Determinants of an Effective Cloud Computing Strategy

James Lawler
lawlerj@aol.com

H. Howell-Barber
h.howell@verizon.net

Rohit Yalamanchi
ry82715n@pace.edu

Anthony Joseph

Pace University
Seidenberg School of Computer Science and Information Systems
New York, New York 10038, USA

Abstract

The cloud continues to be an area of information systems that is being adopted cautiously by business firms. The authors of this study analyze factors that can determine the effectiveness of a cloud strategy as firms invest in this computing method. The authors examine cloud computing strategy from a best practices survey, a detailed case study, and a statistical interpretation of a sample of projects of firms and organizations. The findings impute that technical factors are driving cloud computing projects more than procedural factors, and that projects in the study exhibit less discipline in methodology than might otherwise be helpful in enabling an initial cloud computing strategy. This study contributes a framework for a prudent cloud computing strategy that can help firms as they further invest in this method of technology.

Keywords: cloud, cloud bursting, cloud computing, cloud service provider (CSP), information systems department, infrastructure-as-a-service (IaaS), platform-as-a-service (PaaS), software-as-a-service (SaaS), strategy, virtualization

1. BACKGROUND AND DEFINITION

Cloud computing is defined in the literature as “a model for enabling convenient, on-demand network access [by business firms] to a shared pool of configurable computing resources … that can be provisioned rapidly and released with minimal management effort or [cloud] service provider [CSP] interaction” (Walz and Grier, 2010). It is defined as a model of “pre-existing grid-style compute-and–storage [resources], tightly coupled remote compute–and–storage services that are remote but [seem] local and hosted computing services” (Collett, 2010). It is “the illusion of infinite computing resources available on demand, … eliminating the need for [firms] to plan [in the] far [future] for provisioning; the elimination of an [immediate] commitment by [firms], … allowing [firms] to … increase hardware resources only when there is an increase in their needs; and the [inclusion of paying-as-you-go] for … computing resources … as needed … and release of them as needed [by firms]" (Castro-Leon, Golden and Gomez, 2010). Cloud computing is distinguished by fast elasticity for faster scalability, increasingly on-demand resource self-service, location-independent pooling of resources, measured or metered paying for resource subscription, and ubiquitous network access to high-powered resources by firms (Walz and Grier, 2010). Cloud computing is a method for enabling more effectiveness in the existing information systems of business firms (Linthicum, January, 2010).

Cloud computing is delivered in the following models:

- Infrastructure-as-a-Service (IaaS), employed as on-demand services, such as networks, processors and storage (e.g., Amazon Web Services, GoGrid, IBM Cloud and Rackspace);
- Platform-as-a-Service (PaaS), employed as services, such as languages, operating systems, optimized middleware and tools (e.g., Force.Com, Google App Engine and Microsoft Windows Azure); or
- Software-as-a-Service (SaaS), employed as paying-as-you-go services, such as applications, data and processes (e.g., Cisco WebEx, Intuit QuickBooks OnLine, Sage and SalesForce.Com).

Of the delivery models SaaS is the more frequent model of business firms (Wittmann, 2010), generating $12 billion of sales for technology firms (Economist, 2011).

Deployment of the cloud in business firms is either as a private or proprietary cloud (managed and owned by a business firm or organization), a public cloud (managed by a CSP), or a hybrid cloud (an interoperable mix of private and public clouds) (Red Hat, 2010). Private cloud is the more frequent model of firms (Biddick, 2010), due to perceptions of improved resource scalability, security and self-service of private clouds in contrast to public clouds (Claybrook, December, 2010). Due to difficulty in the orchestration of network, processor and storage services in a private cloud (Claybrook, August, 2010), however, hybrid clouding might be employed by firms for cloud bursting (i.e., including public clouds purely for scaling of services temporarily) (Greengard, 2010). Either as private, public or hybrid, cloud is an evolution of grid computing and utility computing founded on service-oriented computing and server virtualization (CIO, 2009). For business firms and organizations, cloud computing deployment integrates the benefits of earlier computing methodologies.

Benefits of the cloud are in business agility (Fogarty, August, 2010), as deployment of new products or services is enabled by a faster on-demand infrastructure, not rigid infrastructures of information systems departments (Betts, 2010). Elasticity is enabling optimized pay-as-you-go scalability of services in minutes, if not seconds, at a lower investment in over- or under-provisioning of systems (Klems, 2010). Flexibility from cloud computing is enabling a focus more on innovation than on operations of systems (Cloud Computing, 2010). Firms and organizations having limited investment in systems but needing high-performance are benefiting from the pooling of resources on the cloud (Weiss, 2010). The benefits of the cloud are cited frequently in the literature (Kontzer, January, 2011) and are evident in forecasts that cloud computing may be not an evolution but a revolution (West, 2010) – potentially the most profound revolution since the Internet (Hugos and Hulitzky, 2011).

Estimates indicate that business firms are focusing more on the cloud than on other computing methodologies, as indicated in Figure 1 (Johnson and Levien, 2010) of the Appendix. Estimates in the literature indicate that more than 60% of firms and organizations are evaluating or integrating the cloud, as indicated in Figure 2 (Information Week Analytics, June, 2010). Most firms integrating the cloud are forecasted to be further integrating services in 2011. Forecasts for 2011 are indicating cloud computing deployment for 80% of new software technology (Albright, 2011) and integration of it as the highest strategic technology (Information Management, 2010). Forecasts of an average $2 million are estimated for cloud computing in large-sized organizations in 2011 (Finnie, 2011). The market for cloud computing was estimated at $23 billion in 2010 and conservatively is forecasted for $55 billion in 2014 (Thibodeau, 2010), which is indicated as more than 30% of the growth in computer technology (Steele, 2010). Cloud computing as hyped in the literature may be the new mainstream platform (Reisinger, 2010) or strategic inflection point (Chorafas p.57, 2011) of technology in 2011 – 2014.

2. INTRODUCTION TO STUDY

Like any hyped platform of technology, cloud computing is a concern for business firms considering expanded investment in the cloud (McCafferty, 2010). Firms expanding from basic cloud services to complex infrastructures on the platforms are confronted by decisions as to which applications and projects are to have a private cloud infrastructure, which are to have a public cloud hosted infrastructure, and which are to be hybrid systems (Wellman, 2010). Firms are confronted by the integration of cloud and non-cloud systems (Nash, 2010), the migration of non-cloud systems to private cloud infrastructures (Claybrook, August, 2010), and the interoperability performance of CSP cloud infrastructures and systems (Gartner, p.7, 2010). Lack of integration and portability standards on the cloud is a further issue (Harding, 2010 & Schneider, 2010). Staff may not even be proficient in the integration of the systems. Though research is clear that integration of disparate systems is critical in improving initiatives of firms and organizations (Bhatt, 2000), cloud computing is not matured enough as a platform.

