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ASSESSING THE RELATIONSHIPS AMONG CLOUD ADOPTION, STRATEGIC ALIGNMENT AND IT EFFECTIVENESS

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ABSTRACT

Against the backdrop of new economic realities, one of the larger forces that is affecting businesses worldwide is cloud computing, whose benefits include agility, time to market, time to capability, reduced cost, etc. The intent of this research was to contribute to the body of knowledge that could be applied by researchers, businesses, and IT organizations alike to achieve optimal results through the adoption of cloud based services and solutions. The study findings provided statistical evidence that cloud adoption (CA) has a very strong positive correlation on IT effectiveness (ITE) and its relationship is much higher than the relationship of strategic alignment (SA) on ITE or the combination of CA and SA as interaction term (CA x SA). The new knowledge gained from the benefits of cloud adoption on IT effectiveness would enhance the decision-making process for IT managers when considering the adoption of cloud technologies and its business models.

Keywords: cloud computing, information technology, IT, strategic alignment, IT effectiveness, cloud adoption

INTRODUCTION AND BACKGROUND

Information technology (IT) is changing the way businesses operate, the process of creating products and services to their customers, and in the way they compete [9]. Today's IT challenges faced by Chief Information Officers (CIOs) include cost pressure, lack of agility, security, recovery from recession, and to enable new products & services [19]. Cloud computing can potentially transform a majority of the information technology industry into services oriented IT organizations or simply IT as a Service (ITaaS), changing the way software and hardware are designed and purchased. Cloud computing derives from a long history of research and development on various approaches to IT outsourcing, in which customers draw from a service provider's pool of capacity on a pay-as-you-go basis as an alternative to managing their own IT infrastructure [42, 60]. Cloud computing is an outcome from decades of research in various disciplines including virtualization, distributed computing [39], utility computing [22, 56], networking, and software services [65]. Some of the key attributes of cloud computing are service-based, scalable, shared, metered billing, elastic and incorporates advanced technologies like virtualization [53]. However, there are many challenges that come along with cloud concept, biggest of them being security, performance and availability although cost and speed of adoption remain the top benefits of cloud computing [27]. According to Gartner, cloud computing is the top strategic technology for 2010 [54].

There are three service models in cloud computing: (a) Software-as-a-Service (SaaS) (b) Platform-as-a-Service (PaaS) (c) Infrastructure-as-a-Service (IaaS). Effectiveness of IT is known as the degree to which IT can effectively and efficiently deliver and/or integrate with the technology based services and solutions. Strategic alignment with business stakeholders has traditionally been viewed as the means to achieve greater IT delivery capabilities, but recent trends seem to indicate higher cloud adoption (a combination of public and private clouds resulting in community and hybrid clouds) as a means of achieving IT effectiveness.

Pierce examined the relationships between business strategy, IT strategy, strategic alignment, return on IT investment, and corporate performance, and provided empirical evidence on the effect of alignment between business and IT strategies by measuring return on IT investment and corporate performance [55]. Tallon and Kraemer using the theory of dynamic capabilities examined the relationships between IT flexibility, strategic alignment and IT business value to assess whether capabilities around flexibility can enable corporations to realize greater payoffs from IT investment [62]. Ness examined the relationships between IT flexibility, strategic alignment and IT effectiveness to provide empirical evidence on the strength of these relationships and asserted with evidence that IT flexibility has greater influence on IT effectiveness than does strategic alignment on larger IT organizations [48].

In this study, cloud adoption and strategic alignment were analyzed as two constructs that affect IT effectiveness. This study is a modification of Ness's [48] research, replacing IT flexibility with cloud adoption and extending to all IT organizations irrespective of their type and size.

Statement of the Problem

Increased competitive pressures upon businesses as a result of global competition [67], increased complexity and economic uncertainty [36] and more dynamism in the marketplace [9] are continuing to escalate, generating the need for higher efficiency and productivity among IT organizations. In preparation for economic recovery from the latest global recession which started in 2007, many IT organizations have been analyzing their management practices and sharpening their business models [33]. Information technology (IT) budgets will be leaner, management discipline tighter and business models more focused. The practice of removing extra expenses from the IT portfolio and determining areas of strategic investment is essential in a restricted economy [33]. Breakthroughs in technology based services and solutions are driving frequent, rapid, and unplanned changes in business strategies along with the resultant demand upon IT for its support required to achieve sustained competitive advantage [48]. While adoption of cloud computing provides lot of benefits including real time provisioning, pay-as-you-go billing which could align with business strategy in IT organizations, it has its own share of complexities in terms of security, performance, availability and integration challenges [44]. Spending in IT related to adoption of cloud based services and solutions in 2008 is $16.3 B which is projected to reach $42.2 B by 2012 as cloud-computing related spending will account for 25% of annual IT expenditure growth [26]. US government projects that between 2010 and 2015, it's spending alone on cloud computing will be at a 40% compound annual growth rate and will pass $7 B by 2015 [37]. Providing a wide array of computing-related services on the fly on a pay-as-you-go basis opens up many opportunities for the cloud providers in that expanding market which is worth $100B [10]. It is not clear how many of those IT organizations which adopted cloud based services and solutions are more effective than what they were before the cloud adoption. In particular, based on the literature reviewed, there was a lack of empirical evidence about the relationships between cloud adoptions, IT effectiveness, and/or strategic alignment. This study is an attempt to validate their relationships and to analyze which, if any, factor has a higher correlation with IT effectiveness.

Assumptions and Limitations

The assumptions of this study were that the participants would answer the survey questions based on their technical expertise in information technology. The participants' technical expertise must include knowledge pertaining to their firm's cloud adoption and the alignment efforts with business on strategy and how effective their IT organizations are. Also, it was assumed that the participants would answer all survey questions honestly. The limitations of this study were that the sampling population firms in the United States have one, or more, IT employees. The results from this study should not be generalized to non IT organizations. In addition, the results would represent participants from multiple business types, and therefore, the results should not be interpreted as representing any specific business sector, type or size.

