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Cloud Computing: Changing Paradigms for Information Systems Development Service Providers and Practitioners

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Abstract

Cloud computing has changed the way that management information systems (MIS) service providers and their employees conduct business and perform key tasks. This emerging cloud paradigm has significantly impacted the industry providing MIS database development services by instituting and demanding new employee roles and competencies through introduction of new ways that work processes are performed, and through provisioning of new service models by development contractors. This paper examines how cloud computing has altered the traditional professional technical competencies, as well as how the growth of cloud computing is impacting service provider activities by focusing on database development processes. The paper concludes with recommendations on what service providers and their employees must do to remain relevant, competent, current, and competitive as the cloud computing paradigm continues to emerge.

Keywords: cloud computing, MIS services, database development, systems development, information systems services, systems analysis.

1. INTRODUCTION

This paper discusses the effects of cloud computing on management information systems service providers and their employees performing enterprise system database development projects, one of the major development efforts pursued by many development organizations. The information systems field is undergoing a paradigm shift, with cloud computing significantly and successfully changing business models and work processes, not only for enterprises that are information systems end users, but also for contractors and providers of information systems development and implementation services. It is postulated that emerging cloud technologies are simplifying and automating traditional information systems infrastructure preparation and set-up processes. These paradigm alterations are contributing to significant changes to the systems development service provider roles, functions, technical skill requirements, as well as key provisioning processes.

The cloud computing impacts are pervasive and well recognized as major drivers of change in the industry. These impacts include dynamic scalability and increased usage of virtualized compute and storage resources that can be accessed as services through an Internet connection. The shift to the cloud has been predicted to have a significant, primarily positive impact on organizations operating in environments facing budget shortages. Cloud environment resources are said to mitigate the limitations originations face when making significant investments in their computers and network devices. This situation can be found in academic organizations where researchers have posited that cloud-based applications offered by service providers can be implemented to perform new and expanding business and academic functions required by the organizations. Of critical importance is answering questions about what must be changed to enable institutions like those in academic environments to capitalize on the benefits of cloud enabled applications for educational or other institutions (Ercan, 2010). However, while asking this important question, Ercan did not address how legacy applications are to be supported and maintained while the benefits of the cloud enabled applications are captured during the change processes.

It is widely accepted that the information systems field is defined as leveraging technology to solve business problems. For management information systems service contractors, a large portion of this work involves database systems development projects. The emergence of cloud computing has radically changed the service delivery paradigm for these service providers. Well established processes and activities associated with these projects are changing, with the result that contractors must change their resource allocations, structures and offerings. At the same time, employees of these service providers must adopt to changing organizational needs to remain relevant. New technical strengths and skills are needed to first acquire cloud services and products that meet the needs of the organization. The acquisition process must be based on very strong business drivers. For example, this means that organizations must know how their spending on compute or storage is increasing and which of the resource needs is costing the organization the most. The key is for the technical staff to be capable of linking the business product and service growth to specific hardware (processor, storage, communication) requirements, systems and licensing costs, new application functionality, and the rate of change or increase in the demand for one or a group of specific resources (Pricing Overview – How Azure Pricing Works, 2017; AWS Cloud Pricing Principles – Amazon Web Services (AWS)). Understanding this data enables an organization to plan for the acquisition of the more competitive cloud services and acquire them at the best prices in the short and the long term based on organization strategic needs and growth.

In specific technical areas, the cloud service can reduce the cost of system development by providing standard operating environments and tools for future system development efforts. Cloud offerings allow one to select a specific operating system, version, utilities, etc. and with only the *push of a button* have the machine available for developer use. Further, when development is complete, the system environment can be closed and resource costs reduced. Thus, if an organization needs a new financial tool, a frequent need, it can be developed at reduced costs and then implemented in a production environment with relative ease.

Cloud Computing Development Overview

Cloud computing consists of using a constellation of computer servers on the internet to store, access and manage data that was traditionally hosted locally on enterprise servers. This change to a remotely hosted cloud paradigm is not merely a switch of locally hosted applications and databases from local servers to remote cloud servers. The cloud architecture has changed the way development service providers interact and *do business* with clients because of the impacts of new business models as shown in the dominant provider pricing and service selections previously referenced.

Management information systems service providers have traditionally used data-base development projects as an end-to-end solution for enterprises seeking process automation or reengineering. Typical job roles in the database development project include project manager, systems analyst, database administrator, developer (programmer), systems/network administrator and security specialist, among others.

The legacy database development project consists of a project manager, who oversees the project and sends systems analysts to interact with the customer and capture their business process. The customer typically has a business problem or process that needs improvement. To solve this business problem, the service provider hired by the customer performs problem analyses, and identifies user requirements describing the information users need for business decision making. Such projects are endeavors with a beginning and an end, designed to produce a product or a service, and to resolve problems.

