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Cloud Computing: The Emergence of Application Service Providers (ASPs) in Developing Economies

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***Abstract*— The Cloud Computing paradigm has triggered a major shake-up in the way ICT infrastructure is delivered, priced and consumed. The underlying factors for this phenomenon are highly abstracted or virtualized infrastructure, a variable OPEX-based model (determined by usage requirements), support for multi-tenant user model and immediate computing resource scalability.**

This paper provides an insight into the Cloud computing eco-system in a developing economy, with Ghana as case example. It reveals that there is positive experience with this computing model from the consumer standpoint. It also reveals that virtualization, which has been identified to be the stepping stone to full Cloud services, is in demand. Hybrid deployment models also represent an opportunity area due to the paucity of deployed instances.

Keywords **– Application Service Provider, Cloud Computing, ICT. Emerging economy, SaaS, IaaS, PaaS, Ghana**

I. Introduction

Cloud Computing has taken the Information and Communications Technology (ICT) industry by storm in the past few years. Two events in 2006 can be regarded as key to bringing the phenomenon into the mainstream [1]. First was Google CEO Eric Schmidt's announcement of a new business model "Cloud Computing", which enables access to remotely hosted data and computation resources from anywhere. The second event was the launch of Amazon's Elastic Cloud Computing (EC2) service as part its web services portfolio; Amazon Web Services (AWS).

The Cloud Computing phenomenon is responsible for a major shakeup across several layers of IT service delivery namely application and presentation layers and even the facility and IT infrastructure layers [2]. The underlying factors for this disruptive capability come from four key characteristics; namely, highly abstracted or virtualized infrastructure, a variable expense model (determined by usage requirements), support for multi-tenant user model and immediate computing resource scalability [3].

This paper assesses the penetration of the Cloud Computing paradigm in the Ghanaian ICT industry with a focus on Application Service Providers (ASPs) or Cloud Service Providers (CSPs). It explores the motivations, enablers and inhibitors to the ASPs and the paradigm shift.

The assessment is based on a combination of an online survey and semi-structured interviews with a sample of Cloud service providers and consumers in the sector.

In this paper, we have focused the discussion on organizations in developing economies. Basically, firms in developing economies are said to have low and uncertain revenues [4]. According to [5] information systems installations in developing economies bring in socio-economic developments. This fact is emphasized in literature, as the emergence of Internet facilities, including cloud computing, in developing economies inure to positive socio-economic developments for both consumers and service providers [4][5] [6]. Firms in developing economies are also characterized by massive and rapid developments.

Firms in developing economies do not have programs or strategic plans to harness the opportunities accruing from emerging technologies [5], even though they are opened to seizing the opportunities for techno-economic developments.

The rest of the paper is structured as follows. The following section discusses the state-of-the-art on cloud computing; dilating on the technology, delivery and deployment models. In the third section, we deal with cloud computing from a business perspective, including its eco-system and the strategic management implications of the cloud. The fourth section provides adequate background to the Ghanaian ICT market. The following section presents the findings of the study and then, follow with some conclusions.

II. Cloud Computing – The Technology Basics

A. Origins and Building Blocks of Cloud Computing

The evolution to today's view of Cloud Computing can be broken down into a number of key phases [7].

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In the 1950's: hardware time-sharing on massive and expensive mainframe computers was the status quo [8] [7].

In the 1980's, personal computing took off and enabled business users to run their businesses based on individual data and applications on their PCs [7]. This decentralization of computing power formed the basis of the concepts of 'utility' and 'grid' computing [40].

The 1990's witnessed a rapid spread of high speed Internet access which in turn ushered in an effective delivery mechanism for utility and grid computing [8]. By the late 1990's, a new IT sourcing model had emerged initially called "application service provision" [9]. This sourcing approach allowed business owners to lease business applications over the Internet. The client-server model based software architecture also emerged in this era [10].

Finally, the first decade of the new millennium saw the emergence of many start-ups as well as established players offering a wide range of services via the Internet. This has been made possible by the rapid growth of broadband technology [8].

The building blocks of Cloud Computing are virtualization, multi-tenancy and web services [11]. Along similar thought lines, [12] assert that Cloud Computing is a "convergence of various technology fields" namely Hardware, Internet, Systems Management and Distributed Computing. A representation of this convergence is illustrated in Figure 1.

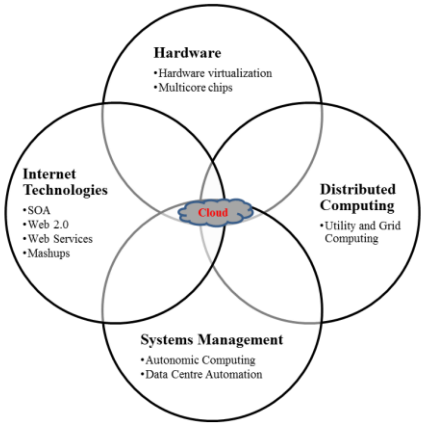

FIGURE I CLOUD COMPUTING BUILDING BLOCKS [9]

Web services as described by [11] is found within the 'Internet Technologies' component of the model in Figure 2-2. Virtualization and the concept of multi-tenancy are dealt with in the 'Hardware' component of the model proposed by [12].

