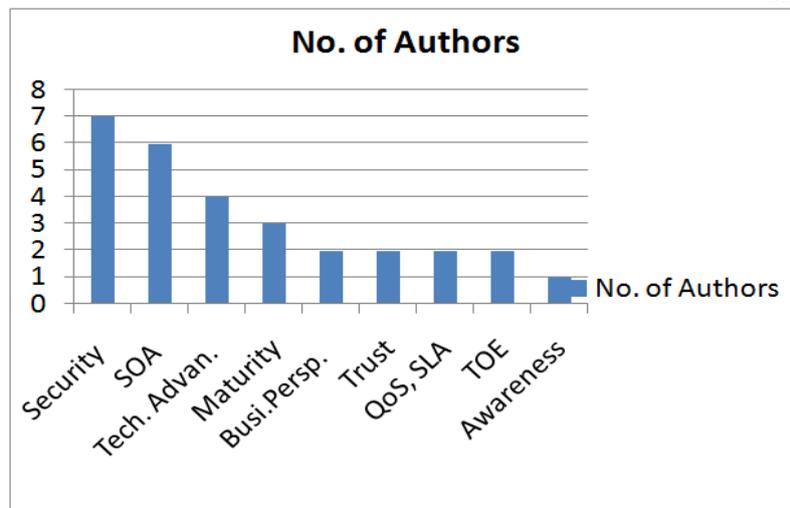| Critical Success Factors	No. of Authors
Security	7
SOA	6
Tech. Advancement	4
Maturity	3
Business Perspective	2
Trust	2
QoS, SLA	2
TOE	2
Awareness	1

Fig2. Graph for success factors verses number of authors consider them.

It is depicted from graph that security and service oriented architecture factors are at top most priority while technology business architecture factor is above mid, awareness is at least and other lie in mid range of criticality from authors point of view for cloud adoption in latest trend.

Security refers to protecting data from malicious use since data may have privacy concerns, typical law enforcement that if compromised may harm dignity hence demand for standards in quality of security measures. Service oriented architecture refers to adopting cloud in service oriented delivery model of the functionality rather than delivering as a complete product, moving from data to services to processes [4]. Maturity refers to accessing the level of maturity at which a domain is in cloud adoption stepwise process, and then taking decision in keeping that in mind. Open Data Centre Alliance ODCA define five progressive level of maturity namely none, initial, Repeatable, Defined, Measured, Optimized [28].

IV. CONCLUSION

We conclude with analysis that although each critical factor is very crucial but by specific domain wise in which we want to use cloud criticality may vary. For instance for government sector, finance security is for most above all while for established enterprises service oriented architecture is most important, for 3-4 year domains accessing their maturity level and trust is at prime. But again all factors are still play role at different stages of cloud adoption for on domain. Hence all factors have their unique impact value that we need to understand and adapt according to our need for cloud adoption. In this paper we perform a systematic analysis of critical success factors given by authors in cloud adoption in recent trend. This study will be useful for further researchers as a clear image and in simplified way to investigate more that will be significant in cloud adoption.

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