Journal of Information Systems Applied Research

Volume 11, Issue 3
December 2018
ISSN: 1946-1836

In this issue:

4. Exploratory Study of Organizational Adoption of Cloud based Big Data Analytics
Biswadip Ghosh, Metropolitan State University of Denver

14. Student Intentions and Behaviors Related to Email Security: An Application of the Health Belief Model
Gregory Schymik, Grand Valley State University
Jie Du, Grand Valley State University

25. Text Messaging Today: A Longitudinal Study of Variables Influencing Text Messaging from 2009 to 2016
Alan Peslak, Penn State University
D. Scott Hunsinger, Appalachian State University
S. E. Kruck, James Madison University

35. Cloud Computing: Changing Paradigms for Information Systems Development Service Providers and Practitioners
Lionel Mew, University of Richmond
William H. Money, The Citadel

iscap
Information Systems & Computing Academic Professionals

The **Journal of Information Systems Applied Research** (JISAR) is a double-blind peer-reviewed academic journal published by **ISCAP,** Information Systems and Computing Academic Professionals. Publishing frequency is three issues a year. The first date of publication was December 1, 2008.

JISAR is published online (http://jisar.org) in connection with CONISAR, the Conference on Information Systems Applied Research, which is also double-blind peer reviewed. Our sister publication, the Proceedings of CONISAR, features all papers, panels, workshops, and presentations from the conference. (http://conisar.org)

The journal acceptance review process involves a minimum of three double-blind peer reviews, where both the reviewer is not aware of the identities of the authors and the authors are not aware of the identities of the reviewers. The initial reviews happen before the conference. At that point papers are divided into award papers (top 15%), other journal papers (top 30%), unsettled papers, and non-journal papers. The unsettled papers are subjected to a second round of blind peer review to establish whether they will be accepted to the journal or not. Those papers that are deemed of sufficient quality are accepted for publication in the JISAR journal. Currently the target acceptance rate for the journal is about 40%.

Questions should be addressed to the editor at editor@jisar.org or the publisher at publisher@jisar.org. Special thanks to members of AITP-EDSIG who perform the editorial and review processes for JISAR.

Journal of Information Systems Applied Research

Editors

2018 JISAR Editorial Board

Exploratory Study of Organizational Adoption of Cloud based Big Data Analytics

Biswadip Ghosh
bghosh@msudenver.edu
Computer Information Systems and Business Analytics
Metropolitan State University of Denver
Denver, Colorado 80217, USA

Abstract

Consumers are increasingly using internet applications for ecommerce, mobile, social and business computing. As a result, a large amount of usage data is being gathered and aggregated by ISP's (Internet Service Providers). However, due to the high velocity, massive volume and highly dispersed nature of this "big data", organizations need to adopt new distributed cloud based analytics tools to access and process these data sets. Organizational benefits can result from improved estimates of market demand, identification of client preferences and business trends. Several cloud providers, such as Google, Microsoft, SAP and IBM Watson are advancing analytics tools that can be used by organizations to utilize these big data sets. Most cloud based tools offer convenient, ubiquitous and on-demand access to data sets and services. However, typical challenges include information security, integration and availability, data veracity and the need to build new IT infrastructure and capabilities within the organization. This study applies the TOE framework to identify and rank the factors that impact the adoption of such cloud based analytics tools. The TOE framework identifies three determinants of IT system adoption at the organizational level – Technology, Organization and Environment. Using a survey of medium to large sized companies in a variety of industries, this study finds that having compatible IT infrastructure components and internal firm capabilities for the secure integration of cloud based analytics data and tools and vendor support strongly facilitates the adoption of cloud based analytics, while the lack of an analytics culture and management support can hinder it.

Keywords: TOE framework, Big data, cloud computing, business analytics.

1. INTRODUCTION

Business Analytics (BA) is an expanding business function that has the potential to improve business decision making and supporting data-driven processes. Typical BA tools enable business users to manipulate large data sets and to formulate steps in business decision making by supporting the creation of visualizations and predictive and prescriptive models using advanced statistical techniques. The typical functionalities of such tools include query, selecting and aggregating data from multiple sources, statistical data analysis, report generation and syndication (Chaudhury, Dayal and Narasayya, 2011). With the proliferation of online data sets originating from multiple ecommerce and enterprise applications, business analytics (BA) tools are necessary technology components for organizations to exploit such online data sets.

Recently, there has been a growth in the use of internet services such as mobile commerce and social computing resulting in the proliferation of consumer data collected outside organizational systems. Every minute 217 new mobile web users are added to the internet (Valerdi, 2017). Internet Service Providers (ISP's) continue to accumulate vast amounts of user data from diverse domains including retail transactions, transportation and GPS data, social interactions and consumer behavior, computer gaming, online search engines and web logs that track web site visits. This data is termed "big data" and is vast and is being generated at a high rate through the online activities of users (Gantz and Reinsel, 2011). Big data involves situations that are characterized by the four V's – high velocity, variety, volume and veracity ("uncertainty") (Valerdi, 2017). Organizations, that can utilize this "big data" in concert with their internal enterprise data, may be able to better spot business trends, better manage risks and enhance competitiveness, thereby creating business value. For example, Coca-Cola captures information on what drinks are dispensed from their freestyle dispensers to fine-tune stocking and inventory (Kho, 2017). Also, Duetto Research offers a hotel revenue management SaaS solution that allows hotels to price rooms dynamically, based on dynamic factors such as weather and local events (Kho, 2017).

But most organizations are still grappling with how to unlock Big Data's potential. Over 80% of this big data is unstructured, consisting of textual narratives, images and non numerical values. Moreover, the big data is sparse and distributed across the internet and needs extensive processing. This is very different from the typical highly structured enterprise data generated during business transactions. The volume and high velocity of big data along with it's distributed nature makes it difficult to manage and process with traditional BI tools due to scalability issues. Exiting data warehousing and ETL (Extract, Transform and Load) tools work well with a small limited number of data sources. Beyond 25-30 data sources, data aggregation, cleaning and processing become unmanageable as the present BI tools require strict data schemas and defined storage structures to operate. A typical big data analytics application needs to access heterogeneous data from tens of thousands of internet sources and leverage objective data (e.g., observed transactions and logs) with perceptual data (e.g., survey, sentiment, voice transcript, and interview) in conjunction with various intermediate decisions and actions to predict individuals' behaviors in a variety of applications in marketing, e-commerce, security, health, and finance (Abbasi, Lau, & Brown, 2015). There is a need to harmonize various terms during data generation, translation, dissemination and adoption. As a result, new cloud based technologies and organizational capabilities are needed to integrate big data with enterprise data in order to exploit the potential of the big data universe.

Examples of cloud based BA tools to process big data include Google's BigQuery, which allows the execution of SQL queries on Google's distributed infrastructure and Amazon Redshift, which is a hosted analytical database. Another example is a cloud based tool called Splunk (www.splunk.com), which helps to analyze distributed web logs to create interesting graphs and patterns on web site navigation. These cloud providers such as IBM Watson will play a key enabling role in nearly every facet of big data analytics (IBM, 2017). They are the most important collectors of data streams and content and also provide tools to enable big data use by other organizations through provisioning and transformation of large data pools that can be integrated with existing organizational IT infrastructure.

Regardless of the type of IT tools, chosen approach and vendor, an organization needs to invest in both human and technological resources to build the needed organizational capabilities. For exploiting a combination of internal and external data, important organizational capabilities that focus on ingesting, organizing, processing, generating and syndicating information outputs from heterogeneous data are needed. Consequently, there are calls for more research to understand "what works" and "what enables" the adoption of big data analytics tools (Abbasi, Sarker and Chiang, 2016).

Research Goals

The research goal of this study is to understand the important organizational, environmental and technological factors from the TOE framework that influence the adoption of cloud based "big data" analytics tools by organizations.

1. The study applies the TOE framework to develop and validate a research model that measures the impact of organizational, environmental and technological factors that influence the adoption of cloud based "big data" analytics tools.

2. Identification of the most important factors from the above three dimensions that impact the adoption of cloud based "big data" analytics tools.

. 2. CHARACTERISTICS OF BIG DATA

Examples of big data projects are starting to emerge in diverse industries from healthcare to retail and transportation. Healthcare organizations are leveraging big data to track their patient's compliance with treatment regimens. Insurance companies are managing insured risk profiles using GPS data from cars. Financial applications of big data analytics include revenue and profit forecasting, prediction of loan default, fraud detection, credit scoring and identifying money laundering. Supply chain decisions are changing towards modulating demand rather than forecast based. This is particularly true in industries where the supply is perishable (e.g., airline passenger transportation) and supply chain issues have become linked to the marketing and finance decisions in pricing and promotions. Retail chains are planning and stocking stores based on classification models of their customers with granular data that can predict when and who will visit their store and what they will browse. Other examples include Netflix suggesting a movie rental based on recommendation analysis, dynamic monitoring of embedded sensors in bridges to detect real-time events and longer-term erosion, and retailers analyzing digital video streams to optimize product and display layouts and promotional spaces on a store-by-store basis.

According to Gantz and Reinsel (2011), a staggering 1.8 zettabytes of data were generated in 2011. Current estimates suggest that 1.7MB of data are generated every second by a single user leading to a cumulative daily rate of 2.5 exabytes. Companies such as Walmart, handle more than 1 million customer transactions per hour, producing 2.5 petabytes of data in a 24-hour period. Every minute, there are 98,000 tweets, 695,000 Facebook status updates, 11 million instant messages, 698,445 Google searches, 168 million emails sent over the internet (Valerdi, 2017). Facebook manages 300 million photos and 2.7 billion 'likes' per day, thus adding 100 petabytes of data to its warehouse; and eBay has a single table of web clicks featuring more than 1 trillion rows. There was 5 exabytes of information created between the dawn of civilization through 2013, but that volume of information is now created every 2 days, and the pace is increasing' (Kirkpatrick, 2010).

A major driver of cloud based big data analytics has been the opportunity to leverage the sharply declining cost per performance level of three key information technologies: computing power, data storage, and networking bandwidth. Other benefits of using such cloud based BA tools include fast deployment of BA applications, high scalability to tackle sudden spikes in big data processing workflows and reduction in data movement across the internet by allowing the distributed processing of data on the cloud. Despite these benefits of cloud based BA tools, there are several challenges from a data lifecycle, security/privacy and aggregation perspective. There is a dearth of technical standards to curate this heterogeneous data and limited support for integrating the analytics into process workflows. Therefore, it is undesirable to force fit this data into a global schema and process the data using the traditional BI tools available currently. Typically big data is distributed and dirty with duplicate, ambiguous and missing values and needs to be processed in situ with on-demand, cloud based tools that are collocated with the distributed data sets. The nature of "big data" also leads to "data silos" due to the numerous schemas and heterogeneous sources. Much of the "big data" can also be of varying degree of reliability, conflicting and composed of narratives that require interpretation before it can be used in a business situation**.** Additionally attention must be paid to the variety of use cases from diverse business stakeholders for outputs of the analytics tools. These challenges can be addressed by establishing organizational capabilities along with the adoption of cloud based BA tools (Kho, 2017). Organizations need to perform various data tasks such as data aggregation from multiple heterogeneous sources, data cleaning and validation, data transformations, model generation, and building user interfaces for role based access to the information outputs (Ferranti, et;al., 1998). Decision making scenarios depend on the creation of models that draw on processing of aggregated internal and external data from large dynamic repositories. For structured data, predictive models, such as regression models, allow the creation of models that can facilitate business decision making. However for unstructured "big data", such as blogs and textual information, classification models are popularly used to identify patterns that create meaning.

3. RESEARCH MODEL & HYPOTHESES

Cloud based BA tools are typically adopted at the organizational level as these tools must be integrated into the organization's enterprise IT infrastructure to have the potential to impact multiple business processes and functions. Tomatzky and Fleischer (1990) developed the TOE framework, which identifies three dimensions of an organization's context that impacts it's adoption of new technology. The three dimensions include the technological factors, the organizational (internal) factors and the environmental (external) factors. According to Tomatzky and Fleischer (1990), technological factors determine what technological characteristics influence the adoption and are a combination of the new technology to be adopted along with the organization's current technology. The organizational context describes the characteristics of the organization that can facilitate or hinder the adoption of the technological innovation, such as management support and culture. The environmental context captures the characteristics of the external arena in which the organization conducts its business. The environmental factors include the industrial environment in which the organization conducts its business, influences from its competitors, regulations, business partners and any government entities that it interacts with.

Technology (T) Influence

In the context of cloud based big data analytics applications, three technological factors of the new tools are important: relative advantage, complexity and compatibility. Tomatzky and Klein (1982) showed that both relative advantage and complexity were consistently found to be significant in the prior adoption studies they reviewed. Furthermore, these two attributes are identified as critical adoption factors in numerous prior IS research studies (Jayaraj, Rottman and Lacity, 2006; Kwon and Zmud, 1987).