B. Cloud Delivery Models

The different layers of the Cloud Computing architecture are referred to as delivery models of Cloud Computing [11]. The characteristics of these delivery models are captured in the Table I.

TABLE 1
KEY CHARACTERISTICS OF THE IPS STACK

Cloud Delivery Model	Key Characteristics
Software-as-a-Service (SaaS)	•Application runs on the Cloud, doing away with client-side installations [11]; instead access is via various thin client interfaces such as a web browser from a variety of devices [13]. •The service subscription fee covers application usage, user support, backups etc. [14].
Platform-as-a-Service (PaaS)	•Enables the development and deployment of applications without the cost and complexity of purchasing and managing the underlying hardware and software stack [11]. •PaaS provider provides a development and a deployment environment that is automatically scalable while assuring reliability and security [14]. •The developers work within some constraints in terms application design e.g. use of distributed storage systems for structured data instead of a traditional relational database [15].
Infrastructure-as-a-Service (IaaS)	•Storage and compute capabilities are offered as a service [11]. •The Cloud infrastructure is used to deliver a virtualization platform [14]. •Subscribers are able to deploy and run software of their choice (including operating systems) and may have limited control of some networking devices like firewalls [13].

Often cited examples for SaaS include Salesforce and Google Apps as enterprise-level offerings and GMail, Facebook and Twitter as personal-level. For PaaS, Microsoft's Azure Services Platform, Salesforce's Force.com, Google App Engine, Amazon Relational Database Services. Amazon's S3 storage service and EC2 computing platform and Rackspace Cloud Servers are IaaS offerings [11] [14] [3].

C. Cloud Deployment Models

Deployment models present a scheme for grouping Cloud Computing solutions according to the "degree of externalisation" from the customer in terms of service access and control [3].

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Sapkota & Khawar [16] outline the points of differentiation for these various deployment models for Cloud as network infrastructure, physical location of the computing resources and the proposed utilization of the model. Private, Public, Hybrid, and Community Clouds are the most cited deployment models.

TABLE 2
CLOUD DEPLOYMENT MODELS

Cloud Deployment Model	Key Characteristics
Private	• Computing infrastructure is designed, hosted and operated internally by a single organisation i.e. full control over the underlying hardware and software environment [16].
Public	•Computing infrastructure is designed, hosted and operated by a service provider that offers it on a shared basis to several subscribers over the Internet [16]. •Computing resources are shared by several subscribers, with varying degrees of data privacy control [3] [17].
Hybrid	• The organisation stores and processes critical data in-house in a private Cloud but has the ability to extend the infrastructure to the Public Cloud when needed [16].
Community	•The Cloud infrastructure is used by several related entities that form a community e.g. government, education, healthcare [18]. •The infrastructure may be on or off premise and managed by the participating organizations or a third party [13]. •It is a convergence of Cloud, Grid and Green Computing, and Digital Ecosystem principles [15].

D. Drivers for the Cloud Computing Paradigm

One of the key drivers for Cloud Computing is that it offers organisations the opportunity to swap the current CAPEX (CAPital EXpenditure) based model of providing ICT infrastructure for a 'pay-as-you-go' or OPEX (Operational EXpenditure) one [10]. In other words, rather than put down large capital outlays to acquire ICT infrastructure, businesses can now pay a periodic fee for only the computing resources they require at any given time.

The Cloud enables subscribers to capitalise on business opportunities that require quick provisioning of the required resources [10].

Organizations are empowered to develop virtual and "open" business processes that provide their customers, business partners, suppliers, etc. with the means to connect seamlessly for business transactions.

The global economic downturn has driven organizations to increase efficiencies through collaborative solutions and real time information exchange. Cloud computing's 'as-a-service' paradigm delivers this capability in a flexible, scalable and cost-efficient manner [10].

The advantages that Cloud Computing offers that count as drivers for considering it as opposed to the traditional IT infrastructure development approach include:

- Enabling third-world nations to leap into the information age while avoiding huge investments into local IT infrastructure capability [11];
- Lowered entry barrier for small firms seeking to leverage the capabilities of applications they hitherto had no means of acquiring computing resources for [11] [19]; and
- Facilitating ICT innovation by allowing start-ups to focus on their ideas rather than on the ICT infrastructure requirements [11].