Literature cites concerns in cloud computing maturity, as indicated in Figure 3 (Information Week Analytics, October, 2010). Control and security of information in public cloud and even private cloud infrastructures is a frequent concern in the literature (McCall, 2010), as public infrastructures are not controlled by business firms and organizations. Privacy processes for legal jurisdictions and regulatory requirements, such as from the Health Insurance Portability and Accountability Act (HIPPA) and the Sarbanes – Oxley (SOX) Act, may not be evident in public cloud security standards (Linthicum, March, 2010). Concerns are heightened in current information leaking of WikiLeaks (Sausner, 2010). On-demand performance and reliability are concerns, as real-time planning of resource scalability may burden private and public cloud projects and systems (Castro-Leon, Golden and Gomez, 2010), especially if contracts of CSP firms are not customized to the requirements of business firms (Gartner, pp.1,4, 2010) and if business firms and organizations do not have monitoring tools. Essentially business firms and organizations may not be protected on public cloud systems (Kontzer, October, 2010). Though the cloud furnishes benefits, these concerns on cloud computing may hinder investment in the platform if firms and organizations lack an initial strategy.

From the literature of practitioners, the authors of this study attempt to clarify determinants that can contribute to an effective cloud computing strategy. Even though there are concerns on cloud computing, business firms and organizations are experimenting in the cloud (Lawler, 2011). How are firms and organizations deploying on the cloud despite the concerns?; which cloud deployment factors and methods are consistent and effective models of projects?; and which are the right applications and projects in the right infrastructure systems? How are organizations impacted by new technologies (Kauffman and Techatassanasoontorn, 2010)? Cloud-in-a-box answers for different business firms, customers and organizations are not evident in the practitioner literature (Linthicum, September, 2010) – cloud is not in one form – nor are explored fully in the scholarly literature. This study attempts to evaluate the effectiveness of projects and systems of business firms and organizations on the cloud, distinct from the embellishing hyperbole of technology firms (Brooks, 2010). The authors of the study define factors for a framework for projects and systems in cloud computing strategy.

3. FACTORS IN CLOUD COMPUTING STRATEGY

The determinants for the effectiveness of cloud computing projects and systems are defined as business, procedural and technical factors in the following framework for a cloud computing strategy. The factors are formulated largely from earlier models of the authors on service-oriented architecture (SOA) (Lawler and Howell-Barber, 2008) and Web services (Lawler, Anderson, Howell-Barber, Hill and Javed and Li, 2003), inasmuch as services and SOA are considered a foundation for the cloud (Lawler, 2011), and are improved for this cloud study. These methodologies were at the forefront of innovation in 2008 and 2003, as cloud is at the forefront in 2011.

Business Factors in Cloud Computing Strategy

- *agility benefits* (1), extent to which cloud enables organization to be more agile;

- *competitive market* (1), extent to which cloud enables organization to confront industry issues more effectively;

- *cost benefits* (1), extent to which cloud enables organization to deliver more financial return;

- *customer demand for improved service* (1), extent to which cloud enables improved service to customers;

- *executive business leadership* (2), extent to which senior managers in business units evangelize cloud computing;

- *executive sponsorship* (1), extent to which senior managers in organization evangelize and fund cloud computing;

- *executive technology leadership* (1), extent to which senior managers in information systems department evangelize cloud computing;

- *organizational change management* (2,3), extent to which management is evident in helping organizational staff enhance cloud computing projects;

- *participation of client organizations* (1,3), extent to which client organizational staff participate on cloud computing projects;

- *regulatory requirements* (2), extent to which cloud computing project is impacted by governmental, industrial or internal requirements; and

- *strategic planning of organization* (2), extent to which cloud computing is articulated as part of organizational strategy.

Procedural Factors in Cloud Computing Strategy

- *business process management* (1), extent to which improvement of processes is a cloud goal;

- *candidate application selection* (*), extent to which a process for cloud computing content and project selection is evident in organization;

- *change management* (2,3), extent to which a controlled procedure is evident for ensuring optimal resolution of requests for changes in existing processes or of requests for new processes or services due to cloud computing projects;

- *cloud computing center of excellence* (2,3), extent to which a centralized team is evident for furnishing cloud expertise to cloud computing project staff;

- *cloud planning* (3,*), extent to which a cloud computing plan is evident before initiating cloud computing projects;

- *continuous improvement process* (2), extent to which cloud computing projects are included in continuous improvement process plans;

- *costing techniques* (2), extent to which costing techniques of cloud CSP technology firm(s) are easily integrated into organizational project costing techniques;

- *education and training* (2,3), extent to which skill training on cloud computing is evident for project staff;

- *infrastructure architecture in organization* (1,3), extent to which cloud computing projects are evident in infrastructure architecture of organization;

- *problem management* (3,*), extent to which problem management and reporting are evident in cloud computing projects;

- *process deployment techniques* (2), extent to which procedures are evident for furnishing software and tools to cross-organizational project staff;

- *program management methodology in organization* (2,3), extent to which cloud computing projects are guided from a program management structure;

- *project management methodology in organization* (1,3), extent to which project management methodology is modified to a cloud computing structure;

- *responsibilities and roles* (2), extent to which responsibilities and roles of cloud computing project staff are clearly identified for project tasks;

- *risk management* (2), extent to which procedures are identified for mitigating failure or loss caused by cloud computing projects;

- *security management* (2), extent to which procedures are identified for safeguarding access to information on cloud systems;

- *service orientation of organization* (2), extent to which cloud computing project staff is receptive to principles of service-oriented architecture (SOA);

- *standards management* (1), extent to which cloud computing project staff is receptive to official standards, scope of standards of cloud CSP technology firm(s), and standards gap resolution techniques;

- *strategy management* (2,3), extent to which procedures are evident for improving cloud computing program strategy; and

- *technology firm evaluation process* (*), extent to which procedures are evident for formally selecting cloud CSP technology firm(s).

