1. INTRODUCTION

Cloud Computing has transformed the way many organisations work and offers added value for operation management and service computing. Researchers have demonstrated the positive impacts Cloud can offer for business engineering and service level management (Ambrust et al., 2009; Brandic et al., 2009; Buyya et al, 2009). Ambrust et al. (2009) identified cost reduction in IT services from using Cloud Computing. They also presented their Cloud Computing economics and ten major challenges for Cloud Computing. They emphasise a shift of risk from maintaining data centres and the capital costs of running them to the loss of data while managing Clouds in a demand-based model. Buyya et al. (2009) assert that Cloud Computing offers billing-based Service Level Agreements (SLA) which can be used for operational management offering cost savings and streamlining business activities and processes. In addition, Cloud Computing offers a variety of other benefits including agility, resource consolidation, business opportunities and green IT (Foster et al; 2008; Weinhardt et al. 2009 a; 2009 b; Schubert, Jeffery and Neidecker-Lutz, 2010; Kagermann et al., 2011; Khajeh-Hosseini et al., 2010 a; 2010 b; Chang et al., 2010 a; 2010 b; 2011 b; 2011 c; 2013 a; 2014).

There is an increasing number of organisations offering Cloud Computing products and services in industry. Salesforce.com is a pioneer in Cloud Computing and offers their Customer Relation Management (CRM) applications to a large number of their users. Amazon is the market leader in Public Cloud Computing and offers Elastic Compute Cloud (EC2) for computing capacity and Simple Storage Service (S3) for storage capacity. Microsoft provides Windows Azure services for developers to store their code and develop new applications for their clients or companies. IBM and Oracle (following their acquisition of Sun Microsystems) both offer products and services ranging from hardware to application services. In addition, there are many more Small and Medium Enterprises (SMEs), who can offer different types of business models and perspective (Marston, et al., 2010), developing and selling Cloud Computing services and products.

Computing Clouds are commonly classified into Public Clouds, Private Clouds and Hybrid Clouds (Ahronovitz et al., 2010; Boss et al., 2007; Marston et al., 2011). 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 (Khajeh-Hosseini et al., 2010 a; 2010 b). For organisations that have sensitive data and have data ownership and privacy concern, hosting private clouds is more suitable. Chang et al (2011 a; 2013 a; 2013 b) demonstrate the use of private clouds 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 (Ahronovitz et al., 2010; Khajeh-Hosseini et al., 2010 a; 2010 b).

The majority of Cloud literature defines a Cloud Computing Framework as a Service Oriented Architecture (SOA) (Foster et al; 2008; IBM, 2008; Dillion et al. 2010; Chang et al., 2010 a; 2010 b; 2013 a; Schubert, Jeffery and Neidecker-Lutz, 2010) offering one of three types of service: Infrastructure as a Service (IaaS); Platform as a Service (PaaS) and Software as a Service (SaaS).

Lin et al. (2009) provide an overview of industrial solutions for Cloud Computing, and summarise the list of challenges for the enterprise. They state that adoption benefits of cost and flexibility are enterprise-ready, but security, performance and interoperability need significant improvement. There are two issues to be resolved for each of security, performance and interoperability.

The remainder of this article is structured as follows. Section 2 presents motivation for organisations adopt Cloud Computing and Section 3 describes technical review for Cloud Computing. Section 4 explains Cloud business models and Section 5 lists risk factors and categorises them into Cloud adoption challenges from stakeholders' points of views, which leads to Section 6 that a framework for Cloud Computing is necessary. Section 7 evaluates 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. Sections 7 and 8 explain our proposal for the framework. Section 8 discusses two topics related to the proposed framework and Section 9 sums up Conclusion and Future Work.

2. WHAT DRIVES ORGANISATIONS ADOPTING CLOUD COMPUTING?

There are several explanations for the rise of Cloud Computing. Firstly, many technologies in Grid Computing and Web 2.0 are mature enough and able to simplify the complex process while maintaining high performance capability and web-interfaced environments. The fusion between Grid and Web 2.0 allows ease of use for business processes and technical resolutions (Hunter, Little and Schroeter, 2008). Secondly, the economic downturn makes many organisations want to consolidate their data centre deployment. Reduction in servers, server maintenance and staffing costs by virtualisation make this attractive (Gillen, Grieser and Perry, 2008). Electricity and operational costs can be saved as shown by the CA Technologies case (Dunn, 2010) which highlighted savings of US $6.5 million for labour costs; and US $2.4 millions of operational costs in 5 years through the closure of 19 server sites.

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 (Buyya et al., 2009; 2010 b; Celik; Holliday and Hurst; 2009; Khajeh-Hosseini et al., 2010 a; Schubert, Jeffery and Neidecker-Lutz 2010) and industrialists (Creeger, 2009; Dunn 2010; Oracle, 2009 a; 2009 b; 2010). 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, Buyya et al. (2009) introduced Service Level Agreement (SLA) led cost-saving models and explained how to calculate savings in detail. Buyya et al. (2010 a) also demonstrate applications and services developed for Cloud Computing, and these services are helpful for start-up firms generate additional revenues. Further to their work, Buyya et al. (2010 b) introduced a Return on Investment (ROI) power model which can calculate power cost-saving and present it using 3D visualisation. Celik, Holliday and Hurst (2009) introduce their Broadcast Clouds technique which allows communications and cost-savings. They use simulations to support their proposal. Khajeh-Hosseini et al. (2010 a; 2010b) use qualitative research methods to explain how industry can save costs. They present case studies of two companies and demonstrate cost-saving in infrastructure costs, and support and maintenance costs. Schubert, Jeffery and Neidecker-Lutz (2010) present an overview and opportunities including cost-saving as an added value offered by Cloud Computing.

In industry, CA Technologies (a global IT firm) use Cloud Computing for cost-saving including: US $6.5 million for labour costs; and US $2.4 millions of operational costs in 5 years; and closure of 19 server sites. 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 (Oracle 2009 a, 2009 b, 2010).

