

# JOURNAL OF INFORMATION SYSTEMS APPLIED RESEARCH

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# JOURNAL OF INFORMATION SYSTEMS APPLIED RESEARCH

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# Outsourcing Best Practices

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## Abstract

Outsourcing of a software project can have many benefits to an organization, but how to implement a successful outsourcing initiative can be very difficult. The decision to outsource a software project can provide many benefits to an organization, yet they may also incur several challenges. These can include items such as the interaction between current employees and the outsourcing service provider, the technological environment needed to successfully create the proper work environment, and total cost considerations. If executed properly, the outsourcing of a specific project can have a substantial gain in company growth and efficiency. Improper implementation can lead to total project failure and the loss of project resources. In spite of the challenges inherent with outsourcing, this strategy is fast becoming a popular solution to implementing corporate projects without endangering the jobs of current employees. This paper will investigate and suggest best practices that may be used to maximize the anticipated outcome of this endeavor while minimizing potential challenges.

**Keywords:** outsourcing, offshoring, smart sourcing, information technology outsourcing

## 1. INTRODUCTION

Outsourcing of information technology projects has been used by companies for several decades, since Kodak outsourced their IT function (Applegate and Montealegre, 1991). This trend towards outsourcing began due to the growing budget needed by the IT field in general (Amiti, 2004). With the growing importance of technology and the need for experts in the field, costs were climbing quickly. The need to control costs must be balanced with an understanding of the activities that should remain in-house. King (2005) states that IT executives need to identify IT activities that are best performed within the firm or to create new, innovative ways to enable activities to continue to be performed in the firm.

The topic of outsourcing has been discussed as a negative by many in the United States government, because of the negative impact it has on the United States job market (Amiti, 2004). In fact, many states have introduced legislation that would affect companies looking to offshore, or those already offshoring (Kukumanu and Portanova, 2006). As an example, New Jersey has banned offshore outsourcing of state government work (Pfannenstien and Tsai, 2004).

Even though this argument has merit, outsourcing an IT project can still be beneficial under the right circumstances. Many practitioners and academics now argue for selective or "smart" sourcing (Earl, 1996). Smart sourcing refers to the use of outsourcing

as a means for the project team to grow and fluctuate with the amount of work. This approach makes the most sense for the business, as well as the economy as a whole. The resources needed by a project will approximate the shape of a bell curve, with fewer resources needed when the project starts and gradually increasing as the project is underway. The greatest resource need will occur during the development portion of the project, with resources needs diminishing thereafter. Smart sourcing allows a company to have access to the right resources when needed, without the overhead of maintaining this staff after project completion.

There can be many benefits to outsourcing a project that extend past the monetary benefit. These would include intangible items such as access to resources, knowledge, and organizational flexibility. This will be the subject of the next section.

## 2. BENEFITS

In many outsourcing situations, the service provider is located offshore. Offshoring can be defined as the relocation of business processes (including production, distribution, and business services, as well as core activities like research and development) to lower-cost locations outside national borders (Erber, 2005). There are many benefits to outsourcing a project within the IT world. Lowering the overall cost of the service to the business allows for re-pricing, re-negotiation, and cost re-structuring. Access to lower cost economies through off-shoring produces "labor arbitrage" generated by the wage gap between industrialized and developing nations.

There are two major types of outsourcing that can be discussed: the move from having a permanent team locally and replacing that with a new outsourced team, and the hiring of an outsourced team in addition to the current local team ("smart" sourcing) (Bardhan, 2003). The latter is an effective way to complete a project that requires more hires, but without the commitment to a full time position. In either situation, there are several similarities and challenges within the implementation process that must be addressed.

### "Smart" Sourcing

The idea of "smart" sourcing is an effective and efficient way to maintain a reliable source of developers that are closely tied to projects and the company, while still being able to fluctuate with demand for developers. As enhancement to current applications is needed or new applications are mandated, it is easy to create a larger workforce without the commitment to the employees hired. The benefits of this allow the company to keep a dedicated team of developers on staff at all times to maintain the applications. These developers will also be intimately involved in the company, and thus will have the connections and knowledge of the applications to manage any new projects or answer any type of support questions.

Not only does this help support the local economy, it also provides a backup in the case that an outsourcing endeavor does not work out the way it was planned. In the case where an entire team is replaced by an outsourced initiative, if the contract becomes unreasonable or the relationship grows sour, it can be extremely difficult to capture and transfer all the information that was maintained or "owned" by the outsourced service provider. This is another example where "smart" sourcing is an effective solution, or at the very least a backup in worst case scenarios.

The quality of a project can also be affected in a positive manner with the use of "smart" sourcing. By having a dedicated individual or team always available, the quality of training and information will also increase. This in turn will allow the outsourcing service provider to have better initial training and a stronger source of direction when the project's architecture is questioned. By having this permanent wealth of knowledge, a consistent architecture and direction can be realized.

Besides the obvious advantages of using "smart" sourcing, there are several other benefits to the general topic of outsourcing that should be mentioned.

### Benefits

By focusing on core business resources, for example - investment, people, and infrastructure - organizations are able to outsource their IT support to specialized IT services companies (Sako, 2005). By doing this,

an organization is able to achieve an increased level of quality through contracting out that service with a new service level agreement. Along with the increase in quality, another benefit of outsourcing a team or a project is knowledge. Many times, by outsourcing to a specialized company, a company is granted access to intellectual property and a much higher level of experience and knowledge.

Another benefit is the contract itself. The services specified in the contract will be provided to a legally binding contract with financial penalties and legal redress (Erber, 2005). This is not the case with internal services. This means that if a mistake is made that was the responsibility of the outsourcing service provider; they are the ones that must take responsibility, legally, for the mistake. Having access to a team which already has the skills and experience necessary for the project can provide a higher quality product with less investment. To create an in-house team like this would be too difficult or time consuming.

Companies increasingly use external knowledge service providers to supplement limited in-house capacity for product innovation. The acceleration of the development or production of a product through the additional capability brought by the supplier can be very noticeable. Finally, many countries offer tax incentives to move manufacturing operations to counter high corporate taxes within another country and the outsourced company will usually be prepared to manage a temporary or permanent increase or decrease in production.

In addition to the benefits accrued from outsourcing or offshoring software development, there are several challenges that must be considered before undertaking this endeavor. Awareness of issues that may develop, or weaknesses that may be inherent in the relationship, will help balance the benefits and determine whether outsourcing will be the right approach for a project.

### **3. TAKING A CLOSER LOOK**

Although there are many benefits to outsourcing a project or even an entire functional team, there are many hidden costs and difficulties that will be encountered along the way. The expected benefits of outsourcing have failed to materialize and approximately half of offshore outsourcing initiatives fail or do not meet stated

performance objectives (Nakatsu and Iacovou, 2009).

We will now discuss the problems that are most regularly encountered, and how to deal with them if they do occur. Many of these issues are related to the problems caused by people and their emotions. Other problems include not training or managing the outsourcing service provider's team adequately. All of these topics are covered in detail in section four.

Section five discusses the hurdles involved in setting up the service provider with adequate resources, accounts, documentation, and development environments.

Before continuing, it important to remember the possibility of restructuring the current resources available instead of outsourcing them. If cost or quality problems are due to inadequate economies of scale, outsourcing can make sense (Earl, 1996). If outsourcing is the direction chosen to pursue, it is important to have strong management in place to reduce initial risks; a company must be capable of managing the IT service first. Nakatsu and Iacovou (2009) note that middle management resistance will often result in project failure.

An argument for outsourcing is that specialist IT companies are likely to have better IT specialists than the client company currently has. This may be, and often is, true, but the differences in every program and project can sometimes place the existing employees in a better position to complete the project in a timely manner (Erber, 2005).

When moving to an outsourcing solution, the skills and technology of the service provider are important to analyze. When outsourcing an entire team, it is difficult to change direction quickly, thus it is imperative to have a solid future direction in place. In conjunction with this, determining if the technical skills of the service provider chosen fit in with the company's future goals can have a huge impact on whether or not those goals are reachable (Earl, 1996).

It is also important to note the hidden costs of training the service provider and the length of the contract (Ngwenyama, 1999). Williams (2011) finds that client-vendor knowledge transfer is positively associated with formal training and client embedment. Investment in these areas will provide returns, although this

needs to be considered in the context of each individual project. If the length of contract is short, a large portion of the money spent will be on training. It is necessary to calculate the percentage of time that will be spent on training and preparation to determine whether or not outsourcing a project will be worth the capital spent. Overby (2003) places transition cost estimates - based upon interviews with executives - at 15% - 57% of the cost of the project. Rottman and Lacity (2006) also support this finding as their research uncovered transaction costs for offshore projects of 50% of contract value. Williams (2011) concurs in that over large geographic, cultural and institutional distances, effective knowledge transfer is difficult to achieve and while placement of vendor personnel at onshore client locations will assist with knowledge transfer, it will often be cost prohibitive. This is an important consideration as Remus and Ulrich (2009) identify the importance of knowledge transfer as a key factor in establishing a true strategic partnership between the client and service provider. Given the significant investment companies will make in project transition, these costs need to be considered in total project cost calculations. Yu (2006) also concurs that although there are often lower-cost offshoring alternatives to a company's current situation, the transaction costs of choosing offshoring are often greater than any cost advantages.

Although the trend of outsourcing projects is becoming a common practice, there are additional problems that can occur with the people involved.

#### 4. THE PEOPLE PROBLEM

The implementation of outsourcing a project can at times be very difficult, even for those organizations that have been through the process several times before. The initial implementation of the service provider is the most crucial aspect of a successful outsourcing experience. Typically, an "outsourcing implementation" is defined as the first 6-18 months in which a change occurs in a relationship with an outsourcing service provider (McCray, 2008). A change can be a new contract, change in an existing contract, or a change in project direction or scope. In most cases, the overall experience with an outsourcing endeavor is determined by the implementation.

