

An Analysis of the Existing Frameworks in Cloud Computing Adoption and Introduction to RAF

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ABSTRACT

The coming up of cloud computing in recent years has evolved an interest from different organisations, institutions and users to take advantage of web applications. This is a result of the new economic model for the Information Technology (IT) department that cloud computing promises. The model promises a shift from an organisation required to invest heavily for limited IT resources that are internally managed, to a model where the organisation can buy or rent resources that are managed by a cloud provider, and pay per use. Cloud computing also promises scalability of resources and on-demand availability of resources. Although, the adoption of cloud computing promises various benefits to an organisation, a successful adoption of cloud computing in an organisation requires an understanding of different dynamics and expertise in diverse domains. Currently, there are inadequate guidelines for adopting cloud computing and building trust. This paper aims to evaluate a shortlist of eleven frameworks for Cloud Computing and concludes that none of them addresses all Cloud adoption challenges fully so that a new framework is required. Later we explain our proposal for the framework discusses and topics related to the proposed framework.

I. INTRODUCTION

With its promise of a new economic model for the Computing/Communication and Information Technology (CIT) department of business organisation, cloud computing brings about a shift in the way organisation invest in their IT resources. The new economic model removes the need for the organisation to invest a substantial sum of money for purchase of limited IT resources that are internally managed, but rather the organisation can outsource its IT resource requirements to a cloud computing service provider and pay per use. This new computing paradigm called cloud computing has also brought challenges to the organisation seeking to adopt it. The challenges that are raised are: trust, security, legal, compliance and organisational challenge. Computing Clouds are commonly classified into Public Clouds, Private Clouds and Hybrid Clouds. Cloud adoption is dependent on the type of Clouds and the intended use for the deployment. For small organisations that aim to save cost and test their software products before release, using public clouds is a good option. For organisations that have sensitive data and have data ownership and privacy concern, hosting private clouds is more suitable. It was demonstrated that the use of private clouds can be designed and adopted in finance and healthcare sectors. Hybrid clouds may be used for large scale simulations and experiments, since they allow

Scientists at different sites to work and collaborate with one another. Cloud computing is an emerging challenge due to factors such as cost, deployment and organisational change. They also explain that understanding the benefits and drawbacks is not straight forward because the suitability of the cloud for different systems is unknown; cost calculations are complicated; the adoption results in a considerable amount of organisational change that will affect the way employees work and corporate governance issues are not well understood. However, there are benefits of adopting Cloud such as consolidation of resources, green IT, cost-saving and new business opportunities which make adoption attractive. Accordingly a framework should be developed that would serve as a guide as to how the cloud adoption should take place.

II. MOTIVATION FOR ORGANISATIONS TO ADOPT CLOUD

The type of Cloud an organisation adopts will depend on the organisation's needs and the volumes, types of services and data the organisation plans to have and use. Cost-saving offered by Cloud Computing is a key benefit acknowledged by academia. It is one of the reasons for its popularity and organisational adoption in the economic downturn. Achieving long-term organisational sustainability is an important success factor for organisations particularly in an economic

downturn. Chang, Mills and Newhouse, (2007) present case studies of organisations which achieve more than ten years of organisational sustainability and conclude that their success factors include cost saving methodology. Creeger (2009) and Dunn (2010) demonstrate their cost-saving methodology and conclude that it helps their organisations to do well in an economic downturn. This explains why cost saving is a common organisational goal of technology adoption from the academic point of view. This allows CA Technologies to consolidate their infrastructure and remove maintenance costs such as staffing and resource expenses (Dunn, 2010). In addition, Oracle who faced a similar challenge after acquiring Sun Microsystems, consolidated their infrastructure and resources using Cloud Computing. After spending a six month transition period, Oracle is able to share and use a similar level of IT resources and data centres to before acquisition, instead of doubling its size. This is largely due to virtualisation. Many of their servers and services are in clusters of virtual machine (VM) farms, facilitating effective management from architects and management.