2.1 SURVEYS FOR CLOUD COMPUTING ADOPTION

There are different factors for organisations to adopt or consider adoption. Khajeh-Hosseini et al (2011 a) assert that 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 (Buyya et al., 2009; 2010 b; Celik; Holliday and Hurst; 2009; Khajeh-Hosseini et al. 2010 a; Schubert, Jeffery and Neidecker-Lutz 2010; Creeger, 2009; Dunn 2010; Oracle, 2009 a; 2009 b, 2010).

Khajeh-Hosseini et al. (2010 a) also conduct a large number of interviews with stakeholders who decide in favour of organisational Cloud adoption. They perform stakeholder analysis and summarise benefits and risks arriving at top ranking factors as follows.

Benefits:

- Improve satisfaction of work
- Opportunity to develop new skills
- Opportunity for organisational growth
- Opportunity to offer new products/services
- Improved status
- Opportunity to manage income and outgoings

Risks:

- Lack of supporting resources
- Lack of understanding of the Cloud
- Departmental downsizing
- Uncertainty with new technology
- Deterioration of customer care and service quality
- Increased dependence on third parties
- Decrease of satisfying work

Khajeh-Hosseini et al. explain their rationale for each top-ranked factor. Interestingly, the top ranked-factors for benefits are different from the researchers' views which include factors such as availability, agility, scalability and elasticity (Armbrust et al. 2009; Buyya et al, 2009). Those top ranked factors for benefits indicate the outcome of adopting Cloud from the perspective of organisations. Employees can learn new skills. They will enjoy their work more if they find those skills are useful and interesting. This is particularly true for technical developers. If their work can be completed while maintaining the quality of their service, they can have better satisfaction of work. In addition, Cloud computing can offer the organisations new products and services, which then offer opportunity for organisational growth with potentially more customers, cost-saving and revenues involved. On the other hand, the top-ranked risks factors suggest that organisations are concerned about lack of supporting resources and understanding of the Cloud. Stakeholders are uncertain whether Cloud adoption can provide the long-term benefits they look for. The risk-level increases when there is a temporary upsizing in the IT department or a surge in demands for services. Those factors need to be clarified and explained intelligently by a framework and model that can provide guidance to the organisation as to whether they should adopt Cloud computing or use another alternative.

According to Dillion et al (2011), IDC conducted a survey in 2008 (sample size = 244) to investigate what type of IT systems or applications migrated to Cloud. Their results indicate as follows: IT Management applications (26.2%), Collaborative applications (25.4%); Personal Applications (25%); Business Applications (23.4%); Application Development and Deployment (16.8%); Server Capacity (15.6%) and Storage Capacity (15.5%). Those results show that some organisations which have migrated to the Cloud have several different types of applications and also suggest organisations deploy more SaaS than IaaS to Cloud because core activities are kept in house with additional software outsourced to Cloud.

IT outsourcing is an alternative to Cloud migration and adoption and there are researchers investigating the implications of IT outsourcing. Dibbern et al. (2004) studied the impacts of outsourcing and found that although it was beneficial to the organisation at the beginning, outsourcing projects performed unsatisfactorily after going through several rounds of contracts. This led some organisations to take previously outsourced IT systems and services back in house as a result of unsatisfactory service levels, change in strategic direction or cost-saving failure (Overby, 2003). Some organisations use Cloud as an alternative to outsourcing their resources. However, Khajeh-Hosseini et al (2011 a) explain there is a key difference between Cloud Computing and IT outsourcing: Self-service, scalability and pay-as-you-go model give clients more flexibility and control than traditional IT outsourcing.

3. TECHNICAL REVIEW FOR CLOUD COMPUTING

Chen et al. (2010) define Cloud Computing as a tower architecture where the virtualisation layer sits directly on top of hardware resources and sustains high-level cloud services. It goes onto the IaaS, PaaS and SaaS layers. The IaaS layer provides an infrastructural abstraction for self-provisioning, controlling and management of virtualised resources. In PaaS, consumers may leverage the development platform to design, develop, build, and deploy cloud applications. The SaaS layer is the top of the cloud architectural tower and delivers specific applications as a service to end users. There is a self-managing cloud system for dynamic capacity planning which is underpinned by monitoring and accounting services. Capacity planning hides complex infrastructural management tasks from users by automatically scaling in and out virtualised resource instances in order to enforce established SLA commitments. Security applies at each of the service delivery layers to ensure authenticated and authorised cloud services and features include identity management, access control, single sign-on and auditing. Chen et al. (2010) also identify CC for research challenges and classify this as Research Clouds. They have presented six user cases as below:

- Cloud Sourcing: Researchers using cloud capabilities (compute, storage, platform) provided by public Cloud Service Providers (CSPs) to develop, test or run research applications.
- Cloud Bursting: HEIs own research computing services while bursting and offloading to public cloud services due to fluctuating demands. Cloud bursting is commonly used to improve demand management.
- Private clouds: HEIs own research cloud computing services shared inside an institution only.
- Hybrid clouds: Cases involving both private cloud and public cloud.
- Community clouds: Multiple private clouds with shared requirements and interfaces. This includes federations of multiple private clouds.
- Cloud tool/services provisioning: Provisioning of self-management facilities, programming abstraction tools, debugging tools, and other platform services to public and/or private clouds.

Use cases are useful to support technical Cloud projects and support the validity of Cloud technical review.

Rozsnyai et al. (2007) propose an Event Cloud, where they use XML and AJAX technologies to implement a Cloud Search platform and they explain how their Cloud Architecture works. Their Event Cloud also provides ranking of search outcomes. Hammond et al. (2010) provide an overview of Cloud Computing for research and classify Political, Social, Economic, Societal, Technological and Legal issues to be resolved while adopting Cloud Computing. They have presented research use cases in storage, Monte Carlo simulations, bioinformatics and SLA.

There are additional technical reviews for Cloud Computing, which are essential for organisations to adopt Cloud. These technical reviews present current literature and state-of-art solutions for Cloud implementations, which allow stakeholders and management need to know limitations and challenges as a result of Cloud adoption.