As the formal project is chartered, a systems analyst is directed by the project manager to capture the business process details, develop user stories and use cases, suggests a solution in the form of a database design and development project. The target project will be the creation and implementation of a system giving managers access to the data and the decision relevant information. The systems analyst then takes this business process information and develops a plan, or requirement to build an information system that will improve the business process. When the developer can change or improve the current process, it is referred to as business process reengineering. Therefore, the outcome of the systems analysis is usually a clear requirements document supporting analyses, a database schema to be used to build the proposed system, and a project plan for the efforts required.

The systems analyst, under the supervision of the project manager, then works with database specialists and developers to build an application, or program, that allows entry, modification and deletion of the data in the database. The data are then put into customized management reports, so that managers and executives can make informed decisions. The data are kept in databases, which are managed by database administrators.

Once the new application is designed and built, it is frequently (for the past ~ 20 years or so) implemented as a distributed system. These are referred to as distributed systems because they can be accessed from many points. They are also known as client-server systems, because the data are served up on a server computer, and accessed by a client computer. The internet can be viewed as such a system. Intranets are local versions of the internet with restricted access which execute inside organizations. The people who manage these are network administrators and system administrators.

Against this basic set of fundamental high-level processes, the roles of the people working in information systems development, including the project man-agers, systems analysts, database administrators, network administrators, system administrators and developers, and security specialists are changing because of the *way* cloud computing is changing the focus, content, technical requirements, business costs structure and alternatives for providing these essential MIS services. The changes are driven by the ever expanding appetite organizations have for IT. Simply said, everyone wants more servers, storage, licenses, support, systems features, tools, etc. This has driven the demand for IT professionals and skills to extreme level to support the servers, storage, WANs, LANs, exploding endpoint devices, with access needed to all of these applications and data all the time, while also keeping it secure. It is easy to see why this exploding growth in IT demand is both unaffordable and unsustainable from a technology, personnel and skills perspective. It is also difficult if not impossible to manage from a governance perspective - difficult trade-off decisions about what organization office, or unit will get the investment dollars to obtain the resources and support they believe they need.

It is suggested that this combination of factors, like a perfect storm, is making cloud a new era, with a new paradigm for development that we will explore in the context of database project development and implementation. This paper describes how the roles and tasks of the providers are changing due to the new technologies and technical capabilities of the cloud, the new processes that are altering the work steps, and what service providers and practitioners must do to remain relevant in the industry.

As evidence of this change, database systems development is explored to assess the impacts of cloud computing upon the initial phases of the database development project described above. However, we note the impacts described are only illustrated with the exploration of database development. The considerations explored also have deep impacts on the development of other functional and enterprise systems, communication processes and programs, and information tools broadly used by organizations in the future.

We have identified several new technologies and competencies introduced into the roles of MIS providers. Cloud computing can deliver cost efficiencies and flexibility if organizations address ongoing fears of compromised data and systems where the risks can be mediated through trusted computing and computation-supporting encryption (Chow et al., 2009). Trusted Computing utilizes a trusted monitor at the cloud server that audits and monitors activity within the cloud environment. This monitor provides *proofs of compliance* with access and control policies that are established by the data owner, and are assured of not being violated. The monitor is securely bootstrapped, and operates beside but isolated from the operating system and applications in the cloud environment. It effectively enforces the defined access control policies and executes the monitoring/auditing tasks. The code of the monitor is signed, and statements of compliance are provided by the monitor to show the data owner the monitor is functioning, and that the cloud has implemented the defined access control policies. An alternative technique for maintaining data control encrypts all cloud data (Bansal, 2012). Combined cryptography and database tools to solve these problems through end-to-end encryption technology and encryption methods ensuring that files cannot be decrypted in the cloud. This ensures that a decryption key is required to gain access to the data (Tresorit, 2011).

2. LITERATURE REVIEW

Cloud Computing

There have traditionally been various definitions of cloud computing. Plummer et al. (2009, p. 1) defines cloud computing as "a style of computing in which scalable and elastic IT-enabled capabilities are delivered as a service to external customers using Internet technologies." Cloud computing basically consists of using remotely stored processing resources and data instead of locally hosted servers or computers. Among the various definitions, the National Institute of Standards and Technology (NIST) definition is the most often cited, and is thus arguably the most widely accepted definition. This definition was developed by Mell & Grance (2011).

According to Mell & Grance, (2011, p.2), cloud computing is "a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction."

Mell & Grance (2011) further define cloud computing in terms of characteristics, and service and deployment models. Characteristics include on-demand self-service, broad network access, resource pooling, rapid elasticity or expansion, and measured service.