LITERATURE REVIEW

Cloud Computing

From a technical perspective, cloud computing mainly focuses on service-oriented architecture (SOA) and virtualization of both hardware and software [37, 44]. Cloud computing offers reduced IT overhead for the customers, great flexibility, reduced TCO (Total Cost of Ownership), on-demand services, and improved productivity [68]. Economic benefits, simplification and convenience of the way computing services are delivered seem to be the key drivers to speed up the adoption of cloud computing [20]. Cloud adoption fast tracks the cost reduction, increases efficiency and ultimately creates a competitive advantage in any market [21].

There are lot of application types (reporting, transactional, data-interactive) where cloud computing has been adopted including higher education [60, 69, 59], solutions for human resources [21], software testing [4], data back-up or archive services [64], web 2.0 based collaborative applications [51], storage capacity on demand [38], and content distribution services [23]. New use cases and approaches, taking advantage of cloud computing are being actively proposed in the industry, for example, market oriented allocation of resources [10], hard discrete optimization problems [41], defending financial infrastructures against attacks and frauds using intelligence in the cloud [43], collaborative business intelligence [12], data mining algorithms and predictive analytics [71, 30], software testing as a service [14], e-government solutions [11], architecture and implementation courses at graduate level in the cloud [32]. Various cloud agnostic middleware is mushrooming up to augment the functionality provided by cloud providers [44]. Cloud brokers are helping to increase the adoption of cloud computing for various IT organizations by addressing secure and reliable integration needs. The evolving approach of using cloud adapters which use APIs targeting multiple clouds and hide the complexity could help cloud adoption further.

There are several research opportunities in cloud computing that are actively being pursued in the areas of cloud process and workflow management, meta-data management, security, service portability [65], enterprise grade cloud computing [47], efficient indexing for data management on cloud [72], various fee structures and classification and quantification of the execution costs on cloud [18]. Cloud computing poses tremendously interesting research questions and opportunities, especially in the areas of distributed systems, power management, inter-cloud communication protocols, virtualization architectures, service-oriented architectures and management technologies [6, 19] and automated control in terms of decoupling, feedback, and granularity [42].

There are some challenges of cloud computing like trust, privacy, data ownership and control, which trade-off with the cloud benefits like scalability, ease of deployment and ease of management [20]. Various aspects of security need to be addressed by cloud computing technology solutions and cloud computing service providers to increase the cloud adoption [13, 37, 46, 52, 66, 68]. However, some cloud providers argue that their security measures and processes are more mature than those of an average IT organization, which suggests that the security posture of applications or services will be improved with the adoption of cloud. Cellary and Strykowski [11] stated that the professional security staff employed at a cloud provider will be able to ensure higher security of hardware and software than the corresponding security personnel employed in multiple smaller IT organizations. The ability to get smarter through the use of cloud is the key differentiator that will sufficiently alleviate security concerns to ensure widespread adoption [12]. As the cryptographic techniques get more mature, like those which allow computations to be performed on cipher text, they may open up new possibilities for cloud computing security. Chow et al. [12] proposed that by taking an information-centric approach to data and information protection, where data can be self-defending and self-describing can help in cloud security rather than relying on systems and applications that use data. Federated identity management needs to become a common architectural model to authenticate users on applications which are deployed at multiple cloud providers. Increasingly complex integration and the dynamics in cloud computing present significant challenges to timely diagnosis and resolution of incidents such as malware detection and immediate intrusion response to mitigate the impact [13]. Incidence management should be thought through and integrated into service life cycle management (design, deployment and maintenance of services) on the cloud.

US government launched a major cloud initiative to come up with useful minimal standardizations to promote interoperability and portability of services across cloud providers that will help large enterprises unlock the full potential of cloud computing [24]. Open source community in an effort to develop inter-operability frameworks and standards for cloud computing, created what is called open cloud consortium, which is being used by various organizations for information sharing on various aspects of cloud [30]. Vendor lock-in issues are discussed in greater detail by Brandel [7] who summarized both sides of the argument about the amount of risk associated for cloud based systems as against to on-premise systems. According to Brandel [7], the degree of vendor lock-in issue depends on the type of cloud deployment, use of proprietary user interfaces (UIs) and application programming interfaces (APIs). This implies that risk is more in case of SaaS and PaaS models than IaaS models due to the potential usage of APIs in SaaS and PaaS models. There are tools available in the market which creates an abstraction layer on top of the vendor services and interfaces and hence make the cloud based applications more portable across cloud providers. In some cases, vendor lock-in risk involved with cloud based systems is the same as the risk involved with data housed in traditional on-premise ERP systems, like Oracle, SAP [7].

Due to the cost structure and pay-as-you-go flexibility promise, the adoption of cloud services may be more applicable for small and medium scale companies and cash-strapped educational establishments which are often used to similar outages caused by their own in-house IT systems in the past [60]. Among individual or end users, as of September 2008, about 69% of Americans use some form of cloud computing services, including webmail and online data backup services [37]. But, recent research suggest that even large companies are in fact already using certain types of cloud services like infrastructure and storage services and their cloud adoption is only going to increase in future [28]. Enterprises will start building private clouds to leverage existing infrastructure, thereby making cost-effective use of previous investment. Some other enterprises are adopting hybrid cloud models as they build private clouds while still using public clouds as a means to complement their internal capacity [5, 24]. The more and more the applications move onto the cloud, the more and more, the requirements come up to connect back to the systems (e.g., databases, email servers) that are remaining on-premise or located at other cloud providers [70]. Even though data security is a common concern for public cloud adoption, about 75 to 80 percent of intellectual breaches are a result of attacks originating inside the company, which would not impact a decision to use clouds one way or other [17].

Strategic Alignment

Strategic alignment is viewed in the literature as a bridge that links IT to different viewpoints on other domains of an organization and its environment [3]. Strategic alignment process makes sure that business strategy, IT strategy, organizational infrastructure and processes, and IT infrastructure and processes are all in alignment. Strategic alignment exists when a business organization's goals and activities are in harmony with the information systems that support them. CIOs have consistently considered alignment of IT strategy with business strategy as a top priority. Two major themes identified in the research literature about strategic alignment success factors are (a) mutual understanding of business strategy between business and IT managers and (b) incorporation of this understanding into IT planning and development. Huang [35] studied how IT resources can be strategically used to be an innovative company and found that in order to increase strategic alignment while pursuing aggressive innovation at large companies, their IT functions should be flexible in structure. Brodbeck, Rigoni, and Hoppen [8] studied the level of maturity and order of importance of the criteria that promote strategic alignment and found that elements such as communication, skills and architectural scope are of greatest importance to promote strategic alignment between business and IT.