3.1 Security for Cloud Computing

Security is always a popular topic and there are the following areas of specialisations for Clouds: identity management, access control, single sign-on and auditing (Chen et al., 2010; Martino and Bertino, 2009). In Chen et al. (2010) context, auditing means intrusion and detection mechanisms as well as policy-related security. The Hwang et al. (2009) proposal for cloud security relates to intrusion and detection despite having identity management enforced. Yee and Korba (2008) identify that personalising a security policy to a particular customer is needed. Therefore, Yee and Korba (2008) propose a flexible security personalisation approach that aims to allow an Internet or Web service provider and customer to negotiate an agreed-upon personalised security policy. They also present two application examples of security policy personalisation. The proposal from Paci et al. (2008) is for access control where they explain and demonstrate their Access-Control Framework for WS-BPEL, so that WS-BPEL not only has high performance but also maintains a high level of security for Web Services and interoperability. Kangasharju et al. (2008) investigate mobile WS security and focus on XML security with binary XML.

Security is a concern for some organisations to adopt Cloud, since privacy and data ownership are amongst key factors for organisations that decide not to move to Cloud Computing. Chang et al (2011 a) introduce “Fined Grained Security Framework” (FGSF) for Cloud security. In the most recent work, Chang and Ramachandran (2014) demonstrate the prototype as follows. There are three layers of security mechanisms in place to protect the data and access. The first layer of defence is Access Control and firewalls, which only allow restricted members to access. The second layer consists of Intrusion Detection System (IDS) and Prevent System (IPS), which detect attack, intrusion and penetration, and also provide up-to-date technologies to prevent attack such as Denial of Service (DoS), anti-spoofing, port scanning, known vulnerabilities, pattern-based attacks, parameter tampering, cross site scripting, SQL injection and cookie poisoning. The third layer is the isolation management: It enforces top down policy based security management; integrity management – which monitors and provides early warning as soon as the behaviour of the fine-grained entity starts to behave abnormally. It offers both weak and strong isolations. Weak isolation focuses more on monitoring and captures end-to-end provenance. Strong isolation can fully isolate malicious hosts and cut all attacking connections to ensure that existing services are not affected by the attacks or unauthorised intrusion.

3.2 Portability for Cloud Computing

Ambrust et al. (2009) state Cloud portability is one of the challenges in Cloud deployment. Ahmed (2010) identifies data risk mitigation to Cloud as an adoption challenge where the portability is important in ensuring data risk mitigation to Cloud over different Clouds. Ahronovitz et al. (2010) identify applications portability as a challenge and classify it as a Cloud bursting, a desirable characteristic for Cloud Computing. Friedman and West (2010) focus on privacy and security of Cloud Computing as a focus in Cloud risk mitigation to Cloud which they explain as adoption challenges. They make these recommendations:

- Transparency: This allows users to understand the security precautions taken by a particular provider and have enough information to make an informed choice between two alternatives about their risk exposure.
- Competition: Cloud infrastructure is a competitive marketplace in which the service provider must improve the extent of security functionality and services. Providers must be large enough to leverage economies of security investment, information sharing and usable interfaces.
- Legal Clarifications: The first issue is the privacy rights of all users should be protected. The second issue is that the law must reflect how Cloud-based data and systems will become a new target for online criminals.

3.3 Business Integration

In their pioneering paper on business integration (BI) for Cloud Computing, Service Oriented Architecture (SOA) is a common approach. Chrisdutas (2008) presents SOA Java business integration (JBI), and he explains the operation of JBI including each individual component and the interactions between different JBI containers. This work is based on SOA architecture which either focuses on JBI or semantic approaches. The first ‘pure’ Cloud approach is designed by Papazoglou and van den Heuvel (2011), who present two models related to BI. The first is a cloud delivery model in which they explain interactions between virtualised applications, clients and a stack comprising IaaS, PaaS and SaaS suitable for Business Process as a Service (BPaaS). Their second model, the blueprint model, is proposed to allow BPaaS or SaaS applications to run dynamically on virtualised clouds to enable service virtualisation. There are three components to the model: (i) blueprint definition language (BDL); (ii) blueprint constraint language (BCL) and (iii) blueprint manipulation language (BML). They also explain an architectural scenario showing how blueprint support for the cloud service life cycle can work. However, their approach is at the system design level without details of implementation, testing or use cases. Moran et al (2011) present Rule Interchange Format (RIF), RIF Mapping, RIF-expressed rules and a use case. They explain how semantic based integration can be achieved on IaaS level. However, their notion of BI is not the same as ours for the following reasons. Firstly, their integration is based on data exchange between different VMs to update the RIF status in the Cloud. Secondly, it is not clear whether their use case only works for IaaS, although they seem to imply this approach may work on PaaS and SaaS level in future work.

Understanding how to integrate different Cloud services is important, since this is also a Cloud adoption challenge, where Buyya et al (2010 a) propose a Federated Clouds to provide work-around and solutions for service integrations. Integrations between different services can offer benefits including improvement in efficiency and collaboration while bringing down the costs of deployment and maintenance. Chang et al. (2012 b) present the concepts of Business Integration as a Service (BIaaS), which includes the architecture, implementation and discussions. There are two case studies involved. Firstly, the University of Southampton has adopted BIaaS to allow different departments to work on business analytics projects, which can compute both of cost-saving and risk modelling calculations in one go without using two different services. Secondly, the Vodafone case study allows the computations of profitability and risk modelling to be performed simultaneously. This allows the investors and stakeholders to understand the pricing and risks associated with their investment at any time.