Technical Factors in Cloud Computing Strategy

- *cloud computing "bill of rights" with CSP technology firm(s)* (2), extent to which a cloud "bill of rights" is evident or negotiated at CSP technology firm(s);

- *cloud computing data model of organization* (1), extent to which a data, privacy and security model is evident for ensuring data integrity and quality in cloud systems;

- *cloud CSP technology firm location* (2), extent to which off-shoring or on-shoring of CSP technology firm(s) is evident for impact on processing of systems;

- *continuous processing* (*), extent to which a procedure is evident for enabling failover of cloud computing systems;

- *data ownership* (*), extent to which information ownership is clearly evident before implementation of cloud computing systems;

- *elasticity for faster provisioning and resource scalability* (2), extent to which deployment of resource scalability is facilitated by cloud computing systems;

- *faster delivery of new application systems* (2), extent to which deployment of new processing systems is facilitated by cloud technology;

- *faster delivery of new technologies* (2), extent to which faster deployment of new technologies is facilitated by cloud technology;

- *integrated non-cloud application systems of organization* (1), extent to which cloud computing systems integrate information of non-cloud systems in internal organization;

- *integrated non-cloud application systems with external organization(s)* (1), extent to which cloud computing systems integrate information of external non-cloud systems of external organization(s);

- *management and monitoring* (*), extent to which monitoring of new systems is integrated into organizational procedures;

- *multiple cloud CSP technology firm(s)* (2), extent to which multiple technology firms are involved on cloud computing systems;

- *networking technology* (*), extent to which in-house networking technology is integrated on systems;

- *non-integrated cloud application systems of organization* (1), extent to which cloud computing systems exist in internal organization but do not integrate into current project systems;

- *non-integrated cloud application systems with external organization(s)* (1), extent to which cloud computing systems exist in external organization(s) but do not integrate into current project systems;

- *open standards* (*), extent to which non-proprietary standards are integrated in cloud computing systems;

- *platform of cloud CSP technology firm(s)* (1), extent to which infrastructure platform(s) of cloud CSP technology firm(s) are integrated on systems;

- *product-specific tools of cloud CSP technology firm(s)* (1), extent to which implementation tools of CSP technology firm(s) are integrated on systems;

- *product-specific utilities of cloud CSP technology firm(s)* (1), extent to which run utility tools of technology firm(s) are integrated on systems;

- *proprietary technologies of cloud CSP technology firm(s)* (1), extent to which proprietary tools of technology firm(s) are integrated on systems;

- *security provision of cloud CSP technology firm(s)* (2), extent to which security techniques of CSP technology firm(s) are integrated on systems;

- *service level agreements with cloud CSP technology firm(s)* (1), extent to which a service level agreement is integrated in methodology with CSP technology firm(s);

- *service-oriented architecture (SOA) of organization* (2,3), extent to which project is integrated in an SOA initiative;

- *standards organization membership of cloud CSP technology firm(s)* (2), extent to which technology firm(s) are members of Cloud Standards Coordination Initiative;

- *standards organization membership of organization* (1), extent to which organization is a member of Cloud Standards Coordination Initiative; and

- *technology process management of organization with cloud CSP technology firm(s)* (2,3), extent to which process management of organizational technology is integrated and provided with methodology of technology firm(s).

(1) Lawler, Anderson, Howell-Barber, Hill, Javed and Li, 2003
(2) Lawler and Howell-Barber, 2008
(3) Mendoza, Perez and Grimian, 2006
(*) New to Study

These factors are considered by the authors of the study to be critical in a cloud strategy. Few practitioner or scholarly publications have included this diversity of non-technical and technical factors in attempting to analyze cloud computing strategy.

4. FOCUS OF STUDY

The focus of the study is to attempt to evaluate the aforementioned factors that can contribute to the effectiveness of an initial cloud computing strategy. The study contributes findings on best and non-best performance practices on cloud projects and systems that can be formulated or corrected into generic principles of strategy not frequently found in practitioner literature (Fogarty, May, 2010). The study expands scholarly findings on performance strategy for maximizing the benefits from and minimizing the concerns for technology at the forefront of practice in industry (Wang, 2010). The authors of this study form the earlier factor framework for a goal of guiding business managers investing on the cloud and in helping them in insuring the fruitfulness of the investment. This framework benefits managers as cloud computing continues to be less the hyperbole of technology firms and more the mechanism of information systems and technology of business firms and organizations in 2011 (Rash, 2010).

5. RESEARCH METHODOLOGY OF STUDY

The methodology of this study consisted of a population of 31 business firms and organizations (>$500 million in revenue in 2010) from a diverse 9 industry sectors investing in cloud computing projects and systems, as indicated in Table 1 of the Appendix.

The firms and organizations were analyzed by the authors in three iterative stages of analysis in 2010 – 2011.

In the period of October 2010 – January 2011 in stage 1, the principal author, and a graduate student majoring in information systems in the Seidenberg School of Computer Science and Information Systems of Pace University who is the third author of this study, conducted a literature survey of 28 business firms and organizations on cloud computing projects and systems found in leading practitioner publications, as indicated in Table 1. The features of the projects and systems in each of the 28 firms and organizations conformed to the definition of cloud computing: fast elasticity for faster resource scalability, increasingly on-demand resource self-service, location-independent pooling of resources, metered paying for resource subscription, and ubiquitous network access to resources (Walz and Grier, 2010). By a checklist instrument identifying the 57 business, procedural and technical factors defined in the earlier framework of this study, the student evaluated, as feasible from the information, evidence or non-evidence of the factors on the projects and systems in each of the 28 firms and organizations. To the factors were applied by him a six-point Likert like rating scale of 5 – very high, 4 – high, 3 – intermediate, 2 – low, 1 – very low, and 0 in perceived enablement of the factors in an implied initial cloud computing strategy. The evaluations were filtered for creditability by the principal author.

In the period of January 2011 – March 2011 in stage 2, the second author of this study who is an experienced practitioner of 35 years in technology, conducted a detailed case study of the cloud computing projects and systems of 3 business firms and organizations investing in the cloud, as indicated in Table 1, in an attempt to collectively confirm or not confirm the findings of the literature survey in stage 1. The 3 firms and organizations were chosen by the second author because of distinguishing entrepreneurial and first mover features of the projects and systems, evident knowledge of the information systems staff on the technology, and implementation of individual private, public and hybrid cloud systems. The second author evaluated evidence of the factors and implied strategy on the projects and systems in each of the 3 firms and organizations by the checklist instrument in stage 1, from her observation and perception at the firms, research at the firms, and research at other secondary sector sources, the evaluation of which was founded largely on principles of research (Yin, 2003). The author applied the six-point rating scale, as in the literature survey. These evaluations were filtered for creditability by the principal author, who also supervised the second author in stage 2.

In the final period of April – June 2011 in stage 3, the fourth author interpreted the data from stages 1 and 2 in Matlab 7.10.0 (R2010a) Statistics Toolbox, in measures of means, standard deviations and analysis of variance (ANOVA) (McClave and Sincich, 2006) for the analysis and discussion that follows in the next section.

6. ANALYSIS OF FINDINGS ON FIRMS AND ORGANIZATIONS OF STUDY

Analysis of 28 Firms and Organizations from the Survey

The firms and organizations in the literature survey were from diverse industry sectors: automotive, business services, chemical, energy research, financial services, food, health care, pharmacy and technology, and from diverse cloud delivery and deployment models, as indicated in Table 1.