Relative Advantage is defined as the degree to which the technology is perceived as better than the existing tools it supersedes (Rogers, 1995). Relative advantage renders the usefulness of the new analytics tools and technology and positively influences the users in their adoption (Agarwal and Karahanna, 2000; Keil, Beranek and Konsynski, 1995). This leads to the first hypothesis:

Hypothesis 1: Relative advantage will have a significant positive effect on the adoption of cloud based BA applications.

Complexity is defined as the degree to which an innovation is perceived as difficult to understand, use and manage (Rogers, 1995). The degree of complexity of an analytics tool or application can be an inhibitor to its trial and usage (Agarwal and Karahanna, 2000; Gefen, Karahanna and Straub, 2003). BA applications are inherently complex, due to a large number of parameters, data discrepancies, a plethora of algorithms and their technical configuration to run the analysis and get and interpret results to apply to the business decision to be made. Published reports indicate that fewer than 30 percent of enterprise users who have access to BA tools actually use the technology due to the complexity of getting it going (Gartner, 2011). This leads to the second hypothesis:

Hypothesis 2: Complexity will have a significant inverse effect on the adoption of cloud based BA applications.

Big data business analytics, when integrated with enterprise data processing, offer several benefits that include improving the timeliness and quality of the decision making process, providing actionable information delivered at the right time, enabling better forecasting, helping streamline operations, reducing wasted resources and labor/inventory costs, and improving customer satisfaction (Chaudhuri, et.al., 2011; Negash, 2004; Yeoh, and Koronios, 2010). Many existing organizational technologies and tools need to be integrated with the new cloud based big data analytics tools to sustain organizational capabilities needed for big data analytics. A combination of enterprise technologies are needed to deliver the information used for making decisions. They include tools that support traditional ad hoc queries, inferential statistics, predictive analytics, simulation, and optimization, thus supporting descriptive, diagnostic, predictive, and prescriptive analytics. Therefore, for successful adoption of cloud base BA applications, it is desirable for the new technologies and existing enterprise technologies to integrate and share data assets with each other. This leads to the third hypothesis:

Hypothesis 3: Compatibility with existing IT infrastructure will have a significant positive effect on the adoption of cloud based BA applications.

Organizational (O) Influence

Prior research has shown that situational constraints or "organizational contexts" are important determinants of intentions to adopt and use technology (Venkatesh and Morris, 2000). Organizational influence can radiate from a variety of sources, including co-workers, supervisors, friends, and family (Agarwal and Karahanna, 2000; Lewis, Agarwal and Sambamurthy, 2003). Influence from co-workers and supervisors on a users' technology adoption behavior has been widely acknowledged in IS research (Karahanna and Straub, 1999; Lee, Lee and Lee, 2006; Taylot and Todd, 1995; Venkatesh and Morris, 2000).

Co-workers can introduce useful features in an application and demonstrate steps that the worker(s) may not be able to discover on their own. In addition, managers may promote technology usage as standard work practices, and encourage their subordinates to adopt and use the technology as standard operating procedures

(Switzer, Nagy and Mullins, 2005). The above suggest that the extent to which others' view technology use as valuable has positive influence on technology experimentation and use and leads to the fourth hypothesis:

Hypothesis 4: Social influence from co-workers and supervisors will have a significant positive effect on the adoption of cloud based BA applications.

As business contacts convey the benefits of the analytics tools and applications, their use by individual users is driven by the organization's analytical maturity. In addition to business and technical expertise, analytical organizations are highly quantitative and data driven (Lawler, 2016). Therefore, analytical capabilities of the organization such as ways to acquire and manage data or prior knowledge about the development and use of models influences the adoption of the new BI applications ad leads to the fifth hypothesis:

Hypothesis 5: Organizational analytics capabilities will have a significant positive effect on the adoption of cloud based BA applications.

End user training literature suggests that organizational culture supplements formal user training programs in building requisite tool procedural and cognitive skills, that can influence adoption behavior (Egan, Yang and Bartlett, 2004; Tharenou, 2001). Employees are more willing to learn new things, discover new ways to accomplish their job and apply technologies to their work when the organization's learning climate promotes learning and trialing innovations (Noe and Schmitt, 1986). Furthermore, an organizational learning climate that promote an environment of continuous learning develops a perception that the learning curve associated with new technology adoption may be interpreted as a necessary investment to improve job performance rather than an obstacle to their existing work routines (Liang, Xue, Ki and Wei, 2010). This leads to the following hypothesis:

Hypothesis 6: Organizational learning climate will have a significant positive effect on the adoption of cloud based BA applications.

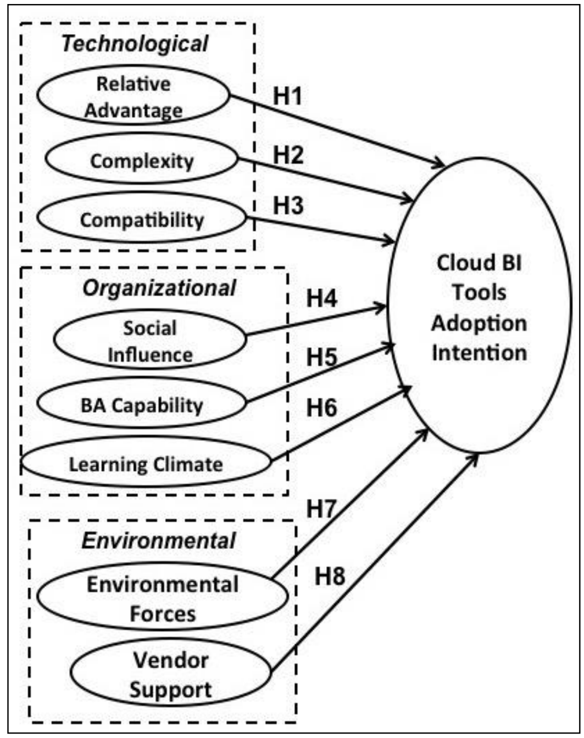

Figure 1. Research Model

Environmental (E) Influences

The organization's external environment has factors that place impact on the adoption of technologies. This study considers two types of factors that may influence the adoption decision of cloud based BA tools – environmental forces caused by competition, business partners and customer behaviors and the support ecosystem created by the BA tools vendor.

Environmental forces are typically normative and coercive in nature. Normative forces are primarily from customers, business partners and industry competitors (Liu, Ke, Wei, Gu, Chen, 2010; Teo, Wei, Benbasat, 2003) Normative forces drive an organization to learn and conform to industry best practices and can influence the organization to change its business processes and adopt innovative technologies (Scott, 2003). Additionally coercive pressures from external stakeholders such as dominant business partners or intense competitors force organizations to adopt business innovations such as new technology, when it is perceived as required practices (Teo, Wei and Benbasat, 2003). Therefore, the following hypothesis is suggested:

Hypothesis 7: Environmental forces will have a significant positive effect on the adoption of cloud based BA applications.

The ecosystem created by the cloud based BA tools vendor is another environmental factor that can positively impact adoption of new tools. The vendor ecosystem refers to the existence and level of influence of external resources such as user groups, implementation consultants, tool demonstrations, trials and training opportunities for tools knowledge exchange. Vendor support also comes in the form of coordination and counseling to develop necessary strategies to plan tool adoption. Vendors can also provide access to other user organizations as case studies that can be used as reference models and examples for planning the adoption projects. Vendors also provide logistical support to answer questions about the technology and can ease the shortage of skilled personnel in the early parts of the adoption project (Fink, 1998). Vendor support could be more elaborate and extend to providing dedicated project personnel to assist the adopting organization to help the adoption of the BI tools (Sarosa and Underwood, 2005). Therefore, the following hypothesis is suggested:

Hypothesis 8: BA tools vendor support will have a significant positive effect on the adoption of BA applications.

Adoption of Cloud BA Tools

The dependent variable of the study is a five valued variable to measure the current status of the adoption of cloud based BA tools in the organization (Oliveria, Thomas and Espandel, 2014). The five items in the Cloud based BA tool adoption survey question (dependent variable) are: 1 -Not considering the adoption of cloud based BI tools, 2 - Have evaluated, but not currently planning the adoption of cloud based BA tools, 3- Currently evaluating cloud based BA tools, 4 - Finished evaluation, and currently planning the adoption of cloud based BA tools, 5 - Have already adopted cloud based BA tools.

The sources of the nine research constructs and measurement items for the survey are listed in Table 1. The complexity construct is worded in the survey to measure its inverse – simplicity.

Construct	Items
Relative Advantage [37]	1. Using cloud based BA application will enhance my efficiency in gathering and using relevant information 2. Using cloud based BA application will make it easier to gather and use relevant information 3. Using cloud based BA application will increase the quality of the information that I gather and use
Complexity [37]	1. There is a clear and understandable process regarding how to use cloud based BA applications 2. Using cloud based BA application will not require a lot of effort 3. Using cloud based BA application will not be difficult
IT Infrastructure Compatibility [1], [14]	1. Our existing information technologies are well integrated and share data assets with the new cloud based big data analytics tools. 2. Our organization has the skills and capabilities to successfully manage big data datasets and projects. 3. Using cloud based big data technologies will not result in any disruption in our business processes and projects.
Social Influence [28], [38], [39]	1. My manager views using BA application as an important aspect of his/her job 2. My manager is supportive of efforts to apply newly acquired skills and knowledge about BA application 3. My manager supports using BA application 4. My co-workers value using BA application
Organizational Analytics Capabilities [26]	1.Our organization has the skills and capabilities to successfully manage big data datasets 2. Our organization has successfully implemented business analytics in the past 3. Our organization is highly analytical and decision making is quantitative and data
Organizational Learning Climate [28]	1. My company's policies and work rules allow me to participate in training for new applications 2. My company values employee learning and development activities for supporting the adoption a new technologies 3. My company emphasizes the need for data driven, analytical approaches to decision making to their employees
Environmental Forces [31], [32], [33]	1. Our industry has forces are that are driving our organization to learn and conform to industry best practices. 2. Our business partners can influence the organization to change its business processes and adopt innovative technologies 3. We face coercive pressures from external stakeholders such as dominant business
BI tools vendor support [34], [35]	1. The big data tools vendor provides coordination and counseling to develop necessary strategies to plan tool adoption. 2. The vendors also provide access to other user organizations as case studies that can be used as reference models and examples 3. The Vendors provide consulting support to answer questions about the technology and ease the shortage of skilled personnel

Adoption Intention [36]	1 - Not considering the adoption of cloud based BA tools. 2 - Have evaluated, but not currently planning the adoption of cloud based BA tools. 3- Currently evaluating cloud based BA tools 4 - Finished evaluation, and currently planning the adoption of cloud based BA tools.

Table 1. Research Constructs and Measurement Items.

4. SURVEY RESULTS

A survey was conducted with a convenience sample of 30 business users representing 30 medium to large sized companies in a variety of industries. The demographics of the companies identified in the 30 completed surveys are tabulated in Table 2. Based on reported annual revenues, 21 of the 30 companies had revenues greater than $500 million. The most frequently identified industry was manufacturing and utilities. The survey users also identified various business functions where cloud based BI tools are being used or being considered for use. The business functions most frequently identified include business activity monitoring for audits/compliance/fraud, competitive analysis, financial management and customer relationship management (CRM). Reports, scorecards, dashboards and text analytics were the leading analytics tools identified as being used or planned for usage in the 30 companies.

Variable	Survey Response
Revenue	<$10 Mil -0; $10-100 Mil -9; $100-500 Mil - 5; $500 Mil-1B - 7; > $1B - 9
Industry	Manufacturing – 9; Utilities – 5; Media/Communications – 5; Financial – 4; Retail – 3; Insurance – 2; Logistics – 2;
Business Function for BA Usage *(Multiple selections allowed)*	Business Activity Audit Compliance/Fraud Monitoring – 15; Competitive Analysis – 14; Financial Mgmt. – 11; CRM – 10; Product/Offer Development – 7; Marketing – 6; Logistics/SRM - 5
Specific Cloud BA tool *(Multiple selections allowed)*	BI Reports – 21; Dashboards – 18; Business Scorecards – 12; Mobile Analytics – 9; Text Analytics – 10; Social Media – 5;

Table 2. Company Demographics

Partial least squares (PLS), a component-based structural equation modeling (SEM) approach, was used to test the research model. SmartPLS version 2.0 was used for the analysis. PLS works well for relatively small sample sizes and the total number of completed surveys in this study is 30. The PLS method is also recommend when the objective of the research is predicting key target constructs or identifying key driver constructs whereas a covariance-based structural equation modeling is recommended for theory testing, theory confirmation, or the comparison of alternative theories (Hair, Anderson, Tatham and Black, 2005; Chin, 1998).