Organisational adoption for Cloud computing is an emerging challenge due to factors such as cost, deployment and organisational change. They also explain that understanding the benefits and drawbacks is not straight forward because the suitability of the cloud for different systems is unknown; cost calculations are complicated; the adoption results in a considerable amount of organisational change that will affect the way employees work and corporate governance issues are not well understood. However, there are benefits of adopting Cloud such as consolidation of resources, green IT, cost-saving and new business opportunities which make adoption attractive.

III. RISKS INVOLVED IN CLOUD ADOPTION

Before considering or deploying organisational adoption, different types of benefits and risks should be identified so that mitigation approaches can be proposed. This is useful for project management to maximise the extent of benefits and to minimise the risks. Some of the risks faced are-

- Loss of governance and control over resources which might lead to unclear roles and responsibilities.
- Reduced staff productivity during the migration as changes to staff work and job uncertainty lead to low staff morale and anxiety spreading in the organisation.
- Managing a system deployed on several clouds can make extra management effort compared to deploying systems in-house.

- Interoperability issues between clouds as there are incompatibilities between cloud providers' platforms.
- Increased costs due to complex integrations. Inability to reduce costs due to unrealisable reductions in system/support staff.

IV. MOTIVATION OF USING A FRAMEWORK AND IDENTIFIED PROBLEMS WITH EXISTING FRAMEWORKS

We investigate a number of frameworks and study the suitability of using any of them for organisational adoption. Each of the Cloud Computing frameworks presented has some drawbacks such as insufficient detail of how organisations should adopt Cloud Computing; and if they adopt, what are the issues and priorities they should be aware of for delivery of Cloud deployment and services. Limitations of existing good frameworks are presented in, with the proposal for the development of a new framework to address those issues to be known as RAF.

Table I: Limitations Of Existing Frameworks

Existing frameworks	Limitations of existing frameworks
Cloud Business Model Framework (CBMF; Weinhardt et al., 2009 a; 2009b)	CBMF assumes that each layer is independent, and only connects directly to Business Model layer. CBMF does not provide any details about how their framework can help organisations to adopt Cloud Computing, services.
Linthicum Cloud Computing Framework (LCCF; Linthicum, 2009)	There are not enough use cases/case studies, as Linthicum appears to generalise his architectural framework based on his own experience. There are not enough details about whether organisations should continue adopting more Cloud resources and services, or simply run one service without opening new services or expanding existing services.
Return on Investment (ROI) for Cloud Computing (ROICC; Skilton, 2010)	ROICC does not show any details about how to calculate ROI (or return) and how to perform cost-benefit analysis. By stating KPIs without showing how to calculate ROI, it does not help stakeholders to understand whether they should adopt Cloud Computing or expand existing services.

Performance metrics framework (PMF; (Assuncao, Costanzo and Buyya, 2010)	They only focus on one aspect of risk and return analysis, particularly SLA. There are other types of risk and return analysis they should look at. PMF does not measure other services such as PaaS and SaaS, and does not deal with challenges in Cloud adoption such as risk mitigation to Cloud.
IBM Framework for Cloud adoption (IFCA; IBM, 2010)	IFCA tries to provide a generic solution for all types of industries and all types of Clouds. However, there are no use cases or case studies at all since it has been available for more than 2 years.
Oracle Consulting Cloud Computing Services Framework (OCCCSF; Oracle, 2011)	It is difficult to see how OCCCSF can be fully adopted and applied by non- Oracle customers. A robust and valid framework should allow customers to choose any technologies and vendors which can work under different types and conditions for Cloud implementation.
CloudSim (Calheiros et al., 2009)	Key variables and values must be defined before the use of CloudSim. Not all organisations that adopt Cloud should always need these variables. There are insufficient examples that CloudSim can be fully delivered for private clouds and hybrid clouds, as the challenges for Cloud adoption should be resolved. Their proposal of Inter Cloud may resolve some of these issues
BlueSky Cloud Framework for e-Learning (BCF; Dong et al., 2009)	BCF is a conceptual framework, as there are insufficient evidences to justify it has real implementations and case studies. There are no descriptions about the validation methods. There are no follow-up journal articles to explain the current status of their framework project.
Hybrid ITIL V3 Cloud (Heininger, 2012)	ITIL V3 does not provide specific solutions for any types of Cloud adoption problems and expects organisations to resolve problems themselves. There are no any guidelines and recommendations for