The business factors of *cost benefits* (means = 2.82 / 5.00) and *customer demand for improved service* (2.00) were the beginning drivers of the projects of the 28 firms and organizations in the survey. The emphasis of the firms was clearly more on the technical factors of *data ownership* (4.89); *elasticity for faster provisioning and resource scalability* (4.25); *faster delivery of new application systems* (4.18) and *new technologies* (4.32); *networking technology* (5.00); and *platform* (4.71) and *product-specific tools* (3.39) *of cloud technology firms* than on any of the business factors. The technical factors eclipsed even more the procedural factors on the projects of the organizations in the survey. The procedural factors of *candidate application selection* (2.82) and *costing techniques* (1.07) were the highest in the monitoring of the projects in the survey.

Overall, the focus of the 28 firms and organizations was more on the technical factors (means = 1.93) than on procedural (0.48) and business (0.75) factors of the projects in the survey. The means of 1.93 and the standard deviations of 2.00 on the technical factors were more than the means of 0.48 and 0.75 and the standard deviations of 0.64 and 0.87 on the procedural and business factors; and the spread about the means was the least on the procedural factors and the most on the technical factors. The goal of the firms and organizations in the survey was an immediate play on the technology.

(Factors analyzed in the survey are detailed in Tables 2 and 3.)

Analysis of 3 firms and organizations from Case Study

Analysis of Firm 1 – Energy Research Organization

Firm 1 is a large-sized mid-west energy research organization that focused on a delivery model of Microsoft Windows Azure as platform-as-a-service (PaaS) and a deployment model of a hybrid cloud. The goal of the project was to expand external high performance computing resources for internally generated Monte Carlo simulations, and to furnish provisioning of the results of the simulations on to geo-located networks for researchers internationally. The project was to improve the performance processing of petabytes of simulations to the researchers requesting improved service, and to lessen pressure on internal systems of the organization.

The business factors of *agility benefits* (5.00) and *customer demand for improved service* (5.00) were the beginning drivers of the project in Firm 1. The focus of the information systems department however was the technical factors of *elasticity for faster provisioning of resource scalability* (5.00); *faster delivery of new application systems* (5.00) and *new technologies* (5.00); *integrated non-cloud systems of organizations* (5.00) and *with external organizations* (5.00); *networking technology* (4.00); and *platform* (4.00) and *tools of cloud technology firms* (4.00). Governance in *program management methodology in organization* (0.00) was non-existent and process management as a methodology was largely non-existent in *business process management* (0.00), *organizational change management in organization* (0.00) and *technology process management* (2.00), and even though *continuous improvement process* (3.00) was evident on the initial project. Though *executive technology leadership* (5.00) was highly indicated on the project, *executive business leadership* (0.00) and *sponsorship* (0.00) were non-existent for a Firm 1 strategy. Throughout the organization, *cloud computing "bill of rights"* (1.00) and *service level agreements with technology firms* (1.00) were largely non-existent as was monitoring of *costing techniques* (1.00), which may hinder planned *cost benefits* (3.00) on the project.

Firm 1 was focused more on technical factors than on procedural and business factors, in order to benefit from the faster cloud, but this method limited the benefits of a formalized governance and process strategy.

Analysis of Firm 2 – Financial Services Organization

Firm 2 is a large-sized mid-west financial services organization that focused on models of EMC infrastructure-as-a-service (IaaS) and private cloud. The goal of the project was to improve the efficiency and flexibility of server and storage systems for internal mortgage staff, and to furnish a foundation for faster growth of the systems. The project was to increase the response of the systems at notable savings.

The business factors of *agility* (5.00) and *cost benefits* (5.00) were the beginning drivers of the project. The information systems department in Firm 2, as in Firm 1 focused on the technical factors of *elasticity for faster provisioning of scalability* (5.00); *faster delivery of new application systems* (5.00) and *new technologies* (5.00); *integrated non-cloud systems of organization* (5.00) and *with external organizations* (5.00); and *tools* (5.00) and *utilities of technology firms* (5.00). Governance of the project was improved in *program management methodology* (4.00) in Firm 2, but management of the organizational process was non-existent in *business process management* (0.00), *organizational change management* (0.00) and *technology process management* (0.00), as in Firm 1 – evidence of business process frameworks, enterprise road maps and end-to-end operations was non-existent in Firms 2 and 1. The information systems department in Firm 2 led the project in *executive technology leadership* (5.00), as in Firm 1, and in *cloud planning* (4.00) and *strategy management* (4.00) in the data center department, but without an *executive business leadership strategy* (0.00) and even without *participation of client departments* (0.00), which if continued in 2011 - 2012 may hinder the information systems department staff in learning of new opportunities in project savings. The factors of *cloud computing "bill of rights"* (0.00) and *service level agreements with technology firms* (2.00) were largely not within the projects in Firm 2 and Firm 1, as the organizations focused on tactical tasks.

Firm 2 was focused more on technical factors than on non-technical factors, in order to gain project savings, but, as in Firm 1, this method might be limiting in the potential of the technology.

Analysis of Firm 3 – Health Care Organization

Firm 3 is a mid-sized health care organization in the northeast that focused on Amazon Elastic Computing (EC2) PaaS and public cloud as delivery and deployment models. The objective of the project in 2010 was to improve the processing of medication simulations of medical researchers. This project was to increase the processing of terabytes of simulations, and to lessen pressure on in-house server systems.

The business factors of *agility* (5.00) and *cost benefits* (4.00) and *customer demand for improved service* (5.00) were the founding drivers of the project, as essentially in Firms 2 and 1. Firm 3 focused more on the tactical technical factors of *elasticity for faster provisioning of scalability* (5.00); *faster delivery of new application systems* (5.00) and *technologies* (5.00); and *technologies* (5.00), *tools* (5.00) and *utilities of the technology firms* (5.00), as in Firms 2 and 1. Neither *program management* (0.00) nor even *project management methodology* (0.00) was followed on the project in Firm 3. *Risk management* (0.00) and *security management in the organization* (0.00), and *security provisioning of the technology shops* (0.00), were especially not followed on the project in Firm 3, even though such factors are important on a public cloud. The information systems department was the leader in *executive technology leadership* (5.00) on the project, and as on the Firm 2 and 1 projects, the department was without a *business leadership* (0.00), *management planning* (0.00) and *sponsorship strategy* (0.00). *Infrastructure architecture* (0.00) and the responsibility of the chief architect for overall blueprinting of the technology in Firm 3 were non-existent in the organization. *Responsibilities and roles of organizational staff* (0.00) were without a strategy. This organization, as in organizations 2 and 1, was focused on tactical tasks that precluded strategy.