IT Effectiveness

Several studies have shown that effectiveness of IT investments lead towards favorable results in terms of firms' performance directly or indirectly across various business fields such as health care industry [31], rubber industry [34], supply chain management [29], and across various countries and transitional economies [57]. Research also indicates that firms with superior IT capability exhibit higher performance when compared to average industry performance [58]. Huang [34] found that several factors such as ease of use, frequency and length of use and company culture and attitudes of employees towards IT affects the company's performance in a positive manner, even though there is no direct impact of IT investment on performance. Motjolopane & Brown [45] recognized that by achieving strategic business-IT alignment, IT investments contribute immensely in improved organizational performance. Lee, Chu & Tseng [40] argued that strategic alignment between IT and business is required to use IT assets effectively to assist business management and practices and to functionally integrate with internal and external variables. González-Benito [29] found out that IT investment and its effectiveness is related to the degree of strategic integration with business and the performance improvement of business due to IT takes place in different ways and at different levels.

METHODOLOGY

Research Design

The purpose of this quantitative correlative study was to examine the relationship between cloud adoption by IT organizations and their IT effectiveness in relation with strategic alignment with business, which can be measured and published. The intent of this research was to contribute to the body of knowledge that could be applied by researchers, businesses, and IT organizations alike to achieve optimal results through adoption of cloud based services and solutions. The research was designed to study the degree to which cloud adoption correlates with IT effectiveness in terms of IT's ability to deliver solutions to the business in a dynamic marketplace. In addition, the research was intended to study how another key variable, strategic alignment relates with cloud adoption and IT effectiveness. The research questions were:

1. To what extent, if any, was cloud adoption related to IT effectiveness within all IT organizations, irrespective of their type and size?
2. To what extent, if any, was strategic alignment related to IT effectiveness within all IT organizations, irrespective of their type and size?
3. To what extent, if any, was strategic alignment related to cloud adoption within all IT organizations, irrespective of their type and size?
4. To what extent, if any, was the relationship between cloud adoption and IT effectiveness stronger than that between strategic alignment and IT effectiveness within all IT organizations, irrespective of their type and size?

The research design was non-experimental and the research approach was quantitative correlational, which allows for some flexibility in assessing the relationships among the variables. In an effort to retain the identical validity and reliability from previous research methods and instrumentation by Ness [48], and Tallon and Kraemer [62], a 7-point Likert-type scale was used to represent ordinal data values. Prior research was used as the basis for certain construct elements, measures, as a means for measuring and determining construct's reliability, validity, and correlation. The studies from Ness [48], Tallon and Kraemer [62] and Pierce [55], along with their survey formats, were used as a means to achieve construct measurement and instrumentation.

The analyses of ordinal data values were handled through chi-square testing followed by multiple regression tests and analysis. The use of regression analysis for ordinal data types was consistent with prior research by Ness [48], Tallon and Kraemer [62] and Pierce [55]. The survey questions on strategic alignment and IT effectiveness by Ness [48] were used as part of the total survey instrument in this study to achieve overall construct reliability, validity, and correlation among strategic alignment and IT effectiveness. Also, the survey questions on IT flexibility by Ness [48], with appropriate modifications to apply for adoption of cloud computing technologies were used as part of the total survey instrument in this study to achieve overall construct reliability, validity, and correlation among cloud adoption and IT effectiveness.

Conceptual Model

This study's conceptual model is shown in Figure 1. It is a modification of Ness's [48] research, replacing IT flexibility with cloud adoption and extending to all IT organizations irrespective of their type and size.

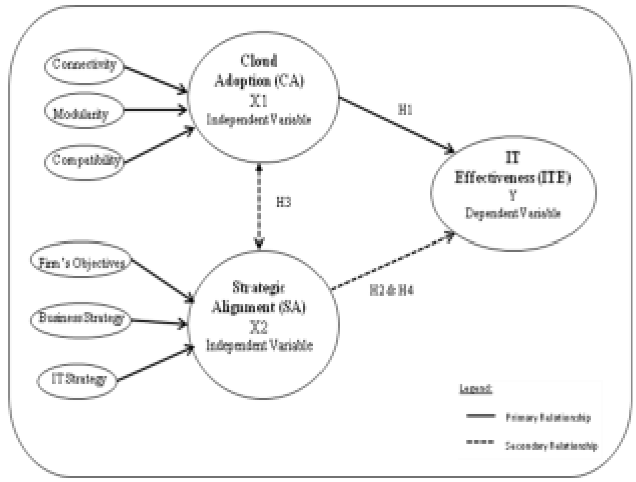

Figure 1: Conceptual Model

Operational Definition of Variables

The elements from prior research by Ness [48] and Tallon and Kraemer [62] were used to assess the constructs of strategic alignment and IT effectiveness, whereas the elements used to assess the construct of IT flexibility were used to assess the construct of cloud adoption. This method of measurement helped to ensure validity and reliability between this study and previous research. Cloud adoption and strategic alignment both had multiple survey questions that were used to measure each element's strength towards IT effectiveness based on a 7-point Likert-type scale. The total strength of the overall construct on IT effectiveness was determined through an averaging of the means of each construct's elements. The primary elements belonging to each of the three constructs on this study were as follows:

Cloud Adoption Elements. The three elements are connectivity (CON), modularity (MOD) and compatibility (CMP). The research instrument questions to assess IT flexibility used by Ness [48] and Tallon and Kraemer [62] were all based on a 7-point Likert-type scale, representing ordinal data.

Strategic Alignment Elements. The primary elements (or items) that were identified by Pierce [55] were used to measure strategic alignment construct. Ness

[48] asserted that specific elements identified by Pierce [55] regarding coordination of business and IT plans were very closely aligned to that required for strategic alignment. The research instrument questions used by Ness [48] and Pierce [55] were all based on a 7-point Likert-type scale, representing ordinal data.