Typically, required planning should already be defined in order to properly train and set-up the service provider. This also includes having all contract negotiations and preparations by the client and service provider complete. Having a process which moves the work from a planning stage on the client side, to an execution stage on the service provider's side, is the other piece to the puzzle of a successful outsourcing implementation.

To successfully implement an outsourced project there are several areas that cause problems. The most commonly experienced problem in outsourcing implementations is a lack of understanding of post-contract processes and decision rights (McCray, 2008). This means that the client and service provider are not operationally prepared to work together following the signing of a contract. The result of this leads to both sides becoming increasingly frustrated with the other, as well as the expectation for completing the project according to the previously detailed schedule, to be delayed. Alami et al. (2008) state that setting clear goals is beneficial for providers as they are trying to avoid unrealistic expectations.

The problem can be addressed by having all processes and decision rights properly documented and socialized. Although every project and organization has its own processes, it is important to document what they are so the service provider has a place to determine the proper action to be taken. This document should also include who should be contacted in the various situations that are possible to arise during the course of the relationship.

Another pitfall that often occurs is that of poor understanding of the contract from either participant (McCray, 2008). Following the initial signing of the contract, the client and service provider both have individuals working on a successful initial implementation. There are many dynamics that vary upon the situation, but in some situations the client could have employees who are emotionally upset about the decision to outsource a portion of the work. In nearly all situations though, the client employees have multiple views of what the service provider should or should not be responsible for. With so many new people and significant speed of implementation, responsibilities and social dynamics can often become confused and stressful.

In many outsourcing projects, the client often assumes that there is no need to keep any local team, or there is underestimation of how many individuals are still needed to properly run the outsourcing endeavor (McCray, 2008). Williams (2011) mentions that codified knowledge dissemination through formal training is beneficial for an offshore engineer's understanding of their client. While knowledge transfer to the offshore team is crucial to success of their efforts, many on the local team are still required for effective transition and continuing support. If training and transfer of knowledge is improperly managed, it can cause issues in implementation because there is no one guiding the service provider, especially if the project is complex.

Additionally, there is an inadequate team left in place to manage the outsourcing service provider. This team is often referred to as the governance team. Data gathered by Technology Partners International's (TPI) Governance Benchmark database states that 60 percent of staff assigned to the team which managed an outsourced project had no prior experience with dealing with an outsourcing endeavor (McCray, 2008). It was also found that 40 percent of clients in the benchmark did not provide any initial training for the governance team assigned to manage the agreement and only 20 percent of the clients felt that they provided enough ongoing training for their governance team.

Training of the outsourcing service provider can also lead to several problems. The first notable issue with outsourcing is the loss of pivotal knowledge and talent. This is almost an inevitable outcome of replacing a currently local team with an outsourcing endeavor. Within IT there are many small pieces of knowledge that only one member of a team may know. Additionally, this one member may only have to perform the task once in a great while.

The possibility of losing members of your team before the outsourcing implementation has been completed can lead to the need for backfilling the positions or a reduction of service quality (McCray, 2008). A similar issue can occur even if no talent is lost, this happens due to the regular employees spending their time training the outsourcing service provider instead of maintaining their normal responsibilities.

An often overlooked problem within outsourcing is when the culture of the two companies does

not mix well together (Grossman, 2002). This is actually a very important aspect that many companies tend to ignore. It is always important to be able to work comfortably and efficiently with a client or service provider. A clashing of culture can many times affect the overall outcome of a project. Depending on where the service provider or client is located, there can be several cultural differences that should be kept in mind for both. Some of these include language, religion, holidays, and work hours. Although this list is not extensive, it should be used as a starting point when determining if the culture of an outsourcing service provider will mesh well with a team.

## 5. BEST PRACTICES

There are several pitfalls that can cause an outsourcing implementation to fail, many of which have been noted above. In most cases though, there are simple ways to achieve success during the implementation of an outsourcing project. It may have been noticeable in the previous section that nearly every common people problem faced during an outsourcing implementation results from a lack of sponsorship and commitment of 'Change Management'.

### Change Management

Change Management refers to a team, individual, or process that acts as the guiding hand throughout the entire experience. The amount of people, ideas, and change that occurs during an implementation requires this guide to achieve a smooth implementation (McCray, 2008).

To effectively implement a Change Management process, it is important to make sure everyone understands their roles and goals. According to TPI (McCray, 2008), there are several key concepts to include in a Change Management strategy.

- **Leadership Vision and Commitment:** client and service provider leaders must be clear about the future state and drive the changes required to get there through words, actions and commitment of appropriate resources.
- **Staff Effectiveness:** client and service provider staff responsible for negotiating, implementing, performing and managing outsourcing services must have the necessary skills, knowledge and capacity.



- **Organizational and Procedural Alignment:** client policies, programs and other operating model components are aligned to support and enable the change.
- **Governance Readiness:** the outsourcing governance model is in place with a shared understanding of responsibility, decision-making authority and how services are managed.
- **Change Acceptance and Adoption:** client groups and individual stakeholders who are involved understand, accept, and are committed to operate according to the new model.

As can be seen above, the role that Change Management fulfills can be critical to the success of an outsourcing implementation. By providing this role, the emotional, contractual, and business relationships between the service provider and client can move in a positive direction throughout the entire process.

Raisinghani (2008) notes that by implementing a true strategic partnership between the provider and client, the preparations and governance become seamless. A big part of the strategic partnership endeavor will involve both parties moving to a common understanding of what needs to be done for successful implementation. The above mentioned items need to be managed as they could involve significant change and development on the part of both parties to bring goals into alignment.

### **Technical Concerns**

Along with the relationship oriented issues described above, there are several technical considerations that need to be addressed before any work can begin. Nakatsu and Iacovou (2009) identify lack of required technical capabilities and inadequate vendor staffing as important issues. Other issues range from configuring user accounts to setting up a development environment, which can be compounded when you are working with an offshore organization due to the language, distance, and time barriers (Lacity, 1995). Although setting up a development environment can take only moments, the process can take an extended period of time for the outsourcing team.

For larger organizations, there can be many user specific criteria that need to be configured before any work can be completed. Many

company networks are completely locked down and require a Virtual Private Network (VPN) to be accessed externally. In many of these organizations, a "token" is required to access these networks. A "token" is a small electronic device that can be attached to a key chain which displays a number that changes every thirty seconds or so. These "tokens" can take time to get to a local employee let alone shipping it to another country. It is important to plan ahead to get these and other similar devices to the service provider in a timely manner.

Examples of other user accounts and roles that may need to be created include: wikis, issue tracking, version control, company ID, and email. It is sometimes surprising how many user roles a new employee needs, and in the case of outsourcing, these individuals will need nearly all the same roles as a new employee. The most unforeseen hurdle to this is the elaborate and involved processes for having these accounts created. This can require many emails to several different individuals and multiple days of waiting for the requests to be fulfilled.

Other considerations include the technology chosen for the developers to work on. Many organizations choose to use a terminal server instead of each developer using their own computer due to security concerns and ease of environment management. This solution can provide many benefits, the greatest being that the client company can set up a user account and environment for each user before they ever sign in themselves. This set-up allows for the client company to easily control what the service provider is able to see and access. This can keep the client organization's code base and any documentation safe.

Because every project is unique, it is imperative to have good documentation of the application requirements and caveats. Well documented set-up procedures are also imperative for the outsourcing initiative to be a success. A great tool to use for documenting any training sessions are tools like GoToMeeting, created by Citrix Online. Tools like these allow for the sharing and recording of the instructor or student desktop. Paired with the recording of the actions taken on the desktop is an audio description of what is being shown. These tools allow the service provider to look back at a detailed training session to recall how or why a certain step was taken.

To properly prepare for an outsourcing project, having a plan in place *before* the project begins is ideal. This plan should include:

1. All user accounts necessary and how to have them created.
2. A list of tools that will be used for the different situations including how to use them (including more user accounts) and where to find them.
3. A detailed description of the project and what expectations there are in the deliverables.
4. Training documents and a plan of execution.
5. Requirements documents for the application or project.
6. Any use cases available to help guide the project in the desired direction.

By having this plan created prior to the implementation of an outsourcing project, the ease and speed with which the service provider can be trained and start with actual development will be noticeably smoother and faster. The obvious goal of outsourcing is to have some amount of work completed. Thus putting an early investment in a solid plan will be worth the quality of the product in the end.

## 6. CONCLUSION

The choice to outsource a project, or a whole team, can appear to be simple on the surface. This is far from the truth and the decision to outsource any part of a company should be reviewed and analyzed for the benefits as well as the possible detriment it could bring. Remus and Wiener (2009) suggest that project success requires a strategy, consideration of risks, cultural and language issues, and management factors.

There are very few instances where outsourcing can be implemented without any difficulties, and the majority of the time those issues are in relation to the people in both companies. Whether it is a cultural misunderstanding or a difficulty accepting the new company direction, there can be several emotional human difficulties that appear.

Although the emotional problems can be the most difficult to find solutions to, there are several other areas to keep in mind when implementing an outsourcing endeavor. Having the right people in the right positions to guide and support the growing pains that come with

outsourcing is one of the keys to making sure it is a success. The change management position is the center of this support team and should always be one of the first positions filled when an outsourcing project first begins.

Finally, the technology used to provide not only a development environment, but also the training documentation, communication, and troubleshooting, is the final stumbling block that can make an outsourcing implementation difficult. Having a plan in place as well as documentation detailing how all user accounts are set-up is the first step in providing a smooth start-up.

Having a plan before the start of an outsourcing project is crucial and should be the first order of business. Outsourcing is not an easy endeavor and thought should be put into whether or not it is the right option for the project at hand. Outsourcing can be a strong addition to a company toolkit, but if handled incorrectly can bring even the largest of corporations to its knees.