Assessment of the measurement model includes estimation of internal consistency for reliability and tests of convergent and discriminant validity for construct validity (Hair, Anderson, Tatham and Black, 2005). Internal consistency was evaluated by computing average variance extracted (AVE), composite reliability (CR), and Cronbach's alpha (Chin, 1998; Bagozzi and Yi, 1988). As can be seen in Table 3, all the reliability measures were well above the recommended cutoff level (AVE = 0.5; CR = 0.7; Cronbach's alpha = 0.7), indicating adequate internal consistency. The successful validation of the measurement model allowed the testing of the 8 study hypotheses. All the eight hypotheses were supported at varying T-values (Table 3). By ranking the hypotheses by the T-values, the most important factors that drove cloud based BA tools were: IT infrastructure compatibility, BA vendor support and the organizational analytics capabilities. This study finds that having compatible IT infrastructure components and internal firm organizational analytics capabilities for the secure integration of cloud based analytics tools and vendor ecosystem strongly facilitate the adoption of cloud based analytics tools.

Construct	C.A.	AVE	C.R.	T-Val	R
Relative Advantage	.897	.708	.924	2.176	**7**
Complexity	.857	.640	.898	1.986	**8**
IT Compatibility	.878	.678	.912	6.724	**1**
Social Influence	.861	.565	.863	2.754	**6**
Org Analytics Capabilities	.887	.694	.918	4.637	**3**
Org Learning Climate	.740	.581	.785	3.765	**4**
Environment al Forces	.832	.591	.876	3.267	**5**
BI Vendor Support	.785	.622	.823	5.953	**2**

Table 3. Measurement and SEM Model Results

5. DISCUSSION

Applications of big data analytics in organizations are growing, yet realizing the potential value of these applications is proving to be challenging. Maximizing business value is dependent upon a variety of factors such as organizational analytics culture and compatibility with existing technological infrastructure (Palmer, 2013). This is one of the first studies to empirically apply the TOE framework to evaluate factors influencing adoption of cloud based BA tools using a survey research methodology. The survey results show that the presence or absence of compatible infrastructure and capabilities necessary to integrate big data cloud based tools influence the likelihood of adopting that tool. In addition to the requisite capabilities and IT infrastructure, the organizational learning climate and external forces in the organization's industry also influences adoption of cloud based BI applications (Cegielski and Farmer, 2016).

6. CONCLUSIONS

This study provides some practical implications for IT managers. When organizations adopt cloud based BA application, they should pay attention to the organization's analytics capabilities such as processes to protect the security of the data and working with data to build analytics models. An established analytics culture can drive business value from these cloud based BA tools. Integration of new cloud based technologies with existing BA infrastructure is also necessary for successful adoption. Cloud based BA tools require a new level of commitment and rigor toward managing the data lifecycle process. Additionally, big data projects must be ranked on potential for having the most business impact along with the uncomplicated availability of requisite data sets. The organizational data strategy must facilitate the integration of external and internal organizational data and the adoption of any new required tools and techniques (Kho, 2017).

Implications for Practice

The following points have practical implications for BA practitioners and organizations looking to adopt cloud based BA tools and applications:

- Similar to any other IT innovation project, planning for a BA implementation project must be initiated by identifying key business users who are motivated to adopt the new technologies and put them to use.
- BA implementations cross-functional boundaries and often do not fit well with existing organizational structures. In these environments, the organizational learning climate and social influence are important factors to consider that can support experimentation of big data resources by users (Cegielski and Farmer, 2016).
- Demonstration and experimentation can allow users to identify the usefulness of BA tools and gage the relative advantage of a BA tool. These experiments can also increase their desire to adopt.
- Environmental forces from tools vendors, consumers and business partners play an important role in technology adoption. It is desirable to identify and select BA tools vendors who have established and s ecosystem and can offer support for the chosen tool adoption.

7. REFERENCES

Abbasi, A., Lau, R. Y. K., & Brown, D. E. (2015). Predicting Behavior. *IEEE Intelligent Systems,* 30(3), 35-43.

Abbasi, A., Sarker, S., Chiang, R. H. L. (2016). Big Data Research in Information Systems: Toward an Inclusive Research Agenda. *Journal of the Association for Information Systems.* 17(2), 1-32.

Agarwal, R. & E. Karahanna. (2000). Time Flies When Agarwal, R., & Prasad, J. (1998). The Antecedents and Consequents of User Perceptions in Information Technology Adoption. *Decision Support Systems*, 22(1), 15-29.

Bagozzi, R.P., & Yi, Y. (1988). On the evaluation of structural equation models. *Journal of the Academy of Marketing Science*, 16(1), 74-94.

Cao, M., Chychyla, R. and Stewart, T. (2015). Big Data Analytics in Financial Statement Audits. *Accounting Horizons,* 29(2), 423-429.

Cegielski, C.G. and Farmer, L.A.J. (2016). Knowledge, Skills and Abiliites for Entry-Level Business Analytics Positions: A Muilti-Method Study. *Decision Science Journal of Innovative Education,* 14(1), 91-118.

Chaudhuri, S., Dayal, U., & Narasayya, V. (2011). An Overview of Business Intelligence Technology. *Communications of the ACM*, 54(8), 88-98.

Chin, W.W. (1998). Issues and opinion on structural equation modeling. *MIS Quarterly*, 22(1), 7-16.

Egan, T.M., Yang, B., & Bartlett, K.R. (2004). The Effects of Organizational Learning Culture and Job Satisfaction on Motivation to Transfer Learning and Turnover Intention. *Human Resource Development Quarterly*, 15(3), 279-301.

Facteau, J. D., Dobbins, G. H., Russell, J. E., Ladd, R. T., & Kudisch, J. D. (1995). The influence of general perceptions of the training environment on pretraining motivation and perceived training transfer. *Journal of management*, 21(1), 1-25.

Ferranti, J.M., Matthew K Langman, D., Tanaka, J. McCall, J., Ahmad, A. ,Fink, D. (1998). Guidelins for the successful adoption of information technology in small and medium enterprises. *International Journal of Infrmation Management* 18(4), pp. 243-254.

Fink, D. (1998). Guidelines for the successful adoption of information technology in small and medium enterprises. *International Journal of Information Management* 18(4), 243-254.

Gantz, J., & Reinsel, D. (2011, June). Extracting value from chaos. Retrieved from http://www.emc.com/collateral/analyst-reports/idc-extracting-value-from-chaos-ar.pdf

Gartner. (2011). Gartner Says Consumerization of Bi Drives Greater Adoption, http://www.gartner.com/newsroom/id/1748214.

Gefen, D., Karahanna, E., & Straub, D. W. (2003), Trust and TAM in Online Shopping: An Integrated Model. *MIS Quarterly*, (27)1, 51-90.

Hair, J.F., Anderson, R.E., Tatham, R.L., & Black, W.C. (2005). Multivariate Data Analysis: With Readings, 6th ed. Upper Saddle River, NJ: Prentice Hall.

IBM (2017, September). Create a Tranformative Digital Experience. Retrieved from http://www.ibm.com

Jeyaraj, A., Rottman, J.W., & Lacity, M.C. (2006). A Review of the Predictors, Linkages, and Biases in It Innovation Adoption Research. *Journal of Information Technology*, 21(1), 1-23.

Karahanna, E., & Straub, D.W. (1999). The Psychological Origins of Perceived Usefulness and Ease of Use. *Information and Management*, 35, 237-250.

Keil, M., Beranek, P.M., & Konsynski, B.R. (1995). Usefulness and Ease of Use: Field Study Evidence Regarding Task Considerations. *Decision Support Systems*, 13(1), 75-91.

Kho, N.D. (2017). The State of Big Data. *EContent,* 40(1). 10-12.

Kirkpatrick, M. (2010, August 4). Google CEO Schmidt: ‘‘People aren’t ready for the technology revolution.’’ Retrieved from http://readwrite.com/2010/08/04/google_ceo_schmidt_ people_arent_ready_for_the_tech#awesm=□oCVcaSZEJssOa4

Kwon, T.H., & Zmud, R.W. (1987). Unifying the Fragmented Models of Information Systems Implementation. John Wiley & Sons, Inc., 227-251.

Lawler, J. (2016). Big Data Analytics Methodology in the Financial Industry, Proceedings of EDSIGCon, Las Vegas, NV.

Lee, Y., Lee, J., & Lee, Z. (2006). Social Influence on Technology Acceptance Behavior: Self-Identity Theory Perspective. *ACM SIGMIS Database*, 37(2-3), 60-75.

Lewis, W., Agarwal, R., & Sambamurthy, V. (2003). Sources of Influence on Beliefs about Information Technology Use: An Empirical Study of Knowledge Workers. *MIS Quarterly*, 27(4), 657-678.

Liang, H., Xue, Y., Ke, W., & Wei, K. (2010). Understanding the Influence of Team Climate on IT Use. *Journal of the Association for Information System*s, 11(8), 414-432.

Liu, h., Ke, W., Wei, K.K., Gu, J., Chen, H. (2010), The role of institutional pressures and organizational culture in the firm’s intention to adopt internet-enabled supply chain management systems. *Journal of Operations Management* 28. Pages 372-384.

Lu, J., Yao, J.E., & Yu, C.S. (2005). Personal Innovativeness, Social Influences and Adoption of Wireless Internet Services via Mobile Technology. *The Journal of Strategic Information Systems*, 14(3), 2005, 245-268.

Negash, S. (2004). Business Intelligence. *Communications of the Association for Information Systems*, 13(1), 177-195.

Noe, R. A., & Schmitt, N. (1986). The influence of trainee attitudes on training effectiveness: Test of a model. *Personnel Psychology*, 39(3), 497-523.

Oliveria, T., Thomas, M. & Espadanal, M. (2014). Assessing the determinants of cloud computing adoption: an analysis of the manufacturing and services sectors. *Information Management* 51(5), 497-501.

Palmer, B. (2013). Part 1: Analytics: A blueprint for value––Converting big data and analytics insights into results [Web log post]. Retrieved from http://www.ibmbig-datahub.com/blog/part-1-analytics-blueprint-value-con-verting-big-data-and-analytics-insights-results

Ramamurthy, K.R., Sen, A., & Sinha, A.P. (2008). An Empirical Investigation of the Key Determinants of Data Warehouse Adoption. *Decision Support Systems*, 44(4), 817-841.

Rogers, E. (1995). Diffusion of Innovations, 4th ed. edn, The Free Press, New York.

Sallam, R.L., Richardson, J., Hagerty, J., & Hostmann, B. (2011). Magic Quadrant for Business Intelligence Platforms. Gartner, http://ai.arizona.edu/mis510/other/magic_ quadrant_for_ business _ 210036.pdf.

Sarosa, S. and Underwood, J. (2005). Factors affecting IT adoption within Indonesian SME's: Manager's Perspective. in Proceeding of the 9th Pacific Asia conference on Information systems, Thialand

Schmitz, J., & Fulk, J. (1991). Organizational Colleagues, Media Richness, and Eletronic Mail: A Test of the Social Influence Model of Technology Use. *Communication Research*, 18(4), 487-523.

Scott, W.R. (2003), Organizations: Rational, natural, and open systems (5th ed.). Upper Saddle River, New Jersey: Prentice Hall.

Slyke, C.V., Bélanger, F., Johnson, R.D., & Hightower, R. (2010). Gender-Based Differences in Consumer Ecommerce Adoption. *Communications of the Association for Information Systems*, 26, Article 2.

Switzer, K. C., Nagy, M. S., & Mullins, M. E. (2005). The influence of training reputation, managerial support, and self-efficacy on pre-training motivation and perceived training transfer. *Applied HRM Research*, 10(1), 21-34.

Taylor, S., & Todd, P.A. (1995). Understanding Information Technology Usage: A Test of Competing Models. *Information Systems Research*, 6(2), 144-176.

Teo, H.H., Wei, K.K., Benbasat, I. (2003). Predicting intent to adopt interorganizational linkages: An institutional perspective. *MIS Quarterly* 27(1), page 19-49.

Tharenou, P. (2001). The Relationship of Training Motivation to Participation in Training and Development. *Journal of Occupational and Organizational Psychology*, 74(5), 599-621.

Tornatzky, L. and Fleischer, M. (1990) The process of technology innovation, Lexington, MA, Lexington Books.

Tornatzky, L.G., & Klein, K.J. (1982). Innovation Characteristics and Innovation Adoption-Implementation: A Meta-Analysis of Findings. *IEEE Transactions on Engineering Management*, 1, 28-45.

Valerdi, R. (2017). When it's big data and when it's not. *Industrial Engineer,* 49(2), 28-28.

Venkatesh, V., & Morris, M.G. (2000). Why Don't Men Ever Stop to Ask for Directions? Gender, Social Influence, and Their Role in Technology Acceptance and Usage Behavior. *MIS Quarterly*, 24(1), 115-139.

Yarnall, J. (1998). Line Managers as Career Developers: Rhetoric or Reality?. *Personnel Review*, 27(5), 378-395.

Yeoh, W., & Koronios, A. (2010). Critical Success Factors for Business Intelligence Systems. *Journal of Computer Information Systems*, 50(3), 23-32.

Editor's Note:

This paper was selected for inclusion in the journal as a CONISAR 2017 Meritorious Paper. The acceptance rate is typically 15% for this category of paper based on blind reviews from six or more peers including three or more former best papers authors who did not submit a paper in 2017.