4. CLOUD COMPUTING FOR BUSINESS USE

Our previous work (Chang et al., 2010 a; 2010 b; 2011 b; 2011 c) explain the importance of Cloud Computing business models and their relevance to orgasnisations that adopt Cloud. There are eight Cloud business models are classified by Chang et al. (2010 a; 2010 b; 2013 a), who explain the background, literature and rationale of Cloud business models categorisation and benefits of using multiple business models. This information is highly relevant to stakeholders who need to decide the best strategies for operating their Cloud business model and computing. These eight business models with supporting case studies and examples are as follows:

- Service Provider and Service Orientation
- Support and Services Contracts
- In-House Private Clouds
- All-In-One Enterprise
- One-Stop Resources and Services
- Government Funding
- Venture Capital
- Entertainment and Social Networking

To classify the business models and processes, Chang et al. (2010 a; 2010 b) classify all Cloud business models into eight types and they use Cloud Cube Model (CCM) to represent the good practices in Cloud businesses supported by case studies. They also explain strengths and weaknesses in each business model which collaborators and investors have found useful. Table 1 shows advantages and disadvantages of eight Cloud business models (Chang et al., 2010 a).

Having the winning strategies also greatly influences decision-makers from traditionally non-cloud organisations. Wolfram is a computational firm providing software and services for education and publishing, and apart from using CCM, it has considered adopting the second business model. Upon seeing revenues in iPhone and iPad, they added a new model, the eighth model, by porting their applications onto iPhone and iPad. Similarly MATLAB, adopted the first and second model, and began the eighth model by porting their application to iPhone and iPad in order to acquire more income and customers. There were start-ups such as Parascale using the seventh model to secure their funding, and they adopted the first model by being an IaaS provider. They moved into the second model to generate more revenues. The National Grid Service (NGS) has used the sixth model to secure funding, and their strategy is to adopt the fifth model by becoming the central point to provide IaaS cloud services for the UK academic community. Facebook has used multiple business models; the first, seventh and eighth model to assist their rapid user growth and business expansion.

Table 1: Advantages and disadvantages of each of eight business models (Chang et al., 2010 a; 2010 b)

No.	Business Models	Advantages	Disadvantages
1	Service Providers and Service Orientation	This is a main stream business model, and demands and requests are guaranteed. There are still unexploited areas for offering services and making profits.	Competitions can be very stiff in all of infrastructure, platform and software as a service. Data privacy is a concern for some clients.
2	Support and Service Contracts	Suitable for small and medium enterprises who can make extra profits and expand their levels of services.	Some firms may experience a period without contracts, and they must change their strategies quickly enough.
3	In-House Private Clouds	Best suited for organisations developing their own private clouds which will not have data security and (permanent) data loss concerns.	Projects can be complicated and time consuming.
4	All-In-One Enterprise	Can be the ultimate business model for big players Consolidating different business activities and strategies, including an ecosystem approach or comprehensive SaaS.	Small and medium enterprises are not suitable for this, unless they join part of an ecosystem.
5	One-Stop Resources and Services	A suitable model for business partnership and academic community. Can get mutual benefits through collaboration.	All participating organisations or individuals should contribute. If not managed well, it may end up in other business models or a community breaking apart.
6	Government Funding	Government can invest a massive amount, and this is beneficial for projects requiring extensive R&D, resources and highly trained staff.	Only affluent governments can afford that, and also top-class firms and universities tend to be selected.
7	Venture Capital	Can receive a surplus that is essential for sustainability. Useful for start-ups, or organisations nearly running out of cash.	It can be a prolonged process without a guarantee to get anything.
8	Entertainment and Social Networking	If successful, this model tends to dash into a storm of popularity and money in a short time.	Teenage social problems and a few extreme cases seen in the media.

Guy's and St Thomas' NHS Trust (GSTT) and Kings College London (KCL) spent their funding on infrastructure and resources to deliver a PaaS project. Knowing that outsourcing would cost more than they could afford financially together with the possibility in project time delays, they decided to use the third business model, "In-House Private Clouds", which matched to cost-saving, a characteristic of Cloud. They divided this project into several stages and tried to meet each target on time. In contrast, other NHS projects with more resources and funding, have opted for vendors providing the second and forth business models, "Support and Service Contract" and "All-in-One Enterprise Cloud".

5. Stakeholders' points of view: Risks for organisational adoption and how risks are related to Cloud adoption challenges

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. There are two steps involved. The first step is to tabulate the types of risks and determine their impact, with the ones with high impact factors being classified as adoption challenges. The second step is to analyse the benefits of adoption and explain how these benefits can address those challenges. Khajeh-Hosseini et al (2011 a) performed a similar survey on Cloud users and clients. Based on their analysis, they tabulate different types of risks while adopting or outsourcing to Cloud presented in Table 2. Related details will be presented in Section 8.2.

Table 2: Different types of risks for organisational adoption of Cloud (Catteddu and Hogben, 2009; Khajeh-Hosseini et al, 2010 a, 2010b; 2011a)

ID	Risks	Mitigation approaches and potential indicators	References
R1	Organisational: Loss of governance and control over resources which might lead to unclear roles and responsibilities.	Clarify roles and responsibilities before cloud adoption.	Catteddu, and Hogben (2009); Dibbern et al. (2004); Khajeh-Hosseini et al (2010 a, 2010 b); Jurison (1995).
R2	Organisational: 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.	Involve experts in the migration project so that they have a sense of ownership.	Khajeh-Hosseini et al (2010 a); Grudin (1994).
R3	Organisational: Managing a system deployed on several clouds can make extra management effort compared to deploying systems in-house.	Make management aware of the extra effort that might be required.	Aubert, et al. (2005); Dibbern et al. (2004); Buyya et al (2010 b)
R4	Organisational: Changes to cloud providers' services or acquisitions by another company that changes/terminates services.	Use multiple providers.	Catteddu, and Hogben (2009)
R5	Technical: Performance is worse than expected. It might be difficult to prove to the cloud provider that their system performance is not as good as they promised in their SLA as the workload	Use benchmark tools to investigate the performance of the cloud under investigation before decision making. Use monitoring tools to independently verify the	Aubert, et al. (2005); Armbrust et al. (2009); Durkee (2010); Jurison, J. (1995).

	of servers and network can be variable in a cloud.	system performance.	
R6	Technical: Interoperability issues between clouds as there are incompatibilities between cloud providers' platforms.	Use cloud middleware to ease interoperability issues.	Catteddu, and Hogben (2009)
R7	Financial: Actual costs may be different from estimates, this can be caused by inaccurate resource estimates, changing prices or inferior performance resulting in more results to be required than expected.	Monitor existing resource usage and use estimation tools to obtain accurate cost estimates of deploying IT systems on the cloud. Check results of performance benchmark.	Aubert, et al. (2005); Khajeh-Hosseini et al., (2011 b); Dillion et al. (2010)
R8	Financial: Increased costs due to complex integrations. Inability to reduce costs due to unrealisable reductions in system/support staff.	Investigate system integration issues upfront, avoid migrating highly interconnected systems initially.	Dillion et al. (2010); Herbert and Erickson (2011); Kotsovinos (2010).