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# An Empirical Study of Social Networking Behavior Using Theory of Reasoned Action

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## Abstract

One of the most important means of communication for young people today is social networking. This study explores social networking behavior using the Ajzen and Fishbein (1980) model of human behavior known as Theory of Reasoned Action (TRA). Specifically, findings reveal that both attitude toward social networking and "subjective norm" are positively associated with intention to use social networking (SN). In addition, intention influences use of social networking. The TRA model provides a strong fit with the overall data and can be used to predict and understand the usage of social networking in the target population.

**Keywords:** Theory of Reasoned Action, TRA, social networking, factor analysis, structural equation modeling.

## 1. INTRODUCTION

One of the most important means of communication for young people today is social networking. Facebook has become the most visited website (Wilhelm, 2010). What elements influence an individual's decision to use social networking? This study is an attempt to understand SN by exploring social networking

(SN) behavior using the Ajzen and Fishbein (1980) model of human behavior known as Theory of Reasoned Action (TRA). Specifically, findings reveal that both attitude toward social networking and "subjective norm" are positively associated with intention to use SN. According to Ajzen (1980), subjective norm is defined as how behavior is viewed by our social circle or those who influence our decisions. Intention influences

the use of social networking. The TRA model provides a strong fit with the overall data and can be used to predict and understand the usage of social networking in the target population.

## 2. SOCIAL NETWORKING

Professional networking began as a way for business professionals to meet and greet others in their fields, whether it was to market oneself, market a product, or just share a common interest. With Internet technology as an aide, it didn't take long for online social networking to catch on. It is a commonly held belief that social networking began with websites such as Facebook and MySpace. However, online social networking is not a recent phenomenon. Interestingly, the term was coined in 1954 by social scientist J. A. Barnes (Webopedia, 2010).

In the early 1980s, bulletin board systems (BBS) services began to gain popularity. These were text-only exchanges for people who had common interests, ranging from hobbyists to academics. The popularity of BBSs lasted from the 1980s well into the 1990s. At the same time, CompuServe allowed users to share files online and to access news and events. Various email systems enabled users to exchange ideas and to share files. America Online (AOL) emerged with member-created communities that provided searchable member profiles where users could list personal information which was accessible to others. Many believe that Classmates.com was the first true online social networking site, coming onto the scene in 1995, followed by SixDegrees.com in 1997. Six Degrees allowed users to create profiles and groups with a function that enabled the user to search for friends. In 2002, social networking site Friendster was launched followed by LinkedIn and MySpace in 2003 (Nickson, 2009). From 2003 onward, many new social networking sites (SNS) were launched (Boyd & Ellison, 2007). Facebook was unveiled in 2004 but was not fully available to the public at-large until 2006, the same year Twitter was introduced (Nickson, 2009). In July 2010, Facebook had reached 500 million users (Wortham, 2010).

There are a variety of definitions for this phenomenon. According to Boyd & Ellison (2007, p. 211), social network sites are defined as,

"... web-based services that allow individuals to (1) construct a public or

semi-public profile within a bounded system, (2) articulate a list of other users with whom they share a connection, and (3) view and traverse their list of connections and those made by others within the system. The nature and nomenclature of these connections may vary from site to site."

Wikipedia defines a social network as,

"... a social structure made up of individuals (or organizations) called "nodes", which are tied (connected) by one or more specific types of interdependency, such as friendship, kinship, common interest, financial exchange, dislike, sexual relationships, or relationships of beliefs, knowledge or prestige" (Wikipedia, 2010, para. 1).

According to the Pew Internet and American Life Project (Lenhart, 2009), young people are much more likely to use social networking sites than older adults. However, Lenhart found that 35% of American adult Internet users maintain a profile on an online social networking site, a four-fold increase since 2005. Teens are generally twice as likely to have profiles on social networking sites. In 2010, 41% of adults surveyed aged 18 - 65+ reported having an online social networking profile ("The Millennials", 2010). Seventy-three percent (73%) of wired American teens use social networking websites, up from 55% in November 2006 (Lenhart, Purcell, Smith, & Zickuhr, 2010). Surprisingly, given the adult population, there are a greater number of adults using online social networking as compared to the total number of teens who are using social networking (Lenhart, 2009).

Online social networking is much more prevalent than professional online networking. Most people use social networking sites to keep up with current friends (89%), make plans with friends (57%) or to meet new friends (49%) (Lenhart, 2009). Facebook is currently the most regularly-used online social network among adults (73%), followed by MySpace (48%), Twitter or similar services (19%), and LinkedIn (14%)(Lenhart et al., 2010).

Many users maintain multiple profiles, particularly when they utilize social networks for both personal and professional applications.

Fifty-one percent (51%) of social network users have two or more profiles compared to 43% of the users who have only one online profile. Eighty-three percent (83%) of the respondents with multiple profiles maintain them on different sites so that they can keep up with their friends who have profiles on various sites (24%) and to keep their personal and professional profiles separate (19%) (Lenhart, 2009).

According to Lenhart, Purcell, Smith and Zickuhr, approximately 80% of teens from lower income families (those earning less than \$30,000 annually) are more likely to use online social networks than teens from wealthier households (70%) (Lenhart et al., 2010). Both boys and girls visit social networking sites equally. Patterns of behavior are similar in the adult online community; an equal percentage of adult men and women visit social networking sites. There is no difference in ethnicity; Caucasians, African-American and Hispanic adults are equally likely to use these sites. However, those who have at least some college education (50%) are more likely to utilize these sites compared to adults who have a high school degree or less (43%). Thelwall (2008) found that female users of MySpace tend to be more interested in friendship and males more interesting in dating.

Although we are spending more time using SNSs, Birnie and Horvath found that, "online social communication appeared to complement or be an extension of traditional social behavior rather than being a compensatory medium for shy and socially anxious individuals." (Birnie & Horvath, 2002, para.1). Lewin (2010, para. 2) asserts that teens that socialize on SNSs are given "the technological skills and literacy they need to succeed in the contemporary world."

Business has jumped on the social networking and social media bandwagon. According to SocialMediaExaminer.com, "...about 77 percent of business-to-business firms use Facebook, and 83 percent of business-to-consumer firms are using it in some way." (Campbell, 2010, para 7). In a 2010 study conducted by MerchantCircle (Swartz, 2010), more than 50% of the respondents said that they planned to create or maintain a social-networking presence compared to 41% in the first three months earlier. In addition, merchant adoption of location-based services is growing rapidly – up from 25% in March 2010 to 32% in July 2010.

In a 2008 study conducted by DiMicco, Millen, Geyer, Dugan, Brownholtz & Muller, internal enterprise-level use of social networking tools "enables a new method of communication between colleagues, encouraging both personal and professional sharing inside the protected walls of a company intranet." (DiMicco et al., 2008, pg. 711). The authors supported the use of internal SNSs, particularly given that the next generation of employees, the Millennials, have used SNSs as their foremost means of communication.

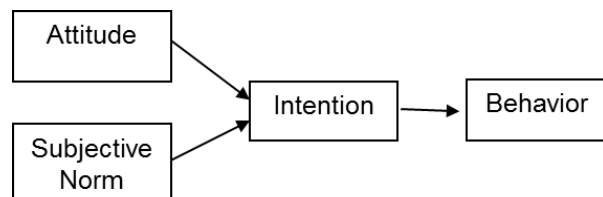
Social networking offers a variety of advantages as an alternative method of communication in business. Row (2009) suggests four key areas where business can be improved through increased use of social networking:

1. Increase the size of your network, increase the number of customers
2. Ability to build a personal relationship with people
3. Establishing an online reputation
4. Low cost marketing

### 3. THEORY OF REASONED ACTION

In order to explore influences on social networking behavior, a common behavioral model was selected: Theory of Reasoned Action (TRA) developed by Ajzen and Fishbein (1980). The model uses four factors: attitude, subjective norm, intention, and behavior. TRA remains an important model for measuring user behavior (Brewer et al., 1999; Lee et al., 2006; Pak, 2000; Song & Kim, 2006; Wooley & Eining, 2006; Wu & Liu, 2007). The model is shown in figure 1.

**Figure 1 Theory of Reasoned Action**



TRA was selected over other models (Theory of Planned Behavior and Technology Acceptance Model) similar to Wu and Liu because TRA has shown successful application to general consumer information technologies (Hansen et al., 2004; Njite & Parsa, 2005; Wu & Liu, 2007)

and organizational knowledge sharing (Hansen et al., 2004; Kwok & Gao, 2005/6; Kwon & Zmud, 1987). Intention to use is a common behavioral factor (Bahmanziari, Pearson & Crosby, 2003). Actual behavior generally follows intention in a variety of models (Bahmanziari et al., 2003; Riemenschneider & Hargrove, 2001). Theory of planned behavior also adds a measure of volitional control which is not suggested as an issue for social networking. TRA is being tested for this particular technology to verify its application for this technology. It is important that the model be tested in order to confirm applicability prior to development of specific action programs based on its theorized fit.

Definitions of the TRA model's factors are as follows:

- *Attitude* is how we feel about the behavior and is generally measured as a favorable or unfavorable mind-set.
- *Subjective norm* is defined as how the behavior is viewed by our social circle or those who influence our decisions.
- *Intention* is defined as the propensity or intention to engage in the behavior.
- *Behavior* is the actual behavior itself.

#### 4. HYPOTHESIS

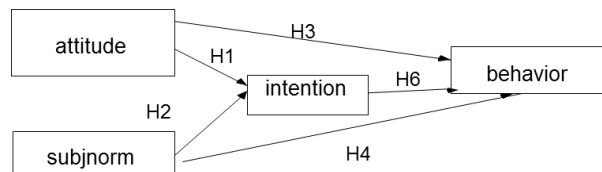
In exploring the degree of fit between the TRA model factors and social networking, a series of hypotheses were developed. The traditional TRA model suggests influences and associations among factors that are tested in this study.