Overall, Firms 3, 2 and 1 were focused more on technical tasks (means = 2.38) than on procedural (1.78) and business (2.30) tasks. The means of 2.38, 1.78 and 1.50 on the technical, procedural and business factors in Firms 3, 2 and 1 were more than the means of 1.93, 0.48 and 0.75 of these factors in the survey; and the standard deviations of 1.92 and 1.50 of the procedural and business factors in Firms 3, 2 and 1 were more than in the survey, indicating more variability about the means, whereas the standard deviations of 1.77 of the technical factors were less than in the survey, indicating less variability about the means than in the survey. The goal of the firms in the case study was impacting project savings sooner from the technology, but the lack of formalized methodology and strategy might be detrimental to these firms in having further organizational savings in 2011 – 2015.

(Factors analyzed in the case study are detailed in Tables 4 and 5.)

*Firms and organizations are confidentially defined in the study because of competitive considerations in industry.

Summary Analysis of 31 Firms and Organizations of Full Study

The findings from the survey and the case study disclosed benefits from the cloud computing projects of the study. The benefits were disclosed frequently from non-core, low risk projects that were less strategic and more tactical in tasks, confirming the literature on cloud projects (Wittmann, 2010). The business factor of *customer demand for improved service* (standard deviations = 2.40) was the most noticeable in spread about the means (means = 2.13) of the 31 firms.

The projects in the survey and the case study were not enabled enough by formalized methodological or procedural factors that are often the prerequisite on non-cloud computing projects. The projects were not enabled enough by multiple factor procedural processes, also confirming the literature (Healey, 2011). The focus of the information systems departments in the firms and organizations were largely on the technical factors of the technology.

The 10 technical factors of *cloud CSP technology firm location*; *data ownership*; *elasticity for faster provisioning and resource scalability*; *faster delivery of new application systems*; *faster delivery of new technologies*; *management and monitoring* [of technologies]; *multiple cloud CSP technology firm(s)*; *networking technology*; *platform of cloud CSP technology firm(s)*; and *product-specific tools of cloud CSP technology firm(s)* represented almost 39% of the 26 technical factors with means more than 2.00, and *multiple cloud CSP technology firm(s)* represented the most noticeable standard deviations of 2.37.

The impact of governance, process management and strategy not largely evident on the projects due to this focus on technology was that an initial cloud computing strategy, leveraging the potential of the cloud beyond limiting stove-piped tactical tasks, was also not evident in the study.

Overall, the means of 1.98 and the standard deviations of 1.92 on the technical factors were more than the means of 0.60 and 0.90 and the standard deviations of 0.63 and 0.88 on the procedural and business factors of the 31 firms by a differential of almost 2:1 and by a spread more about its means.

In short, the findings from the means, standard deviations and variability of the survey and the case study disclosed that technical factors drove the projects of the study more than the procedural factors or even the business factors that might have been instrumental in initiating strategy.

(Factors analyzed in the summary analysis of the firms and organizations of the study are detailed in Tables 6 and 7.)

Further findings from ANOVA testing disclosed no statistical difference in the means of the business, procedural and technical factors (1.525, 1.130 and 2.155 respectively in values) at the 10% significance level. The F statistic and p value were disclosed to be 3.22 and 0.237 respectively. Within 95% confidence intervals, the difference between means of the overall mean ratings of the factors (i.e., 0.395 business / procedural, -0.630 business / technical and -0.025 procedural / technical factors) were disclosed to be insignificant statistically. The effect of firms in the case study vs. the survey disclosed the F statistic and p value of 10.92 and 0.082 respectively, implying that the ratings of the case study were disclosing statistical differences from the ratings of the survey at the 10% significance level. This implication of this statistic might initiate from the small sample size of the case study.

7. IMPLICATIONS OF FULL STUDY

" … The … power of transformative technologies lies in the [manner in which] they [are] implemented by forward-thinking, business-minded [information technology] leaders (Watson, 2010).

Even though the cloud computing projects and systems in the analysis clearly contributed benefits of convenience and efficiency to the business firms and organizations, the development was not largely enabled by a disciplined method. Governance was not evident on the projects and systems of the study. Governance methodology is important in the implementation, if not the pre-implementation, of cloud computing systems (Lawler and Howell-Barber, 2010) as in any earlier technology. The implication of a lack of program management methodology is that the firms and organizations might be impacted later by the fragmentation and proliferation of incompatible cloud computing data, services and systems (Nunziata, 2010). Formalization of governance in a program management methodology is a desirable initiative.

The focus of the projects and systems was not enabled by interactions of other on-premise systems for the provisioning of services and systems in the firms and organizations. Process management was not evident on the systems of the study. Process reengineering evangelized by senior management of organizations is important in the initiation of strategic inflection points of technologies (Chorafas, p.135, 2011). The implication of a lack of process management reengineering is that the firms and organizations of the study might be impacted by a non-integrated ecosystem of cloud and non-cloud on-premise systems. Process management reengineering is a desired initiative in a cloud computing strategy.

The projects and systems were also not enabled by an evangelized end game strategy. Evidence of the experimental projects of the study in a framework of an incremental marketplace strategy was not largely indicated in the analysis of the systems. Having a strategy is important in the innovative mash-up of private and public cloud systems that service the organizations (Lundquist, 2010). The implication of not having an overreaching strategy is that the organizations of the study might be impacted by non-integration of systems and non-optimization for productive products and solutions that might be in the marketplace sooner (Chorafas, p.134, 2011). Strategy is important in any new technology.

Though the projects and systems in the analysis were not largely enabled by governance, process management reengineering or strategy, they contributed benefits for the firms and organizations of the study. The firms and organizations were essentially experimenting by implementing a few cloud systems as first movers in technology. They were focused on non-core systems, knowledgeable of the immaturity of cloud computing technology. The implication of this method is that these organizations might evolve into best practitioners of cloud computing technology if they integrate governance, process reengineering and strategy on core systems. This may be an ideal method, as cloud computing initiatives in core holistic systems are nascent in industry (McCafferty, 2010).

Lastly, the analysis demonstrated that cloud computing is definitely a feasible proposition, even if not enabling strategy. Firms and organizations are investing in the cloud (Kontzer, 2011). Though the immaturity of the cloud might impact investment, organizations might be informed of interoperability potential and standards through Open Cloud Computing Interface; Open Cloud Manifesto; Open Virtualization Format; Organization for Advancement of Structured Information Standards and Trusted Cloud (Hurwitz, 2010); and Enterprise Cloud Leadership Council (MacSweeney, 2010). The implication of non-investment in the cloud is that organizations might be hindered in having productive if not profitable systems (Tabb, 2010). The importance of cloud computing as an organizational proposition apart from the hyperbole of impact is a criteria for initial investment (Gralla, 2010).

8. LIMITATIONS AND OPPORTUNITIES FOR FURTHER RESEARCH

The research is constrained by the current immaturity of the cloud, evident frequently in non-core private projects that might have the less disciplined methodology of the projects in the study. Further constraining the study is the focus on systems of firms divulged from practitioner publications, essentially constraining generalization of the findings. However, the study forms a framework good for guiding managers in firms and organizations in an initial cloud strategy. In a new study in 2012, the authors hope that they are afforded a field in which the cloud has progressed to core systems. The field of cloud computing is ideal for future opportunities in research.