Service models include Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS) (Mell & Grance, 2011). When discussing MIS or database development as a service for the purposes of this paper, the cloud computing service models are included, but the services provided by the cloud provider and employees also include development of those platforms, soft-ware and infrastructure as an end-to-end solution for the enterprise client.

According to Mell & Grance (2011), deployment models include private, hybrid, community and public models. Private clouds are those owned by an organization or enterprise. Public clouds provide services, typically commercially, to multiple clients using an infrastructure that is shared between customers. Examples of public cloud providers include Amazon Web Services, Microsoft Azure and Google Cloud Platform. Hybrid clouds are often used to leverage the security of the private cloud with the scalability and other advantages provided by the public cloud. In the hybrid paradigm, Community clouds are those used by a group of users with similar interests, and are thus advantageous to the community.

The assessment of the value and concerns with cloud computing have been dis-cussed from the business-related perspective with the identification of the strengths, weaknesses, opportunities and threats for the cloud computing industry, and for the different stakeholders of cloud computing. Recommendations for the practitioners who will provide and manage this technology have been out-lined, and key issues facing governmental agencies who will regulate cloud computing have been identified. (Marston et al., 2011)

Adoption of cloud technology is also a significant issue. Research has been conducted on factors that affect adoption of cloud computing in the enterprise. Low, Chen and Wu (2011) focused on the high-tech industry, using eight factors including relative advantage, complexity, compatibility, top management support, firm size, technology readiness, competitive pressure, and trading partner pressure. These factors were analyzed in a survey of 111 firms in Taiwan's high tech industry. The research found that relative advantage, top management support, firm size, competitive pressure, and trading partner pressure characteristics significant affected on the adoption of cloud computing. The data indicate that cloud computing service providers may improve usage with a better understanding of specific industry cloud computing adoption characteristics. Firms must appreciate and apply appropriate methods to successfully improve the adoption and usage of information technology cloud investments when implementing cloud computing. In a further cloud adoption study, the results suggest that business process complexity, entrepreneurial culture and compatibility and application functionality similarities between the cloud offerings and current systems positively affect a firm's likelihood of adopting cloud computing (Wu et al., 2013). Finally, a research study by Lian, Yen, and Yang (2014) showed that the 5 most critical factors impacting cloud adoption in Taiwan hospitals are data security, perceived technical competence, cost, top manager support, and complexity.

The literature suggests that the cloud operational benefits include improved scalability, flexibility and reliability over local systems, with virtualization making changes in resources transparent to users. These cost control benefits (known infrastructure from a basic operating environment, automated push deployment, mobile device support, email, standard apps with enterprise licenses, single help desk, tiered user support; defined acquisition process (negotiated and predictable for the enterprise); and elimination of the possible rogue applications, systems, and devices often found during periodic audits, or when clients expired hardware refreshment is required) are true advantages for the organization and IT manager.

These benefits come with significant cost savings. In one case study of the migration of an in-house solution to Amazon EC2 in the oil and gas industry, researchers found that system infrastructure in the case study would have cost 37% less over 5 years on EC2. Support calls for this system could also have been reduced by 21%, but the stakeholder impact analysis revealed that there are significant risks, and perhaps organizational resistance, in such a migration (Khajeh-Hosseini, Greenwood, & Sommerville, 2010). Thus, this new paradigm is not a *perfect* solution, for some risks still exist. Slow adoption processes, user desires to remain independent, limited trust, and high costs associated with data centers and legacy systems that will require support, staffing, system upgrades and applications maintenance until they can be successful migrated or rebuilt in a cloud environment remain threats to the new paradigm.

The significance of cloud computing is summarized in Table 1 below:

Issue Area	**Changes Attributed to the Cloud**	**Comments**
Job Description	Broader, with greater knowledge of systems and tools	Organizations will seek job applicants with greater experience
Roles	Analyst, systems manager, database developer and administrator, programmer	Talented individuals with multiple roles – that may all be called into use in a rapid manner
Skills	Multiple languages, systems, databases	Require deep conceptual acceptance and "rapid" learning of new tools, and languages
Process flow	More rapid application development, shorter set-up and environment preparation	End – to –end acquire to deploy times for application implementati on may be shortened
Business Value	Build upon organization infrastructure sharing, use when needed, requiring project management and business management close collaboration	Must be sold to the organization which may have "stove – pipe" and "mine" ownership mentality ingrained into the organization culture
Business Models	Sharing of infrastructure costs, and attribution of costs directly to using applications and office/ systems	Costs accumulation and equitable distribution models needed (must be understood and agreed to by the organization)
Knowledge of security needs and technologies	Heightened for the entire organization. Advanced understanding of perimeter defense, and attack prevention tools required	Defense depends upon the entire organization. A weak link is a risk for the entire organization.