- *Hypothesis one: Attitude toward social networking is positively associated with intention to use SN.*
- *Hypothesis two: Subjective norm of social networking is positively associated with intention to use SN.*
- *Hypothesis three: Attitude toward social networking is positively associated with use of SN.*
- *Hypothesis four: Subjective norm of social networking is positively associated with use of SN.*

- *Hypothesis five: Attitude toward social networking will be more strongly associated with intention than subjective norm.*
- *Hypothesis six: Intention to use social networking is positively associated with use of social networking.*
- *Hypothesis seven: Social networking technology will provide a model fit for behavioral intention and behavior.*

All of the hypotheses are graphically represented in Figure 2 except for hypothesis five, which deals with relative strength of relationship, and hypothesis seven which addresses the overall model.

**Figure 2. Proposed Theory of Reasoned Action Model with Hypotheses**



#### 5. METHODOLOGY

A survey was prepared and pretested with a small group of students at a northeastern U.S. university. The survey was modified based on preliminary tests and administered to 196 students at several small northeast U.S. universities. The survey consisted of questions related to social networking intention and behavior. A subset of this study included specific questions that developed into TRA factors (Appendix 1). The use of students is appropriate since this is the group who is most active in using this technology. Studying their usage can lead to factor determination. Albaum and Peterson (2006) contend that students are "stakeholders, especially business students, who collectively constitute the future leadership of corporations".

For each of the relevant factors, survey questions modeled prior research. Subjective norm and attitude were based on Fitzmaurice (2005). Intention factor questions were modeled after Ilie, Van Slyke, Green, & Lou (2005) and behavior was based on common usage terminology and software piracy behavior factor in Woolley and Eining (2006).

The variables needed to test the theory of reasoned action include:

- *Attitudes* –The survey contained five questions that addressed respondents' attitudes toward social networking. The questions asked if they felt that social networking was useful, worthwhile and valuable.
- *Subjective Norm* – Subjective norm is defined as "the person's perception that most people who are important to him or her think he should or should not perform the behavior in question" (Ajzen & Fishbein, 1980). The survey contained four questions to measure subjective norm. Two of the questions asked included, "Most people who are important to me think I should use social networking" and "People who I listen to could influence me to use social networking."
- *Behavioral Intentions* – The behavioral intentions are the probability that the subject will use social networking. The survey questions asked the respondents if they plan to use social networking.
- *Behavior* - Behavior is the transmission of intention into action. The questions formulated in the survey asked if the respondents currently use, plan to use or will continue to use social networking.

The demographic mix shows a traditional college student population with 96% of the participants between the ages of 18 and 24. The gender mix was slightly skewed with 64% females.

The questions measured a five point Likert scale with level of agreement from 1 = strongly agree to 5= strongly disagree. SPSS 17 and AMOS 17 were used to analyze the data and test the proposed hypotheses. Factor analysis and scale reliability as well as structural equation modeling were conducted similar to Wooley & Eining (2006) and Moore (2000).

## 6. RESULTS

Confirmatory factor analysis and scale reliability testing was used to determine the factors used in the model. All the factors were confirmed with one component determined and eigenvalues over 1.0 which is generally seen as the level of acceptability (Moore, 2000).

The attitude five questions resulted in one component with an eigenvalue over 1.0 at 4.261. The component matrix elements all were above .5 (minimum acceptable, Moore, 2000) and scale reliability provided a Cronbach's alpha of .955, well above the minimum acceptable of .7 (Nunnally, 1978).

The four Subjective Norm questions also resulted in one factor with an eigenvalue over one, at 2.888. All components were over .5 and Cronbach's alpha was .870. As noted, these are all well above minimum levels.

Intention and its three variables clearly resulted in one factor with an eigenvalue over one, at 2.929. All components were over .5 and Cronbach's alpha was at .99. These were certainly above minimum levels.

Finally, actual behavior was measured by three variables and it demonstrated one factor with an eigenvalue over 1.0, at 2.705. All components were over .5 and Cronbach's alpha was .944.

In all cases and by all measures, all factors met acceptable levels. Once the factors were determined, the results were analyzed in AMOS 17.0 to test the hypotheses and develop the model using structural equation modeling. (Please note the L designation after a variable denotes a latent variable).

*Hypothesis one* proposed a positive association between attitude and intention to use SN. Theory of Reasoned Action (Ajzen & Fishbein, 1980) suggests a positive and significant relationship between both attitude and subjective norm and intention. As shown in Appendix 2, attitude toward social networking was positively associated with intention to use social networking. This correlation was significant at the  $p < .001$  level. The standardized coefficient was .498. Attitude toward social networking did have an impact on intention to use SN. Hypothesis one was supported.

*Hypothesis two* proposed that subjective norm is positively associated with intention to use SN. Subjective norm was found to have a positive and significant correlation with intention to use SN. This association was found to be at  $p < .005$  as well with a standardized coefficient of a lesser .215. Hypothesis two was supported.



*Hypothesis three* proposed a positive association between attitude toward social networking and use of SN. Gupta and Kim (2007) modified TRA and tested direct associations between base variables and use as opposed to only relationships through intention to use. They found many significant relationships. Our model tested the direct effect of both attitude and subjective norm on SN use. Table 2 shows an additional direct relationship, both positive and significant at  $p < .001$ , between attitude toward SN and actual use of SN. Hypothesis three was supported.

*Hypothesis four* proposed that subjective norm is positively associated with use of SN. It was also hypothesized that subjective norm would have a positive influence on use. This was not found to be the case with a  $p$  value of .425. This relationship was excluded from the model and results shown. There was no direct positive relationship between subjective norm and use of SN. Hypothesis four was not supported in this study.

*Hypothesis five* proposed that attitude toward social networking will be more strongly associated with intention than subjective norm. Woolley and Eining (2006) found a stronger association in TRA between attitude and intention than subjective norm and intention as it relates to software piracy. As shown in table 2, attitude toward SN had a stronger association with behavior intention than subjective norm. The standardized coefficient was nearly double. Hypothesis five was supported.

*Hypothesis six* proposed a positive association between intention to use social networking and the use of SN. The original model of TRA (Ajzen & Fishbein, 1980) found a strong positive relationship between intention and actual behavior. Gupta and Kim (2007) supported this relationship in a study of virtual communities. Our study supported this relationship at  $p < .001$ . Hypothesis six was supported.

*Hypothesis seven* proposed that social networking technology will provide a model fit for behavioral intention and behavior. The inclusion of all factors into a comprehensive model was tested via AMOS 17.0. The model (excluding the direct relationship between subjective norm and behavior) provided a marginally acceptable overall fit. The RMSEA is .076, below the recommended .06 or .08

(Stylianou & Jackson, 2007) and well below the absolute cutoff of .1 (Browne & Cudeck, 1993); the chi square divided by the degrees of freedom is 2.12, below 3 at .123 (Moore, 2000). These findings suggest that the model fits the data in the population from which the sample was drawn. The standardized estimates and squared multiple correlations are presented in Appendix 2 and 3 and Table 1. Hypothesis seven was supported.

**Table 1. Squared Multiple Correlations:  
(Group number 1 - Default model)**

	Estimate
IntentionL	.384
behaviorL	.628

## 7. IMPLICATIONS AND DISCUSSION

Overall, it can be seen that Theory of Reasoned Action can be used as a model for social networking behavior. It has been proposed that social networking provides unique advantages over other electronic communication methods such as email. But despite these advantages, social networking is used much less frequently in business usage. Understanding the factors associated with intention and behavior associated with social networking suggests areas that can be focused on to increase social networking usage in the workplace. First it was found that attitude toward social networking is positively associated with intention to use SN. In fact, it is the most important influencer of intention studied. Other researchers have suggested that education of users about favorable attributes of a product can change attitudes toward the product and thus increase intention to use the product (Bang, Ellinger, Hadjimarcou, & Traichal, 2003; Xu & Paulins, 2005). Workplace education on the benefits, advantages, and details of social networking is suggested to allow further penetration of this useful technology and improve overall communications. This could have significant positive cost and productivity improvements for businesses and organizations.

The second finding is that subjective norm is positively associated with intention to use SN. Subjective norm is the "perceived social pressure to perform or not perform an action" (Tarkiainen & Sundqvist, 2005). The study revealed that use of SN by others in their social

group did have a significant influence on intention to use SN. The growth in SN use by students has been fueled by a social circle incentive. Those in the group have more social interaction and pressure exists to belong to this communication circle. This can expand through wider usage by the sampled population. This has important implications for practitioners.

The study next reviewed whether attitude had a direct influence on behavior rather than just behavior intention. It was found that attitude does have a direct influence on behavior, further emphasizing the need for education, training, and support if social networking usage is to be improved.

Conversely, subjective norm did not have a direct influence on behavior. Though subjective norm does influence intention, there was no significant direct influence on usage. Implications suggest that the social pressure provides a predisposition for behavior but then attitude provides the direct influence. This should be considered when designing education, training, and policy programs in organizations. It was determined that attitude toward social networking was more strongly associated with intention to use SN than behavioral norm. This again supports the environment and education change program to influence attitude is more important than adopted policies in an organization.

As proposed in the original Ajzen and Fishbein (1980) model, intention to use social networking is positively associated with use of social networking. Many researchers have supported this relationship (Gupta & Kim, 2007; Shimp & Kavas, 1984; Tarkiainen & Sundqvist, 2005). Since the authors' overall objective is to study and improve overall behavior, it was important that this relationship was established.

A final finding of the model development was that there was a significant covariance between subjective norm and attitude. This supports the development of a comprehensive program of social persuasion including a favorable climate and view of SN by itself as well as by peer pressure. This program plus education and training should ultimately improve use of social networking in businesses.

## 8. LIMITATIONS

This research examines primarily traditional students at undergraduate university locations. Results should be duplicated across other locations to confirm the preliminary findings of the study. In addition, only students were studied. Results may be different with non-students or with other age groups. Somewhat offsetting this limitation, however, is the widespread use of social networking by this target group and age demographic. With a sizable penetration, factors influencing intention and usage can be studied due to the size of the participation.

Another limitation is the sample size. Though relatively large, the number of participants can be increased to improve reliability.

Finally, the study examines only one model of human behavior. Though support and rationale for the use of Theory of Reasoned Action has been presented, there are other models which could be tested for adoption and behavior.