9. CONCLUSION OF STUDY

This study of the cloud can benefit competitive differentiation of business firms as they invest in the technology. Findings from the survey and the case study inform that technical factors of improved processing are driving projects more than procedural factors, and that the projects of this study have less formality and governance methodology of planning that might otherwise facilitate an initial cloud computing strategy. More structured methodology might identify issues before they become later problems. Firms and organizations might adopt cloud computing projects and systems cautiously, maximizing benefits and minimizing risks, with the factors of the model defined in the study. Further scholarly study of the cloud is required in order to solidify the findings of the study. This study furnishes a foundation for future investment in cloud computing methodology and technology.

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APPENDIX

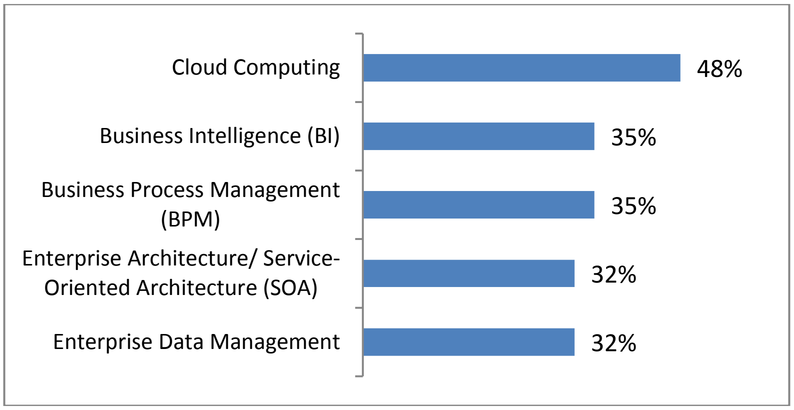

Figure 1: Firms Focusing More on Cloud than on Other Computing Methodologies

Source: Johnson, C., & Levien, S. (2010). Top technology priorities – CIO survey. *CIO*, April 1, 8 [Adapted].

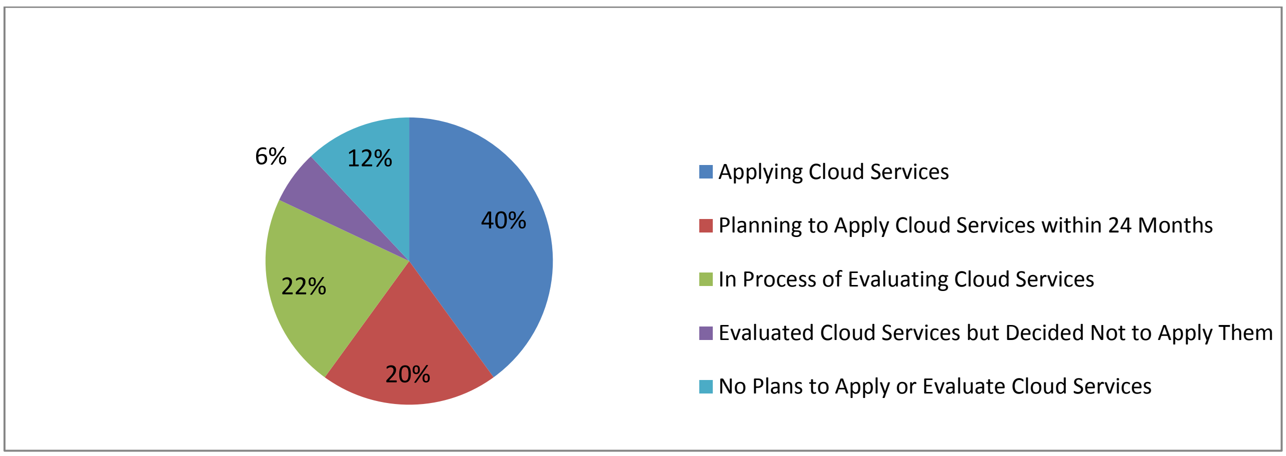

Figure 2: Firms Evaluating or Integrating Cloud

Source: ______ (2010). How is your company approaching cloud services?: Cloud computing & information technology staffing survey. *Information Week Analytics*, June [Adapted].

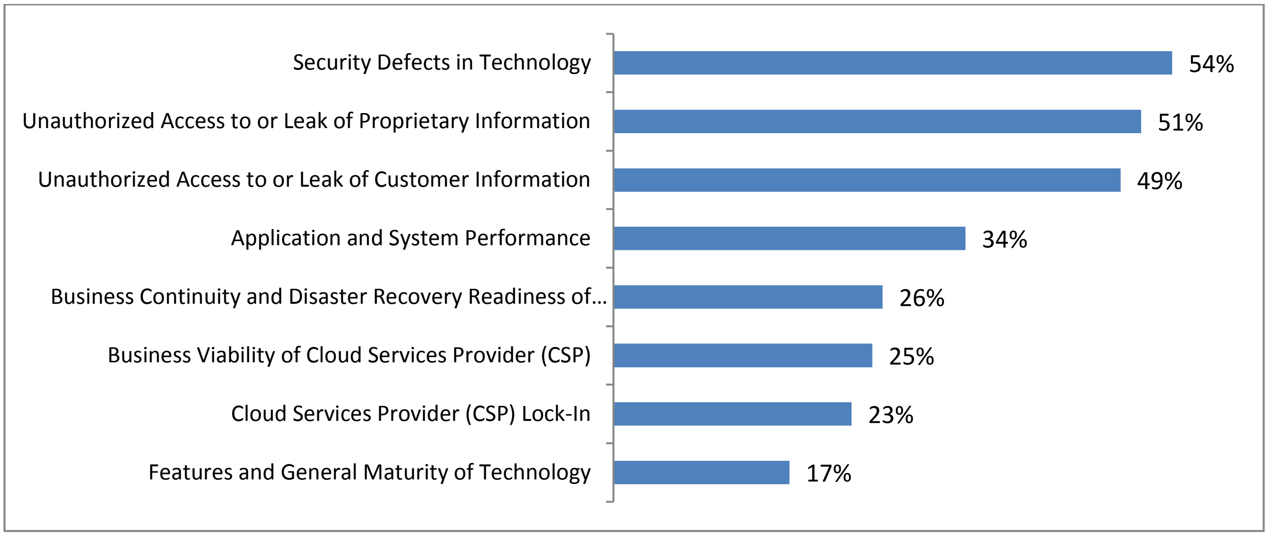

Figure 3: Concerns in Cloud Computing Maturity

Source: ______ (2010). What are your topic computing concerns?: Cloud survey. *Information Week Analytics*, October [Adapted].