Student Intentions and Behaviors Related to Email Security: An Application of the Health Belief Model

Gregory Schymik
schymikg@gvsu.edu

Jie Du
dujie@gvsu.edu

School of Computing and Information Systems
Grand Valley State University
Allendale, MI 49456 USA

Abstract

Information security is an ongoing concern for all of us. Email is frequently the attack vector of choice for hackers and is a large concern for campus IT organizations. This paper attempts to gain insight into what drives the email security behaviors of undergraduate students at one midwestern public, master's granting university by surveying students in an introductory computing course about their email security behavior. The survey questions are developed based on the Health Belief Model and used to measure eight constructs including behavior, perceived barriers to practice, self-efficacy, cues to action, prior security experience, perceived vulnerability, perceived benefits, and perceived severity. The perceived benefits and self-efficacy variables were found to be the most important factors that affect students' security behavior. The findings of this study may help shed light on how universities can better prepare students to handle this critical information security concern.

Keywords: Email security behavior, health belief model, intentions, survey.

1. INTRODUCTION

People, the users of information systems, are still the biggest security concern for most IT organizations (Matthews, 2017). And email is still a popular attack vector for hackers. The US Internal Revenue Service (IRS) lists phishing scams in their "Dirty Dozen" tax scams for the 2017 filing year (Internal Revenue Service, 2017). Symantec's April 2017 Internet Security Threat Report noted that the rate of malicious emails being sent (1 in 131) was the highest it had seen in five years (Symantec, 2017). This is a particular concern on campuses. For the second year in a row, IT security has been identified as the biggest concern for campus IT departments and "phishing and social engineering attacks" was rated the highest concern amongst Higher Education Information Security Council working groups (Grama and Vogel, 2017). Given these concerns about email driven security attacks, the study of email security behavior by students is a timely and important endeavor.

This paper attempts to gain insight into such behavior at one midwestern public, master's granting university by surveying students in an introductory computing course about their email security behavior. The paper presents a brief discussion on the adoption of preventive behaviors and the health belief model and then describes the research model and methodology. It concludes with a presentation of the results and a discussion of their implications.

2. LITERATURE REVIEW

On its surface, the question of whether users will adopt security behaviors appears to be an obvious target for IT adoption research.

However, this research is not testing the adoption of a specific technology or technologies, it is testing the adoption of preventative behaviors. This is a significant difference. Those adopting technologies are thought to do so to gain some sort of advantage or positive result – the efficiency gains through the adoption of a new software package designed as part of a business process re-engineering effort, for example. Those adopting preventative behaviors, however, are believed to be doing so not to gain a positive result or benefit, but to avoid the repercussions associated with the occurrence of some avoidable or preventable problem – a ransomware attack, for example. Recent research in IT security behavior has suggested that this behavior is similar to a patient's preventative behavior in the health care industry, applying the health belief model (Rosenstock, 1974; Rosenstock, Strecher and Becker, 1988) to IT security situations (Ng, Kankanhalli and Xu, 2009; Claar and Johnson, 2010; Williams, Wynn, Madupalli, Karahanna and Duncan, 2014).

Health Belief Model/Security Belief Model

The management literature has referred to the health belief model (HBM) as "an expectancy model of health care decision making" (Walker and Thomas, 1982, p.188). It evolved out of the need to develop a theory that helped explain the failure of people to adopt preventative behaviors or accept testing to screen for diseases for which they exhibited no symptoms (Rosenstock, 1974). The parallel to the need to understand users' information security behavior is clear: IS security behavior researchers seek to understand what makes people adopt (or not adopt) specific behaviors that prevent the hacking of their system, which shows no current evidence of hacking. This model has been the basis of IS research attempting to understand the adoption of preventative behaviors associated with the use of email (Ng et al., 2009), the installation of anti-virus software on home computers (Claar and Johnson, 2010), and typical, recommended practices for preventing unauthorized access to their computers at work (Williams et al., 2014). Williams et al. (2014) renamed the model to the security belief model. For simplicity's sake, we will use the HBM when we refer to these models in this paper.

Table 1 summarizes the constructs used in the HBM and their use in recent information systems security research. The independent variables of the HBM are a person's perceived susceptibility to a condition, their perceived seriousness of a given health problem, their perception of how beneficial an action would be to their case, their perception of negative aspects of the action that might manifest as barriers to action that would prevent actions from being taken, their self-efficacy regarding the actions to be taken, and any triggers or other cues to action that might impact whether or not they adopt the behavior (Rosenstock, 1974; Rosenstock et al., 1988). These variables are easily adapted to IS research (see our explanation in the research model description below).

ROSENSTOCK (1974), ROSENSTOCK, ET AL. (1988)	NG, ET AL. (2009)	CLAAR AND JOHNSON (2010)	WILLIAMS ET AL. (2014)
PERCEIVED BENEFITS	BEN*	BEN	BEN*
PERCEIVED BARRIERS TO PRACTICE	BAR	BAR*	BAR
SELF-EFFICACY	SEF*	SEF*	SE
PERCEIVED SUSCEPTIBILITY	SUS*	VUL*	SUS*
CUES TO ACTION	CUE	CUE	CTA*
GENERAL HEALTH ORIENTATION	GEN	PXP	---
PERCEIVED SEVERITY	SEV	SEV	SEV*
INTERACTIONS			none hypothesized
GENDER		GEN	
AGE		AGE (xBAR*)	
EDUCATION		EDU (xBEN*)	
		PXP (xSEV*, xVUL*)	
	SEV (xBEN*, xCUE* xGEN*, xSEF*)		
R^2	.593	.304	.430
ADJ R^2	.549	.167	not reported

Table 1 - Model Composition -- Independent Variables and Interactions - * indicates significant relationships

Various moderating variables have been suggested. Demographic variables (gender, age, and education) are thought to have some impact on behavior in the HBM (Rosenstock, 1974). Ng et al. (2009) hypothesized that perceived severity would have a moderating effect on all other independent variables (IVs) and found significant interactions with perceived benefits, cues to action, general security orientation, and self-efficacy. Claar and Johnson (2010) hypothesized that prior experience, along with age, education, and gender would have moderating effects on all IVs except for cues to action and found significant interactions between age and perceived barriers to action, education and perceived benefits, and prior experience and perceived severity and self-efficacy. Williams et al. (2014) did not include any moderating variables in their security belief model.

3. RESEARCH MODEL

Our research model is based on the health belief model (Rosenstock, 1974, Rosenstock et al. 1988) that underlies the models tested in Ng et al. (2009), Claar and Johnson (2010) and Williams et al., (2014). All seven independent variables (IVs) and the dependent variable are taken directly from Ng et al. (2009) with one difference being the replacement of their general security orientation variable with Claar and Johnson's (2012) security experience variable (EXP).

The general health orientation variable from the health belief model is intended to represent a basic foundation or consistent behavior related to all health care decision situations (Walker and Thomas, 1982). Ng et al. (2009) defined a general security orientation variable and operationalized it as a set of questions related to subjects' self-awareness of and activities associated with general knowledge of information security. We followed Claar et al.'s (2010) approach to this variable and used a more direct measure of the subjects' experience with email-related information security problems. Given our subject group's age (young, typically traditional, undergraduate students), we feel that it is very likely that they have not had enough life experience to establish Ng et al.'s (2009) general orientation towards security. We see a direct measure of experience as a precursor to a general security orientation and believe it to therefore be a reasonable substitution.

3.1 Main-effects IVs

The dependent variable in the research model (Figure 1) is the subjects' self-reported email security behavior (BEH). Seven main-effects IVs are hypothesized: the perceived benefits of performing email security behaviors (BEN), the perceived barriers to entry of performing the behaviors (BAR), the subjects' belief in their ability to carry out security behaviors - their self-efficacy (EFF), the perceived vulnerability to email attacks (VUL), the existence of any cues to action regarding email security behaviors (CUE), the subjects' prior experience with email-related security issues (EXP) and the subjects' perceived severity of email-related security incidents (SEV).

- H1 – Perceived benefits (BEN) of practicing email security behaviors are positively related to email security behaviors.
- H2 – Perceived barriers (BAR) to practicing email security behaviors are negatively related to email security behaviors.
- H3 – Self-efficacy (EFF) is positively related to email security behaviors.
- H4 – Perceived vulnerability (VUL) to email-related security incidents is positively related to email security behaviors.
- H5 – Cues to action (CUE) are positively related to email security behaviors.
- H6 – Prior experience (EXP) with email-related security issues is positively related to email security behaviors.
- H7 – Perceived severity (SEV) of email-related security issues is positively related to email security behaviors.

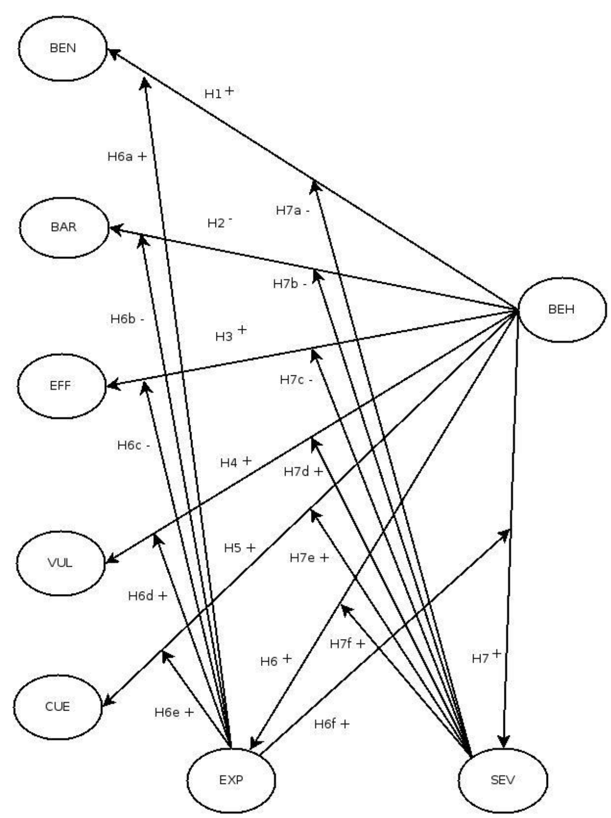

Figure 1 - Research Model

3.2 Interactions

We combine the Ng et al. (2009) and Claar and Johnson (2010) models and hypothesize that the subjects' prior experience with email-related security issues (EXP) and their perception of the severity of email security-related issues (SEV) are moderating variables. While the health belief model (see Rosenstock, 1974) implies several psychosocial variables (age, education, and gender) as moderators, we do not include these in our analysis. Our subject population falls in a narrow age range (96.5% are between the ages of 18 and 26), and subjects are typically first- or second-year undergraduate students. Such homogeneity suggests that we need not include these variables in the analysis. Gender differences will be analyzed and presented in future work.

3.2.1 Experience as a Moderator

We hypothesize that subjects' prior experience with email-related information security attacks would have a moderating effect on the other main-effects IVs. Claar and Johnson (2010) suggested this interaction in their research without explanation. We suggest that those who have had security issues related to email behaviors in the past would be influenced by those experiences in ways that would enhance the likelihood of any individual factor impacting their behaviors. A subject who has experienced email-related information security problems would probably more easily see the value of being diligent with emails (EXPxBEN), be expected to have a reduced focus on the difficulty of performing the appropriate preventative actions (EXPxBAR), give less weight to any perception of self-efficacy (EXPxEFF), have a better/more realistic understanding of their vulnerability to such problems (EXPxVUL), have a higher appreciation for the cues to action they might have seen (EXPxCUE), and have a better understanding of the severity of such problems (EXPxSEV),

- H6a – Prior experience with email-related security incidents increases the positive effect of perceived benefits on email security behaviors (EXPxBEN).
- H6b – Prior experience with email-related security incidents reduces the negative effect of barriers to practice on email security behaviors (EXPxBAR).
- H6c – Prior Experience with email-related security incidents reduces the positive effect of self-efficacy on email-related security behaviors (EXPxEFF).
- H6d – Prior experience with email-related security incidents increases the positive effect of perceived vulnerability on email security behaviors (EXPxVUL).
- H6e – Prior experience with email-related security incidents increases the positive effect of cues to action on email security behaviors (EXPxCUE).
- H6f – Prior experience with email-related security incidents increases the positive effect of perceived severity on email security behaviors (EXPxSEV).

3.2.2 Severity as a Moderator

Ng et al. (2009) relied on expectancy-value theory, protection motivation theory, and health belief model literature to hypothesize that perceived severity would have a moderating effect on the other IVs in the model. Based on their efforts, we hypothesize that perceived severity will have an influence on the remaining independent variables.