Three major market forces serve as both enablers and drivers for the Cloud Computing paradigm [7]. First the increased recognition of organisation of the critical interplay between ICT and actual business issues has meant that increasingly investment decisions are made on expected level of business outcome improvement, not traditional metrics such as the speed or size of the infrastructure. The second factor is the increased drive towards IT resource sharing both internally within organisations as well as the leveraging of external service providers. Data centre virtualization is one of the key enablers of this shift. The third factor is the rapid advancement in the use of technology in both business and personal spheres. For instance social media networks have acted as a catalyst for the "personal cloud".

E. Drawbacks and Criticisms of Cloud Computing

Just like any technology on the ICT landscape, Cloud Computing has associated issues or drawbacks from both technology and business perspectives that need to be taken into account before deciding to deploy it.

A. Drawbacks or Adoption Inhibitors

Security, privacy, and trust are the major issues cited from many surveys about reasons for concerns in adopting the cloud computing paradigm [3] [17]. One of the key underlying perceptions is that vendors have full access to the resources stored on their Clouds [15].

In terms of availability or reliability when a Cloud fails, there is a cascade effect in terms of loss of service (system-wide) for the dependent organisation(s) and in turn the end users [15].

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When a Cloud fails, subscribers may be unable to easily move or "port" their services to another provider; a situation known as lock-in [20] [21].

The rapid increase in the number of data centres being established to support Cloud Computing is raising concern about environmental sustainability [15].

"Cloud washing" was coined by [7] to describe the misuse of the term Cloud by some IT vendors even when these services do not meet the criteria for Cloud e.g. a traditional application service provider (ASP) service which has no notion of pay-per-use and self-service. The effects, according to [7] include creating wrong perceptions about the technology to customers and creating unrealistic expectations that vendors cannot meet.

Den Hoed [14] presents an extensive list of risks associated with Cloud Computing that translate to adoption inhibitors. These were identified in three major industry surveys by the European Network and Information Security Agency (ENISA), the Cloud Security Alliance (CSA) and Gartner, a leading IT research and advisory company.

TABLE 3
THE TOP RISKS OF CLOUD COMPUTING [11]

ENISA	CSA	Gartner
Loss of governance	Abuse and nefarious use of cloud computing	Privileged user access
Vendor Lock-In	Insecure interfaces and APIs	Regulatory compliance
Isolation failure	Malicious insiders	Data location
Compliance risks	Shared technology issues	Data segregation
Management interface compromise	Data loss or leakage	Recovery
Data protection	Account or service hijacking	Investigative support
Insecure or incomplete data deletion	Unknown risk profile	Long-term viability
Malicious insider		Availability

B. Criticisms of the Cloud Computing concept

The Cloud Computing phenomenon is not without major critics [19] [8]. Oracle founder, Larry Ellison views the business models of many CSPs as flawed [23]. Apple co-founder Steve Wozniak is of the view that moving all data to the Cloud poses a control problem [24].

Richard Stallman, architect of the GNU operating system and founder of the Free Software Foundation, describes Cloud Computing as "careless computing" because users store their data in the Cloud rather than on infrastructure under their direct control [25].

However, a key point made by [8] is the uncommon ability of CSPs to convert adoption inhibitors into adoption drivers. Security is cited as an example of this where several industry surveys have shown that the increased investment in infrastructure and expertise by CSPs is now attracting new subscribers to Cloud services when it has for a long time been cited as one of the key doubts for adoption.

III. CLOUD COMPUTING – THE BUSINESS PERSPECTIVE

A. IT Outsourcing Fundamentals

At the heart of the whole conversation for considering Cloud Computing as the means for an organisation to achieve its business objectives, is the topic of IT outsourcing.

Di Giacomo & Brunzel [26] outline what they regard as the five most recognised approaches to IT outsourcing decision-making and hence business models:

- Transaction Cost Theory (TCT) - economic efficiency can be achieved by balancing production costs against transaction costs.
- Agency Cost Theory (ACT) - the decision to outsource or not as being based on the understanding of how much it will cost to maintain the relationship between the user (the principal) and the service provider (the agent).
- Resource-Based Theory (RBT) - competitive advantage can only be achieved when an organization's internal resources (assets, capabilities, processes, attributes, information, knowledge, etc.), are diverse and cannot easily be acquired by the competition.
- Resource Dependence Theory - an organisation's decision to outsource IT any function to achieve effectiveness is tied to the availability of external resources such as land, labour, capital, information or specific product or service.
- Partnership, Relationship and Exchange Theory - the expected mutual benefits from an outsourcing relationship are a key reason for taking this approach to achieve business objectives.

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B. The Cloud Computing Eco-system

Han [1] outlines the players involved in the Cloud Computing eco-system as "service buyers or users, service providers (SPs) and brokers or intermediates". Marston et al. [11] add to this list, "regulators". The ITU-T makes reference to four kinds of "business roles" within the ecosystem namely "Cloud Service Users, Cloud Service Providers, Cloud Service Partners and Inter-cloud" [27]. The ITU-T representation of the cloud eco-system is presented in Figure II.