## 9. CONCLUSION

Overall this study has provided significant factors that influence and model social networking intention and behavior. We see this as the start of an exploration of ways to increase and improve penetration of this valuable communications technology in the workplace. Studies can be undertaken to confirm these findings with larger and more diverse sample groups, but preliminary findings suggest that social networking does adhere to the theory of reasoned action model and is thus subject to efforts to improve behavior through attention to the significant influencing factors of attitude, subjective norm, and intention. The authors welcome efforts to assist in this fertile research area.

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**Editor's Note:**

*This paper was selected for inclusion in the journal as a CONISAR 2011 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 2011.*

## Appendices and Annexures

### Appendix 1 Survey Questions and Factors

Factor	Abbreviation	Questions/Variables
Attitude	ATTITUDE	Social networking is good.
Attitude	ATTITUDE	Social networking is useful.
Attitude	ATTITUDE	Social networking is worthwhile.
Attitude	ATTITUDE	Social networking is helpful.
Attitude	ATTITUDE	Social networking is valuable.
Subjective Norm	SUBJNORM	Most people who are important to me think I should use social networking.
Subjective Norm	SUBJNORM	Close friends and family think it is a good idea to use social networking
Subjective Norm	SUBJNORM	Important people want me to use social networking
Subjective Norm	SUBJNORM	People who I listen to could influence me to use social networking
Behavioral Intention	INTENTION	I predict I will use social networking
Behavioral Intention	INTENTION	I intend to use social networking
Behavioral Intention	INTENTION	I plan to use social networking
Actual System Use	BEHAVIOR	I plan to use social networking in the future.
Actual System Use	BEHAVIOR	I currently use social networking.
Actual System Use	BEHAVIOR	I will continue to use social networking.

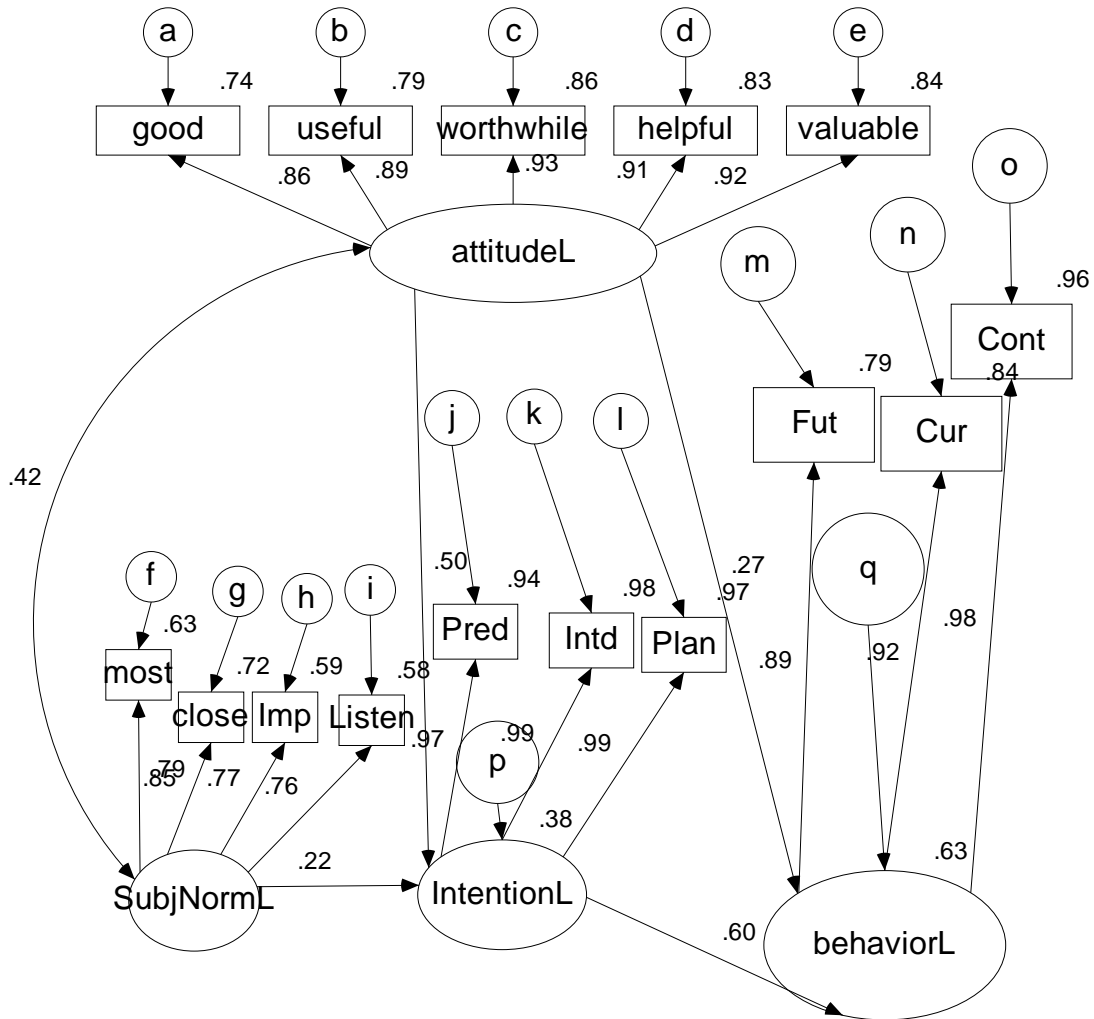
## Appendix 2. Regression Weights: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	P	Label
IntentionL	<---	attitudeL	.583	.089	6.527	***	par_12
IntentionL	<---	SubjNormL	.217	.078	2.776	.005	par_13
behaviorL	<---	IntentionL	.560	.064	8.766	***	par_14
behaviorL	<---	attitudeL	.297	.072	4.117	***	par_16
good	<---	attitudeL	1.000				
useful	<---	attitudeL	.839	.054	15.650	***	par_1
worthwhile	<---	attitudeL	1.080	.063	17.066	***	par_2
helpful	<---	attitudeL	.987	.060	16.417	***	par_3
valuable	<---	attitudeL	1.065	.064	16.718	***	par_4
most	<---	SubjNormL	1.000				
close	<---	SubjNormL	.955	.086	11.052	***	par_5
Imp	<---	SubjNormL	.930	.094	9.941	***	par_6
Listen	<---	SubjNormL	.981	.100	9.828	***	par_7
Pred	<---	IntentionL	1.000				
Intd	<---	IntentionL	1.057	.024	43.207	***	par_8
Plan	<---	IntentionL	1.054	.026	41.229	***	par_9
Fut	<---	behaviorL	1.000				
Cur	<---	behaviorL	1.242	.067	18.502	***	par_10
Cont	<---	behaviorL	1.289	.059	21.668	***	par_11

**Standardized Regression Weights: (Group number 1 - Default model)**

			Estimate
IntentionL	<---	attitudeL	.498
IntentionL	<---	SubjNormL	.215
behaviorL	<---	IntentionL	.601
behaviorL	<---	attitudeL	.273
good	<---	attitudeL	.859
useful	<---	attitudeL	.887
worthwhile	<---	attitudeL	.926
helpful	<---	attitudeL	.910
valuable	<---	attitudeL	.917
most	<---	SubjNormL	.793
close	<---	SubjNormL	.850
Imp	<---	SubjNormL	.769
Listen	<---	SubjNormL	.760
Pred	<---	IntentionL	.968
Intd	<---	IntentionL	.991
Plan	<---	IntentionL	.987
Fut	<---	behaviorL	.889
Cur	<---	behaviorL	.917
Cont	<---	behaviorL	.981

Appendix 3 Theory of Reasoned Action Model with Standardized Estimates



# Using the Cloud: Keeping Enterprise Data Private

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## Abstract

Cloud computing has overwhelmed the computing industry over the past few years. Exciting prospects such as sharing resources, reducing costs, and increasing efficiency have made the cloud computing model highly attractive. In this paper, we will focus briefly on the privacy and security concerns of outsourcing the hosting of a virtual infrastructure, often referred to as Infrastructure as a Service. Also, we will analyze two different methods of encrypting data and the performance degradation that is caused by leveraging encryption in an effort to prevent a cloud provider from accessing your information. Then, we will compare the results of a simulated SQL server and have a basic conclusion of what method offers better performance, and a basic analysis of the degradation of performance caused by encrypting data in a particular cloud computing setting.

**Keywords:** cloud computing, protecting data, encryption, hypervisor, time based tradeoff, infrastructure as a service, software as a service

## 1. WHAT IS 'THE CLOUD'?

The personal and commercial worlds have engrossed themselves with the cloud over the past few years. However, the term Cloud Computing lacks a true meaning by which the key focus of "the cloud" is on. In essence, cloud computing includes any form of computing where information is stored, retrieved, and processed using a third party's computing platform. To differentiate from the various styles of cloud platforms ranging from Google Docs, to Amazon Elastic Compute Cloud (EC2), to Facebook, we will leverage the National Institute of Standards and Technology's (NIST) recognized definitions of cloud computing service

and deployment models. NIST defines the following three different service models: Cloud Software as a Service (SaaS), Cloud Platform as a Service (PaaS), and Cloud Infrastructure as a Service (IaaS). Our focus will be on IaaS (Mell and Grance 2009).

### Cloud Software as a Service (SaaS)

One of the three service models associated with Cloud Computing is that of SaaS. According to Gartner (Hall 2011), sales in 2010 were to reach \$9 billion, an increase of over 15% from 2009. By the end of 2011 sales should represent in excess of \$10 billion, an increase of more than 16%. SaaS is sometimes referred to as on



demand software, and utilizes a centrally located delivery model of software to the users by way of a web browser. The focus of SaaS is that of how this delivery is configured for user access, as it is not considered customizable by the user because source code is not available for such a task.