IT Effectiveness Elements. The primary elements (or items) that were used to measure IT effectiveness construct were taken from prior research by Tallon, Kraemer, and Gurbaxani [63], which they used to assess the construct of strategic flexibility. Ness [48] asserted that elements used to measure strategic flexibility appeared to be closely aligned operationally and provided the best source to measure IT effectiveness. These elements are 'overall quality of service', 'user satisfaction with IT' and 'helpfulness of IT staff to users'.

This study was consistent with the prior researchers in terms of methodology and hence a 7-point Likert-type scale was used as the basis for data collection and analysis. A 7-point Likert-type scale ordinal data represents data elements in an ordered measurement relative to size or quality [1]. In regression analysis, it is verified that independent variables in the collected data have a normal distribution prior to testing.

Sample

The sampling methods used by prior researchers were followed as much as possible to replicate validity and reliability. The target population for this study needs to be those who had extensive knowledge of IT and its relationship to the business. In most cases, senior IT managers (including IT directors, IT VPs, IT SVPs) in the role of CIOs were identified to satisfy this population criterion. A list of 4,146 names and mailing addresses of top IT executives (CIOs - Chief Information Officers) were purchased from Applied Computer Research Inc. (http://www.itmarketintelligence.com). The above count of 4,146 was based on the contacts that were playing CIO role in various IT organizations with titles like CIO, Deputy CIO, Acting CIO, Co-CIO, Global CIO, Interim CIO, and Associate CIO out of a total of 30,466 contacts that were available in ACR database for IT executives based in United States. Unlike similar studies done by Ness [48], size and type of the IT organizations were not used to narrow down the contacts, as this study is focused on all IT organizations, and hence include all sizes (small, medium & large) and all types (for-profit, for-nonprofit, educational, corporate and government organizations). Out of 4,146 survey memos that were mailed, 71 were returned as undeliverable by the USPS. The eligible remaining participants were 4,075.

Instrumentation / Measures

The survey instrument consisted of questions that were designed to collect information from the participants on cloud adoption, strategic alignment, and IT effectiveness. The source for this study's survey instrument was based on the research done by Ness [48] on IT flexibility, strategic alignment and IT effectiveness. The survey was a combination of the original survey questions that were created by Tallon, Kraemer, and Gurbaxani [63] and later used by Tallon and Kraemer [62] and Ness [48] for IT flexibility, strategic alignment and IT effectiveness. The survey questions for IT flexibility were modified minimally to apply for cloud adoption (which is a form of IT flexibility as mentioned earlier). In an attempt to replicate the original survey, the layout and format of the previous survey questionnaire was maintained for added validity and reliability. All questions maintained their original standardized 7-point Likert-type scale format for assessment.

Data Collection and Analysis

Data was collected through an online survey instrument that was described earlier. Online survey link was distributed to the potential participants by sending an envelope by USPS regular mail, which pointed participants to the survey questionnaire hosted at SurveyMonkey's website (https://www.surveymonkey.com), a company specializing in online survey data collection and storage. The targeted participants in this survey were IT executives (whose titles include Director, VP, SVP) playing the role of CIOs for US based firms. A total of 148 participants had responded to the survey questionnaire within the timeframe allotted for statistical analysis from among 4,075 eligible participants, but only 143 participants provided answers to at least one question. The survey results in the form of a zip file containing Microsoft Excel© spreadsheet was downloaded from SurveyMonkey's Web site. The data was then imported into SPSS student version 16.0 software for the required statistical analysis and formatting. Multiple regression analysis were performed as confirmation to the chi-square results obtained as well as to provide comparative analysis to the results obtained through prior research and for analysis of any potential interaction between cloud adoption (CA) and strategic alignment. The strength of each relationship between ITE, SA, and CA was evaluated based on the correlation coefficients and the statistical significance level calculated for each factor.

Validity and Reliability

According to Swanson & Holton [61], there are three common types of validity: content validity, criterion validity and construct validity. A construct is something that cannot be directly measured or observed like job satisfaction and IT effectiveness. A construct can be measured quantitatively and analyzed statistically, which is what this study incorporated. According to Cooper & Schindler [16], a measure is reliable to the degree that it supplies consistent results. Reliability is a necessary contributor to validity but is not a sufficient condition for validity. The reliability of a study implies that the operations of the study can be repeated with the same results.

FINDINGS

Assessment of Scale Validity and Reliability

According to the G*Power 3 post hoc power analyses, a sample size of 118 was recommended to achieve the statistical power necessary to establish the validity of this study. The survey sample collected by SurveyMonkey.com totaled 143. In addition, an overall Cronbach's Alpha score of 0.805 was calculated from standardized items that substantiated the internal consistency for this study. Norusis [50] recommended a Cronbach's Alpha score of at least 0.5 to establish the reliability of a study's measures. These statistical tests have shown that the data used in this study are both valid and reliable. Only 118 participants answered all 25 questions as some participants chose to skip few questions. Norusis [49] recommended that before calculating a correlation coefficient, a screening for data outliners should be made to prevent misleading results. A box and whisker plot was completed using the entire 118 response dataset. The box and whisker plot identified one response dataset (92) for ITE outside of inter quartile range; whereas it identified three response datasets (45, 92, 109) for CA outside of inter quartile range as shown in Figure 2. However, there are no outliers identified for SA outside of inter quartile range. Norusis [50] warned that any dataset outside the whisker range in the box and whisker plot is considered an extreme and should be removed from the full response dataset. Therefore, the datasets (45, 92,109) were removed from this study leaving 115 responses for analysis.

