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## Cloud Computing at the University Level: A Study of Undergraduate Use of Cloud Computing Applications; Special Reference to Google Docs.

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### ABSTRACT

The world has been witnessed with many technological revolutions. One of them is the computing technologies. The world is able to do many things with the utilization of this innovation. There have been many revolutions such as mainframe computers, super computers, web technologies, Internet, grid computing, utility computing, etc even in the computing technologies throughout the history of the world. Cloud computing is another evolutions in the field of computing where computing is delivered as hosted services over the Internet and it has been evolved from the earlier computing technologies by the integration of some of them and removing the obstacles encountered in them as a new technology to the world. Amazon, Google, Microsoft, Salesforce.com, are some of the organizations who provide this technology to organizations and personal users. Google provides a service called Google Docs, a widely used example of cloud computing. Even though many studies have examined the overall concept of cloud computing, no previous research has analyzed students' usage and acceptance of Google Docs in a university setting.

The purpose of this paper is to focus on the factors influencing the use of Google docs as one of the SaaS offering of cloud computing services. The Theory of Planned Behavior was used as the theoretical model for this research in

examining what factors influence students to use Google Docs. The interviews ( $n=20$ ) and surveys ( $n=316$ ) were deployed to gain a better understanding of this phenomenon. By using hierarchical regression analysis and a correlation matrix to analyze the data, it was found that all three constructs of the Theory of Planned Behavior (Attitude, Subjective Norm, and Perceived Behavioral Control) are significantly and positively correlated with intention to use Google Docs. Further, it was found that Affect, which measures a person's emotional responses, is also a significant predictor of Behavioral Intention. The findings of this research could be used by multiple stakeholder groups to better understand the factors influencing the usage of Google Docs.

**Keywords:** Cloud Computing, Google Docs, Theory of Planned Behavior

### INTRODUCTION

The term "cloud computing" is one of the hottest buzzwords in the domain of Information Technology. Although it has been used in many contexts and has been defined in several different ways, cloud computing enables users and developers to utilize services without knowledge of, expertise with, or control over the technology infrastructure that supports them. It is the provision of computing services online.

Since cloud computing is so loosely defined, many studies have been done to explain conceptually what it is, but few have looked at how it is being used. No researcher has looked at its usage and acceptance in a university setting especially in Sri Lankan university context. The purpose of this paper is to examine the factors influencing students in a university setting to adopt Google Docs, an example of cloud computing.

Thus, this paper has been organized into several sections, starting with the Literature Review, which covers relevant research dealing with cloud computing, including a definition and an overview of Google Docs. This section also includes the theory behind this research, followed by the hypotheses that extend from the theory. Methodology is the next section, which explains my approach in collecting both qualitative and quantitative data. The Findings section provides the results from the hierarchical regression and correlation analysis. Finally, this research paper focuses on the implications of these findings in the next to last section, which is followed by the Conclusion section.

## LITERATURE REVIEW

### Cloud Computing

According to the National Institute of Standards and Technology (NIST), cloud computing is a model for enabling 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 [10]. Availability is promoted in the cloud model. However, it should be noted that cloud computing is still an evolving paradigm. Since the purpose of this paper is to examine what factors

significantly influence undergraduates' usage of Google Docs, an overview of the characteristics, service models, and deployment models is provided in the following subsection.

### Characteristics, Service, and Deployment Models

A characteristic of cloud computing is its ability to be accessed anywhere there is a reliable Internet connection. The ability to promote on-demand self service allows a consumer to have computing capabilities without the need of human interaction with a service's provider. This provides the user the flexibility to access data in real time without having to wait for the service to "boot up" [10]. Another important characteristic is the ability to access the data on any network, regardless of the client platform (mobile phone, laptop, etc.) that is used. Having access to the data anywhere means valuable resources are not tied up elsewhere. This leads into another characteristic of location-independent resource pooling. By freeing up valuable resources, cloud computing can reassign the unused resources and move them to where consumer demand is at its highest [10].

Cloud computing has been categorized into three unique service models. They are: Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). IaaS is the capability provided to the consumer to provision processing, storage, networks, and other fundamental computing resources, which can include operating systems and applications [16]. An example of IaaS is Amazon's Elastic Compute Cloud (EC2). EC2 is a web service that provides resizable compute capacity in the cloud. It is designed to make web-scale computing easier for developers [1].

PaaS is the capability provided to the user to deploy consumer-created or acquired applications onto the cloud infrastructure. The consumer does not manage or control the underlying cloud infrastructure, including the network, servers, operating systems, or storage, but has control over the deployed applications and possibly application hosting environment configurations [8]. Google Applications Engine, also known as Google App Engine, is an example of PaaS. Google App Engine enables the user to build and host web apps on the same systems that power Google applications. Basically, Google provides the developer kit that allows the user to create custom apps. The user is not required to have expensive machinery to run it because Google provides the "platform" to run the application.