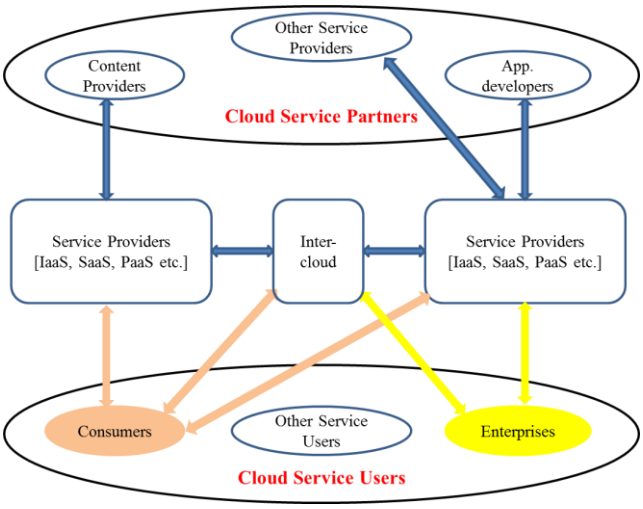

FIGURE II. ITU-T'S REPRESENTATION OF THE CLOUD ECO-SYSTEM [27]

Brokers or enablers play the role of middlemen in linking potential cloud users with service providers by offering a means to exchange raw computing power and applications, providing monitoring software, platform migration software as well as integration services [1] [11]. Regulators have emerged as important stakeholders in the cloud computing ecosystem due to the issues around data control such as location, ownership, applicable laws etc. [11].

C. Cloud/Application Service Providers

The late 1990's saw the emergence of Application Service Providers (ASPs) [9]. While the original ASP business model may be regarded as a precursor to the Cloud, it cannot be called so for a number of reasons [28] [29] [30]:

- The use of a client-server model in contrast to the web services based approach of Cloud [29];
- The lack of sufficient bandwidth to deliver computing services with the speed and reliability that businesses enjoyed with their local machines [30]; and
- The use unique software by most ASPs such that interoperability with other ASPs platforms was impossible [30].

A combination of the above reasons with generally poor business models, inadequate funding, poor architecture execution, lack of diversity in offerings resulted in many ASPs failing after the dot-com bubble bust in 2001 [31] [29]. Some ASPs however, succeeded in transforming themselves into SaaS providers - one of the delivery models of Cloud Computing today [29]. The ASP business model can presently be described as "a customer service approach of providing computer-based services by housing the application software on the vendor's server for users to access through Internet and a Web browser using Hyper Text Markup Language (HTML) or special purpose client software under a subscription or rental pricing strategy." [21].

There are various classes of ASPs based on their service models [21] [29]. These are summarised in the Table IV:

TABLE 4
APPLICATION SERVICE PROVIDER TYPES [29]

ASP Type	Description
Enterprise	Deliver software services directly to customer as Independent Software Vendors (ISV).
Enabler	Provide the delivery infrastructure for other ASPs.
Pure Play	Own and fully manage infrastructure used to deliver web-based applications that are industry-agnostic e.g. email
Vertical	Focus on industry-specific applications and processes
Horizontal	Focus on delivering collaborative applications (e.g. email) or business-oriented software (e.g. accounting)
Full Service Provider	Offer end-to-end solution.

D. Strategic Management Implications of the Cloud

Managing change to achieve strategic objectives is almost as important as having the strategy in the first place and the adoption of Cloud Computing is no different. Carr [41] asserts that attitude is the principal inhibition to utility computing wherein firms will continue to stick with in-house data centres for their IT infrastructure needs for quite some time before embracing the Cloud Computing paradigm.

According to [8] one of the areas where this change is most apparent is in the shift to managing service quality and availability through contracts and relationships, rather than through specifications and direct IT infrastructure deployment.

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The underlying challenge has to do with transforming the corporate culture because of the new set of skills required as existing IT staff will likely need to be retrained or replaced.

To successfully manage the process of combining and/or replacing their current infrastructure with that of ASPs or CSPs, organizations are required to have an intimate understanding of the dependencies between the systems that have been built up over the years. This is required to be able to handle enterprise risk management issues encompassing data security, privacy, service uptime and availability as well as regulatory and legal compliance.

Another implication is that as organization will need to regularly revisit their strategic sourcing decisions as cloud service maturity levels evolve in the years ahead [8].

IV. The Ghanaian ICT Industry

Information Communication Technology (ICT) is the vehicle for ushering in the Information Age [32]. The ICT sector is being transformed by the rapid adoption of Internet-based services, wireless technologies and by the convergence of broadcasting, computing and communication [33]. In developing nations such as Ghana the growth of ICT is fairly recent but nonetheless is fast becoming one of the main factors of development. The possession and control of information offers at various levels, significant strategic advantages that cover a wide range starting with the information necessary for the attainment of basic needs and freedoms all the way to more complex combinations of information that can become independent sources of productivity and power [34].