	specific types of emerging Cloud adoption such as Mobile Clouds
Cloud Computing Business Framework (CCBF; Chang et al., (2011 b; 2011 c; 2012; 2013 a)	The framework focuses more on the literature, process and methodology that leads to the development of the conceptual framework and how it can be useful for organisations and businesses with selected case studies. More case studies and recommendations should be focused on Cloud adoption challenges and issues to resolve

V. PROPOSED FRAMEWORK BASED ON THE ROADMAP

The roadmap which we have proposed has five (5) phases in the adoption of cloud computing project. These are: analysis, planning, adoption, migration and management. It works as follows-

Phase 1: Analysis

As with all software projects, the initial stage is understanding users' requirements in order to determine whether the project is feasible. It is at this stage that the initial requirements, feasibility, project scope, costs and initial plan will be developed. the business case is developed. Thought should be given to how the existing systems strengths and opportunities can be maximised, weaknesses and threats minimised ,the impact to organisation culture, processes, and structure minimised, and the effect to SLAs, how return on investment and costs to adopting cloud computing can be managed and the usability and access to resources will be assured and maintained

Phase 2: Planning

In this phase benchmarks for security, legal and compliance issues identified in the analysis phase are set. The benchmarks will reflect the internal organisational best practices, policies and standards to industry standards and best practices and how these can be achieved when moving to the cloud. The benchmarks also will reflect the legal and compliance best practices that need to be maintained and achieved in the cloud environment

Phase 3: Adoption

This phase is a preparation phase for the actual migration of systems and/or applications selected to the cloud platform and infrastructure of choice. In this phase systems/ application integration is done to ensure that the candidate

applications will be able to function with the internal applications that are not migrated to the cloud and also with the cloud infrastructure of choice. Outsourcing strategies are decided upon and the benchmarks developed in the planning phase are used to measure vendor ability to provide service that will not affect the organisation service delivery and business.

Phase 4: Migration

At this point the preparation for migrating to the cloud concludes and migration can proceed. Either the project can be discarded or enhanced to meet the user requirements. Given the outcomes from the three previous phases, the roll-out plan can be put into practice. Applications and data migration can proceed. Support to users during the migration process is provided, and the monitoring and control of the project is maintained to ensure successful migration

Phase 5: Management

The project now should be fully operational in the cloud; however contract and vendor management, testing and maintenance, user support and review should be ongoing for several months subsequent to launch. The system metrics or benchmarks developed and set in phase 2 can be used as indicators of project success and should be monitored. Security standards compliance, SLAs, legal and compliance issues, IT governance best practices and cost management are desirable metrics.

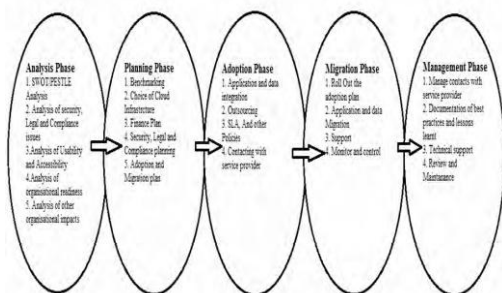


Fig:1 Cloud Computing Adoption Strategies

VI. RAF (ROCCA ACHIEVEMENT FRAMEWORK)

The primary objective of the framework is as a tool for analysing projects carried out based on the roadmap. The use of the framework should be helpful in determining how closely the roadmap was followed in adopting cloud computing. As the roadmap is based on research into challenges and best practices in adopting cloud computing a project with high scores in the framework is more likely to succeed. The framework is divided into five sections, corresponding to the five phases of

the cloud computing adoption roadmap. Each section is composed of a series of questions, with their corresponding weights. The weights to be applied are to be decided by the project management team in advance based on the perceived impact of the phase on the overall project success. Different projects will have to weigh each of these weights differently. The joint usage of the ROCCA and RAF in a cloud computing adoption project should result into an integrated project plan and evaluation framework, minimising risks and increasing the probability of projects' success. The various sections of RAF framework are outlined in figures as follows-