Table 1. Summary of Impacts

Differential Impacts on Roles and Functions
Assessing the impact of using the cloud on job descriptions, roles and functions is not expressly stated as being required by those organizations espousing and providing cloud services. Examination of the key functions performed in the traditional project shows that the adoption of cloud services has different impacts on the job requirements for an application function previously provided, and may well introduce somewhat new and different needs for the organization adopting cloud as its provider of MIS services and capabilities.

The differential impacts begin with the setup and functioning of the cloud environment (VM, operating systems, utilities, etc.). The differences are stark for the cloud provider will have available functioning interfaces (menu driven – dash-board-like to select the tools and capabilities required). These interfaces will greatly simplify the choices of tools and products needed in the development environment. The developer will only need to point and click to select the features that will be generated for the work activity. General characteristics of a cloud service environment include self-service standardized packages with services that are immediately available and the admonition tools and capability to set-up and provision desired resources for systems processing without any interaction with the company offering the service provider. Users can then configure needed alterations to this environment without coding.

A prime advantage of the cloud is that the services are available at any time and from anywhere with the use of web browsers and Rich Internet Application (RIA) clients. Anywhere means from desktops, laptops, smart phones, tablets, and other hand held devices. Application plugins are not required, and the consuming organization does not need to buy additional hardware or software licenses. The resources offered by the cloud provider are pooled through multitenancy. This concept means that software is installed once. The server and resources are then partitioned virtually so that multiple users (viewed as tenants) operate but with their data and configurations functioning isolated from other tenants. Yet, they share the same servers and storage resources, power, and memory.

The entire environment and resources are scalable and elastic with capacity that can grow with an organization or shrink when resources are no longer required. The growth potential may be limited by the application itself, but expandable because the systems is that can be dynamically allocated based upon the need of the using organization. (IT Manager Daily, 2017)

The system processes interact in a very straightforward manner in the eyes of a user. Operationally, a developer will only have to select the components required, and *push a button* to create the virtual machine and system to be used for the target application to be developed or to execute in the environment created. Obviously, the process is simpler than the world without cloud, but the knowledge required of the developer is much greater. The developer must know the components and versions required and not simply the application requirements, and must still possess the coding skills to develop the logic and routines in the application. Domain knowledge and experience are also mandatory knowledge (data-base/terminology conceptual understanding, accurate business rule development, correct and complete presentation of data, etc.), but after development the launch of the operating environment is straightforward requiring only that the system be made available to end-users via permission controls.

As previously discussed, cloud has a significant impact upon the security considerations for information systems as well. Chow et al. (2009) describe the uses of trusted monitors, encryption, monitoring, and auditing. The system security planning, analysis and administration functions provided by the analysts, developers, and security staff will be changed. Once a system migration to and implementation in the cloud has been made for legacy applications, new systems may be more readily supported and introduced into the security model. These systems will inherit the security provided. As long as legacy systems exist outside of the cloud, prior to a full deployment of all the applications and systems with the new security, all employees will have to understand and utilize both the new security features and share the risks associated with older legacy applications approaches and technologies. The meaning for the security specialists is clear – both approaches and all the technologies must be utilized until a full cloud implementation is completed.

Full and detailed assessment of cloud computing's security impacts will be difficult for many analysts for two primary reasons. The traditional issues of risk assessment determining basic threats and vulnerabilities are not really specific to cloud computing. The concern will need to be understood as primary or basic security issues and then addressed from a framework considering how cloud computing really adds or removes a risk by determining how cloud computing directly impacts each risk factor. As Grobauer, Walloschek, and Stocker (2011) note, cloud computing increases certain previously well-understood vulnerabilities by making them more significant and adds new vulnerabilities that may be cloud-specific and dependent upon the cloud reference architecture used by a provider. There are no longer servers, and WANs between buildings to install, update, and manage from a security perspective. Tools required and applied for monitoring applications, and provisioning users will be managed once – in the cloud and thereafter changed as necessary. This includes firewalls, permissions, configurations for network infrastructure segmentation. The developer will find it relative easy to "spin up" the virtual networks required to segregate financial and person-al data apart from the production sales, engineering, and operating units of an organization (Create a virtual network with multiple subnets, 2017).

Systems analysis, hardware selection, and acquisition functions will be greatly impacted since the cloud environment simplifies the provisioning functions. Analysts will no longer be forced to assess and predict future performance and demand as they have for systems that may eventually require new resources. The changes will be most immediately felt by organizations in time frames and planning cycles. Long lead times to order, perform site selections, provision power, cooling, etc. will be greatly reduced.