Broadband is one of the essential elements of the ICT landscape and is one of the key drivers for delivering the Information Age. Kelly et al. [35] propose a new comprehensive view beyond the traditional one that defines broadband as some form of high-speed communications network that connects end users at data transfer speeds higher than some minimum threshold. Instead, broadband can be viewed as a complete ecosystem of several distinct elements that use high-speed connectivity to interact in diverse ways. This relationship is captured in a "virtuous circle for broadband" illustrated in Figure III.

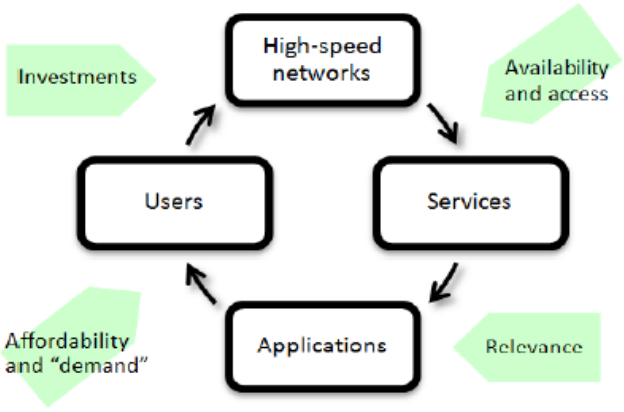

FIGURE III. The Virtuous Circle for Broadband [35]

ICT development in Ghana is driven by the ICT for Accelerated Development (ICT4AD) Policy and the National Telecom Policy (NTP) [33]. The ICT4AD Policy has the overall objective of supporting an ICT-driven socio-economic development process aimed at transforming Ghana into a middle income, information-rich, and knowledge-based society [36]. The goals of the NTP apart from supporting the realisation of the vision of the national ICT4AD policy are to establish market structures that will be most beneficial to Ghana's citizens and businesses, and to set in motion the procedures and incentives that will boost the market's development [37].

Frempong [33] notes that significant improvements have been seen in the Ghanaian ICT industry as a result of the implementation of the strategies coming out of the ICT4AD and NTP policies but also states there is still a lot to do. Indeed in the ITU's 'Measuring the Information Society' report for 2012, Ghana is identified as one among the most dynamic countries, registering a 23 per cent increase in its ICT Development Index (IDI), from 1.81 in 2010 to 2.23 in 2011. In 2007, this index stood at 1.61 [33]. Ghana is among the most dynamic countries in terms of rank change in both the use and access to ICT [38].

V. Research Findings

A. *Delivery Models*

It was found that Infrastructure-as-a-Service (IaaS) i.e. servers, storage, network infrastructure as a service, is the most popular offering in the Ghanaian industry both by availability (37% - Figure IV) and user uptake (75% - Figure V).

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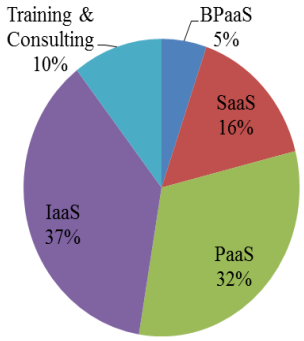

FIGURE IV. AVAILABLE CLOUD SERVICE TYPES (FIELD WORK, 2013)

This is in contrast to general global trend where SaaS is the run-away leader in terms of maturity and adoption by Enterprises ([3]; [2]).

IaaS is also identified as the second leading reason for considering the Cloud from the consumer perspective. This implies that virtualization solutions which form the basis of IaaS are where most of the initial uptake of the cloud business is likely to start from.

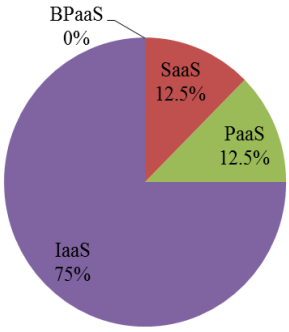

FIGURE V CLOUD SERVICE TYPES BY POPULARITY (FIELD WORK, 2013)

B. Market Entry Strategy

The range of market entry strategies adopted by service providers in the Ghanaian market (Table V) indicates the importance of understanding the local environment in order to achieve penetration. The ability to communicate clearly what is possible with the Cloud to consumers is another implication.

TABLE 5
MARKET ENTRY STRATEGY (FIELD WORK, 2013)

Market Entry Strategic Theme	Strategy Realisation
1. Creating awareness and addressing inhibitions	• Engage potential consumers via variety of media and educational forums • Target specific use cases for consumers e.g. disaster recovery • Build confidence in solutions through: ○ Partnerships with international brands in Cloud services e.g. Microsoft, VMware ○ Implementing and showing compliance to in-depth security best practice ○ Apply best practice IT operations frameworks e.g. ITIL
2. Offering flexible payment options	• Bundle with existing communication services. • Price competitively
3. Offering flexible service level agreements (SLA)	• Customize SLA to suit customer use cases.