- H7a – Perceived severity of any email-related security incidents reduces the positive effect of perceived benefits on email security behaviors (SEVxBEN).
- H7b – Perceived severity of any email-related security incidents reduces the negative effect of barriers to practice on email security behaviors (SEVxBAR).
- H7c – Perceived severity of any email-related security incidents reduces the positive effect of self-efficacy on email security behaviors (SEVxEFF).
- H7d – Perceived severity of any email-related security incidents increases the positive effect of perceived vulnerability on email security behaviors (SEVxVUL).
- H7e – Perceived severity of any email-related security incidents increases the positive effect of cues to action on email security behaviors (SEVxCUE).
- H7f – Perceived severity of any email-related security incidents increases the positive effect of prior experience on email security behaviors (SEVxEXP)

4. METHODOLOGY

To test these hypotheses, an electronic Likert-scale questionnaire was implemented to survey the participants about their email security behaviors. The survey contains 35 questions. Except for the age and gender questions, all questions are focused on the eight constructs and are anchored on 5-point Likert scales. Undergraduate students who completed an introductory computing course in the winter 2016 semester or the fall 2016 semester were asked to complete the survey on Blackboard. The blackboard surveys allow students to complete the survey anonymously. A total of 153 students participated in this study (67 from Winter 2016 and 86 from Fall 2016). Ten responses were removed from the data set due to missing data issues (2 from Winter 2016 and 8 from Fall 2016).

Thus, the data collection yielded 143 useable survey response sets. Table 2 summaries the demographics of the sample. Table 3 shows the descriptive statistics for all constructs. Table 4 shows the inter-correlations between constructs.

Demographic	*Category*	*Percentage*
Age	<19	14.7
	19-22	65.0
	22-26	16.8
	>26	3.5
Gender	Male	51.7
	Female	48.3

Table 2 – Subject Demographics

Construct	*Min*	*Max*	*Mean*	*SD*
BEH	2.00	5.00	4.12	0.72
EFF	1.75	5.00	3.88	0.79
VUL	1.00	5.00	3.56	0.97
BEN	2.20	5.00	4.16	0.60
BAR	1.00	5.00	2.56	0.79
CUE	1.67	5.00	3.84	0.66
EXP	1.00	4.67	1.80	0.80
SEV	1.00	5.00	3.41	1.14

Table 3 - Descriptive Statistics of Constructs

Construct	*BEN*	*EFF*	*VUL*	*BEH*	*BAR*	*CUE*	*EXP*	*SEV*
BEN	.60							
EFF	.24	.79						
VUL	.31	.08	.97					
BEH	.34	.61	.07	.72				
BAR	-.34	-.22	-.07	-.28	.79			
CUE	.27	-.09	.17	-.11	.15	.66		
EXP	-.03	.05	.21	-.01	.23	.07	.80	
SEV	-.06	-.07	.14	-.08	.05	.18	.17	1.14

Table 4 – Constructs' Inter-Construct Correlations

To incent completion of the survey, students were informed that those who completed the survey would be entered into a drawing for one of five gift cards (one $25 and four $15). Anonymity was preserved as responses were not associated with individuals. Email addresses of those who completed the surveys were retrieved – separately from responses – so that the gift card drawing could be completed.

4.1 Survey Development

The survey questions used for each construct (see the Appendix) were derived from those used in Ng et al. (2009) and Claar and Johnson (2010). The items in the survey focused on eight constructs including seven IVs and one dependent variable. All items are anchored on 5-point Likert scales.

4.2 Data Analysis

We conducted a three-step analysis to examine the effects of the key constructs on the email security behavior dependent variable (BEH). First, an exploratory factor analysis was done to extract the factors (latent variables) to validate our model constructs. Second, a multiple regression analysis was conducted using the SPSS calculated factor scores. The dependent variable was regressed on the seven IVs to determine the main effects (Model 1). Last, the moderating variables, perceived severity and prior experience were added into the regression model to examine the interaction effects of those IVs (Model 2).

4.2.1 Construct Validity and Reliability

We first conducted the factor analysis (using primary axis analysis) on the data set to extract the factors that influence students' email security behaviors. As expected, eight factors were extracted, which are consistent with the eight constructs shown in Figure 1. We use 0.5 as the factor loading threshold given the size of our data set (Hair, Tatham, Anderson, & Black, 1998). Accordingly, three survey questions having a factor loading lower than 0.5 were removed from further consideration:

- CUE3: If my computer is attacked by someone, I would be concerned I had improperly handled unsafe emails. (disagree/agree)
- EXP1: How frequently do you receive unsafe emails in your inbox(es)? (never/a great deal)
- SEV3: If my computer is infected by a virus as the result of unsafe email practices, my daily work/schoolwork/social life could be negatively affected. (disagree/agree)

We further examined internal consistency to test the interrelatedness of a sample of items. To evaluate the reliability of the data, Cronbach Alpha coefficients were calculated for each latent variable. The acceptable value of Cronbach Alpha should be at least 0.70 (Nunnally & Bernstein, 1994). Table 5 summarizes the factor loadings and Cronbach Alpha values for each item. The factor loadings for all items are greater 0.5 and the Cronbach Alpha values for all factors are greater than 0.7, which indicates that our survey questions load properly onto our model constructs, allowing us to proceed with our regression analysis and hypothesis testing.

Construct	Item	Factor loadings	Cronbach Alpha
BEH			0.789
	BEH1	.521	
	BEH2	.736	
	BEH3	.659	
	BEH4	.849	
BAR			0.775
	BAR1	.643	
	BAR2	.546	
	BAR3	.725	
	BAR4	.804	
EFF			0.922
	EFF1	.891	
	EFF2	.897	
	EFF3	.784	
	EFF4	.789	
CUE			0.811
	CUE1	.822	
	CUE2	.865	
	CUE4	.584	
EXP			0.809
	EXP2	.887	
	EXP3	.794	
	EXP4	.658	
VUL			0.95
	VUL1	.955	
	VUL2	.995	
	VUL3	.848	
BEN			0.913
	BEN1	.557	
	BEN2	.860	
	BEN3	.887	
	BEN4	.942	
	BEN5	.775	
SEV			0.83
	SEV1	.824	
	SEV2	.821	

Table 5. Construct Validity and Reliability

4.2.2. Hypothesis Testing

To test the hypotheses, a multiple regression analysis was conducted using SPSS. First, the dependent variable, email security behavior was regressed on the seven IVs to examine the main effects. Next, the moderator variables were considered to further evaluate the interaction effects of the prior experience and perceived severity on other constructs. Table 6 shows the results of hypothesis testing using moderated multiple regression. In Model 1, the latent variables, perceived benefits and self-efficacy had significant coefficients as expected. Both the perceive benefits and self-efficacy had a significant, positive effect on email security behavior. Thus, H1 and H3 were supported. In Model 2, the perceived benefits and self-efficacy still had a significant, positive effect on email security behavior. Besides that, prior experience also significantly reduced the negative effect of the perceived barriers on email security behavior. Thus, H6b was supported. It is interesting to find that the coefficients on cues to action and interactions between cues to action and prior experience are negative and significant, which is contradicting with our hypotheses. A detailed discussion is presented in the next section.

5. DISCUSSION

The results show that only three of the seven IVs - perceived benefits (BEN), self-efficacy (EFF), and cues to action (CUE) - are significant determinants of our subjects' email security behavior and that only two of them, BEN and EFF support our hypotheses. One possible explanation for these findings could be the relative immaturity of the subjects. These youngsters have likely failed to have enough experience with security issues in general to limit their rationalizations on this topic only to those that have the most immediate and easily identifiable impacts on their behaviors: their belief that they will benefit from the behaviors (BEN), the potential to reduce the risk of a security incident occurring, and their understanding of their own capabilities in regards to performing the behaviors (EFF). Self-efficacy may be the most easily assessable construct for these young subjects.

The remaining factors might require more life experience – or "wisdom" - before these individuals can truly appreciate and assess them. It might be difficult for these young, immature students to judge their vulnerability (VUL) to email-related security incidents or the true potential impact of such incidents (SEV) or truly understand the difficulty (or ease) of performing the security behaviors.

Model Variables	Model 1 – Main Effects	Model 2 – Main + Interactions	
BEN	0.244**	0.266**	H1 supported
BAR	-0.069	-0.110	H2 not supported
EFF	0.581***	0.579***	H3 supported
VUL	-0.039	-.028	H4 not supported
CUE	-0.117	-0.200*	H5 not supported
EXP	0.003	-.034	H6 not supported
SEV	0.002	0.024	H7 not supported
EXPxBEN		0.006	H6a not supported
EXPxBAR		0.160*	H6b supported
EXPxEFF		0.065	H6c not supported
EXPxVUL		0.003	H6d not supported
EXPxCUE		-0.168*	H6e not supported
EXPxSEV		0.112	H6f not supported
SEVxBEN		0.081	H7a not supported
SEVxBAR		-0.009	H7b not supported
SEVxEFF		0.014	H7c not supported
SEVxVUL		0.006	H7d not supported
SEVxCUE		-0.060	H7e not supported
SEVxEXP		0.112	H7f not supported
R^2	0.514	0.557	
adjusted R^2	0.489	0.493	

Table 6. Regression Model Coefficients – Hypothesis Tests

An interesting result is the negative coefficient associated with the cues to action variable (CUE). This finding is counter to our hypothesis. Upon reflection and a review of our survey questions that reflect on this construct, we can see a possible explanation. Here, again, are the questions that loaded on the construct:

- (CUE1) If I saw a news report or read a newspaper or magazine article about a crime related to unsafe emails, I would be more concerned about opening or clicking links within emails. (disagree/agree)
- (CUE2) If a friend were to tell me of a recent experience with identity theft related to a suspicious email, I would be more conscious of opening emails or clicking links within emails. (disagree/agree)
- (CUE4) If I received an email from the Help Desk of my university about risks posed by unsafe emails, I would be more concerned about opening emails or clicking links within emails. (disagree/agree)

This inconsistency in the results (significant coefficient but its sign being the opposite of our hypothesis) may be the result of a significant number of participants having a faulty perception of cues to action. The word 'perception' is key here. The questions asked are focused on a predicted response to a hypothetical situation, not a specific measurement of a cue to action, such as how often the IT helpdesk sends out alert messages. This might confound the results if the students' predictions don't necessarily line up with their self-reported behaviors.

Regarding the interaction effects, we did not find any significant effects between perceived severity and other core constructs. Again, this might be due to the subjects' lack of awareness (or experience) of security attacks. We did find that the prior experience has a significant moderating effect on perceived barriers (EXPxBAR). This still fits that immaturity analysis: if a subject has prior experience of security attacks caused by unsafe emails, and he or she is more likely to underestimate the barriers, they will probably be more likely to take appropriate email security behaviors.

A significant difference exists between males and females in the latent variable scores for self-efficacy (EFF) and behavior (BEH) calculated during the exploratory factor analysis. These differences will be analyzed and presented in future research.

There are some limitations worth noting with this research. While the sample size was acceptable, a much larger sample would give more reliable statistical results. Finding ways to improve survey response rates would help with this. This survey was limited to students at a single university. Getting students from other schools to participate in the survey would help increase sample size and, more importantly, increase the diversity of the sample and therefore its external validity. Potential issues with the prior experience construct were noted above. The questions reflecting on this construct might need to be rethought. Finally, the applicability of these results is limited by the fact that our subjects were undergraduate students. It would be interesting to see how this same research question would be answered by a broader sample of the population at large.

We should note that Ng et al. (2009) ran a very similar survey with part-time, working students and individuals employed in IT-related organizations with a similar sample size and found only three significant determinants (equivalent to our BEN, EFF, and VUL) which match two of those we found to be significant. Both studies had similar R-squared numbers. Could this be an indicator that the HBM might not be the proper model to explain email security behavior? With our small sample sizes, such an inference might be unwise.

While it is difficult to infer anything from our study's CUE findings, the BEN and EFF significance findings indicate that campus IT departments and computing and technology instructors can make a substantial, positive impact on student email security behaviors by educating students on the risks they take by not practicing good email security behaviors and by educating them on how to properly execute email security behaviors. Since BEN and EFF have a significant impact on students' self-reported email behaviors, instructors and IT departments should work to increase students' knowledge about the perceived benefits of these behaviors and also work to improve students' email security self-efficacy.

The perceived benefits (BEN) result can be exploited by instructors through more detailed discussion, possibly through case studies, of the impacts of email security misbehavior. IT departments can send notices to students reminding them of the risks they are taking if they do not practice secure behaviors. Reports from IT departments to the students and staff regarding the costs the university faces by responding to security issues and what caused the issues in the first place could also help students understand the benefits of good practices. Something as simple as a monthly update from the IT department indicating the number of security-related helpdesk tickets were handled and the hours taken to mitigate those problems could provide a reminder to students to take IT security seriously.

The self-efficacy (EFF) result can be exploited by faculty by including specific lessons and assignments that teach students how to examine email headers – for legitimate sender information - without opening the email, how to review the URLs in links in emails and recognize phishing and pharming URLs before actually clicking on them, and other indicators that an email may not be legit (poor grammar, generic references to IT departments, unsolicited emails, unknown senders, etc.) IT departments can reinforce students' self-efficacy through reminders throughout their time on campus and possibly through testing the students and staff with mock SPAM and phishing/pharming emails that catch users that do not apply appropriate secure precautions when opening, reading, and taking action regarding emails and remind them that they just failed a test of their email security behaviors.