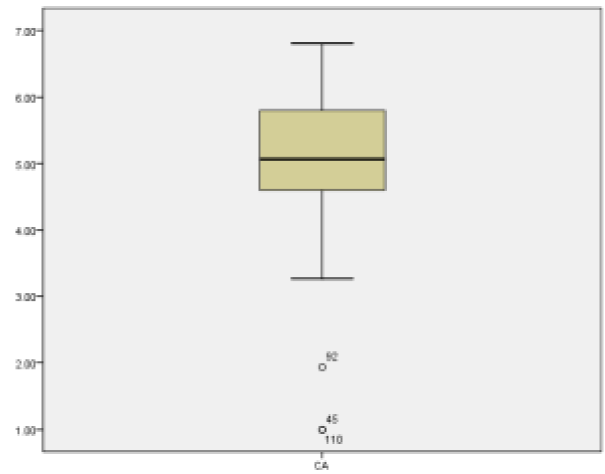

Figure 2: CA and ITE Box and Whisker Plots (n=118)

Analysis and Evaluation of the Research Data

Bivariate Correlations Test: After adjusting the full response dataset to 115, an inter-scale correlation test was performed on all paired constructs, including the interaction term CAxSA (see Table 1). The arrangement of variables in the bi-variate correlations test were that the ITE variable was the target (dependent) and the CA, SA and CAxSA were the predictor (independent) variables. The results of the tests revealed that a positive correlation existed between ITE-CA at $r = .542$ ($p < .001$, $r^2 = .294$), where as a negative correlation exists between ITE-SA at $r = -.117$ ($p > .05$, $r^2 = .014$) and CA-SA at $r = -.159$ ($p > .05$, $r^2 = .025$). However, the tests also revealed that the relationship between ITE-CAxSA is positive at $r = .198$ ($p < .05$, $r^2 = .039$) but relatively lower than the relationship between ITE-CA.

Table 1: Bivariate Correlation Results (n=115)

	ITE-CA	ITE-SA	CA-SA	ITE-CAxSA
Pearson's Correlation (r)	.542	-.117	-.159	.198
R-Square (r^2)	.294	.014	.025	.039
Sig. (p)	.000 (<.001)	.214 (>.05)	.090 (>.05)	.034 (<.05)

Pearson's Chi-Square Test: The Pearson's chi-squared test results with 115 response datasets are shown in Table 2. The Pearson's chi-squared results for ITE-CA were $\chi^2(1, N = 115) = 385.5$, $p < .001$; for ITE-SA were $\chi^2(1, N = 115) = 321.4$, $p > .05$ and that for CA-SA were $\chi^2(1, N = 115) = 1430$, $p > .05$. The relationship between ITE-CA is statistically significant because $p < .001$. The relationships between ITE-SA and CA-SA are weak and their p-values are problematic.

Table 2: Pearson's Chi-Square Crosstabs Analysis Results (n=115)

	ITE-CA	ITE-SA	CA-SA
Pearson's chi-square	385.5	321.4	1430
Phi/Pearson's R	.542	.117	.159
R-Square (calculated)	.294	.014	.025
Approx. Sig.	.000	.214	.090

Linear Regression Analysis: The linear regression tests validated the bivariate correlation test results by producing the exact calculations. The Phi/Pearson's R value provided evidence that there is positive correlation between the paired construct of ITE-CA ($r = .542$, $p < .001$).

Scatter Plot Analysis: According to Norusis [50], the inequality of regressions or heteroscedasticity, represents a sequence of random variables with different variances and hence square-root transformations are commonly used for positive data when addressing the assumption of heteroscedasticity in linear regression analyses. The paired constructs of ITE-CA and ITE-SA have positive and negative slopes respectively, and hence the technique of square-root transformation for the ITE construct was used for further analysis. However, the same kinds of slopes with similar r^2 linear values are obtained as shown in Figure 3.

Normal P-P Plot for √ITE, CA and SA: According to Norusis [49], an assumption of hypothesis testing is a normal distribution of values of the dependent variable. To demonstrate that √ITE had a normal distribution at the reduced response dataset of 115, the observed cumulative probability was plotted against the expected cumulative probability for √ITE. Figure 4 shows that the standardized values represent a normal distribution of the dependent variable and conformed to the assumption of homoscedasticity for regression analysis. Therefore, the 115 datasets represented in √ITE (IT effectiveness) for this study was valid for parametric regression testing. Similarly, the observed cumulative probability was plotted against the expected cumulative probability for CA and SA to make sure that the 115 datasets represented in CA and SA for this study were valid for regression testing.

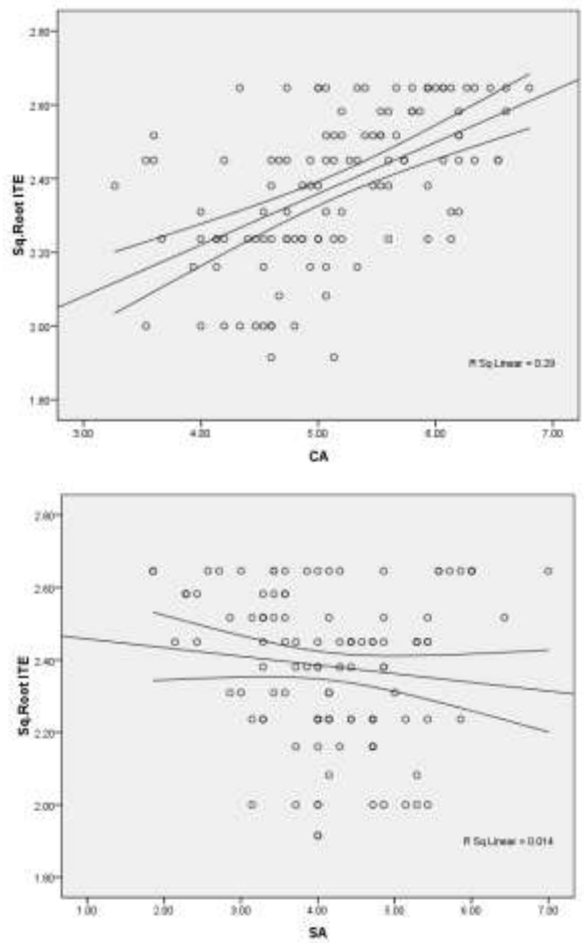

Figure 3: √ITE - CA and √ITE - SA Scatter Plots (n=115)