C. Perception of Regulatory Impact

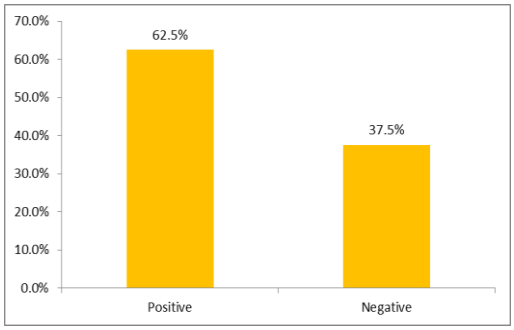

FIGURE VI PERCEPTION OF REGULATORY IMPACT ON BUSINESS (FIELD WORK, 2013)

The service provider perception of the impact a regulator would have on their business is largely positive (Figure VI).

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One service provider in the semi-structured interview indicated that though he did not see an immediate benefit, such a body which would then make policies to foster industry growth would be useful. He cited the absence of any policy around how foreign entities could enter the Ghanaian ICT market e.g. the data centre space which at the moment does not have many indigenous Ghanaian start-ups. The status quo would make it more difficult for such start-ups to develop. He also cited the example of Nigeria which has strict policies around the forming partnerships with local entities, local content thresholds and knowledge transfer. The implication from this finding is that there are strong motivations to have a regulator in the industry.

D. Cloud Pricing Models

The most popular pricing model in Ghana applied in charging for Cloud Computing services currently is that based on a fixed price based on value delivered from offered services (Figure VII). The reason behind this as obtained from the interviews is that this approach is the simplest cost model for both service providers and consumers at present. This could be put down to market maturity with the implication that there is still work to be done in terms helping consumers in Ghana take advantage of the pay-per use capability of the Cloud Computing paradigm.

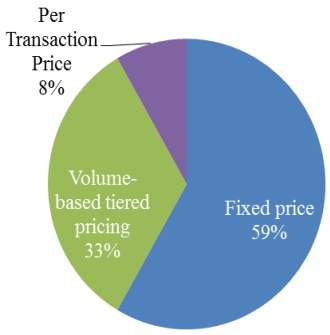

FIGURE VII SERVICE PROVIDER PRICING MODELS (FIELD WORK, 2013)

E. Partnerships & Interoperability

Partnering with other service providers to deliver Cloud solutions appears to be high on the agenda of all but one of the service providers surveyed. Driving down operating costs and secondly leveraging experience and/or best practices are the top motivators identified for this phenomenon.

A related issue is around interoperability between service providers. Only one respondent had no intention of supporting this.

But it is on the minds of 85% of Ghanaian ASPs and this is expected to help re-assure users of the diminished risk associated with data lock-in. This drive for interoperability is also in line with the global industry trend wherein the ease of portability of users from one service provider to the other is fast becoming a fundamental requirement for adoption of the Cloud.

F. Infrastructure Impediments

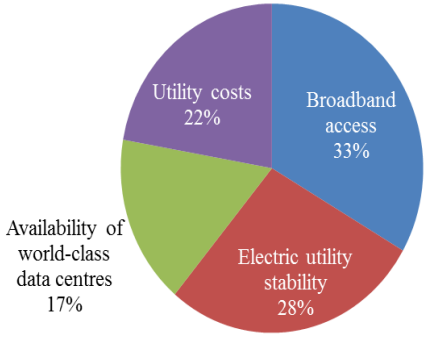

FIGURE VIII CLOUD COMPUTING INFRASTRUCTURE INHIBITORS (FIELD WORK, 2013)

Broadband access is considered by majority of the service providers (33%) as the greatest hindrance in terms of infrastructure when it comes to adopting Cloud Computing in Ghana (Figure VIII). The rapid growth of broadband technology was one of the factors that spurred the development of web services (one of the building blocks of Cloud Computing) [8]. The implication is that ongoing efforts to increase broadband penetration in Ghana need to be intensified through approaches such as increased infrastructure development and sector policy reform to allow for increased competition among Internet service providers [39]. Electric utility stability was the next most cited infrastructure issue (28%). Efforts in the sector by the Ministry of Energy to increase capacity and reliability of the power sector are important to driving the growth of many industries in Ghana.

VI. CONCLUSION

The Cloud Computing phenomenon is growing rapidly globally. It has had and will continue to have a profound effect on how IT functionality is delivered, priced, and consumed. This is especially so because of the shift from a CAPEX (capital expenditure) to operational expenditure (OPEX)-based model for IT infrastructure investment.

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The experience both in migration and actual use for early adopter organizations has been positive. Companies of all sizes should evaluate the potential of Cloud to support their strategic objectives.