5.1 HOW THOSE RISKS RELATE TO CLOUD ADOPTION CHALLENGES

All these risks present a number of adoption challenges, although some can be overlapped or related to one another. For example, both financial risks (R7 and R8) can be classified as cost estimate risks for which a prediction model can be used to calculate business performance including the return on investment (ROI) as accurately as possible.

Rosenthal (2009) report that Cloud Computing offers a new business paradigm for biomedical sharing and the impacts of such adoption have a significant effect on the way biomedical research can go forward. The added value is regarded as 'risk and return analysis', in which Youseff et al (2008), Weinhardt et al (2009 a) and Hugos and Hulitzky (2010) acknowledge the importance of measuring return and risk with their rationale presented. However, their approaches do not include key metrics for a systematic calculation. They do not demonstrate a process and methodology which can be reproduced by the commercial and research communities. This presents the first challenge as "**model and analyse risk and return on adoption of a large computer system systematically and coherently**".

Organisational risks (R1, R2 and R3) and technical risk (R5) present problems related to people, system and policy as a result of service migration to Cloud. Those risks are directly involved with migration, since a change in service model has implications in terms of lack of control, staff morale, system management, service availability and benchmarking. All these terms can be summarised as "**risk mitigation for migrating to a new system including Cloud**", as those problems arise due to service migration to Cloud. Services should be delivered efficiently after migration. To ensure organizations have a smooth transition to system adoption including Cloud adoption, it will be useful to provide detailed descriptions about how to mitigate risks of migrating to Cloud.

Organisational risk (R4) and technical risk (R6) present an interesting case that different services and clouds should work together. This can ensure different clouds can communicate.

However, current deployment is a challenge as integrations are not straightforward. An easy-to-use and innovative approach for cloud and service integration needs to be considered.

There are additional risks such as legal and security risks but neither is dealt with here since additional resources would be required. In addition, the current focus for organisations that are adopting Cloud such as University of Southampton, NHS, IBM and Commonwealth Bank of Australia (CBA) is to address technical, financial and organisational issues and related adoption challenges.

The high-level question is how organisations should adopt or consider adopting Cloud Computing. If they decide to adopt Cloud, "how stakeholders can understand the benefits and risks for Cloud adoption easily" is the question stakeholders ask (Information Week Survey, 2010). This needs to include risk analysis as a critical factor (Misra and Mondal, 2011) as it brings significant impacts to the adopting organisations including organisational and technical risks (R1, R2, R3, R4, R5 and R6) as a consequence of adoption. Meeting the stakeholders' expectations and the evidence of worthiness of adoption is an important agenda for stakeholders (Khajeh-Hosseini et al, 2010 a, 2010b; 2011a). This means return and risk calculation needs to take technical and organisational factors into consideration and is not limited to financial factors. Presenting results of return and risk allows stakeholders to understand the status of benefits and risks, which also fulfil the strategic goal for organisational adoption.

5.2 Additional Cloud adoption challenges

There are researchers investigating adoption challenges such as Service Level Agreements (SLA) in Clouds (Brandic et al., 2009; Buyya et al., 2009) and Business Models and Classification (Chou, 2009; Weinhardt et al., 2009 a). SLA focuses on billing models and has direct implications on prices, but they focus on the prices paid for the duration of using Cloud. Business models and classifications tend to focus on the way organisations can obtain the profitability not limited to SLA. There are initiatives explaining how SLA can demonstrate cloud business models (Brandic et al., 2009; Buyya et al., 2009). A limitation about SLA is they only focus on operational levels and are not directly connected to strategic levels. Other aspects for successful Cloud delivery have to be investigated at a wider scale, particularly the alignment between the strategic and operational focus of Cloud adoption. There are good examples for how dominant Cloud vendors focus on strategic levels for Cloud adoption to get a greater share of benefits. These organisations include Microsoft, Google, Oracle, IBM and Facebook, all of which obtain more revenue through other forms of services.

To help organisations designing, deploying and supporting clouds, especially private clouds, considering both strategic and operational approaches for Cloud adoption is recommended. Armbrust et al. (2009) describe Cloud Computing technical adoption challenges and considered vendors' lock-in, data privacy, security and interoperability as the most important challenges. Khajeh-Hosseini et al (2010 a; 2011 a) identify human-social issues in Cloud adoption to be resolved and explain their importance using case studies. This means adoption challenges need to take technical, financial and organisational issues into strategic consideration before adoption and implementation take place. Based on the discussion above, the most influential adoption challenges are summed up in Table 3 with their justification provided.