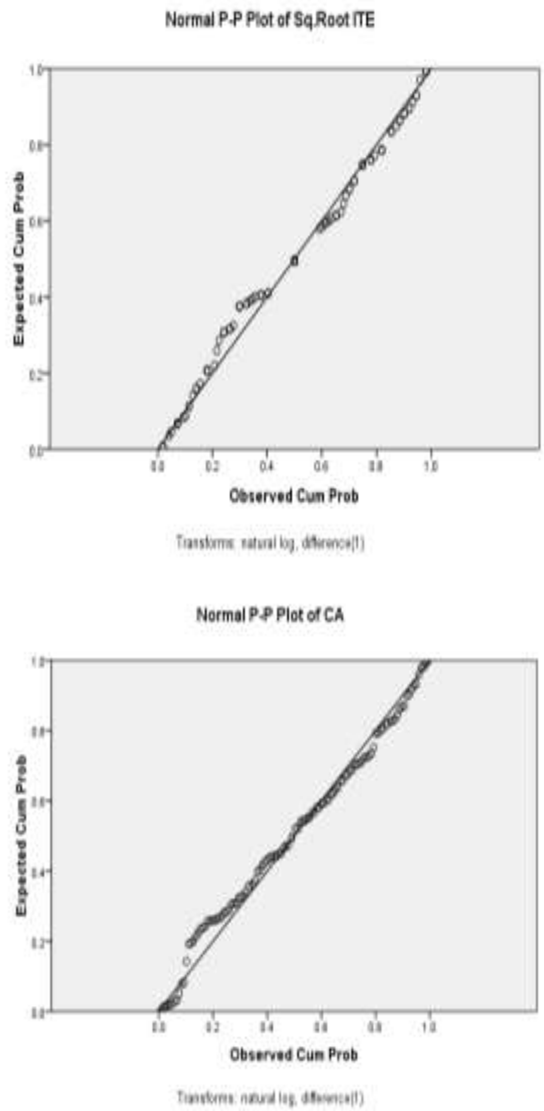

Figure 4: Normal P-P Plots for √ITE and CA (n=115)

Bivariate Correlations Analyses with √ITE: The direction and strength of the relationships between the variables were determined by the r^2 values of each correlation calculation (see Table 3). The p-value was the basis for the rejection or not of each null hypothesis of this study. The bivariate correlations and linear regression analyses were performed using the √ITE transformation for all paired constructs. Table 3 shows that the paired construct of √ITE – CA ($r = .538$, $r^2 = .290$, $p <= .001$) had the strongest positive correlation, whereas the paired construct of √ITE – CAxSA ($r = .194$, $r^2 = .038$, $p < .05$) had weaker correlation. Moreover, paired constructs of √ITE – SA ($r = -.118$, $r^2 =.014$, $p > .05$) and CA–SA ($r = -.159$, $r^2 = .025$, $p > .05$) are negatively correlated, with √ITE – SA being the weakest paired construct in this study.

The same method that was used to determine the correlations among the constructs in Table 3 was also used to determine the correlations among the dimensions of CA. Table 4 shows the correlation and size of each dimension used in CA construct (Connectivity, Modularity, and Compatibility) and √CA. The bivariate correlations test results in Table 4 provided evidence that there were positive correlations among the cloud adoption' dimension of connectivity (√CA – CON) at ($r = .858$, $p < .001$), the dimension of modularity (√CA – MOD) at ($r = .891$, $p < .001$) and the dimension of compatibility (√CA – CMP) at ($r = .864$, $p < .001$). The effect sizes of each dimension represent the r^2 value used in this study's conceptual model results as shown in Figure 5.

Table 3: Bivariate Correlation Results with Transformation (n=115)

	√ITE-CA	√ITE-SA	CA-SA	√ITE-CA x SA
Pearson's Correlation (r)	.538	-.118	-.159	.194
R-Square (r^2)	.290	.014	.025	.038
Sig. (p)	.000 (<.001)	.208 (>.05)	.090 (>.05)	.037 (<.05)

Table 4: Bivariate Correlation Results with Transformation for CA (n=115)

	√CA-CON	√CA-MOD	√CA-CMP
Pearson's Correlation (r)	.858	.891	.864
R-Square (r^2)	.736	.794	.747
Sig. (p)	.000	.000	.000

The conceptual model shows a dominant relationship between the paired constructs of CA-ITE at $r^2 = .290$ over the other relationships in the model, between CA-SA at $r^2 = .025$ and SA-ITE at $r^2 = .014$. In addition, based on the r^2 values, it is easy to argue that there is almost no correlation between the paired constructs of CA-SA and SA-ITE.

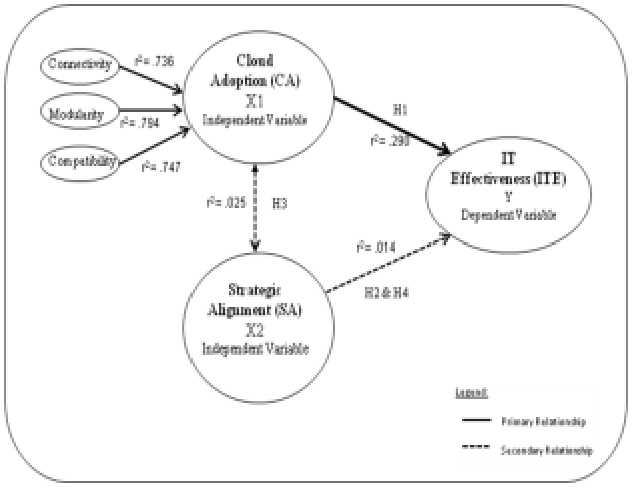

Figure 5: Conceptual Model Results

Stepwise Regression Analysis: A stepwise regression analysis was also performed on the paired constructs to analyze the dominance between CA-ITE, SA-ITE and the interaction of independent variables CAxSA with ITE. Table 5 shows the summary model associated with the stepwise regression test. All stepwise regression tests were performed with ITE normalized through a square root transformation (√ITE). This test verified the dominant correlation between CA-ITE over any other relationship of dependent variables and their interaction with ITE.

Table 5: Stepwise Regression Analysis Results - Summary Model (n=115)

Model	Phi/Pearson's R	R-Square (r^2)	Sig. (p)
1	.538 [a]	.290	<.001

a. Predictors: (Constant), CA

The stepwise regression test results from Table 6 and Table 7 show that there is only one model that represents predictor, as SA is excluded, when the analysis is performed with CA and SA as independent variables and √ITE as dependent variable. Combined effect from CA and SA on ITE provided evidence that a stepwise regression test should also be performed on the interaction term of CAxSA. Tables 8 and 9 show that there is again only one predictor model, as both SA and CAxSA are excluded, when stepwise regression analysis is performed with CA, SA, and CAxSA as independent variables and √ITE as dependent variable.