SaaS is the capability provided to the consumer to use the provider's applications running on a cloud infrastructure. The applications are accessible from various clients such as a web browser (e.g., web-based email) [16]. Google Docs is an example of SaaS. The user only needs to have a web browser like Mozilla Firefox or Internet Explorer to access Google

Docs. Google possesses control over the customization with Google Docs. The user is only allowed to use what is there. To further illustrate, Figure 1 provides a diagram of the three service models.

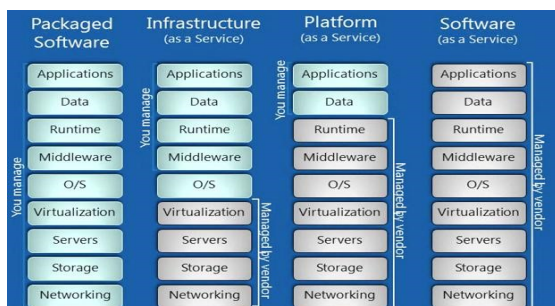


Figure 1: Service Models of Cloud Computing [5]

Cloud computing utilities are delivered to users in a number of ways (Deployment Models). They can be private, public, community based, or a hybrid of the three. The private cloud remains on the inside of the organization while the public cloud is made available to the general public [10].

### Google Docs

In March 2006, Google acquired the rights to Writely, an online word processing application. This became a foundation for Google Docs. Meanwhile, Google developed Google Spreadsheets using the technology it had acquired from 2Web Technologies in 2005 and launched Google Labs Spreadsheets on June 6, 2006 as the first public component of what would eventually become Google Docs. It was initially made available to only a limited number of users on a first-come, first-served basis. The limited test was later replaced with a beta version available to all Google Account holders, around the same time that a press release was issued. In July 2009, Google officially introduced Google Docs, their online office and web storage suite. The Google Docs "office" suite includes applications such as word processing, spreadsheet and a presentation editor. Users have the ability to create new documents and store them securely online, as Google Docs does not need to be installed on a physical device. This is what makes Google Docs an example of SaaS. Google Docs can be accessed from anywhere that has an active Internet connection. This makes it possible to share files around the globe. Google Docs allows for various office file types to be uploaded, which makes this a powerful online collaboration tool. Users can modify documents in real time which makes Google Docs highly desirable when teamwork occurs on the Internet [7].

### Current Usage of Cloud Computing

Ambrose and Chiravuri [2] examined the role of three factors in the personal use of Cloud Computing. Using Partial Least Squares analysis, they discovered that two factors (age and experience) have a significant role in a person's intention to use cloud computing.

Community colleges have become early adopters of the cloud computing technology. Researchers used the Technology Acceptance Model to examine whether community college students would adopt cloud computing technology. Observations were done in a small virtual lab in a community college setting. Their research found that students are more likely to adopt cloud computing technology if it is easy to use and requires little training [4].

### Institutional Influences on Real World Options

A real option theory refers to the right but not an obligation to make a managerial decision to take ownership of a real asset or embark on a project at a future point in time [15], [17]. One study examined how institutional influences may affect organizations' perceptions about the technological characteristics of cloud computing and recognition of real options. Using Partial Least Squares analysis, Saya et al. [12] found that cloud computing characteristics of scalability, cost effectiveness, accessibility and lack of security are motivational factors in growth, abandonment, and deferral.

### Theory of Planned Behavior

The Theory of Planned Behavior (TPB) states that the combination of three constructs: "Attitude toward the Behavior," "Subjective Norm," and "Perceived Behavioral Control," lead to the formation of a "Behavioral Intention." Attitude is defined as an individual's positive or negative

evaluation of self-performance of the particular behavior. Subjective Norm is defined as an individual's perception of social normative pressures, or relevant others' (parents, friends, etc.) beliefs that he or she should or should not perform a particular behavior. Perceived Behavioral Control refers to an individual's perceived ease or difficulty of performing a particular behavior [3]. The Theory of Planned Behavior is illustrated in Figure 2.

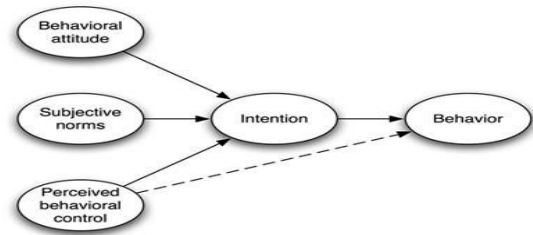


Figure 2: Theory of Planned Behavior Model [3]

### Affect

Although each of the constructs in the Theory of Planned Behavior (TPB) is important to consider, some researchers believe there are other factors that should be included to measure the direct linkage between one's intentions and their behavioral outcomes [13]. Even though Attitude is often a significant indicator, it does not measure one's emotional state. TPB gives minimal attention to the role of Affect or emotions in the prediction of intention.