Table 3: Summary of Cloud adoption challenges

Adoption challenges	How do they relate to Table 2	Justification	Types of focus
Model and analyse risk and return on adoption of a large computer system systematically and coherently	R7 and R8 Additional literature: Youseff et al (2008) Rosenthal (2009) Weinhardt et al (2009 a) Hugos and Hulitzky (2010)	Useful for stakeholders to understand whether they should adopt Cloud and calculate their business performance after adoption to prove its worthiness.	Strategic
Risk mitigation to system adoption including Cloud	R1, R2, R3 and R5	Detailed descriptions about how to compute and reduce risk of system adoption including Cloud will be demonstrated to help organisations have a good management and control of Cloud projects.	Operational

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

Although there are existing work from researchers (Armbrist et al., 2009; Buyya et al., 2009; Weinhardt et al., 2009), recommendation has to be easy to used by organisations adopting Cloud Computing. The feedback from industrialists (Financial Times Book, 2009; Chee, Wong and Jin, interviews, 2009; Chou, 2009; Information Week Survey, 2010) is that the CBMs proposed by Buyya et al. (2008, 2009) and Armbrust et al. (2009) are too complicated to understand and as a result, these models cannot be used and applied easily and effectively in real-time cloud computing businesses and organisational Cloud adoption. In addition, there are few Cloud Business Frameworks that can accommodate different types of technical solution in relation to their businesses (Klems, Nimis and Tsai, 2008). Although IaaS, PaaS and SaaS are generally classified as three business models, there is no definite guideline for running successful and sustainable cloud businesses. Proposing a suitable framework is useful for Cloud Computing adoption.

Our previous work (Chang, 2013 c) define the importance of a proposed framework to addresss Cloud Computing adoption by rganisations. We also 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 Table 4, with the proposal for the development of a new framework to address those issues.

Table 4: What a proposed framework can offer for limitations of existing frameworks

Existing frameworks	Limitations of existing frameworks	What a proposed framework should offer
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, and does not have any recommendations about how to run and maintain Cloud services.	A proposed framework will allow different service layers connecting to each other. For example, work developed for PaaS can be further improved to SaaS. The proposed framework has included case studies for how organisations adopt Cloud and sums up key lessons learned.
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.	A proposed framework should include several case studies, which are used to show how organisations can calculate their Risk and return analysis and discussions about benefits of Cloud adoption supported by results. Examples can allow the finance industry to adopt Cloud and to perform multiple workloads such as calculating risks and pricing, achieving good accuracy without sacrificing performance, and also to perform large-scale simulations in a short period of time.
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.	A proposed framework can calculate risk and return analysis to Cloud for technical, cost and user focused projects for Cloud adoption for organisations that adopt Cloud. Results should be supported by case studies.
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.	A proposed framework can calculate risk and return analysis for three types of Cloud adoption, which include technical, cost and user aspects of risk and return analysis. It can calculate for IaaS, PaaS and SaaS.
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.	A proposed framework has detailed case studies to explain the benefits of Cloud adoption. Stakeholders can understand the extent of return and risks for their Cloud adoption easily. A proposed framework can be fully adopted by non-IT sectors such as

		Healthcare and Finance to demonstrate that it is a generic solution working across sectors.
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.	A proposed framework allows customers to choose their hardware and software technologies. The proposed framework focuses on the delivery of their Cloud adoption and allows flexibility for adoption. The key focus can model risk and return analysis and demonstrate risk mitigation for Cloud adoption.
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 InterCloud may resolve some of these issues.	A proposed framework can allow any Cloud services working on public, private and hybrid Clouds, which are supported by publications and framework adopting-organisations.
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.	A proposed framework will have real implementations and case studies to support its validity. There will be papers published each year to ensure the improvement of the framework is helpful to organisations that adopt Cloud.
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.	A proposed framework should have details of how to help Cloud-adopting organisations to resolve adoption challenges and have hand-on experiences for implementations. Organisations can reproduce recommendation and steps proposed by the framework, which keeps up-to-date with the latest technological offers such as Mobile Clouds.
DAvinCi (Arumugam et al., 2010)	The project does not have any publication updates since 2010. A working framework should have updates to present its most up-to-date results and improvements over existing adoption challenges. In addition, a framework should also work for other domains and not just for robots.	A proposed framework has regular updates to report its progress and most up-to-date results, case studies and successful Cloud deliveries. It can work in a number of domains and organisations, and has a continuous life cycle after Cloud adoption.
Cloud Computing	The framework focuses more on the	A proposed framework needs to

Business Framework (CCBF; Chang et al., (2011 b; 2011 c; 2012; 2013 a)	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.	offer more industrial feedback, case studies and demonstrations of proof-of-concept than CCBF. The proposed framework should offer more technical implementations for Cloud Computing, and recommendations to make good practices into repeatable steps for Cloud-adopting organisations. The proposed framework has more up-to-date summary of lessons learned from case studies and the process of Cloud development.

The eleven different Cloud Computing frameworks presented here have their own drawbacks such as insufficient details of how organisations should adopt Cloud Computing; and if they adopt, what are the issues and priorities they should be aware of. Since adoption is an important organisational decision and process, a relevant and valid framework should address those issues and adoption challenges.

8. DISCUSSIONS

Section 5 identified and discussed Cloud adoption challenges, and explained how work for these two adoption challenges can provide recommendations and workarounds for Cloud adoption. Two key areas for these research questions are identified which correspond to "calculate risk and return analysis of a large computing system adoption including Cloud adoption" and "risk mitigation to Cloud". Section 6 explains why it is better to have a framework approach to deal with Cloud adoption and also describes selected frameworks and highlights the limitations of each. It becomes apparent that there is a need for a new framework to address limitations of the existing frameworks.

8.1 DESIRED CHARACTERISTICS FOR A PROPOSED FRAMEWORK

The new framework needs to overcome limitations from other frameworks presented in Table 4. It can be validated by quantitative methods including simulations, modelling and experiments, and also supported by qualitative methods that contain feedback from surveys and selective interviews. According to Chang (2013 c), a good framework should have the following characteristics:

- Align technical activities with business models and strategies
- Be easily adopted by the industry or any organisations
- Integrate fully with activities of organisations that adopt Cloud
- Compile all key lessons learned and recommendations which can be influential to academia and industry

Table 5 presents how a proposed framework can meet each of these criteria.