From a service provider standpoint, there are strong opportunities to leverage the positive experience of early adopters in spite of broadband penetration limitations, to drive further Cloud deployments. The strongest growth area currently appears to lie in infrastructure virtualization.

REFERENCES

[1] Han L. (2009) Market Acceptance of Cloud Computing - An Analysis of Market Structure, Price Models and Service Requirements Bayreuth Reports on Information Systems Management [online] available at <http://opus.ub.uni-bayreuth.de/opus4-ubbayreuth/files/468/thesis_leihan.pdf> [24 January 2013]

[2] Belmans W., Lambrette U. (2012) 'The Cloud Value Chain Exposed - Key Takeaways for Network Service Providers' [online] available at <http://www.cisco.com/web/about/ac79/docs/sp/Cloud-Value-Chain-ExposedL.pdf> [24January 2013]

[3] Deloitte (2010) Cloud computing: Market overview and perspective [online] available at <https://www.deloitte.com/assets/Dcom-Global/Local%20Assets/Documents/TMT/cloud_-_market_overview_and_perspective.pdf> [24 January 2013]

[4] A. Deaton,"Savings in Developing Countries: Theory & Review," in Proceedings of The World Bank Annual Conference on Developing Countries, 1989., 1990.

[5] E. O. Yeboah-Boateng, "Fuzzy Similarity Measures Approach in Benchmarking Taxonomies of Threats Against SMEs in Developing Economies", Canadian Journal on Computing in Mathematics, Natural Sciences, Engineering & Medicince, Vol. 4, No. 1, February 2013.

[6] Ellefsen, I.D. & S.H. von Solms, Framework for Cyber Security Structure in Developing Countries, University of Johannesburg, 2012.

[7] Forrester (2010) 'The Evolution Of Cloud Computing Markets' [online] available at <http://fm.sap.com/data/UPLOAD/files/Forrester%20-%20The%20Evolution%20Of%20Cloud%20Computing%20Markets.pdf> [08 February 2013]

[8] Ernst & Young (2011) 'Cloud computing issues and impacts' [online] available at <http://www.ey.com/Publication/vwLUAssets/Cloud_computing_issues,_impacts_and_insights/$File/Cloud%20computing%20issues%20and%20impacts_14Apr11.pdf> [08 February 2013]

[9] Kern T., Willocks L.P., Lacity M.C. (2002) 'Application Service Provision: Risk Assessment and Mitigation' MIS Quarterly Executive [online] 1(2) 113-126 available at <http://misqe.org/ojs2/index.php/misqe/article/viewFile/31/26> [20 January 2013]

[10] KPMG (2011a) 'The Cloud: Changing the Business Ecosystem' [online] available at <http://www.kpmg.com/IN/en/IssuesAndInsights/ThoughtLeadership/The_Cloud_Changing_the_Business_Ecosystem.pdf> [20 February 2013]

[11] Marston S., Li Z., Bandyopadhyay S., Zhang J. , Ghalsasi A. (2010) 'Cloud computing - The business perspective' Decision Support Systems [online] 51 (2011) 176–189 available at <http://www.sciencedirect.com/science/article/pii/S0167923610002393> [03 February 2013]

[12] Buyya R., Broberg J., Goscinski A.M. (2011) Cloud Computing: Principles and Paradigms. New York: John Wiley & Sons

[13] Xu Y. (2010) Cloud Services Provider. Unpublished dissertation. Gothenburg: University of Gothenburg

[14] den Hoed A. (2012) Technology Based Methods to Reduce The Risks of Cloud Computing. Unpublished dissertation. Leiden: Leiden University.

[15] Marinos A., Briscoe G. (2009) 'Community Cloud Computing' [online] available at <http://arxiv.org/pdf/0907.2485v3.pdf> [23 February 2013]

[16] Sapkota S., Khawar S. (2011) Cloud Computing for Telecom Systems. Unpublished dissertation. Karlskrona: Blekinge Institute of Technology

[17] Tsybulsky A. (2013) 'Cloud vs. In-House Application Hosting for Government Institutions' [online] available at <http://www.csdcsystems.com/node/735> [30 March 2013]

[18] Mell P., Grance T. (2011) The NIST definition of Cloud Computing, National Institute of Standards and Technology (NIST), Special Publication Draft-800-145 2011 [online] available at<http://csrc.nist.gov/publications/drafts/800-145/Draft-SP-800-145_cloud-definition.pdf/> [21 January 2013]

[19] Kushida, K.E., Murray, J., Zysman J. (2011) 'Diffusing the Cloud: Cloud Computing and Implications for Public Policy' [online] available at <http://brie.berkeley.edu/publications/WP_197%20update%206.13.11.pdf> [12 March 2013]

[20] Ranabahu A. (2012) Abstraction Driven Application and Data Portability in Cloud Computing. Unpublished dissertation. Dayton: Wright State University