### **Cloud Platform as a Service (PaaS)**

To address the customizable desires of information technology users, the PaaS model can be implemented. As its name indicates, the development platform is deployed through a central hub as opposed to the software applications of SaaS. This model facilitates the functionalities of application design, development, testing, and deployment of the system development life cycle and includes services such as collaboration of developers, the integration of databases, security and scalability among other services. The feasibility of customization allows for integrating many solutions in this model.

### **Cloud Infrastructure as a Service (IaaS)**

The 3rd service model, and the focus of this study is that of IaaS. When referring to 'The Cloud' this study is referring to the IaaS model. Where SaaS addresses software use, and PaaS details the development platform functionality of the cloud, IaaS is in effect the network as a whole. It has been our determination that the service model IaaS is teamed with the deployment model of a Public Cloud, therefore privacy of a customers' data may be at risk. In this service/deployment combination, customers purchase hosted infrastructure from a provider and are therefore given the ability to manage operating systems, processing, and various other "fundamental computing resources" from the public cloud owner (Mell and Grance 2009). Common examples, as seen in industry today include Amazon's Elastic Compute Cloud (EC2), Terremark's Infinistructure, and Rackspace's Mosso Cloud Servers (Lenk, Klems et al. 2009). In these agreements, customers pay a fee in order for the cloud provider to host a virtualized copy of a particular operating system and virtual hardware set. Customers are then tasked with the management of the operating system, software, and data contained within the virtual platform.

Leveraging this form of virtualization, a provider company operates their own hardware. Each

instance of a virtual host is essentially a physical machine running virtualization software that allows multiple guest machines (Goth 2007). A guest machine is a single instance of an IaaS model. When a guest machine is operating a portion of the resources of the host are allocated for the guest's processes. All in all, this is generally referred to as virtualization. Throughout the progression, development, and availability of virtualization technology, it has evolved into becoming a mainstream component of IT systems.

## **2. WHAT IS THE RISK?**

In these public, shared environments, one customer's data is housed next to another customer's data; this has already been termed as a feature of the Public Cloud. A user or organization's potentially private data is stored in some form by a third party. Ultimately, the customer is in no way in control of how or where their data is stored in the cloud environment (Kaufman 2009). The level of security required by customers is highly dependent and is therefore tied directly with the value of the data. Customers storing private information (should) place a high price in terms of the level of confidentiality, integrity guarantees, and availability provided by the cloud provider.

With this lack of control over the confidentiality, integrity, and availability (CIA), the owner of the data is left being at a disadvantage, and is therefore taking a certain calculated risk (Olivier 2002). With these details in mind, we focus on our efforts for maintaining data confidentiality. By outsourcing data storage and processing to third party providers, customers are placing their data at risk in situations stemming from provider mistakes, disgruntled employees, physical infiltration, outside attackers, and other inherent risks.

These risk factors are taken into consideration for the purpose of this study. Ultimately, our purpose is to determine a method that balances performance with protection of data. The performance cost (or loss of performance) will be evaluated with the levels of protection offered for level of cost.

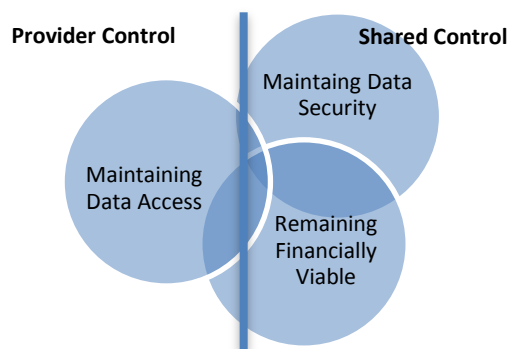
## **3. ISSUES NEEDING SOLUTIONS**

Three key issues, in an effort to reliably protect the data of IaaS customers, have been identified: maintaining data security,

maintaining data access performance, and completing these actions in a way that still makes it financially viable for IaaS providers and customers alike.

Maintaining data access is an issue that customers need to negotiate with their provider. Aside from connection redundancies, the customer has little control over the access to their data.

To address the latter two issues, maintaining data security and managing the performance of the access, a hybrid model of control exists, as exhibited by Figure 1.



**Figure 1 Model of shared responsibility**

In IaaS situations, since the customer is in control over the host operating system, they have the ability to leverage the OS's ability to protect the data at the expense of performance. Several methods exist for protecting data when stored online. Traditionally the two choices have been storage level and database level encryption (Mattsson 2005). As shown by Mattsson's research, database level encryption has traditionally been a high performing method of encryption, although it requires modification to the database schema. On the other hand, storage level encryption tends to require no changes to database schema, however its flexibility limits the data encryption to an all or nothing outcome.

In the instance of a virtualized environment, a new subset variety of data protection exists, which is derived from storage level encryption-hypervisor and guest-based encryption. Traditional forms of database encryption focus on encrypting specific files or datasets within an operating system. In virtualized environments, an additional layer exists between the guest operating system and the hardware, the hypervisor. With hypervisor-level encryption, storage-level encryption can be leveraged

without the knowledge (or ability) of the guest operating system. Guest-based encryption performs the same actions, with the exception that the encryption only takes place on a single virtual machine or guest.

#### 4. WHAT ARE WE PROTECTING AGAINST?

A clearly delineated definition is required in order to see the purpose of the overall data protection scheme. There are certain risks involved when outsourcing data storage to a third party which all depend upon who has access to the data. Employees of the cloud provider generally have full access to customer data. While companywide policies and procedures can be put in place, customer data is still at risk against employees that choose to violate said policies. In essence, any individual that has physical access to the medium for data storage theoretically has access to customer data.

Encryption allows us to protect our information, making data appear as pseudorandom bits written to the storage medium. Two methods have been discussed previously, hypervisor or host-based encryption, and guest-based encryption. Host-based encryption involves the cloud provider encrypting the file system in which the virtual machines are stored. Guest-based encryption takes an alternative approach; the guest virtual machines themselves handle encryption.

In order to mitigate the risks of an inside attacker, such as a disgruntled employee, the type of encryption must be scrutinized. In the event that host-based encryption is used, it can be easily assumed that the cloud provider is in charge of the encryption keys. In the scenario of a rouge employee, it can be assumed that the employee would have access to the encryption keys and could have the ability to reverse encryption that is implemented at the host-level. In contrast, guest-based encryption puts the control of the encryption keys in the hands of the customer. While an employee (or anyone with physical access) may gain the data files from the guest, the files will be encrypted. Assuming the customer properly protects their encryption keys, the attacker will be unable to decrypt the data, thus preventing loss of data to those with physical access.

## 5. COMPARISON OF METHODS

In the realm of system virtualization, several vendors exhibit scenarios for data security. In order to effectively compare encryption methodologies, a comparison must be made between the current virtualization platforms available, including vendor, features, CPU support, *supported* encryption methods, and supported guest operating systems. This comparison appears in Table 2 in the Appendices and Annexures section.

Several other virtualization platforms are available that include, but are not limited to: VirtualBox (an open source project from Oracle), Virtual Server 2005 (predecessor to Hyper-V by Microsoft), Virtual PC (desktop virtualization platform from Microsoft), and VMware Workstation (a desktop virtualization platform from VMware). These product lines are not within the scope of the comparison as they lack the support for true enterprise deployment.

The test is designed to compare the response times to SQL query simulations from a Windows-based virtual machine. Since enterprise database management systems (DBMS) are based upon SQL servers, the test aims to see what cost will be observed in performance. Our results will show what types of protections are more cost efficient in terms of performance. These results will ultimately allow individuals, businesses, and enterprise partners to derive their decisions for levels of protection verses what levels of performance may be lost.

Comparisons will be made between host-based encryption and guest-based encryption. The tests will be compared against a control, which uses no encryption at all. The overall purpose of the test is to compare the performance tradeoffs of the two discussed encryption methods. The hypervisor chosen for testing is the Hyper-V platform (on Windows Server 2008 R2 Enterprise) from Microsoft due to its ease of installation, versatile support for encryption, and large penetration within industry. The hardware used for the tests will be an HP DL380 G6 server with 2X Intel Xeon E5540 processors, 56 GB of RAM, using the Smart Array p410i storage controller with 2X300GB Dual Port SAS drives in a RAID 1 volume for OS installation, and 6X300GB Dual Port SAS drives in a RAID 5 volume for VM storage.

Three tests will be performed. The first test, as a control, will involve executing the queries against an unencrypted installation of Windows

Server 2008 R2 using the SQLIOSim utility. SQLIOSim is a utility from Microsoft designed to simulate algorithms and IO patterns observed in Microsoft SQL Server. In this first test no encryption will be used, therefore making it the baseline for results comparison. This baseline test will then become the control group representing the theoretical performance assuming no protections are used to prevent unauthorized access to the enterprise data.

The second test will measure the data read and write times when the virtual machine implements the encryption. Finally, the third test will compare the performance of host-based encryption with an unencrypted guest. The difference between these two tests is where the encryption is implemented. In the second test, the virtual machine itself manages all encryption activities whereas in the third test the encryption takes place on the physical machine (host). The expected results should show the unencrypted machine, the control, having much higher IO patterns than the encrypted machines. Comparisons of the two encryption schemes will then be made to see if guest-based encryption is more or less efficient.

## 6. OBSERVED RESULTS

The results from SQLIOSim measured four data points relevant to our research: Reads, Scatter Reads, Writes, and Gather Writes. These data points are all methods of input and output that can be measured in any software system, particularly database systems. Reads and writes are simple operations- reading a block of data from some input, often a hard disk, into a memory buffer, or writing a block of data from a memory buffer to an output, again generally a hard disk. Scatter reads and gather writes are referred to as vectored I/O. Vectored I/O is a method of attaining enhanced efficiency during input and output of data within software. In these situations, a block of data is read from the disk into multiple buffers in memory (or written to the disk from multiple memory buffers). Scatter/gather refers to the element that buffers that have data scattered into or gathered from within.