However, as Garrison, Kim, and Wakefield (2012) discussed, a shared resource approach may introduce new and important organizational issues dealing with the management of these resources, and a need to share cost allocations or make payments to the cloud resource provider. Comparative data are available from providers that enable organizations to make comparisons so cost of the compute resources can be pre-determined (Samimi & Patel, 2011). The organization participants and offices may have an inadequate understanding about the span, scope, and implementation of the cloud services. The cloud IT investment must be implemented in an optimized manner to capture the reduced costs and improved performance benefits that can deliver a competitive advantage when cloud services meet expectations. Optimization will mean that a resource-based view of the organization will be used to implement shared governance programs in the form of standards, cost sharing models, agreements of terms, definitions and even shared data. An organization wide cost sharing process, decision making hierarchy, standards and guidance for developers, approval process applied via governing board are all mandatory. These organizational procedures may be new, or at least far more explicit when the organization moves to in the cloud. Finally, cloud can be strategic. An organization must address the factors most likely to enable deployment of cloud computing so as to differentiate the organization from its competitors.

How to select a cloud provider is also an important question. The data and issues previously addressed are all incorporated into this decision. It has been explored from various perspectives, such as architecture, cost, services, support and longevity (Buyya, Yeo, & Venugopal, 2008; Buyya, Yeo, Venugopal, Broberg, & Brandic, 2009; Rittinghouse & Ransome, 2016). This will not be fully addressed in this paper, but the key principles involved in making the selection via a clear, rational decision process. However, it should be noted that some heuristic concepts are involved in the decision.

First, it now appears to be a long term decision. Moving to another provider will require significant cost benefits justification once applications have already been migrated and legacy systems shut down. Secondly, there are now three dominant major providers of cloud services that must be realistically included in any decision process. Microsoft, Amazon, and Google appear to be very dominant in the Assessment of the differences among these offers are difficult to make. Observations from marketing materials do not provide the needed support for choosing one provider over another. We observe that materials seems to say that Microsoft has significant Fiber (transport capability, a strong security posture, and obvious desktop applications with an established Office 365 offering.

Amazon has its own fiber network, strong security but a less widely accepted desktop application presence. Google offers networking via fiber, widely used personal applications, but does not have as clear a security model as its other two competitors. It would appear that desktop application preferences might dictate selecting one provider over another, but few technical limitations prevent a large organization from utilizing more than one provider. Assessments must be made by organizations regarding the business and management objective to have a *one shop* policy, single bill/payment process, and strong organizational policy controls. A significant technical question may be the issue of scalability. This is defined from both a total user perspective and from a distribution perspective. The questions are how quickly and with what distributions can the provider accept very large numbers of additional users, disparate divisions, and remote offices (perhaps overseas) with both networking services (in many countries) and tools that provide assured levels of required security.

Skills

There are limited numbers of studies available of skills truly required of cloud developers that have followed various training and teaching programs and related the results to development performance over time. Cloud is a relatively new phenomenon, thus skill requirements may be self-serving and distorted. However, available reach on student performance and cloud development by Vaquero (2011) gives an indication of the impact of changes in skills that support the arguments put forth in this paper. The assessment of the type of cloud most valuable for students based on the technical knowledge required for its usage was assessed for various types of cloud technologies. The scenario used an advanced course on network overlays offered by four professors. The evaluation of the performance of 84 students which types of cloud technologies were useful in educational scenarios, and determined that platform clouds are valued by both students and professors because clouds offered significant improvements over pervious labs. The reason that greater value was derived was that students did not have to significant effort to setting up the software needed to perform the assignments. The components that were most effected were network nodes, databases, mechanical equipment, and the cloud itself (Vaquero, 2011).

Innovation and Business Value

Marston et al. (2011) note that cloud computing allows smaller enterprises to reap the benefits of the cloud's ability to dynamically provision resources, devoting huge amounts of computing power for short periods of time to yield sophisticated data analyses previously available only to bigger enterprises able to support that kind of computing power in-house. Further, they suggest that the cloud al-lows enterprises immediate access to hardware resources, with easy scalability according to demand, and no upfront costs. Finally, and most importantly, they find that cloud computing technology makes applications and services possible that were not available under legacy technologies.

In a 2010 paper, Armbrust et al. state that cloud computing can transform the IT industry, as it allows development of innovative applications without large capital investment. Developers need not worry about over or under-provisioning hard-ware or services, since the scalability of the cloud paradigm allows near instantaneous changes to virtual hardware and services. Marston et al., 2011, note that virtualization is technology that makes physical computing platform characteristics transparent to users. Armbrust et al. (2010) state that the success of cloud computing is due to three new concepts; the appearance of infinite computing resources on demand, the lack of a requirement for up-front investment and the ability to pay for resources and services on a short term basis. There is also savings as costs do not mount until cloud systems are deployed.

In addition to the aforementioned advantages, Iver and Henderson (2010) submit that additional advantages of cloud computing over local hosting include lo-cation independence, sourcing independence, ubiquitous access and virtual business environments.