6. CONCLUSIONS

A survey was developed based on the HBM and conducted at a public university to understand students' intentions and behaviors when using emails. It is found that self-efficacy and the perceived benefits are the important factors that affect students' email security behaviors.

Understanding people's intentions and behaviors when using technologies is just the first step towards the goal of providing effective education and policies on security and privacy related to the use of technologies. This study sheds light on new endeavors that educators could try in the future to better educate students how to protect their security and privacy when using technologies.

7. REFERENCES

Claar, C. L., & Johnson, J. (2012). Analyzing home PC security adoption behavior. Journal of Computer Information Systems, 52(4), 20-29.

Grama, J., & Vogel, V. (2017). Information security: Risky business. EDUCAUSE Review, 52(1), 22.

Hair, J., Tatham, R., Anderson, R., & Black, W. (1998). Multivariate data analysis. London: Prentice-Hall.

Internal Revenue Service, 2017 https://www.irs.gov/uac/newsroom/phishing-schemes-lead-the-irs-dirty-dozen-list-of-tax-scams-for-2017-remain-tax-time-threat accessed 6/1/2017.

Ng, B. Y., Kankanhalli, A., & Xu, Y. C. (2009). Studying users' computer security behavior: A health belief perspective. Decision Support Systems, 46(4), 815-825.

Matthews, E. 2017. https://www.afcea.org/content/?q=node/17346/ accessed 6/1/2017.

Nunnally, J., & Bernstein, L. (1994). Psychometric theory. New York: McGraw-Hill Higher Ed.

Rosenstock, I. M. (1974). Historical origins of the health belief model. Health education monographs, 2(4), 328-335.

Rosenstock, I. M., Strecher, V. J., & Becker, M. H. (1988). Social learning theory and the health belief model. Health Education Quarterly, 15(2), 175-183.

Symantec (2017), Internet Security Threat Report, Volume 22. https://www.symantec.com/security-center/threat-report. accessed June 1, 2017.

Walker, L. R., & Thomas, K. W. (1982). Beyond expectancy theory: An integrative motivational model from health care. Academy of Management Review, 7(2), 187-194.

Williams, C. K., Wynn, D., Madupalli, R., Karahanna, E., & Duncan, B. K. (2014). Explaining Users' Security Behaviors with the Security Belief Model. Journal of Organizational and End User Computing (JOEUC), 26(3), 23-46.

Appendix

Survey Questions (Likert Scale End Points Indicated in Parentheses)

CONSTRUCT	Questions
BEHAVIOR (BEH)	(BEH1) Before opening an email, I first check if the subject and sender make sense. (never/every time)
	(BEH2) Before opening an email attachment, I first check if the filename of the attachment makes sense. (never/every time)
	(BEH3) Before clicking on a link in an email, I first check to see if the URL for the link makes sense. (never/every time)
	(BEH4) Before opening an email attachment, I first check to see if the contents and sender of the email make sense. (never/every time)
BARRIERS (BAR)	(BAR1) Being on the alert for unsafe emails is time consuming. (disagree/agree)
	(BAR2) The expense of being on the alert for unsafe emails is a concern for me. (disagree/agree)
	(BAR3) Being on the alert for unsafe emails would require changing my email habits, which is difficult. (disagree/agree)
	(BAR4) Being on the alert for unsafe emails would require substantial investment in effort other than time. (disagree/agree)
SELF-EFFICACY (EFF)	(EFF1) I am confident I can recognize unsafe emails. (disagree/agree)
	(EFF2) I am confident I can recognize unsafe email attachments. (disagree/agree)
	(EFF3) I am confident I can recognize unsafe links in emails. (disagree/agree)
	(EFF4) I can recognize unsafe emails even if no one was around to help me. (disagree/agree)
CUES TO ACTION (CUE)	(CUE1) If I saw a news report or read a newspaper or magazine article about a crime related to unsafe emails, I would be more concerned about opening or clicking links within emails. (disagree/agree)
	(CUE2) If a friend were to tell me of a recent experience with identity theft related to a suspicious email, I would be more conscious of opening emails or clicking links within emails. (disagree/agree)
	(CUE3) If my computer is attacked by someone, I would be concerned I had improperly handled unsafe emails. (disagree/agree)
	(CUE4) If I received an email from the Helpdesk of my university about risks posed by unsafe emails, I would be more concerned about opening emails or clicking links within emails. (disagree/agree)
PRIOR EXPERIENCE (EXP)	(EXP1) How frequently do you receive unsafe emails in your inbox(es)? (never/a great deal)
	(EXP2) How frequently have you be affected by unsafe emails? (never/a great deal)
	(EXP3) How recently have you been affected by unsafe emails? (never/in the last week)
	(EXP4) The level of impact I have experienced due to receiving unsafe emails is? (no impact/major impact)
PERCEIVED VULNERABILITY (VUL)	(VUL1) There is a good chance that I will receive an unsafe email. (disagree/agree)
	(VUL2) There is a good chance I will receive an email with an unsafe email attachment. (disagree/agree)

	(VUL3) There is a good chance I will receive an email containing links to phishing sites. (disagree/agree)
PERCEIVED BENEFITS (BEN)	(BEN1) Being on the alert for unsafe emails is effective in preventing viruses from infecting my computer. (disagree/agree)
	(BEN2) Checking if the sender and subject make sense before opening an email is effective in preventing viruses from infecting my computer. (disagree/agree)
	(BEN3) Checking if the filename of the attachment makes sense before opening an email is effective in preventing viruses from infecting my computer. (disagree/agree)
	(BEN4) Exercising care before opening email attachments is effective in preventing viruses from infecting my computer. (disagree/agree)
	(BEN5) Exercising care before clicking on links in emails is effective in preventing viruses from infecting my computer. (disagree/agree)
PERCEIVED SEVERITY (SEV)	(SEV1) Having my computer infected by a virus as the result of unsafe email practices is a serious problem for me. (disagree/agree)
	(SEV2) Putting the school's network at risk because of unsafe email practices is a serious problem for me. (disagree/agree)
	(SEV3) If my computer is infected by a virus as the result of unsafe email practices, my daily work/schoolwork/social life could be negatively affected. (disagree/agree)

Text Messaging Today: A Longitudinal Study of Variables Influencing Text Messaging from 2009 to 2016

Alan Peslak
arp14@psu.edu
Penn State University
Scranton, PA

D. Scott Hunsinger
hunsingerds@appstate.edu
Appalachian State University
Boone, NC

S. E. Kruck
kruckse@jmu.edu
James Madison University
Harrisonburg, VA

Abstract

This paper shares the results of our longitudinal study of text messaging. The same survey was given at 2 institutions seven years apart. All variables showed a gain in positive valence from 2009 to 2016. In other words, all variables were more positive in 2009 versus 2016. For nearly all these variables, these differences were significant. The influencing variables from many popular behavioral models including Theory of Reasoned Action, Theory of Planned Behavior, Technology Acceptance Model, End User Computer Satisfaction, and to a lesser extent Diffusion of Innovation all were found to have increased over the seven years.

Keywords: Text Messaging, Theory of Reasoned Action, Theory of Planned Behavior, Technology Acceptance Model, End User Computer Satisfaction, Diffusion of Innovation

1. INTRODUCTION

We hear all the time on the news that text messaging is one of the most used data phone services and how often those without unlimited text messaging incur very large bills. A few recent stats indicate how popular text messaging has become. The number of monthly texts sent increased more than 7,700% over the last decade and over 18.7 billion texts are sent worldwide every day (not including app to app) (Statistic Brain, 2014). Furthermore, 4.2 billion+ people text worldwide (Burke, 2015). But a question is whether this increase is due to sheer growth by necessity or whether there has been a corresponding increase in influencing variables that affects this increase.

This paper will share our longitudinal study using variables from five models on human behavior to determine whether there has been a corresponding increase in influencing variables that affects the increase in text messaging usage. Those five models are: End User Computer

Satisfaction (EUCS); Theory of Reasoned Action (TRA); Theory of Planned Behavior (TPB); Technology Acceptance Model (TAM) and Diffusion of Innovation (DI). Each of the variables will be explored using each of the five models.

2. LITERATURE REVIEW

Text messaging

Nielsen (2013) reports that text messaging (SMS) is the most used data service in the world. Over the last decade, the number of texts sent has increased by more than 7,700% (Statistic Brain, 2014). More than 560 billion texts are sent monthly worldwide, including over 6 billion texts sent daily in the United States alone (Burke, 2016).

It has been estimated that 97% of American adults text on a weekly basis (Smith, 2015), with the average adult texting 23 hours per week (Wolff, 2014). According to Gallup (Newport, 2014), texting is the most common form of communication for adults under 50 years old in the United States. On average, college students spend over 90 minutes texting per day (Wood, 2014). As shown in Table 1, texting has become popular for a wide range of age groups, as even those individuals over 55 years of age send and receive an average of 16 texts per day.

Age Range	**Approximate Number of Texts Sent and Received Daily**
18 – 24	128
25 - 34	75
35 - 44	52
45 - 54	33
55+	16

Table 1: Number of Texts Sent and Received Daily by Age Group

Text messages are much more likely to be opened than emails, as SMS messages have a 98-99% open rate while email's open rate is 20% (Burke, 2016; Essany, 2014). The response rate for text messages (45%) is also higher than the response rate for email messages (6%) (Small, 2013). Forbes reported that 95% of texts are read within three minutes of when they were sent, with an average response time of 90 seconds. Text messages also take less time to read - approximately 5 seconds, on average (Burke, 2016).

Review of Relevant Theories

This paper integrates variables from multiple relevant theories in order to examine their influence from our previous work (**blind this – previous study**) and our data collection completed in 2016. We used variables from the following models.

- Diffusion of Innovation Theory (*Compatibility; Complexity; Relative Advantage; Visibility*)
- End User Computing Satisfaction (*Timeliness*)
- Theory of Reasoned Action (*Attitude*)
- Theory of Planned Behavior (*Perceived Behavioral Control*)
- Technology Acceptance Model (*Ease of Use; Usefulness*)

In the following subsections, we provide a brief overview of each of these theories.

Diffusion of Innovation Theory

The Diffusion of Innovation theory (Rogers, 1962; Rogers, 2003) seeks to explain how, why, and how quickly new ideas and technology spread. As shown in Figure 1, adopters are grouped into into five categories: Innovators, Early Adopters, Early Majority, Late Majority, and Laggards.

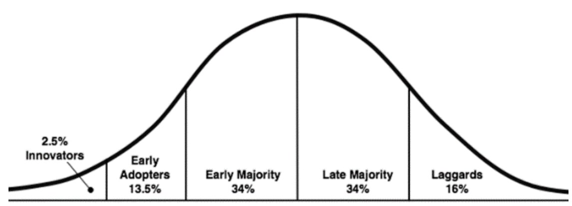

Figure 1: Diffusion of Innovation

Rogers (2003) identified five major factors that impact the rate of adoption. These factors include relative advantage, complexity, compatibility, trialability, and observability or visibility. The adoption of an innovation or technology follows an S curve when it is plotted over a period of time (Fisher, 1971). Critical mass occurs when enough people have adopted the innovation and its rate of adoption becomes self-sustaining (Rogers, 2003).

End User Computing Satisfaction

Doll and Torkzadeh (1988) developed the End User Computing Satisfaction model using the five factors shown in Figure 2: Content, Accuracy, Format, Ease of Use, and Timeliness. They suggested a twelve question instrument to measure these five components. Our study uses the Timeliness factor, which measures whether the information is up to date and was supplied in time.

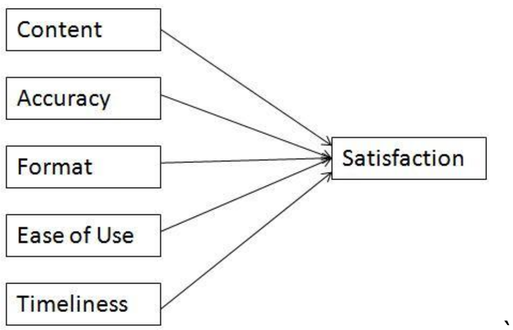

Figure 2: End User Computing Satisfaction

Technology Acceptance Model

The Technology Acceptance Model examines an individual's willingness to adopt technology (Davis, 1989). The Technology Acceptance Model uses two factors to measure an individual's intention of adopting a technology: 1) Perceived Usefulness and 2) Perceived Ease of Use. Perceived Usefulness is defined as "the degree to which a person believes that using a particular system would enhance his or her job performance." Perceived Ease of Use is defined as "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989). Our study integrates the perceived usefulness and perceived ease of use components from the Technology Acceptance Model as shown in Figure 3.