Table 5: How a proposed framework can meet the criteria to be a Cloud adoption framework

Criteria for a Cloud adoption framework	How to meet the criteria
Align technical activities with business models and strategies	Business model is at the top of a proposed conceptual framework to apply strategies and case studies approach. The Business process is on the strategic layer of the proposed framework. The objective is to align IT and business requirements and to fully translate the stakeholders' demands to design, deployment, data collection and analysis for Cloud adoption.
Be easily adopted by the industry or any organisations	There are several organisations that have used the proposed framework.
Integrate fully with activities of organisations that adopt Cloud	A proposed framework can demonstrate different levels of Cloud framework adoption. The level-four and level-three adoption are the highest, which are organisations that design the Cloud service from the beginning to the implementation and to the service delivery and support.
Compile all key lessons learned and recommendations which can be influential to academia and industry	All key lessons can contribute to recommendations which can be influential in academia and industry. There are organisations which have used CCAF to report contributions to their Cloud adoption. There are good-quality journals to be published.

8.2 FUTURE CHALLENGES FOR RISK AND RETURN ANALYSIS

Risk and return analysis is a major challenge identified in Section 5 from the stakeholders' points of view. There are three types of risk and return analysis required: technical, costs and users (Chang et al; 2011 b; 2011 c; Chang 2013 c). These are future challenges for a proposed framework to resolve.

8.2.1 Costs (financial) measurement for risk and return analysis

There is a need to measure risk and return analysis in terms of its business benefits to aid the strategic decision of Cloud adoption. This will address the key financial risk that needs to be addressed when adopting cloud: R7 the risk of the actual costs being different from the estimates, this can be caused by inaccurate resource estimates, changing prices or inferior performance resulting in more resources spent than expected. This is mitigated by monitoring existing resource usage and using estimation tools to obtain accurate cost estimates of deploying IT systems on the cloud. (Aubert, et al., 2005; Khajeh-Hosseini et al., 2011b; Dillion et al., 2010). The type of risk and return analysis is focused on cost-saving and profitability. Inaccurate resource estimates can be reduced using precise cost calculations and consolidated resources to reduce operational costs. Precise and accurate calculations of profitability enable stakeholders to understand benefits due to Cloud adoption.

8.2.2 Technical measurement for risk and return analysis

Technical performance (R5) considers whether Cloud adoption can provide better performance such as completing requests more quickly or whether more work can be done in the same period of time. This relates to efficiency, and this type of risk and return analysis is focused on improvements in efficiency. The same number of jobs/requests can be completed quicker, or more jobs/requests can be done in the same time frame for Cloud systems comparing to non-Cloud systems.

8.2.3 Users (or organisations) measurement for risk and return analysis

Organisational issues identified (R2 and R3) are concerned with adoption challenges which include whether the internal feedback is positive and the extent of user satisfaction rating. This is a measurement to reflect users and clients' rating about Cloud adoption, which is an important aspect to confirm the added values of using a new Cloud platform or application. This type of risk and return analysis is focused on User satisfaction ratings. An increased percentage of users (or clients) feel there is an improvement to the quality of products and services such as having a quicker response time, a higher proportion of jobs completed at the same time and a more efficient system/application to get their work completed, which results in a higher positive rating for Cloud adoption. In general, this is summed up as user satisfaction rating.

The proposed framework should be able to meet all these three requirements and allow stakeholders to understand the extent of return and risk of their Cloud adoption, regardless of whether they adopt a technical, costs or users focus.

8.3 THE DESIRABLE FEATURES IN THE IMPROVED FRAMEWORK

Since there is a need for redevelopment of the framework, the improved version, Cloud Computing Adoptiopn Framework (CCAF), should have the desirable features for future development presented as follows.

- Integration: Integrations with different services are crucial to the organisations in their enterprise activities. The advantages of doing so allow them to improve efficiency and need not spend multiple resources to do multiple tasks. Instead, one single service can deliver requests for two services. Chang et al (2011 d) firstly made a pioneering proof-of-concepts, Business Integration as a Service (BIaaS), to demonstrate how different services can work together as a single service. They expand their work by demonstrating architecture, computational analysis and methodology (Chang et al., 2012 b). Further to this, Chang (2013 a) demonstrate his BIaaS work for small and medium enterprises that adopt SAP. Those results can help organisations to analyse return and risk in one go, instead of inputting different data for each service and get two separate results which are not connected together. Integrations between services can reduce time, effort and funding to manage Cloud services.

- Big Data: The return and risk analysis is essential to Big Data research, which needs algorithms to process datasets, calculate complex modelling and present them in a way that can be understood easily by researchers and stakeholders. Some of the work has been demonstrated by Chang et al (2012 c; 2013 b) to manage and analyse medical data including images, datasets and experimental results. A platform is required to help scientists analyse Big Data, process results quickly and accurately and present the results which can be interpreted easily. The use of BIaaS can help achieve these goals.

- Specialised disciplines for Cloud adoption: Some disciplines require highly sophisticated tools and services for Cloud adoption. Medical informatics is one of such area that needs integrations of different expertise and technologies. Chang (2013 b; 2013 d; 2014 e) demonstrate that Cloud Computing can be used in brain segmentation technology to understand the brain cell activities while relearning a skill such as dance. Advanced techniques can be applied to analyse thousands of datasets and process them at once between four and ten seconds.

CCAF will aim to develop new case studies for Cloud Computing adoption and demonstrations in healthcare, finance, education and natural science.

8.4 THE DEVELOPMENT OF LEEDS BECKETT CLOUD

This section describes the development of Leeds Beckkett Cloud, which follows the recommendations from our previous work (Chang et al., 2011 a; 2011 b; 2011 c; 2012 a; 2012 b; 2013 a; 2013 b; Chang, 2013 a; 2013 b; 2013 c; 2013 d; 2014 a; 2014 b; 2014 c; 2014 d; 2014 f; 2014 g; Chang and Ramachandran, 2014; Ramachandran and Chang, 2014 a; 2014 b) and the essence of this paper. All the Cloud projects are presented as follows:

- Cloud security: As explained in Section 3.1, innovative approaches in the use of Fined Grained Security Framework has been developed with three layers of security. The techncial design, implementation and experiments have been demonstrated (Chang and Ramachandran, 2014; Ramachandran and Chang, 2014 a).