The literature suggests that the advantages of the cloud computing paradigm change the way that services are provided significantly over the legacy locally hosted paradigms.

3. DISCUSSION

If cloud computing consisted solely of migrating current systems and systems development practices from locally hosted servers to the cloud, that action alone would radically change the systems development process. Migration to the cloud transcends the traditional processes. For example, a large part of the traditional systems analysis consists of determining capacity, performance and reliability of locally hosted system hardware as mentioned above. With the advent of cloud computing, with its increased scalability and reliability, these calculations are no longer relevant, and the specifics of these requirements are provided by and are the responsibility of the cloud provider. The provider would have to state such things as mean time between failures, mean time to restore, capacity and scalability information, etc. Other aspects of the systems analysis are similarly changed from the traditional paradigm. These specific changes include sequence of analysis, return on investment, methodology and others.

In the cloud environment the changes are obvious. The data center goes away, but the networking connections to the cloud and equipment required to connect end-user devises (fixed desktops, printers, and mobile divides) remain. Application appear to move closer to the infrastructure- they are accessible from browsers without the other networking equipment and controls. This is something of an illusion to the user for the network still exists as do the utilities, controls, and security components. They are now *hidden*, for the networks are defined and virtually functioning in the cloud. Access is granted with a link that now permits one to connect as needed.

The process and program deliverable (and development blueprint) for the traditional systems development lifecycle (SDLC) systems analysis is a requirements analysis consisting of a system introduction and planning information, system description including managerial decision making and process model; system requirements including functional capabilities, capacity, reliability and error handling; systems analysis; system design and configuration, including architecture, hardware and software; interface, database, reliability and performance analysis; security and privacy; system implementation and test; and requirements verification. On the other extreme, Agile development processes develop systems on an incremental basis.

Specific analytic processes and new analysis tools must be understood and utilized as cloud computing becomes more prevalent. For example, quantitative risk and impact assessment can be utilized to identify and evaluate the security risks associated with cloud computing's various platforms. A research and analysis framework, known as Quantitative Risk and Impact Assessment Frame-work (QUIRC), is proposed to define the risk of could computing defined as a combination of severity and likelihood of a threat or risk (Saripalli and Walters, 2010). The security threat event probability and impact or severity are important because they can enable analysts to assess the offerings of different cloud vendors. The assessment is conducted against six key security objectives (SO) associated with cloud platforms. The researchers propose that most of the typical attack vectors and security events map to one of these six categories, and utilize a collect the information necessary for assessing security risks with Delphi techniques. It is suggested that risk assessment knowledge bases could be developed for vertical industries. These knowledge bases can then be used as inputs for security risk assessment of cloud computing platforms through a quantitative and iterative convergence approach that aids on a comparative evaluation of the relative robustness of different cloud vendor offerings and approaches (Saripalli & Walters, 2010).

Roles

All of the roles and activities or functions performed within these traditional roles in the systems development processes are affected by the shift to cloud development and agile practices. First, the roles also seem to merge. The systems analyst role is changed in numerous ways. The functional needs to capture a business processes and develop a database schema remain. However, for some projects of low-to-mid complexity, the systems analyst may be able to provision and deploy a database application on the cloud without additional assistance. Time spent working on functional capabilities, capacity, reliability, error handling, some parts of the systems analysis, design and configuration, architecture, hardware and software, database, reliability and all other tenets of the systems analysis are unnecessary or reduced when systems are built using the cloud. Further, there are new tasks that must be added to the analyst role. Opportunities for rapid development and migration are not without costs and organizational impacts. Analysts must concentrate on communications, security, macro backup and disaster scenario analysis and provisioning, administrative controls, and cost modeling and cost sharing perspectives that demand strong governance and collaborative management decisions prior to cloud contract acceptance and implementation activities.

A requirement in legacy systems development was supported with systems analysts from a variety of sources, as previously mentioned. As cloud paradigms mature, the requirement for support continues to diminish in some areas and shift to different issues. For example, Microsoft Azure now supports Oracle databases. Using such a database involves provisioning the database in Azure, users are not required to configure a virtual server for the database. Making this portion of the task transparent to users mitigates the need for tech support in server administrator tasks, and perhaps other tasks as well, such as database administrators and network engineers. However, unless the organization has some unlimited enterprise-like agreement, service costs and administrative support must be assessed and appropriately structured to address budgeting and planning considerations.

Systems analysts will not have to complete many of the traditional portions of the requirements analysis, as these are relegated to the responsibility of the cloud provider in the new paradigm as previously noted. But they may take on a new set of staff level or organizational roles associated with the management and control of shared resource models.