All four of these values are representative accumulators indicating what levels of performance would be expected in a production database environment with a heavy I/O load on a server's hard disk. For example, every time a basic read operation is completed, such as a

query against a database, the Reads accumulator is incremented. For the purposes of comparison, higher values are an indication of higher levels of attained performance.

Upon the completion of the three test cases (ran at four iterations each), the averages of the results are shown in Table 1.

	Reads	Scatter Reads	Writes	Gather Writes
Control	69764	61010.5	3216	98116.25
Guest Based	34242	35066	1991.5	63525.25
Host Based	64930.5	58741.25	3134.75	96322

**Table 1 Average IO From Tests Completed.**

A significant drop in performance was observed when the guest-based encryption was utilized. Leveraging guest-based encryption under the presented conditions resulted in nearly a 50% drop in performance on average. Raw results appear in Table 3 located in the Appendices section.

Notably the results show that using guest-based encryption methods caused an average loss in performance greater than 60%. Because of the nature of virtualization, we do expect there to be a lower level of performance (Goth 2007). All operations that require disk access in the guest-based scenario require complex cryptographic calculations to be performed. Since in the guest-based scenario, the guest is offered a share of CPU resources it is observed that this has a significant impact in the levels of performance achieved.

Considering full disk encryption to be a high performance computing (HPC) operation due to the nature of complex calculations required, we can leverage current research in an attempt to explain this observation. It has been shown that various HPC workloads can be highly inefficient, depending on the combination of the workload and the hypervisor in place (Simons and Buell 2010). As a part of our ongoing research, in the future we will compare similar results with alternate hypervisors, such as Xen.

In the host-based scenario, the virtual machine is not concerned with making cryptographic calculations. The host handles the cryptographic calculations in the host-based scenario. The host, operating the hypervisor, has preferential treatment in using CPU power and is therefore

able to attain significantly higher performance. This observation can be seen in various other HPC situations as well; host-based calculations generally outperform guest-based calculations of a similar nature.

## 7. CONCLUSION

With the observed loss of performance, it can be concluded that guest-based encryption mechanisms have a significant detriment to the performance in situations where high performance is a requirement. In these situations, as it stands, leveraging third party IaaS solutions will continually pose security, privacy, and regulatory risks to both businesses and consumers hosting their data in the cloud. As discussed, host-based encryption mechanisms do provide a level of security, but the ability for compromise still exists due to the lack of control outside of the consumers' hands.

For future study, we propose a comparison of performance tests and measurement of the load imposed upon the host hardware, comparing the IO advantages of host-based encryption in greater detail. The evaluation of alternate hypervisors is important in order to compare the relative performance outcomes that could be observed in a cloud-computing situation. Additionally, studies should be conducted that include situations where multiple machines are active on a single host- some using guest-based encryption while others are running without any encryption mechanisms. The outcome of such studies would be to measure the potential impact on IO performance that guest-based encryption may have on other guest operating systems. Finally, we look to observe the impact of host and guest-based encryption as it pertains to the overall host resource usage.

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**Appendices and Annexures**

<b>Name</b>	<b>Vendor</b>	<b>Host Encryption Support</b>
Hyper-V	Microsoft	Yes
Oracle VM	Oracle Corp	Yes- with add on
Xen Parallels Server 4	Citrix Systems	Yes- with add on
ESXi	VMware	No

**Table 2 List of available virtualization platforms**

	Reads	Scatter Reads	Writes	Gather Writes
Control	67028	59600	3145	95680
Control	70087	61522	3567	99051
Control	70504	61591	3049	99201
Control	71437	61329	3103	98533
<b>Average</b>	<b>69764</b>	<b>61010.5</b>	<b>3216</b>	<b>98116.25</b>
Guest Based	34335	37967	1955	62247
Guest Based	36604	27100	2110	61582
Guest Based	29975	37936	1943	67875
Guest Based	36054	37261	1958	62397
<b>Average</b>	<b>34242</b>	<b>35066</b>	<b>1991.5</b>	<b>63525.25</b>
Host Based	68205	59848	3359	96705
Host Based	64100	58402	3097	96610
Host Based	62989	58374	3051	96515
Host Based	64428	58341	3032	95458
<b>Average</b>	<b>64930.5</b>	<b>58741.25</b>	<b>3134.75</b>	<b>96322</b>

**Table 3 Raw data results from testing**

# Google Chrome and the Paradigm Shifts in the Browser Market Among Users

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## Abstract

In November 2011, Google's Chrome browser became the second most popular browser worldwide, surpassing Mozilla Firefox for the first time. This study investigates the perspective of users using two methodologies. First, a focus group was interviewed regarding factors influencing their decision to use specific Internet browsers. Second, a survey was constructed and administered based on the information gathered from the focus group, recent studies noting influence of the 'affect' construct in decision-making, and Ajzen's recommendations for the Theory of Planned Behavior. The results of data analysis suggest Attitude, Perceived Behavioral Control, and Affect positively and significantly influence a user's intention to use the Chrome browser. Implications are discussed.

**Keywords:** Google Chrome, Theory of Planned Behavior, Behavioral Intention, Affect

## 1. INTRODUCTION

The widespread adoption and use of mobile computing devices (e.g., smart phones, tablet computers, etc.) and increased expectations among users (e.g., ubiquitous, processor intensive computing) are driving paradigm shifts among users. The solution is pushing processor intensive operations to servers and utilizing web applications through browsers to display the results. Traditional browsers were not originally developed to support web applications. Consequently, as this paradigm shift began, running web applications on traditional browsers proved to be problematic. Given these issues, developers at Google began developing a new browser designed specifically for seamless operation with web applications.

In September 2008, approximately 2 years after development began, Google introduced their Chrome browser to the public. Since its initial release, the popularity of the Chrome browser has increased exponentially. In November 2011, Chrome became the second most popular web browser worldwide (StatCounter.com). So why has the Google Chrome browser captured such a large share of the browser market in just over three years after its initial release? This research study attempts to answer this question.

To date, no known study has examined the factors influencing individual users to choose Chrome over other popular web browsers. The purpose of this research study is to use both qualitative and quantitative methods to

investigate the factors influencing individuals to use Google Chrome.

This paper is organized into several sections, beginning with the Literature Review section, which provides background information about Google Chrome and competing browsers. This section also includes the theory behind our paper, followed by the Hypotheses. The next section is Methodology, which describes our approach in collecting both interview and survey data for this study. In the findings section, we provide the results from our correlation and hierarchical regression analyses. We provide the implications of our findings in the Discussion section, which is followed by the Conclusion section.

## 2. LITERATURE REVIEW

### Google Releases the Chrome Browser

Google introduced an Internet browsing platform named Chrome on September 9, 2008 (Perry, 2008). The initial launch, included 43 languages and 122 countries (Green, 2008), which is quite an extensive launch for a completely new browser. Many experts reported the Chrome browser to be the most significant change since Microsoft launched Internet Explorer (IE) to compete with Netscape (Rapoza, 2008).

### Google's Overall Goal in Launching the Google Chrome Browser

In contrast to traditional browsers designed for simply viewing web pages, the Chrome browser was developed as part of Google's web application platform. This is what made the Chrome browser unique. Google's engineers were often crashing traditional browsers while working on web applications such as Gmail and YouTube. To overcome these problems, the development of a browser application for internal use began approximately two years before it was released to the public (Green, 2008).

Google's goal in the development and release of the Chrome browser was "to change the nature of Internet browsing and the way we use computers" (Green, 2008). This follows Google's overall "Cloud Computing" initiatives with the ultimate goal of moving computing from the desktop toward data centers ("Chrome Wars," 2009). Google offers their Chrome browser to the public free of charge on an open-source

development platform utilizing Apple's Web Kit and some of the best parts of Mozilla's Firefox and other browsers (Perry, 2008).

### Features of Chrome

One of the best features of the Google Chrome browser is security. Chrome includes the use of sandboxing to limit the amount of damage caused by malicious software, automation of browser updates, and a variety of technical strategies for protecting against malware (Reis, Barth, & Pizano, 2009). Chrome received much praise and publicity from experts for incorporating security into the core underlying development (Ashford, 2008a, 2008b; "Google Chrome -- an essential guide," 2008; Reis, et al., 2009). However, recent reports have pointed out security vulnerabilities in Google Chrome (Brinkmann, 2011) and its operating system extensions (Finkle, 2011).

Other advantages of the Chrome browser include speed and improved user interaction. Chrome was developed with a focus on running web applications and supporting cloud computing. This resulted in a faster and more stable browsing experience (Ashford, 2008b; Reid, 2008; Schenker, 2008). Chrome also offers a streamlined user interface with less tool bars, menus, and includes multipurpose areas for entering both web addresses and search terms. This increases the amount of real estate on the screen dedicated to viewing web sites on the Internet (Gibbs, 2008; "Google Chrome -- an essential guide," 2008; Gray, 2009; Reid, 2008). Google Chrome is also the first browser capable of language translation without requiring plug-ins or extensions ("Google Chrome Features", 2011).

### Publicity, Marketing, and Advertising

The launch of the Chrome Browser included another initiation for Google - television advertisements. A series of promotional videos for the Chrome browser were created in-house by Google in Japan. These promotional videos became extremely popular after they were made available on YouTube, and given the popularity of the videos, Google decided to promote the Chrome browser with 30-second television ads (Morrissey, 2009). Google's television promotion continued in 2011 with a campaign created with the ad agency Bartle Bogle Hegarty (Cain Miller, 2011). However, this campaign focused on the



overall mission of Google with more subtle references to the Chrome Browser.

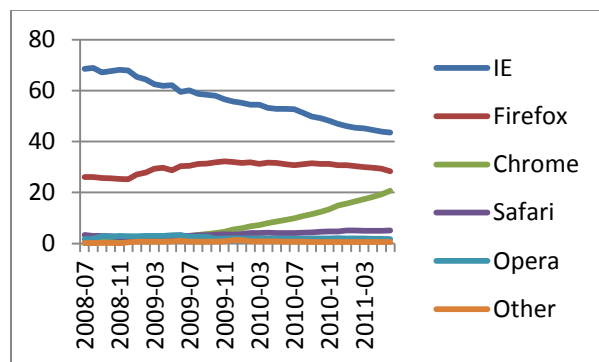
**Browser Market Share**

Google’s overall goal is to push the market leaders to adopt and support web based applications and cloud computing initiatives ("Chrome Wars," 2009; Claburn, 2010; "Google Chrome OS to Boot PC Within 7 Seconds," 2009; Green, 2008). The popularity and general acceptance of each application Google releases help promote future web applications and tools released by Google.