Phase 1: Analysis			
Question	Weight	Response	Score
1. Have the initial project requirements been identified and defined?		<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5	
2. Has the analysis of internal systems and application been done? Were proper analysis tools used?		<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5	
3. Have security, legal and compliance issues for migrating to cloud analysed?		<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5	
4. Have the risks and benefits of outsourcing to cloud been analysed?		<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5	
5. Is the impact of moving to cloud to different stakeholders been analysed?		<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5	
6. Has the financial implications been analysed?		<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5	
7. Are the candidate applications/systems been identified?		<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5	
Weighted Total			

Figure 2: Raf-Analysis Phase

Phase 2: Planning			
Question	Weight	Response	Score
1. Are systems and application metrics known?		<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5	
2. Have benchmarks for candidate applications/systems set?		<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5	
3. Have the cloud platform and infrastructure been selected based on the metrics?		<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5	
4. Is the cost management and finance plan developed? Does it address the mode of payment?		<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5	
5. Is the plan for security, legal and compliance management feasible?		<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5	

Figure 3: Raf-Planning Phase

Phase 3: Adoption			
Question	Weight	Response	Score
1. Are prototypes or trial service to be used to ensure application integration?		<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5	
2. Are outsourcing strategies compliant with procurement procedures?		<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5	
3. Have SLA, security policies and IT governance procedures agreed upon with vendor?		<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5	
4. Is the contract written in a manner that guarantees the client value for money?		<input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5	
Weighted Total			

Figure 4: RAF-Adoption Phase

Phase 4: Migration			
Question	Weight	Response	Score
1. Is the roll-out plan comprehensive and detailed enough?		<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 1 2 3 4 5	
2. Are users affected by the migration aware of the changes?		<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 1 2 3 4 5	
3. Are application/data for migration critical to the organisation?		<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 1 2 3 4 5	
4. Are user support and control and monitoring mechanism in place?		<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 1 2 3 4 5	
Weighted Total			FI

FIGURE 5: RAF-Migration Phase

Phase 5: Management			
Question	Weight	Response	Score
1. Are contract and vendor management done appropriately?		<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 1 2 3 4 5	
2. Has the project been signed off?		<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 1 2 3 4 5	
3. Have the lessons learnt and best practices been documented?		<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 1 2 3 4 5	
4. Have technical support been established or outsourced?		<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 1 2 3 4 5	
5. Is testing and maintenance plan in place for the first few months after launching?		<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 1 2 3 4 5	
6. Are application metrics and data being collected, analysed and used to enhance project success?		<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 1 2 3 4 5	
Weighted Total			FIGURE 6

FIGURE 6: RAF-Management Phase

Project Phase Totals			
	Phase	Weight	Score
1	Analysis		
2	Planning		
3	Adoption		
4	Migration		
5	Management		
Overall Total			FIGURE 7

FIGURE 7: RAF-Project Phase Tools

VII. CONCLUSION

This paper presents a review related to Cloud Computing focusing on the benefits of adoption and background to Cloud Computing. This is highly relevant to industry and academia as there are growing numbers of organisations adopting or actively using Cloud. Understanding Cloud usage and adoption is highly relevant, as it helps stakeholders to understand their risk and return analysis and the extent of added values (such as efficiency, cost-saving, profitability and user satisfactions) offered by Cloud adoption. Adoption challenges including risk and return analysis and risk mitigation to Cloud arise for organisations that adopt Cloud, particularly private clouds. The use of a framework can help to manage Cloud design, deployment and services much better. Existing frameworks all have their limitations and cannot meet requirements for Cloud adoption challenges

fully. A new framework is required to deal with adoption challenges and offer solutions and recommendations in the shortcoming of other frameworks. This framework is RAF(ROCCA Achievement Framework which will fully integrate with existing and new projects together.

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