Effects on practitioners
For employees working for service providers, these changes have a profound effect. Systems analysts may find themselves deploying applications on their own due to the ease of cloud application development. For this, they may want to pursue cloud competencies or commercial certifications such as Amazon Web Services (AWS) Cloud Developer. Alternatively, they may conduct analyses of alternatives to see which cloud or third-party service providers will best meet client needs, and then plan to meet these needs for all of the cloud users in the organization. They may also consider changing the level of their employment. Systems analysts may consider working for cloud providers to develop the tools that IT end users need to deploy MIS applications.

The same principle applies to other roles and competencies. Although there will always be a role for networking practitioners to ensure local network connectivity, the need to maintain connectivity for distributed systems may no longer exist. Security professionals may not be needed to secure those distributed systems, but may now need to focus much more closely on the end-point security needed to protect this shared environment. Currently, IT departments control and monitor security on locally hosted resources, both during development, and during the ensuing operations. In the cloud paradigm, customers are reliant on controls and compliance provided and certified by cloud providers. Thus, contractor IT departments to control and monitor cloud security, institutions are reliant on controls and compliance by cloud providers. Many institutions lack the resources to evaluate or audit cloud provider resources. Database administrators may not be as busy managing the integrity and availability of data as the emerging cloud paradigm makes database management easier and more reliable. These database administrators may keep themselves relevant by developing competencies analyzing the ever larger amounts of data generated by the cloud applications. This may be accomplished by intra-organizational cross department analysis methodologies that are now possible. Project managers need to adapt to all of the changes affecting other roles and systems to maintain their relevance. A new role – data analytics or knowledge management many be needed.

New roles
There are opportunities to develop new competencies for maintaining relevance in the cloud driven world. An example of this is the compliance role. Third party providers may have the lead in addressing regulatory issues. One third party provider suggests that they can comply based on their provision of a dedicated disk controller and storage media owned by the institution, and serviced by the third party provider. Emerging paradigms may result in third party providers addressing compliance issues by adopting substantially equivalent alternative standards, implementing alternative compliance schema, or by demonstrating compliance themselves, thus transferring compliance responsibility from institution to provider. The final solution remains unclear, as cloud technology and business cases continue to emerge. However, assessment and audit of these new compliance methodologies may be a new role for practitioners to leverage.

Technical support for end users beyond the custom application may be transferred from the local help desk to the cloud provider. It may be that the help desk may triage trouble calls, and decide which problems can be handled locally, and which should be transferred. It is also possible that help desk services may be provided through the SaaS model.

Effects on Service Providers
MIS development service providers obviously need to consider how these changing roles affect their profit models. Those providers with rate schedules must examine their rate structure to ensure that they have the proper labor categories to support cloud development. New categories such as cloud developers, auditors, etc. must be added to schedules. New organizational structures must be developed to create teams to do cloud development. For example, when users migrate to Azure, there are whole teams to assist with the migration.

For those providers providing end-to-end solutions, the complete business process must be examined, perhaps jointly with the service providers who may assist or complete a migration. For providers providing software and hardware with wholesale partners, these arrangements may have to be reviewed, and new partnerships negotiated. A service provider used to receiving a markup on hardware may need to change their business model to transfer that revenue from the hardware to a markup on cloud services. As the business model is reviewed, all aspects of the model must be examined.

Traditional overhead costs might not be able to be absorbed by the new cloud paradigm, and some functions previously charged to overhead may no longer be necessary or supportable. There are of course many other areas where service providers need to review their business model, but these examples provide a glimpse of the depth to which providers must review their processes due to the change to a cloud paradigm.

How such changes are viewed by customers will also be very important. The organizations acquiring cloud services will find new infrastructure alternatives and competing features difficult to assess. Further, the business models used to ac-quire services, allocate capital expenditures to programs, offices, and divisions will lack maturity and organization wide understanding. Usage costs which must be directly tied to usage and consumption of compute and storage resources (for accurate assessments of ROI) may not yet be built into operating budgets. There-fore, it may be useful (or required in the future) to utilize certification processes in areas such as those suggested by Sunyaev and Schneider (2013) to compare the offerings from various cloud providers so quality and experience of the providers can be assessed and dependable while the organization is developing its own experience and cloud working processes. They recommend that assessment of cloud providers be based on a number of factors that can be collected for all providers and qualitatively (if not quantitatively) assessed. The factors suggested include data such as on-site data center audits, comparisons of contracts and services, service level agreements), legal requirements such as privacy policies, security feature like encryption, API implementations, quality processes and data center infrastructure physical access controls (Sunyaev & Schneider (2013). Although these assessment data are not yet standardized, the providers supplying services to the federal agencies have security standards set and assessed by a formal process. The Federal Risk and Authorization Management Program (FedRAMP) establishes and assesses a broad set of system (including cloud) security requirements. The program is established with working groups from the General Services Administration (GSA), National Institute of Standards and Technology (NIST), Department of Homeland Security (DHS), Department of Defense (DOD), National Security Agency (NSA), Office of Management and Budget (OMB), the Federal Chief Information Officer (CIO) Council and its working groups, as well as with industry input. This federal security program requires cloud service providers to meet the goals and standards set if they seek to deliver systems for use by the federal government. The program covers cloud security issues and requirements in its assessment, and requires uninterrupted checking of cloud offerings (recertification) to ensure that standards are continually met after systems are authorized by the program (Taylor, 2014; Pal, 2012).