Table 6: CA, SA Stepwise Regression Analysis Results - Coefficients[a] (n=115)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	1.663	.107		15.525	.000	1.451	1.875
	CA	.139	.021	.538	6.791	.000	.099	.180

a. Dependent Variable: Sq.Root ITE (√ITE)

Table 7: Stepwise Regression Analysis Results - Excluded Variables[b] (n=115)

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
1	SA	-.034[a]	-.419	.676	-.040	.975

a. Predictors in the Model: (Constant), CA
b. Dependent Variable: Sq.Root ITE (√ITE)

Table 8: CA, SA, CAxSA Stepwise Regression Analysis Results - Coefficients[a] (n=115)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	1.663	.107		15.525	.000	1.451	1.875
	CA	.139	.021	.538	6.791	.000	.099	.180

a. Dependent Variable: Sq.Root ITE (√ITE)

Table 9: Stepwise Regression Analysis Results - Excluded Variables[b] (n=115)

Model		Beta In	T	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
1	SA	-.034[a]	-.419	.676	-.040	.975
	CAxSA	-.040[a]	-.456	.649	-.043	.822

a. Predictors in the Model: (Constant), CA
b. Dependent Variable: Sq.Root ITE (√ITE)

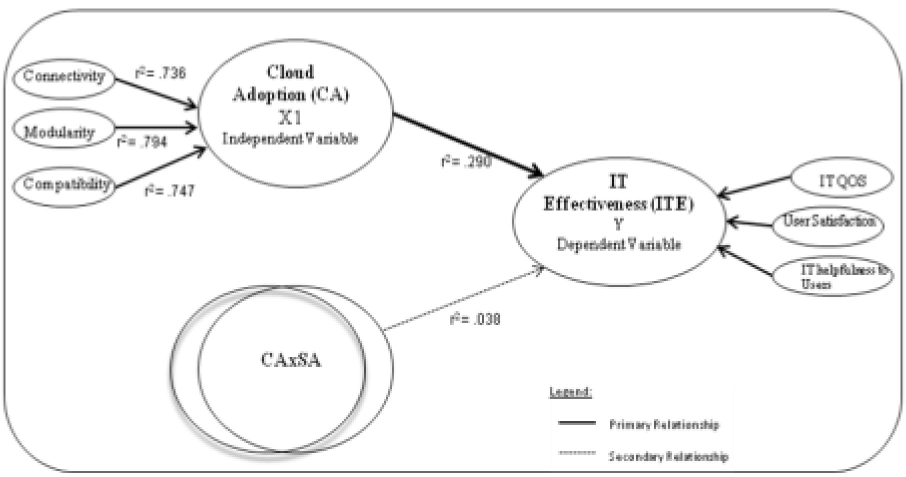

Figure 6: Revised Conceptual Model with CA and CAxSA Interaction Term

Due to the weakest relationships of SA on ITE (r^2 = .014) and SA on CA (r^2 = .025), but relatively better relationship of the interaction term CAxSA on ITE (r^2 = .038) along with strongest relationship of CA on ITE (r^2 = .290), warrants a revised conceptual model representing these findings. Figure 6 illustrates the relationships of CA and CAxSA on ITE. Applying Cohen's rule of thumb [15], the r^2 values of CA (r^2 = .290, $p<.001$), and CAxSA (r^2 = .038, $p<.05$), are considered medium to insubstantial respectively, but the variances were statistically significant at $p<.05$ and therefore valid. The findings from this study are comparable to that of Ness's [48] research which have shown that the relationship of ITF on ITE (r^2 = .206, $p<.001$) is much stronger than that of SA on ITE (r^2 = .068, $p<.05$).

Examination of Hypotheses

An examination of the research findings was performed to determine the rejection or not of the study's hypotheses. The values in Table 3 represent the inter-scale correlation results with transformation for the dependent variable (√ITE) which were used to reject, or accept each null hypothesis.

Hypothesis 1: CA correlated with ITE

$H1_0$: Cloud adoption was not positively correlated with IT effectiveness, irrespective of the type and size of the IT organization.

$H1_a$: Cloud adoption was positively correlated with IT effectiveness, irrespective of the type and size of the IT organization.

Finding 1: $H1_0$ Rejected

Cloud adoption did positively correlate with IT effectiveness. The null hypothesis was rejected because the p-value of .000 was less than the significance level of .05 for testing [49].

The values for CA in Table 3 confirmed positive correlation between cloud adoption and IT effectiveness. The values for CA were $r = .538$, $r^2 = .290$, $p < .001$, therefore, the findings established a positive correlation with IT effectiveness. This finding is consistent with prior research done by Ness [48] which established a positive correlation of IT flexibility with IT effectiveness.

Hypothesis 2: SA correlated with ITE

$H2_0$: Strategic alignment was not positively correlated with IT effectiveness, irrespective of the type and size of the IT organization.

$H2_a$: Strategic alignment was positively correlated with IT effectiveness, irrespective of the type and size of the IT organization.

Finding 2: $H2_0$ Not Rejected

Strategic alignment did not positively correlate with IT effectiveness. The null hypothesis was not rejected because the p-value of .208 was greater than the significance level of .05 for testing [49].

The values for SA in Table 3 confirm that there is no or very little negative correlation between strategic alignment and IT effectiveness. The values for SA were $r = -.118$, $r^2 = .014$, $p > .05$, therefore the findings established that there is no positive correlation between SA and ITE with the sample population which includes all types and sizes of IT organizations. This finding is inconsistent with prior research done by Ness [48] which established a positive correlation of IT flexibility with IT effectiveness with a sample population which includes only large and for-profit IT organizations.

Hypothesis 3: CA correlated with SA

$H3_0$: Cloud adoption was not positively correlated with strategic alignment, irrespective of the type and size of the IT organization.

$H3_a$: Cloud adoption was positively correlated with strategic alignment, irrespective of the type and size of the IT organization.