Table 1: Descriptive Summary of Firms and Organizations of Study

Industry Sectors	Firms and Organizations		Cloud Models					
	Survey	Case Study	Delivery			Deployment		
			IaaS	PaaS	SaaS	Private	Public	Hybrid
Automotive	3	-	-	-	3	3	-	-
Business Services	3	-	-	1	2	-	-	3
Chemical	1	-	-	-	1	1	-	-
Energy Research	-	1	-	1	-	-	1	-
Financial Services	4	1	1	1	3	3	-	2
Food	6	-	2	-	4	1	2	3
Health Care	4	1	-	3	2	-	1	4
Pharmacy	2	-	-	-	2	-	-	2
Technology	5	-	-	-	5	5	-	-

Table 2: Analysis of Factors of 28 Firms from Literature Survey

Business Factors	Means	Standard Deviations
Agility Benefits	0.89	1.77
Competitive Market	0.36	1.31
Cost Benefits	2.82	2.36
Customer Demand for Improved Service	2.00	2.37
Executive Business Leadership	0.57	1.45
Executive Sponsorship	0.25	0.93
Executive Technology Leadership	0.25	0.93
Organizational Change Management	0.14	0.76

Participation of Client Organizations	0.18	0.67
Regulatory Requirements	0.29	0.90
Strategic Planning of Organization	0.54	1.35

Procedural Factors	**Means**	**Standard Deviations**
Business Process Management	0.96	1.91
Candidate Application Selection	2.82	0.39
Change Management	0.29	1.08
Cloud Computing Center of Excellence	0.00	0.00
Cloud Planning	0.21	0.52
Continuous Improvement Process	0.29	1.05
Costing Techniques	1.07	1.56
Education and Training	0.00	0.00
Infrastructure Architecture in Organization	0.25	0.93
Problem Management	0.00	0.00
Process Deployment Techniques	0.07	0.38
Program Management Methodology in Organization	0.00	0.00
Project Management Methodology in Organization	0.64	1.37
Responsibilities and Roles	0.29	0.57
Risk Management	0.36	0.75
Security Management	0.54	0.96
Service Orientation of Organization	0.75	1.44
Standards Management	0.07	0.38
Strategy Management	0.50	1.32
Technology Firm Evaluation Process	0.39	0.99

Technical Factors	**Means**	**Standard Deviations**
Cloud Computing "Bill of Rights" with CSP Technology Firm(s)	0.25	0.93
Cloud Computing Data Model of Organization	0.89	1.81
Cloud CSP Technology Firm Location	3.29	0.66
Continuous Processing	3.00	1.94
Data Ownership	4.89	0.42
Elasticity For Faster Provisioning and Resource	4.25	1.35

Scalability		
Faster Delivery of New Application Systems	4.18	1.02
Faster Delivery of New Technologies	4.32	1.06
Integrated Non-Cloud Application Systems of Organization	0.00	0.00
Integrated Non-Cloud Application Systems with External Organizations	0.00	0.00
Management and Monitoring	5.00	0.00
Multiple Cloud CSP Technology Firm(s)	3.11	2.39
Networking Technology	5.00	0.00
Non-Integrated Cloud Application Systems of Organization	0.00	0.00
Non-Integrated Cloud Application Systems with External Organizations	0.00	0.00
Open Standards	0.00	0.00
Platform of Cloud CSP Technology Firm(s)	4.71	0.46
Product-Specific Tools of Cloud CSP Technology Firm(s)	3.39	1.87
Product-Specific Utilities of Cloud CSP Technology Firm(s)	0.46	1.37
Proprietary Technologies of Cloud CSP Technology Firm(s)	0.00	0.00
Security Provision of Cloud CSP Technology Firm(s)	0.61	1.37
Service Level Agreements with Cloud CSP Technology Firm(s)	0.21	0.79
Service Oriented Architecture (SOA) of Organization	2.00	2.37
Standards Organization Membership of Cloud CSP Technology Firm(s)	0.00	0.00
Standards Organization Membership of Organization	0.00	0.00
Technology Process Management of Organization with Cloud CSP Technology Firm(s)	0.68	1.49

Legend: 5 – Very High, 4 – High, 3 – Intermediate, 2 – Low, 1 – Very Low, and 0 in Perceived Enablement of the Factors in a Cloud Computing Strategy

Table 3: Analysis of Categorical Factors of 28 Firms from Literature Summary

	Means	**Standard Deviations**
Business Factors	0.75	0.87
Procedural Factors	0.48	0.64
Technical Factors	1.93	2.00

Table 4: Analysis of Factors of 3 Firms from Case Study

Business Factors	**Firm 1 Means**	**Firm 2 Means**	**Firm 3 Means**	**Summary Means**	**Summary Standard Deviations**
Agility Benefits	5.00	5.00	5.00	5.00	0.00
Competitive Market	0.00	4.00	0.00	1.33	2.31
Cost Benefits	3.00	5.00	4.00	4.00	1.00
Customer Demand for Improved Service	5.00	0.00	5.00	3.33	2.89
Executive Business Leadership	0.00	0.00	0.00	0.00	0.00
Executive Sponsorship	0.00	0.00	0.00	0.00	0.00
Executive Technology Leadership	5.00	5.00	5.00	5.00	0.00
Organizational Change Management	0.00	0.00	0.00	0.00	0.00
Participation of Client Organizations	4.00	0.00	5.00	3.00	2.65
Regulatory Requirements	0.00	4.00	0.00	1.33	2.31
Strategic Planning of Organization	3.00	4.00	0.00	2.33	2.08

Procedural Factors	**Firm 1 Means**	**Firm 2 Means**	**Firm 3 Means**	**Summary Means**	**Summary Standard Deviations**
Business Process Management	0.00	0.00	0.00	0.00	0.00
Candidate Application Selection	4.00	4.00	4.00	4.00	0.00
Change Management	2.00	2.00	3.00	2.33	0.58
Cloud Computing Center of Excellence	4.00	3.00	3.00	3.33	0.58
Cloud Planning	3.00	4.00	2.00	3.00	1.00
Continuous Improvement Process	3.00	3.00	3.00	3.00	0.00
Costing Techniques	1.00	5.00	5.00	3.67	2.31
Education and Training	0.00	0.00	0.00	0.00	0.00
Infrastructure Architecture in Organization	3.00	4.00	0.00	2.33	2.08
Problem Management	0.00	3.00	5.00	2.67	2.52
Process Deployment Techniques	0.00	0.00	0.00	0.00	0.00
Program Management Methodology in Organization	0.00	4.00	0.00	1.33	2.31