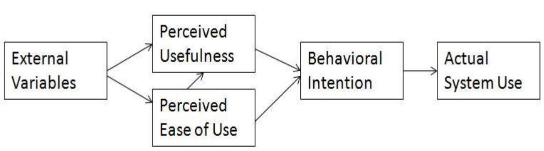

Figure 3: Technology Acceptance Model

Theory of Reasoned Action

According to the Theory of Reasoned Action (Fishbein & Ajzen, 1975), an individual's performance of a specific behavior is determined by his or his/her individual's attitude and his/her subjective norm about the behavior. As shown in Figure 4, a person's intention to perform a specific behavior leads to increased effort and likelihood for the behavior to be actually performed.

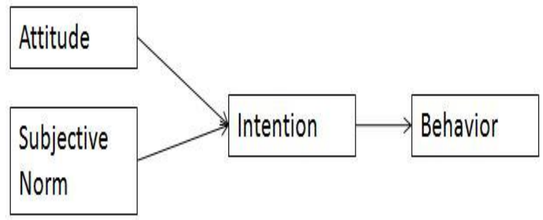

Figure 4: Theory of Reasoned Action

Theory of Planned Behavior

The theory of planned behavior, shown in Figure 5, expands the theory of reasoned action by adding the construct of Perceived Behavioral Control (PBC) in order to deal with behaviors under incomplete volitional control. Performance of behaviors that are not under total volitional control may depend on the availability of opportunities and resources such as time, money, skills, and the cooperation of others (Ajzen, 1991).

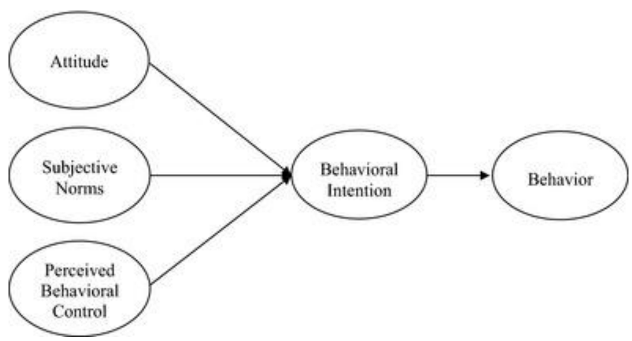

Figure 5: Theory of Planned Behavior

Role of Emotions

Previous research has shown that emotions can impact performance and behavior (Glinow, Shapiro, and Brett, 2004; Peslak and Stanton, 2007; Sy, Cote, and Saavedra, 2005). Our study integrates a group of four positive emotions used in our previous work.

3. RESEARCH APPROACH

A comprehensive survey was developed to explore all aspects of text messaging usage in 2009. The survey included key questions used in the development of past studies of Theory of Reasoned Action, Technology Acceptance Model, Theory of Planned Behavior, End User Computer Satisfaction, and Diffusion of Innovation. The same survey was used for 2016. Table 2 shows the variables and questions that were used in this study. Appendix 1 shows the variable, question, model, and source for question.

Our primary research goal was to determine how various variables associated with technology adoption changed with regard to text messaging from 2009 to 2016.

One key question was selected for each variable. This survey was administered in 2009 to students and other University personnel at two Northeastern Universities. Many results were published as a result of this survey **(blinded).** The exact same survey was repeated in 2016 to see if attitudes towards text messaging had changed over time. The study this time was administered at three Northeastern Universities and though the same subjects were not available for the 2016 study, they were drawn from the same demographic pool as the 2009 study.

Variable	Actual survey question
Attitude	Text messaging is good.
Compatibility	Text messaging is completely compatible with how I communicate.
Complexity	Text messaging requires a lot of mental effort.
Critical Mass	Many people I know will continue to use text messaging.
Ease of Use	Text messaging is easy to do.
Emotions	Pleased Satisfied Contented Delighted
Perceived Behavioral Control	Text messaging is entirely within my control.
Relative advantage	Text messaging improves my productivity.
Timeliness	Text messaging provides needed information quickly.
Usefulness	I find Text messaging useful.
Visibility	I have seen many people Text messaging.

Table 2: Variable Models and References

All questions were scaled from 1 to 7 with 1 being Strongly Disagree and 7 being Strongly Agree. Four was a Neutral view. All the questions except the one used to measure Complexity were positive questions (good, pleased, compatible) so the higher the score the higher the favorability toward text messaging. By having all scaled similarly, relative comparisons could be made across all variables. The one exception to positive questions was Complexity in Diffusion of Innovation Theory, Text messaging requires a lot of mental effort which is a negative question. The same survey instrument was used in 2009 and in 2016.

The statistical analyses were based on a sample of 153 valid surveys in 2009 and 162 valid surveys in 2016. Since the surveys were collected in classes, response rate was near 100%. The 2009 survey however included a strong mix of faculty and other professionals. In order to properly compare 2009 with 2016, only self-identified students were included in the survey analysis. This resulted in 72 respondents from 2009 and 141 from 2016. The gender mix was higher in females in 2009 versus 2016 as shown in table 2. A prior study **(blinded**) however found no significant difference between females and males in all these variables except emotions. The age distribution is shown in Table 3 and the gender distribution is shown in Table 4. Most students in both 2009 and 2016 were in the 18-24 age bracket. We propose the sample has a comparable mix of gender and age.

		09or16		Total
		1	2	
18-24	Count	84	144	228
	% within 09or16	97.7%	92.9%	94.6%
25-30	Count	0	10	10
	% within 09or16	0.0%	6.5%	4.1%
31-40	Count	0	1	1
	% within 09or16	0.0%	0.6%	0.4%
41-50	Count	2	0	2
	% within 09or16	2.3%	0.0%	0.8%
Total	Count	86	155	241
	% within 09or16	100.0%	100.0%	100.0%

Table 3 Age

		09 or16		
		Female	Male	Total
2009	Count	47	64	111
	% within 09or16	54.7%	41.0%	45.9%
2016	Count	39	92	131
	% within 09or16	45.3%	59.0%	54.1%
	Count	86	156	242
	% within 09or16	100.0%	100.0%	100.0%

Table 4 Gender

4. RESULTS

The variables were analyzed using SPSS 22.0 using Independent Samples t-tests. The results of this analysis are presented in Tables 5 and 6. Table 5 shows the mean for each of the influencing variables. Table 6 shows the results of the t-test to determine whether the differences between 2009 and 2016 were statistically significant. Overall, it can be said that nearly all variables showed an increase in positive effect between 2009 and 2016. In the two situations where a decrease was shown this decrease was found not to be statistically significant. Our overall assessment is that for all variables across all popular behavioral models studied, text messaging is seen more favorably in 2016 than in 2009. Supporting this conclusion was a separate studied variable, Time Spent text messaging. This significantly increased from a mean of 4.18 to 4.62 from 2009 to 2016. This takes us from a "4", which is 3 hours per month, to nearly a "5" which is 10 hours per month. Not only is it viewed more favorably but also significantly more time is spent using it. It has become an integral form of communication in our society. An analysis of each of the variables follows.

	09or16	Mean
Is good	2009	4.96
	2016	5.59
Is compatible	2009	4.68
	2016	4.66
Requires mental effort	2009	2.76
	2016	2.85
Many people	2009	5.08
	2016	6.50
Easy to do	2009	5.04
	2016	6.05
Pleased	2009	2.68
	2016	4.82
Satisfied	2009	2.59
	2016	4.89
Contented	2009	2.68
	2016	4.86
Delighted	2009	2.63
	2016	4.69
Within my control	2009	5.08
	2016	5.55
Improves my productivity	2009	4.67
	2016	4.61
Information quickly	2009	5.18
	2016	5.73
Useful	2009	5.13
	2016	6.00
Seen many people	2009	5.41
	2016	6.28
,	2009	6.44
	2016	6.62
Time	2009	4.18
	2016	4.62

Table 5 Variable Means

t-test for Equality of Means		Sig. (2-tailed)
Is good	Equal var	0.006
Is compatible	Equal var	0.943
Requires mental effort	Equal var	0.716
Many people	Equal var	0.000
Easy to do	Equal var	0.000
Pleased	Equal var	0.000
Satisfied	Equal var	0.000
Contented	Equal var	0.000
Delighted	Equal var	0.000
Within my control	Equal var	0.037
Improves my productivity	Equal var	0.810
Information quickly	Equal var	0.012
Useful	Equal var	0.000
Seen many people	Equal var	0.000
Often	Equal var	0.205
Time	Equal var	0.023

Table 6 Independent samples t test

"Text messaging is good" measures overall attitude toward the activity. It is a key influencing variable in both Theory of Reasoned Action and Theory of Planned Behavior. In these models it influences behavioral intention which then influences actual behavior. The rating here rose from 4.96 in 2009 to 5.59 in 2016. This moves the favorable rating from a 5 or somewhat agree to nearly a 6, Agree. This increase was statistically significant at p <.006. Text messaging is viewed better in 2016 versus 2009.

"Text messaging is completely compatible with my current situation" measures overall compatibility toward the activity. It is a key influencing variable in Diffusion of Innovation theory. In this model it influences behavioral intention which then influences actual behavior. The rating here fell slightly from 4.68 in 2009 to 4.66 in 2016. This increase was not statistically significant at p <.05. Text messaging is viewed with the same compatibility in 2016 versus 2009.

"Text messaging requires a lot of mental effort" measures overall complexity of the activity. It is a key influencing variable in both Diffusion of Innovation theory. In this model it influences behavioral intention which then influences actual behavior. The rating here rose from 2.76 in 2009 to 2.85 in 2016. This is a small increase in the unfavorable variable but this increase was not statistically significant at p <.005. Text messaging is viewed as requiring the same mental effort in 2016 versus 2009.

"Many people use Text messaging" measures critical mass of the activity. It is a key influencing variable in Diffusion of Innovation theory. In this model it influences behavioral intention which then influences actual behavior. The rating here rose from 5.08 in 2009 to 6.50 in 2016. This moves the favorable rating from a 5 or somewhat agree to nearly a 7, Strongly Agree. This increase was statistically significant at p <.001. Text messaging is seen as being used more in 2016 versus 2009.

"Text messaging is easy to do" is ease of use of the activity. It is a key influencing variable in both Technology Acceptance Model and End User Computer Satisfaction. In these models it influences behavioral intention which then influences actual behavior. The rating here rose from 5.04 in 2009 to 6.05 in 2016. This moves the favorable rating from a 5 or somewhat agree to over a 6, Agree. This increase was statistically significant at p <.001. Text messaging is seen as easier to use in 2016 versus 2009.

"Pleased, satisfied, contented and delighted" are emotions associated with overall attitude toward the activity. It is a key influencing variable in models of Emotions. In these models it influences behavioral intention which then influences actual behavior. The rating here rose from about 2.6 in 2009 to about 4.8 in 2016. This moves the favorable rating from a 3 or somewhat disagree to nearly a 5, Somewhat Agree. This increase was statistically significant at p <.001. The emotions associated with text messaging have changed a great deal for the better in 2016 versus 2009.

"Text messaging is entirely within my control" is perceived behavioral control toward the activity. It is a key influencing variable in Theory of Planned Behavior. In this model it influences behavioral intention which then influences actual behavior. The rating here rose from 5.08 in 2009 to 5.55 in 2016. This moves the favorable rating from a 5 or somewhat agree to nearly a 6, Agree.

This increase was statistically significant at p <.037. Respondents feel more in control with text messaging in 2016 versus 2009.

"Text messaging improves my productivity" measures relative advantage of the activity. It is a key influencing variable in Diffusion of Innovation. In this model it influences behavioral intention which then influences actual behavior. The rating here rose from 4.67 in 2009 to 4.61 in 2016. This decrease in the favorable rating was not statistically significant at p <.05. Text messaging is viewed the same in productivity improvement in 2016 versus 2009.

"Text messaging provides needed information quickly" measures timeliness of the activity. It is a key influencing variable in End User Computer Satisfaction. In this model it influences behavioral intention which then influences actual behavior. The rating here rose from 5.18 in 2009 to 5.73 in 2016. This moves the favorable rating from a 5 or somewhat agree to nearly a 6, Agree. This increase was statistically significant at p <.012. Text messaging is viewed as providing information more quickly in 2016 versus 2009.

"I find Text messaging useful" is usefulness toward the activity. It is a key influencing variable in Technology Acceptance Model. In this model it influences behavioral intention which then influences actual behavior. The rating here rose from 5.13 in 2009 to 6.00 in 2016. This moves the favorable rating from a 5 or somewhat agree to nearly a 6, Agree. This increase was statistically significant at p <.001. Text messaging is viewed as more useful in 2016 versus 2009.

"I have seen many people Text messaging" measures usefulness of the activity. It is a key influencing variable in both Theory of Diffusion of Innovation Theory. In this model it influences behavioral intention which then influences actual behavior. The rating here rose from 5.41 in 2009 to 6.28 in 2016. This moves the favorable rating from a 5 or somewhat agree to nearly a 6, Agree. This increase was statistically significant at p <.001. Text messaging is viewed as more ubiquitous in 2016 versus 2009.