Finding 3: $H3_0$ Not Rejected

Cloud adoption did not positively correlate with strategic alignment. The null hypothesis was not rejected because the p-value of .090 was greater than the significance level of .05 for testing [49].

The values for SA in Table 3 confirm that there is no or little negative correlation between cloud adoption and strategic alignment. The values for CA-SA were $r = -.159$, $r^2 = .025$, $p > .05$, therefore, the findings established that there is no positive correlation between cloud adoption and strategic alignment with a sample population which includes all types and sizes of IT organizations. This finding is inconsistent with prior research done by Ness [48] which established a positive correlation of IT flexibility and strategic alignment with a sample population which includes only large and for-profit IT organizations.

Hypothesis 4: CA was correlated at a higher level than SA with ITE

$H4_0$: Strategic alignment has an equal or greater correlation with IT effectiveness than does cloud adoption, irrespective of the type and size of the IT organization.

$H4_a$: Cloud adoption has a higher correlation to IT effectiveness than does the strategic alignment, irrespective of the type and size of the IT organization.

Finding 4: $H4_0$ Rejected

Cloud adoption did correlate with IT effectiveness higher than does the strategic alignment with IT effectiveness. The null hypothesis was rejected because the p-value of CA with ITE is .000 which was less than the significance level of .05 for testing; whereas p-value of SA with ITE is .208 which was greater than the significance level of .05 for testing [49].

The values from Table 3 confirmed that the correlation between cloud adoption and IT effectiveness is much higher than the correlation between strategic alignment and IT effectiveness. The values for CA-ITE were $r = .538$, $r^2 = .290$, $p < .001$, whereas the values for SA-ITE were $r = -.118$, $r^2 = .014$, $p > .05$. This finding is consistent with prior research done by Ness [48] which established that the correlation of IT flexibility with IT effectiveness is higher than the correlation of strategic alignment with IT effectiveness.

SUMMARY, IMPLICATIONS, RECOMMENDATIONS

Summary

This research study provided new empirical evidence that cloud adoption has a positive correlation ($r = .538$, $r^2 = .290$, $p < .001$) with IT effectiveness and is correlated at a much higher level than strategic alignment with IT effectiveness regardless of type and size of IT organizations (hypotheses one and four). These findings are consistent with Ness's [48] research for those two hypotheses with IT flexibility, strategic alignment and IT effectiveness variables for large and for-profit IT organizations. Moreover, this study provided new evidence that the interaction term of cloud adoption and strategic alignment is more correlated ($r = .194$, $r^2 = .038$, $p < .05$) with IT effectiveness than does the individual variable strategic alignment which is different from Ness's [48] findings (hypothesis 2). Ness [48] established that the individual variable strategic alignment is more positively correlated than the interaction term of IT flexibility and strategic alignment with IT effectiveness. The results also found that cloud adoption and strategic alignment were truly independent variables by establishing that there was no correlation between the variables (hypothesis 3), which is also different from Ness's [48] findings which established that there is a correlation between his independent variables.

Many authors have researched the constructs of IT flexibility, strategic alignment, and IT effectiveness for large, for-profit IT organizations, either as a singled or as paired factors to determine business value through competitive advantage. However, this study filled in information gap in the literature because it focused on the impact of cloud adoption (replacing IT flexibility) and included small, medium, large, for-profit, for-nonprofit, educational, corporate, and government IT organizations.

Implications

By determining the dominance and prioritization of cloud adoption and strategic alignment for IT effectiveness, IT executives and IT managers could more effectively decide where and when to allocate financial resources for the implementation, deployment and maintenance of their complex IT systems in their respective organizations. The regression testing in this study showed that cloud adoption is much more dominant than strategic alignment for IT effectiveness. The implication of this research finding is that IT executives and IT managers should allocate more financial resources towards cloud adoption than resources to strategically align with business to improve their IT effectiveness. If they are planning to align strategically with business, they should do so along with cloud adoption to improve their IT effectiveness.

The findings from this study represented only firms in US that were from multiple business types, sizes and therefore, the results should not be interpreted as representing any specific business sector type or size. Finally, since the participants were all top IT executives that are playing CIO (Chief Information Officer) role in various IT organizations the findings did not reflect any information that could have been obtained from lower managers or end-users.

The research findings in this study have advanced the current knowledge of the relationships among cloud adoption, strategic alignment, and IT effectiveness for IT organizations. The findings addressed the benefits of cloud adoption on IT effectiveness and would enhance the decision-making process for IT managers when considering the adoption of cloud technologies and its business models.

Recommendations

The study's recommendations are that IT executives and managers should look for adoption of cloud based technologies and solutions and allocate resources for cloud adoption more than they allocate resources to strategically align with business in order to improve their IT effectiveness.

Recommendations for Further Research: The authors recommend that this study be repeated with a case-study using qualitative approach on popular cloud providers and platforms like Amazon's EC2, Google's AppEngine, Microsoft's Azure, Cisco's WebEx and Salesforce.com etc about how their cloud based solutions impact IT effectiveness. This study could be repeated with a quantitative approach with the same variables by narrowing down on how a specific type of cloud service model (IaaS/PaaS/SaaS) or how a specific type of deployment model (public/private/hybrid/community) would impact IT effectiveness. In addition, the authors recommend that this research be repeated with a similar quantitative correlative study to analyze the same variables by narrowing down to either just small IT organizations or medium IT organizations or for-nonprofit or government organizations only or educational or corporations only. This study's findings provided additional evidence that the combination of the interaction term of cloud adoption and strategic alignment did have a positive correlation on IT effectiveness than just the individual relationship of strategic alignment on IT effectiveness. Bringing security into the mix, this quantitative study could be repeated to analyze the relationships among regulatory compliance, cloud adoption and how they impact IT effectiveness in large IT organizations in a single regression model. On similar lines, this study could be repeated either as a quantitative study or qualitative case study to analyze the relationships among regulatory compliance, cloud adoption and how they impact data management in large IT organizations in a single regression model. Authors hope that IT executives use this new knowledge when allocating their human and financial resources towards improving their IT effectiveness and deliver solutions to the business in a dynamic marketplace.

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