Project Management Methodology in Organization	2.00	0.00	0.00	0.67	1.15
Responsibilities and Roles	0.00	0.00	0.00	0.00	0.00
Risk Management	2.00	4.00	0.00	2.00	2.00
Security Management	1.00	4.00	0.00	1.67	2.08
Service Orientation of Organization	0.00	0.00	0.00	0.00	0.00
Standards Management	0.00	0.00	0.00	0.00	0.00
Strategy Management	0.00	4.00	0.00	1.33	2.31
Technology Firm Evaluation Process	5.00	3.00	5.00	4.33	1.15

Technical Factors	**Firm 1 Means**	**Firm 2 Means**	**Firm 3 Means**	**Summary Means**	**Summary Standard Deviations**
Cloud Computing "Bill of Rights" with CSP Technology Firm(s)	1.00	0.00	0.00	0.33	0.58
Cloud Computing Data Model of Organization	1.00	4.00	0.00	1.67	2.08
Cloud CSP Technology Firm Location	0.00	3.00	0.00	1.00	1.73
Continuous Processing	0.00	5.00	0.00	1.67	2.89
Data Ownership	4.00	5.00	5.00	4.67	0.58
Elasticity for Faster Provisioning and Resource Scalability	5.00	5.00	5.00	5.00	0.00
Faster Delivery of New Application Systems	5.00	5.00	5.00	5.00	0.00
Faster Delivery of New Technologies	5.00	5.00	5.00	5.00	0.00
Integrated Non-Cloud Application Systems of Organization	5.00	5.00	0.00	3.33	2.89
Integrated Non-Cloud Application Systems with External Organization(s)	5.00	5.00	0.00	3.33	2.89
Management and Monitoring	4.00	5.00	5.00	4.67	0.58
Multiple Cloud CSP Technology Firm(s)	5.00	4.00	0.00	3.00	2.65
Networking Technology	4.00	4.00	0.00	2.67	2.31
Non-Integrated Cloud Application Systems of Organization	0.00	4.00	0.00	1.33	2.31
Non-Integrated Cloud Application Systems with External Organizations	0.00	4.00	0.00	1.33	2.31
Open Standards	0.00	0.00	0.00	0.00	0.00
Platform of Cloud CSP Technology Firm(s)	4.00	0.00	5.00	3.00	2.65

Product-Specific Tools of Cloud CSP Technology Firm(s)	4.00	5.00	5.00	4.67	0.58
Product-Specific Utilities of Cloud CSP Technology Firm(s)	2.00	5.00	5.00	4.00	1.73
Proprietary Technologies of Cloud CSP Technology Firm(s)	1.00	5.00	0.00	2.00	2.65
Security Provision of Cloud CSP Technology Firm(s)	1.00	2.00	0.00	1.00	1.00
Service Level Agreements with Cloud CSP Technology Firm(s)	1.00	2.00	5.00	2.67	2.08
Service-Oriented Architecture (SOA) of Organization	0.00	0.00	0.00	0.00	0.00
Standards Organization Membership of Cloud CSP Technology Firm(s)	0.00	0.00	0.00	0.00	0.00
Standards Organization Membership of Organization	0.00	0.00	0.00	0.00	0.00
Technology Process Management of Organization with Cloud CSP Technology Firm(s)	2.00	0.00	0.00	0.67	1.15

Table 5: Analysis of Categorical Factors of 3 Firms from Case Study

	Means	**Standard Deviations**
Business Factors	2.30	1.92
Procedural Factors	1.78	1.50
Technical Factors	2.38	1.77

Table 6: Summary Analysis of Categorical Factors of All 31 Firms

	Means	**Standard Deviations**
Business Factors	0.90	0.88
Procedural Factors	0.60	0.63
Technical Factors	1.98	1.92

Table 7: Summary Analysis of Factors of All 31 Firms

Business Factors	**Means**	**Standard Deviations**
Agility Benefits	1.29	2.08
Competitive Market	0.45	1.41
Cost Benefits	2.94	2.28
Customer Demand for Improved Service	2.13	2.40
Executive Business Leadership	0.52	1.39
Executive Sponsorship	0.23	0.88
Executive	0.71	1.68

Technology Leadership		
Organizational Change Management	0.13	0.72
Participation of Client Organizations	0.45	1.26
Regulatory Requirements	0.39	1.09
Strategic Planning of Organization	0.71	1.49

Procedural Factors	**Means**	**Standard Deviations**
Business Process Management	0.87	1.84
Candidate Application Selection	2.94	0.51
Change Management	0.48	1.21
Cloud Computing Center of Excellence	0.32	1.01
Cloud Planning	0.48	1.06
Continuous Improvement Process	0.55	1.29
Costing Techniques	1.32	1.81
Education and Training	0.00	0.00
Infrastructure Architecture in Organization	0.45	1.21
Problem Management	0.26	1.03
Process Deployment Techniques	0.06	0.36
Program Management Methodology in Organization	0.13	0.72
Project Management Methodology in Organization	0.65	1.56
Responsibilities and Roles	0.26	1.03
Risk Management	0.52	1.12
Security Management	0.65	1.11
Service Orientation of Organization	0.68	1.45
Standards Management	0.06	0.36
Strategy Management	0.58	1.41

Technology Firm Evaluation Process	0.77	1.54

Technical Factors	Means	Standard Deviations
Cloud Computing "Bill of Rights" with CSP Technology Firm(s)	0.26	0.89
Cloud Computing Data Model of Organization	0.97	1.82
Cloud CSP Technology Firm Location	3.06	1.03
Continuous Processing	2.87	2.03
Data Ownership	4.87	0.43
Elasticity For Faster Provisioning and Resource Scalability	4.32	1.30
Faster Delivery of New Application Systems	4.26	1.00
Faster Delivery of New Technologies	4.39	1.02
Integrated Non-Cloud Application Systems of Organization	0.32	1.25
Integrated Non-Cloud Application Systems with External Organizations	0.32	1.25
Management and Monitoring	4.97	0.18
Multiple Cloud CSP Technology Firm(s)	3.10	2.37
Networking Technology	4.77	0.92
Non-Integrated Cloud Application Systems of Organization	0.13	0.72
Non-Integrated Cloud Application Systems with External Organizations	0.13	0.72
Open Standards	0.00	0.00
Platform of Cloud CSP Technology Firm(s)	4.55	0.96
Product-Specific Tools of Cloud CSP	3.52	1.82

Technology Firm(s)		
Product-Specific Utilities of Cloud CSP Technology Firm(s)	0.81	1.74
Proprietary Technologies of Cloud CSP Technology Firm(s)	0.19	0.91
Security Provision of Cloud CSP Technology Firm(s)	0.65	1.33
Service Level Agreements with Cloud CSP Technology Firm(s)	0.45	1.18
Service Oriented Architecture (SOA) of Organization	1.81	2.33
Standards Organization Membership of Cloud CSP Technology Firm(s)	0.00	0.00
Standards Organization Membership of Organization	0.00	0.00
Technology Process Management of Organization with Cloud CSP Technology Firm(s)	0.68	1.45