A final measure which confirms that the majority of variables potentially affecting text messaging usage has indeed increased usage is the measure of time spent using text messaging. The measure here rose from 4.18 in 2009 to 4.62 in 2016. The scale used here indicated "4" as 3 hours per month and "5" as 10 hours per month. Our respondents significantly increased their time text messaging at p < .001. Interpolating these measures suggests an approximate increase from 4.26 hours per month to 7.34 hours per month.

5. LIMITATIONS

As with any study, there are limitations. We used a convenience sample of undergraduate students at two university locations. Although students are significant users of text messaging, they are a select population in the 18-24 age bracket. The figure 6 below shows that although 18-24 send the most text messages, it is used by all ages (Burke, 2016). It was not a surprise that text messaging is seen as more favorable for 18-24 year olds because of the increase in usage. And the increase in usage means there is an increase in time spent text messaging, almost 8 hours per month. Test messaging in personal use has increased but so has text messaging for business purposes. It is the highest rated contact method for customer satisfaction compared to all other communication channels (Text – 90; Phone – 77; Facebook – 66) (Eddy, 2014). Not only is it a preferred method, it costs a company's customer service center a lot less; pennies per conversation instead of several dollars (Varley, 2014).

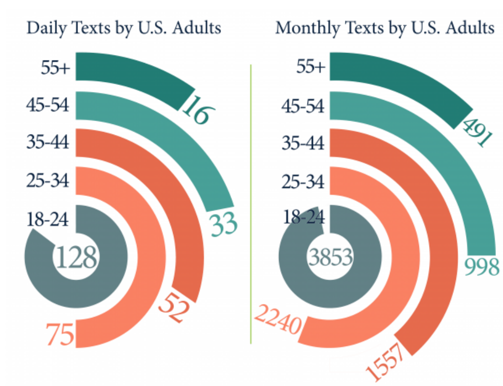

Figure 6 Text Trends

This study should be replicated with other populations, other age groups, and again in another 7 years.

6. CONCLUSION

Overall, this longitudinal study of text messaging has provided significant variables that influence and affect text messaging frequency of use and time spent using the technology has increased in the last 7 years. We see this as the continuation of an exploration of ways to increase and improve penetration of this valuable communications technology. With a high rate of acceptance, more and more businesses are likely to text message with their customers. We conclude that text messaging has not just grown due to popularity but has grown due to specific influencing variables from each of the five studied theories of technology adoption.

7. REFERENCES

Abdinnour-Helm, S. F., Chaparro, B. S., and Farmer, S. M.(2005). Using the End-User Computing Satisfaction (EUCS) Instrument to Measure Satisfaction with a Web Site. *Decision Sciences* ,36(2), 341-365.

Ajzen, I. (1985)."From intentions to actions: A Theory of Planned Behavior," in (Eds.), J. Kuhl & J. Beckmann *Action control: From cognition to behavior*, Berlin, Heidelber, New York: Springer-Verlag. 3.

Ajzen, I. and Fishbein, M. (1980). *Understanding Attitudes and Predicting Social Behavior*. Englewood Cliffs: Prentice-Hall, Inc.

Burke, K. (2014) "Is Our Mobile Dependence Actually A Bad Thing? Here's the Research." Last accessed 6/13/2017 https://www.textrequest.com/blog/is-mobile-dependence-actually-a-bad-thing/

Burke, K. (2016) "63 Texting Statistics That Answer All Your Questions." Last accessed 6/13/2017 https://www.textrequest.com/blog/texting-statistics-answer-questions/

Burke, Kenneth. How Many Texts Do People Send Every Day? May 18, 2016. https://www.textrequest.com/blog/many-texts-people-send-per-day/

Burke, Kenneth. Is Our Mobile Dependence Actually a Bad Thing? Here's the Research. October 27, 2015. https://www.textrequest.com/blog/is-mobile-dependence-actually-a-bad-thing/

Burke, Kenneth. Your Complete Guide to Successful Business Texting / SMS Online. May 3, 2016. https://www.textrequest.com/blog/complete-overview-business-texting/

Davis, F. D. (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly* , 13(3), 319-340. 9.

Doll, W., and Torkzadeh, G. (1988). The Measurement of End-User Computing Satisfaction. *MIS Quarterly* , 12(6), 259-274.

Eddy, N. (2014) "Consumers Like Using Text Messages to Solve Customer Service Issues." Last accessed 6/13/2017http://www.eweek.com/networking/consumers-like-using-text-messages-to-solve-customer-service-issues

Essany, Michael. SMS Marketing Wallops Email with 98% Open Rate and Only 1% Spam.Mobile Marketing Watch. https://mobilemarketingwatch.com/sms-marketing-wallops-email-with-98-open-rate-and-only-1-spam-43866/ August 6, 2014.

Experian Digital Market Report. http://www.experian.com/marketing-services/2013-digital-marketer-report.html?WT.srch=PR_EMS_DMReport_020813_DMReport.

Fishbein, M., & Ajzen, I. (1975). Belief, Attitude, Intention, and Behavior: *An Introduction to Theory and Research.* Reading, MA: Addison-Wesley.

Fisher, J.C. (1971). "A simple substitution model of technological change". Technological Forecasting and Social Change. 3: 75–88.

Fitzmaurice, J. (2005) Incorporating Consumers' Motivations into the Theory of Reasoned Action. *Psychology & Marketing*. 22(11), 911-929.

George, J. (2004) The theory of planned behavior and Internet purchasing. *Internet Research*, 14(3), 198-212.

Glinow, M., Shapiro, D., and Brett, J. (2004). Can we talk, and should we? Managing emotional conflict in multicultural teams. Academy of Management Review, 29(4), 578-92.

Ilie, V., Van Slyke, C., Green, G., and Lou, H. (2005). Gender Difference in Perception and Use of Communication Technologies: A Diffusion of Innovation Approach. *Information Resources Management Journal*. 18(3), 13-31.

Lee Y., Kozar K., and Larsen K. (2003) The Technology Acceptance Model: Past, Present, and Future. *Communications of the Association for Information Systems*, 12, 752-780.

Newport, Frank. The New Era of Communication Among Americans. November 10, 2014. http://www.gallup.com/poll/179288/new-era-communication-americans.aspx

Rogers, Everett (2003). *Diffusion of Innovations*, 5th Edition. Simon and Schuster.

Rogers, Everett M. (1962*). Diffusion of innovations (1st ed.)*. New York: Free Press of Glencoe.

Small, Adam. How to Use SMS to Win Love, Leads, Revenue. https://martech.zone/text-messaging/ March 5, 2013.

Smith, Aaron. U.S. Smartphone Use in 2015. http://www.pewinternet.org/2015/04/01/us-smartphone-use-in-2015/ April 1, 2015.

Statistic Brain Research Institute (2014). "Text Message Statistics." Last accessed 6/13/2017 http://www.statisticbrain.com/text-message-statistics/

Varley, L. (2014) "7 Key Statistics for SMS Marketing." Last accessed 6/13/2017 http://digitalmarketingmagazine.co.uk/mobile-digital-marketing/7-key-statistics-for-sms-marketing/558#

Sy, T., Cote, S., and Saavedra, R. (2005). The contagious leader: impact of the leader's mood on the mood of group members,group affective tone, and group processes. *Journal of Applied Psychology*, 90(2), 295-305.

Text Message Statistics. http://www.statisticbrain.com/text-message-statistics/

The Mobile Consumer – A Global Snapshot. February 2013. http://www.nielsen.com/content/dam/corporate/uk/en/documents/Mobile-Consumer-Report-2013.pdf

Venkatesh, V., and Morris, M.(2000). Why Don't Men Ever Stop to Ask for Directions? Gender, Social Influence, and Their Role in Technology Acceptance and Usage Behavior. *MIS Quarterly*, 24(1), 115-39.

Wolff, Michael. How Media Usage is Taking Over Our Lives. July 10, 2014.http://experience.usatoday.com/weekend/story/lifestyle/2014/07/10/michael-wolff-how-media-usage-is-taking-over-our-lives/12487581/

Wood, Janice. College Students in Study Spend 8 to 10 Hours Daily on Cell Phone. https://psychcentral.com/news/2014/08/31/new-study-finds-cell-phone-addiction-increasingly-realistic-possibility/74312.html

Appendix

Table 1: Variable Models and References

Variable	Actual survey question	Model	Questions adapted from
Attitude	Text messaging is good.	Theory of Reasoned Action/TPB	Fitzmaurice
Compatibility	Text messaging is completely compatible with how I communicate	Diffusion of Innovation	Ilie, Van Slyke, Green, & Lou
Complexity	Text messaging requires a lot of mental effort	Diffusion of Innovation	Ilie, Van Slyke, Green, & Lou
Critical Mass	Many people I know will continue to use text messaging	Diffusion of Innovation	Ilie, Van Slyke, Green, & Lou
Ease of Use	Text messaging is easy to do.	Technology Acceptance Model /EUCS	Davis [8]
Emotions	Pleased Satisfied Contented Delighted	Emotions	Peslak and Stanton
Perceived Behavioral Control	Text messaging is entirely within my control.	Theory of Planned Behavior	Venkatesh & Morris
Relative advantage	Text messaging improves my productivity.	Diffusion of Innovation	George
Timeliness	Text messaging provides needed information quickly	End User Computer Satisfaction	Fitzmaurice
Usefulness	I find Text messaging useful	Technology Acceptance Model/ECT	Abdinnour-Helm, Chaparro, & Farmer
Visibility	I have seen many people Text messaging.	Diffusion of Innovation	Davis

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

Lionel Mew
lmew@richmond.edu
University of Richmond
Richmond, VA

William H. Money
wmoney@citadel.edu
The Citadel
Charleston, SC

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 in-vestments 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.

7. REFERENCES

Armbrust, M., Fox, A., Griffith, R., Joseph, A. D., Katz, R., Konwinski, A., ... & Zaharia, M. (2010). A view of cloud computing. Communications of the ACM, 53(4), 50-58.

Bansal, N. (2012). Investigation to implicate data on clouds. arXiv preprint arXiv:1202.1366.

Chow, R., Golle, P., Jakobsson, M., Shi, E., Staddon, J., Masuoka, R., & Molina, J. (2009, November). Controlling data in the cloud: outsourcing computation without outsourcing control. In Proceedings of the 2009 ACM workshop on Cloud computing security (pp. 85-90). ACM.

Cloud Storage Security Comparison. (2017)

Ercan, T. (2010). Effective use of cloud computing in educational institutions. Procedia-Social and Behavioral Sciences, 2(2), 938-942.

Garrison, G., Kim, S., & Wakefield, R. L. (2012). Success factors for deploying cloud computing. Communications of the ACM, 55(9), 62-68.

Grobauer, B., Walloschek, T., & Stocker, E. (2011). Understanding cloud computing vulnerabilities. IEEE Security & Privacy, 9(2), 50-57.

Iyer, B., & Henderson, J. C. (2010). Preparing for the Future: Understanding the Seven Capabilities of Cloud Computing. MIS Quarterly Executive, 9(2).

Khajeh-Hosseini, A., Greenwood, D., & Sommerville, I. (2010, July). Cloud migra-tion: A case study of migrating an enterprise it system to iaas. In Cloud Com-puting (CLOUD), 2010 IEEE 3rd International Conference on (pp. 450-457). IEEE.

Lian, J. W., Yen, D. C., & Wang, Y. T. (2014). An exploratory study to understand the critical factors affecting the decision to adopt cloud computing in Taiwan hospital. International Journal of Information Management, 34(1), 28-36.

Low, C., Chen, Y., & Wu, M. (2011). Understanding the determinants of cloud computing adoption. Industrial management & data systems, 111(7), 1006-1023.

Marston, S., Li, Z., Bandyopadhyay, S., Zhang, J., & Ghalsasi, A. (2011). Cloud computing—The business perspective. Decision support systems, 51(1), 176-189.

Mell, P., & Grance, T. (2011). The NIST Definition of Cloud Computing. Recom-mendations of the National Institute of Standards and Technology (NIST), Special Publication 800–145 (January 2011).

Plummer, D. C., Smith, D., Bittman, T. J., Cearley, D. W., Cappuccio, D. J., Scott, D., ... & Robertson, B. (2009). Gartner highlights five attributes of cloud com-puting. Vol G00167182, 1-5.

Saripalli, P., & Walters, B. (2010, July). Quirc: A quantitative impact and risk as-sessment framework for cloud security. In Cloud Computing (CLOUD), 2010 IEEE 3rd International Conference on (pp. 280-288). Ieee.

Tresorit. (2017). Cloud Storage Security Comparison. Retrieved from https://tresorit.com/cloud-storage-comparison?gclid=CL_DjJzH_dQCFQdahgodfYMIuQ

Wu, Y., Cegielski, C. G., Hazen, B. T., & Hall, D. J. (2013). Cloud computing in support of supply chain information system infrastructure: understanding when to go to the cloud. Journal of Supply Chain Management, 49(3), 25-41.