Several researchers have demonstrated that Affect may be an important predictor. Hunsinger and Smith [9] used TPB along with an Affect construct to predict hiring managers' intentions to use IT certifications when hiring new candidates. Another study [6] looked at health related behaviors and how Affect influences decisions when health related issues appear. Thus, the researcher has included the Affect construct to the model to examine whether emotions significantly influence usage of Google Docs.

**HYPOTHESES**

**Hypothesis 1:** Attitude toward the Behavior is significantly and positively correlated with the intent to use Google Docs.

**Hypothesis 2:** Subjective Norm is significantly and positively correlated with the intent to use Google Docs.

**Hypothesis 3:** Perceived Behavioral Control is significantly and positively correlated with the intent to use Google Docs.

**Hypothesis 4:** Affect is significantly and positively correlated with the intent to use Google Docs.

**METHODOLOGY**

An interview instrument and a survey questionnaire were used to collect data. The interview questions ranged from basic demographics to statements that measured Ajzen’s Theory of Planned Behavior. Many previous studies have been done using questionnaires based on the Theory of Planned Behavior, thus it would be appropriate to use this as a measuring tool to predict this behavior in question.

First, the interview was conducted among randomly selected 20 undergraduates in the Faculty of Management Commerce of the South Eastern University of Sri Lanka. The interview questions were based on the measures from the Theory of Planned Behavior and the Affect construct. After the interviews with the undergraduates, an online questionnaire survey was developed and was sent to approximately of 500 undergraduates through Google’s Google Docs hosted service to complete the survey. A total of 355 undergraduates responded to the survey. However, only 316 responses could be used, as 39 of the undergraduates did not complete the survey.

Table 1: Constructs and Measures

Constructs	Measures
Attitude	(ATT1) Using Google Docs is a good idea, (ATT2) Using Google Docs is a positive idea, and (ATT3) Using Google Docs is a helpful idea.
Subjective Norm	(SN1) My lecturer or professors influence me in my decision whether to use Google Docs, (SN2) My friends influence me in my decision whether to use Google Docs, and (SN3) Other people important to me influence me in my decision whether to use Google Docs.
Perceived Behavioral Control	(PBC1) I have the ability to use Google Docs, (PBC2) I possess enough knowledge to use Google Docs, (PBC3) I have the resources to use Google Docs, and (PBC4) I have the time to use Google Docs.
Affect	Affect was measured using four statements that have been validated in previous studies [6], [9]. Five-Point Likert scale. (AFF1) I would love/hate to use Google Docs, (AFF2) I would be excited about/be bored using Google Docs, (AFF3) I would be happy/unhappy using Google Docs, and (AFF4) I would be relaxed/stressed using Google Docs.
Behavioral Intention	(BI1) I intend to use Google Docs in the next three months, (BI2) I plan to use Google Docs in the next three months, and (BI3) I anticipate I will use Google Docs in the next three months. Respondents replied using a seven-point bi-polar scale ranging from Strongly Agree to Strongly Disagree. Listed below in Table 1 are the results for Cronbach Alpha for each construct. Each construct is acceptable as the Cronbach Alpha is greater than .70 for each [11].

Table 2: Computed Cronbach Alpha for Each Construct

\* acceptable > .70

Construct	Value
Attitude	.924*
Subjective Norm	.771*
Perceived Behavioral Control	.864*
Affect	.823*
Behavioral Intention	.977*

**FINDINGS**

Hierarchical regression is used in this study since it allows for specification of the order of entry of the variables based upon theory and previous studies. In addition, hierarchical regression allowed to observe the change in R<sup>2</sup> as each independent variable is entered into the model. This allowed me to determine whether additional variables are significant when entered into the equation.

The data were entered into an Excel 2010 spreadsheet and then imported into SPSS 17.0 for hierarchical regression analysis and correlation analysis. The results of the correlation analysis and hierarchical regression analysis are shown below in Tables 2 and 3.

	Attitude	Subjective Norm	Perceived Behavioral Control	Affect
Behavioral Intention	.640*	.332*	.417*	.589*
Attitude		.237*	.391*	.659*
Subjective Norm			.240*	.196*
Perceived Behavioral Control				.387*

Table 2: Correlation Matrix

\* Correlation is significant at the 0.01 level (2-tailed)

Predictors (Constants)	R	R <sup>2</sup>	Sig. F Change	Durbin - Watson
ATT	.639	.408	.000	
ATT, SN	.665	.442	.000	
ATT, SN, PBC	.682	.465	.000	
ATT, SN, PBC, AFF	.706	.498	.000	2.087

Table 3: Hierarchical Regression Analysis

using Attitude, SN, PBC, and AFF  
(Dependent Variable = Behavioral Intention)

ATT - Attitude; SN - Subjective Norm; PBC - Perceived Behavioral Control; AFF - Affect

The Durbin-Watson statistic is a method for checking serial dependence. Results of the Durbin-Watson test ( $d=2.087$ ) for autocorrelation fall within the appropriate range 1.5 - 2.5 [14].