- Cloud Computing Quality of Experience (QoE): The majority of Cloud services follow the SLA models and do not entirely take users' experience into consideration in Cloud adoption (Ambrust et al., 2009; Buyya et al., 2009). The latest theories and empirical studies have been presented (Safdari and Chang, 2014).

- Analysing customer satisfaction in Mobile Cloud services: Chang (2013 a, 2014 a) develop the Organisational Sustainability Modelling (OSM) to analyze the status of risk and return of Cloud projects or organisations that Cloud Computing. OSM has been used for mobile phone industry (Chang et al., 2011 b). The most recent work include analysing the German customer satisfaction of using iPhone 4S Mobile Cloud service in 2011.

- Risk Visualisation as a Service (RVaaS) and Financial Software as a Service (FSaaS): Chang (2014 b) demonstrate the latest development of his proposed RVaaS with the improved version of Black Scholes Model. Experiments and simulations have been used to support his work. Ramachandran and Chang (2014 b; 2014 d; 2014 f) illustrate their latest FSaaS prototype and demonstrate their research contributions to the community.

Additionally, there are other Cloud Computing and Big Data project lead by Chang (2014 a; 2014 b) and new projects such as weather science, social network analysis and business intelligence systems. The next stage is to integrate all these projects altogether under the development and careful implementation of CCAF. All the demonstrations will ensure that CCAf is a dynamic and useful framework for organisations to adopt Cloud Computing. Eventually, all the proof-of-concepts, services, case studies and demonstrations will get to the highest level in Cloud Computing adoption, Consulting as a Service, in which Chang (2014 c) also illustrate his previous experience while working in China for a short period of time.

9. 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 Cloud Computing Adoption Framework (CCAF), which will fully integrate with existing and new projects togehte rwith Leeds Beckett Cloud.

Technical, financial and user requirements and complexity in handling Cloud adoption challenges need a structured and well-organised framework to deal with emerging issues and provide solutions for others. A proposed framework needs to be dynamic and structured to help different types of Cloud services, whether risk and return analysis and risk mitigation to Cloud. Future directions are discussed, and innovative ways for integrations, Big Data and specialised disciplines for Cloud adoption will be the focus of the next-generation of Cloud adoption.

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KEY TERMS AND DEFINITIONS

- Cloud Computing: It consists of three major services: Infrastructure as a Service, Platform as a Service and Software as a Service and four main types of Clouds: Public Cloud, Private Cloud, Hybrid Cloud and Community Cloud. Cloud Computing is a technology-based (normally internet based) service that allows organisations to offer service delivery that supports the organisational IT strategy, design, transition, operation and continuous service improvement. Organisations need to buy servers and hardware equipment since the resources are outsourced to the Cloud, normally Public Cloud. Private Cloud are the internal clouds implemented and used by the employees of the same organisation. Virtualisation is the main technology behind Cloud Computing that allows rapid scaling up and down of resources and creation of virtual hardware in the Cloud to improve on the work efficiency. Cloud Computing can work with Green IT to reduce electricity consumption due to consolidation of data centres and business models to provide additional revenues and opportunities for the service providers.
- Cloud Computing Adoption for Organisations: This is an area to investigate why organisations adopt Cloud Computing and use it dauily for their work. As closely related to the benefits of Cloud Computing adoption, some businesses use it to reduce the operational costs like CA technologies. Some organisations use it to allow the businesses to be more competitive since they can create virtual hardware much quicker, they can offer more types of services to customers, and they can integrate different types of services together. This area can also provide an in-depth study, since adoption depends on various factors apart from technical reasons. Organisational and financial reasons can motivate organisations for adoption. However, there are technical, financial and organisational risks which pose challenges for Cloud Computing adoption.
- Business models for Cloud Computing adoption: The establishment of new business models pose a main factor for organisational Cloud computing adoption. Table 1 of this chapter has explained there are eight identified types of business models based on literature review and our previous research. Successful businesses should adopt multiple types ofm business modesl to ensure their businesses are competitive in the market.
- Risks for Cloud Computing adoption: They are classified as technical, financial and organisational risks. It is important for organisations to know their impacts and the recommendations overcoming these risks. However, the first step before Cloud adoption is to understand eight major types of common risks as presented by Table 8. Rationale and supporting literature have been provided.
- Cloud Computing adoption challenges from the stakeholders' perspective: Amongst the eight identified risks, some can be categorised together. Based on our analysis, literature review and our previous studies, we identify two major risks for Cloud Computing adoption in the eye of the stakeholders since they influence the way that organisations go

forward and they are the main decision-makers. Many papers focus much more in the eye of service providers or technical specialists who only focus on the "service level agreement" and "security" respectively. In the eye of the stakeholders, they highly regard anything that can prevent their success or return on investment. Thus, each adoption challenge consists of the combination of technical, financial and organisational challenges.

- Two major challenges: Continued from the previous point, organisations should know the most two important challenges in order to set the required targets and milestones for successful deliveries of Cloud Computing services and projects. This can also directly affect the successful rate of cloud Computing adoption and let the organisations to know how well they perform as a result of cloud computing adoption. Hence, we identify two issues to resolve. First, it is about "a model and analyse risk and return on adoption of a large computer system systematically and coherently". Second, it is about "risk mitigation to system adoption including Cloud". Table 3 has explained the rationale and supporting literature.
- Frameworks for Cloud Computing adoption: Frameworks are commonly used in IT to recommend the best practices and encourage the organisations to follow the successful deliveries illustrated in the past. Often frameworks are designed and implemented by experienced researchers and practitioners who have extensive level of experience of successful deliveries based on their own experiences. However, most of the frameworks are not particularly designed for Cloud Computing and there are limitations that can prevent organisations from successful Cloud adoption. Some frameworks have been designed for Cloud Computing but they are generic and do not provide detailed solutions for adoption challenges. As a result, adopters may experience problems during or after the migration to Cloud computing. Revuiews have been explained in Section 6 and Table 4. Table 5 then explains how a proposed framework can meet the criteria to be a Cloud adoption framework, which will be presented in our future work.