[21] Liang Y. (2008) The Determinants of Customer Perceptions in a Dynamic Business Environment: An Exploratory Analysis of the ASP Business Model. Unpublished dissertation. Hamilton: University of Waikato

[22] Jäätmaa J. (2010) Financial Aspects of Cloud Computing Business Models. Unpublished dissertation. Espoo: Aalto University

[23] Hasson J. (2008) 'Cloud computing is for the birds' [online] available at <http://www.fiercecio.com/story/cloud-computing-birds/2008-10-11> [07 February 2013]

[24] Angotti (2012) 'Apple Co-Founder Wozniak Believes Cloud Computing is a Brewing Storm' [online] available at <http://www.searchenginejournal.com/wozniak-cloud-horrible-problems/47097/> [07 February 2013]

[25] Arthur, C. (2010) 'Google's ChromeOS means losing control of data, warns GNU founder Richard Stallman' [online] available at <http://www.guardian.co.uk/technology/blog/2010/dec/14/chrome-os-richard-stallman-warning?INTCMP=SRCH> [07 February 2013]

[26] Di Giacomo D., Brunzel T. (2010) Cloud Computing Evaluation - How it Differs to Traditional IT Outsourcing. Unpublished dissertation. Jönköping: Jönköping University

[27] Jamoussi B. (2011) ITU-T Cloud Computing Focus Group [online] available at <http://www.itu.int/ITU-D/afr/events/FTRA/2011/documents/Session1ITU.pdf> [03 March 2013]

[28] Murphy L. (2009) 'ASP vs SaaS – What's the difference?' [online] available at <http://sixteenventures.com/difference-between-asp-and-saas> [04 March 2013]

[29] Jungck K., Rahman M. S. (n.d.) Cloud Computing Avoids the Downfall of Application Service Providers [online] available from <http://www.academia.edu/934013/Cloud_Computing_Avoids_Downfall_of_Application_Service_Providers> [18 January 2013]

[30] Sultan N. (2009) 'Cloud computing for education: A new dawn?' International Journal of Information Management [online] 30 (2010) 109–116 available at <http://www.sciencedirect.com/science/article/pii/S0268401209001170> [03 February 2013]

[31] Johansson B. (2004) Deciding on Using Application Service Provisioning SMEs. Unpublished dissertation. Linköping: Linköping University

[32] Lallana, E.C., Uy M.N. (2003) 'The Information Age' [online] available from <http://en.wikibooks.org/wiki/The_Information_Age> [30 December 2012]

[33] Frempong G. (2010) 'Ghana ICT Sector Performance Review 2009/2010' Towards Evidence-based ICT Policy and Regulation [online] 2(8) available at <http://www.researchictafrica.net/publications/Policy_Paper_Series_Towards_Evidence-based_ICT_Policy_and_Regulation_-_Volume_2/Vol%202%20Paper%208%20-%20Ghana%20ICT%20Sector%20Performance%20Review%202010.pdf> [04 February 2013]

[34] van Dijk, M. (2005). The Deepening Divide: Inequality in the Information Society. California: Sage Publications

[35] Kelly T., Mulas V., Raja S., Zhen-Wei Q. C., Williams M. (2009) 'What role should governments play in broadband development?' [Online] Available from <http://www.oecd.org/ict/4d/43631862.pdf> [18 December 2012]

[36] Ghana Government (2003) 'The Ghana ICT for Accelerated Development (ICT4AD) Policy' [online] available from <http://www.nca.org.gh/downloads/Ghana_ICT4AD_Policy.pdf> [19 December 2012]

[37] Ministry of Communications (2005) National Telecommunications Policy [online] available at <http://www.nca.org.gh/downloads/Ghana_Telecom_Policy_2005.pdf> [04 March 2013]

[38] ITU (2012) 'Measuring the Information Society' [online] available from <http://www.itu.int/ITU-D/ict/publications/idi/material/2012/MIS2012_without_Annex_4.pdf> [31 December 2012]

[39] Addo, K. (2010) 'Proposed strategies (focusing on public policy) for increased broadband penetration in the rural areas in Ghana' [online] available at <http://www.grin.com/en/e-book/183395/proposed-strategies-focusing-on-public-policy-for-increased-broadband> [29 April 2013]

[40] Sourya B. (2011) 'Cloud Computing vs Utility Computing vs Grid Computing: Sorting The Differences' [online] available at <http://www.cloudtweaks.com/2011/02/cloud-computing-vs-utility-computing-vs-grid-computing-sorting-the-differences/> [17 February 2013]

[41] Carr N.G. (2005) 'The end of corporate computing' MIT Sloan Management Review [online] 46 (3) 67–73 available at <http://www.cs.sfu.ca/CourseCentral/301/cwa50/Readings/end_of_corporate_computing.pdf> [06 February 2013]