**Hypothesis 1 is supported.** The correlation between Attitude and Behavioral Intention is +.640. Attitude was entered first into the hierarchical regression equation and explained 40.8% of the variance in Behavioral Intention. Hence, it could be concluded that Attitude is significantly and positively correlated with the intent of undergraduates to use Google Docs.

**Hypothesis 2 is supported.** The correlation between Subjective Norm and Behavioral Intention = +.332. Subjective Norm was entered second into the hierarchical regression equation and the total variance in intentions explained increased to 44.2%. Therefore,

it is conclude that Subjective Norm is significantly and positively correlated with the intent of undergraduates to use Google Docs.

**Hypothesis 3 is supported.** The correlation between Perceived Behavioral Control and Behavioral Intention =  $+0.417$ . Perceived Behavioral Control was entered third into the hierarchical regression equation and the total variance in intentions explained increased to 46.5%. Therefore, it is conclude that Perceived Behavioral Control is significantly and positively correlated with the intent of undergraduates to use Google Docs.

**Hypothesis 4 is supported.** The correlation between Affect and Behavioral Intention is  $+0.589$ . Affect was entered in last into the hierarchical regression equation and the total variance in Behavioral Intention explained increased to 49.8%. Therefore, it is concluded that Affect is significantly and positively correlated with the intent of undergraduates to use Google Docs.

**DISCUSSION AND FUTURE STUDIES**

Through the use of interviews and results gathered from the survey, the research was able to better understand what factors influence students to use Google Docs. This is important for a number of reasons. First, this study indicates that Google Docs has a number of benefits for undergraduates in their higher studies characterized with team learning. One of the interviewees stated, "...it (Google Docs) makes it easier geographically to work on projects." Another stated, "Google Docs is a great tool for collaboration..." and then goes on further to state that it is "...very useful for group(s) working on any data that constantly needs updates."

This research could be extended to include working professionals in a university setting such as college instructors or lecturers. For instance,

several respondents implied that they were required to use Google Docs for several courses. Moreover, lecturers who utilize multiple teaching methodologies encouraged the class to use Google Docs to keep track of their collaborative assignments. Google could eventually look at aiming at other possible target markets. For instance, one question from the interview and the survey asked respondents if they would be willing to pay for a service like Google Docs. This question was then followed up by how much they would be willing to pay for it. During one interview, I found out that "...as a student, I could not afford to pay for Google Docs." Another interview yielded the result of "...if Google Docs had more features, I would consider paying for it." These statements together imply that Google Docs could potentially seek more markets if more features were available from it. Affect's significant influence on attitude is illustrated by respondents' emotional comments, positive and negative, about the overall use of Google Docs. Several quotes from my interviews and open-ended survey questions are provided on the following page.

- "I like using Google Docs just fine..."
- "Dislike (using Google Docs)"
- "I like it for group papers..."
- "I do not prefer to use it..."
- "I like it, it's simple..."
- "I hate using it..."

Figure 3 shows how the Theory of Planned Behavior can be extended to include the construct of Affect.

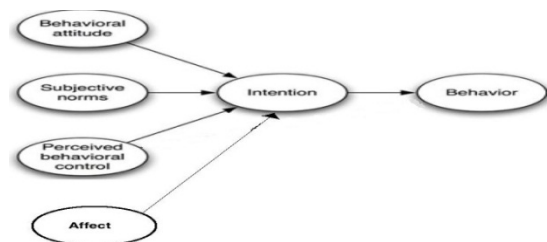


Figure 3: Theory of Planned Behavior with Affect construct

Since both Attitude (which measures what a person believes / thinks) and Affect (which measures how a person feels) were significant contributory factors in the study, and t should be examined further in future research. Future research could integrate other theories such as the Technology Acceptance Model to examine whether perceived usefulness and/or ease of use play a significant role in predicting students' intentions to use Google Docs. Further, the study could be extended to include other undergraduates from the faculty of Management and Commerce and other faculties from other universities in Sri Lanka. This would in turn enable for a larger sample size to generalize the findings further.

## CONCLUSION

The results derived from this research show that at the university level, undergraduates' intentions to use Google Docs are positively and significantly correlated with the constructs from the Theory of Planned Behavior. All three constructs from the TPB (Attitude, Subjective Norm, Perceived Behavioral Control), as well as Affect, are significant when measuring students' intentions to use Google Docs. Future research using the Theory of Planned Behavior should consider the role of Affect, as it plays a significant role in this study in predicting intentions.

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