4. FUTURE RESEARCH

The cloud paradigm continues to emerge, and will for some time. It is anticipated that the technical and architectural changes to cloud offerings will continue to change the way that cloud developers conduct business. The importance of new business models has been critical to the success of many organizations in the IT area. For example, mobility that enhances or promotes increasing productivity in work activities can be viewed as a major beneficiary of the cloud. Organization requirements to compete in the mobile business surge may create a demand for new development processes and skills to meet the needs of competitors in many industries. Studies of cloud provider collaborative options and offerings may be needed to ensure how cloud services can be maximized for customers that are widely distributed. At this time, large enterprises can acquire services from the three large providers (Amazon Microsoft, Google) but new alternatives and wide needs for cloud may drive demands that are not yet present in the market.

Studies based on an ethnographic approach may yield insight into how the cloud is affecting service providers. Meta analyses of cases and papers on cloud development scenarios may discover trends on how the cloud is affecting development services and which organizations are making the best use of cloud advantages. Case studies of entrepreneurial organizations and startups could show that the cloud eliminates the extensive infrastructure investments and long lead times needed to expand a new business. Thus, cloud may be a first order driver of new business opportunities and new organization growth.

Research studies of organizations with different characteristics (older, large capital investments, regulated, regionally focused, government, etc.) are needed to assess the types of cloud services (hybrid, public, private) that can best meet their business objectives and reduce or control the need for asset investments. Cloud providers, analysts, and staff with in depth domain knowledge may be needed to design cloud offerings that can meet the needs in these organizations. Further research may aid the largest organization with huge infrastructure investments that require periodic refreshes in hardware and software in finding cost effective ways of migrating to the cloud and maintaining the functionality and performance of the legacy applications developed over many years. With empirical case studies and research, predictions may be made of how long and how to what degree infrastructure legacy platforms and investments must be maintained.

Finally, empirical works using survey instruments may provide evidence on how the industry is changing, and what practitioners and providers are doing to maintain their relevance and profit. Benchmarks for effective performance may show that organizations need to develop key cloud components (application approval processes, governance policies, standard operating environments that can be deployed across the organization) and security controls (no access for any unknown devices to organization networks, no permitted access even for known divides unless operating systems, security software, and compliance with version and policy standards) are met.

5. SUMMARY

The legacy database development project model consisting of a project manager directing systems analysts to interact with the customer and capture their business process seems dated in the age of cloud. Although cloud acceptance is a concern, as experienced or cloud accepting customers encounter business problems there may be a growing expectation that new tools can be used to more rap-idly address the needs of the user. This change in approach and expectations re-quires that providers and implementers implement work and process improvements, and possibly new MIS roles. To quickly solve this business problem and remain competitive, service providers and end using organizations may wish to develop more rapid solution strategies, and new employee roles that deliver the benefits of the traditional database development project but also overcome the new cloud introduced issues in security, governance, and operations.

6. CONCLUSIONS

MIS development service providers must consider the continuing shift to cloud computing in their current and future business models. Those who have approved GSA schedules for labor rates must consider how the mix, descriptions and qualifications for various labor categories should be changed to ensure that needed resources are available, and properly deployed and billed. For example, if they do not have a range of cloud developer labor categories, the possibility of adding these categories to their schedules must be investigated.

Practitioners working in systems development roles must consider current and future needs regarding competencies, and how those with necessary skills are compensated. A systems analyst currently working in a locally hosted proprietary database environment such as Oracle will likely have sufficient work to last the remainder of their working career, even if they are at the beginning of a career in MIS development. However, regardless of where they fall in the career lifecycle, they can improve their desirability to industry and improve their compensation and career lifespan by adapting to the coming cloud paradigm and developing core competencies that will be in strong demand.

Service providers currently including hardware and software sales, development, provisioning and hosting as services or offerings must adapt their practices to the new paradigm. Those who have partnerships with hardware and software wholesalers must determine how the change to the cloud will impact their offerings. They must change their business model to adapt, by developing similar partner-ships with cloud providers, and by changing their service offerings to match the emerging paradigm. For example, a service contractor providing server security services may need to move away from protecting locally hosted servers, and switch to offering services monitoring and auditing security of cloud providers.

In short, both development service providers and their employees must examine business models and core competencies as the cloud computing paradigm continues to emerge.

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