Both in the United States (see Figure 1) and worldwide (see Figure 2), the Chrome Browser has steadily increased its market share since it was first released on September 9, 2008 (StatCounter.com). Worldwide, Google Chrome surpassed Safari and Opera becoming the third most popular web browser in August of 2009 with 3.38% of the market following Mozilla Firefox (31.28%) and Microsoft IE (58.69%). In the United States, Google Chrome surpassed Safari and Opera becoming the third most popular web browser in November of 2010 with 10.89% of the market following Mozilla Firefox (26.75%) and Microsoft IE (50.24%).

According to StatCounter.com, the most recent data available from November 2011 indicates Google’s Chrome browser has become the second most popular browser worldwide (25.49%) and remains the third most popular browser in the United States (17.3%).

**Figure 1: Percent Usage of Top 5 Browsers Worldwide**

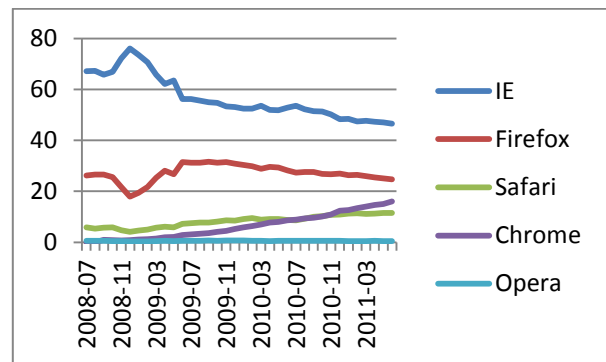


**Theory of Planned Behavior**

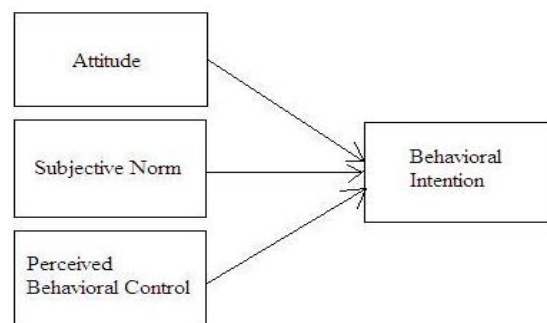
The Theory of Planned Behavior (Ajzen, 1991) can be used to examine the factors that

influence an individual’s decision to use Google Chrome. This theory uses three constructs to predict Behavioral Intention: Attitude towards the Behavior, Subjective Norms, and Perceived Behavioral Control. Behavioral Intention has been shown to be a strong predictor of actual behavior, which is difficult to measure in some domains. Attitude towards the behavior is defined as the degree to which a person has a favorable or unfavorable evaluation of the behavior in question (Ajzen, 1991). Attitude examines a person’s beliefs concerning a behavior of interest. Subjective Norm refers to the person’s perception of the social pressures to perform or not perform the behavior (Ajzen, 1991). Perceived Behavioral Control deals with the perceived ease or difficulty of performing the behavior (Ajzen, 1991). The Theory of Planned Behavior (TPB) expands a previous theory, the Theory of Reasoned Action (Fishbein and Ajzen, 1975), by including Perceived Behavioral Control as a third predictor of Behavioral Intention. The TPB is illustrated in Figure 3.

**Figure 2: Percent Usage of Top 5 Browsers in the United States**



**Figure 3: Theory of Planned Behavior (after Ajzen, 1991)**



Ajzen (2001) has acknowledged that the TPB does not directly measure a person’s feelings or

emotions about a behavior of interest. Therefore, we have included an additional construct, Affect, as a fourth predictor of Behavioral Intention in order to determine whether feelings significantly influence the usage of Google Chrome.

### 3. HYPOTHESES

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

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

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

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

### 4. METHODOLOGY

We integrated both qualitative and quantitative approaches to capture data for this study. First, we asked for twelve volunteers from our classes to participate in short interviews. The purpose of the interviews was to elicit background information from students concerning their usage of Internet browsers such as Google Chrome. These interviews were open-ended in order to allow students to elaborate on reasons why they may or may not use specific Internet browsers.

We then used the interview responses to guide the construction of the survey instrument. Our survey followed Ajzen's suggestions (Ajzen, 2001) for using the Theory of Planned Behavior. We also included questions to measure the Affect construct. 149 students taking a required course for all College of Business majors at our university were asked to participate in our survey. 133 students began the survey; 131 completed it. Near the beginning of the survey, we asked students whether they had heard of Google Chrome before today. After removing the incomplete responses and the data for those students who had not previously heard of Google Chrome, we ended up with a sample size of 115.

### Measures

#### **Attitude**

A direct measure of Attitude toward using Google Chrome was measured with three statements. (ATT1) Using Google Chrome is a good idea, (ATT2) Using Google Chrome is a positive idea, and (ATT3) Using Google Chrome is a helpful idea.

#### **Subjective Norm**

We used three statements to measure the construct of Subjective Norm: (SN1) My professors influence me in my decision whether to use Google Chrome, (SN2) My friends influence me in my decision whether to use Google Chrome, and (SN3) Other people important to me influence me in my decision whether to use Google Chrome.

#### **Perceived Behavioral Control**

Four statements were used to measure Perceived Behavioral Control: (PBC1) I have the ability to use Google Chrome, (PBC2) I possess enough knowledge to use Google Chrome, (PBC3) I have the resources to use Google Chrome, and (PBC4) I have the time to use Google Chrome.

#### **Affect**

We measured Affect using four statements: (AFF1) I would love/hate to use Google Chrome, (AFF2) I would be excited about/be bored using Google Chrome, (AFF3) I would be happy/unhappy using Google Chrome, and (AFF4) I would be relaxed/stressed using Google Chrome.

#### **Behavioral Intention**

To measure Behavioral Intention, we used three statements: (BI1) I intend to use Google Chrome in the next three months, (BI2) I plan to use Google Chrome in the next three months, and (BI3) I anticipate I will use Google Chrome in the next three months. Respondents replied using a seven-point 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 as recommended by Santos (1999).

**Table 1: Cronbach Alpha for each Construct**

Construct	Value
Attitude	.975*
Subjective Norm	.822*
Perceived Behavioral Control	.877*
Affect	.851*
Behavioral Intention	.986*

**Demographics**

Undergraduates at a large southeastern university were recruited as participants for this study. A total of 115 participants (62.6% males and 37.4% females) completed the research survey and indicated they had heard of Google Chrome prior to participating in the research study. At least 80% of the participants were business majors (23.5% Computer Information Systems, 22.6% Undecided, 11.3% Accounting, 9.6% Management, 8.7% Marketing, 7.0% Healthcare Management, and each of the remaining majors represented less than 5.0% of the sample).

**Table 2: Count of Gender Versus Major**

Major	Male	Female	All
Accounting	8	5	13
CIS	23	4	27
Economics	2	1	3
Entrepreneurship	3	0	3
Finance & Banking	3	2	5
Healthcare Mgmt.	3	5	8
H & T Mgmt.	1	3	4
Int'l Business	3	1	4
Management	9	2	11
Marketing	4	6	10
Undecided	13	13	26
Other	0	1	1
<b>Grand Total</b>	<b>72</b>	<b>43</b>	<b>115</b>

**Table 3: Percentage of Gender Versus Major**

Major	% M	% F	% All
Accounting	7.0	4.3	11.3
CIS	20.0	3.5	23.5
Economics	1.7	0.9	2.6
Entrepreneurship	2.6	0.0	2.6
Finance & Banking	2.6	1.7	4.3
Healthcare Mgmt.	2.6	4.3	7.0
H & T Mgmt.	0.9	2.6	3.5
Int'l Business	2.6	0.9	3.5
Management	7.8	1.7	9.6
Marketing	3.5	5.2	8.7
Undecided	11.3	11.3	22.6
Other	0.0	0.9	0.9
<b>Grand Total</b>	<b>62.6</b>	<b>37.4</b>	<b>100.0</b>

**Table 4: Class Distribution by Gender**

	Male	Female	All
Freshman	0	0	0
Sophomore	1	2	3
Junior	40	26	66
Senior	31	15	46
<b>Grand Total</b>	<b>72</b>	<b>43</b>	<b>115</b>

**Table 5: Class Distribution by Gender**

	% M	% F	% All
Freshman	0.0	0.0	0.0
Sophomore	0.9	1.7	2.6
Junior	34.8	22.6	57.4
Senior	27.0	13.0	40.0
<b>Total %</b>	<b>62.6</b>	<b>37.4</b>	<b>100.0</b>

**5. FINDINGS**

We used hierarchical regression in this study since it allows for specification of the order of entry of the variables based upon theory and previous studies. This approach also let us observe the change in  $R^2$  as we entered each independent variable into the model. This allowed us to see whether additional variables are significant as they are entered into the equation.

We imported the survey data from SurveyMonkey, analyzing it in Excel 2010 and SPSS 17.0. The following tables provide the

results from the correlation analysis and hierarchical regression analysis.

**Table 6: Correlation Matrix**

	ATT	SN	PBC	AFF
BI	.730*	.142	.357*	.798*
ATT		.306*	.260*	.784*
SN			.107	.251*
PBC				.241*

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

\* Correlation is significant at the 0.01 level

**Table 7: Hierarchical Regression Analysis**

Predictors (Constants)	R	Adjusted R <sup>2</sup>	Sig. F Change
ATT	.730	.529	.000
ATT, SN	.730	.525	.765
ATT, SN, PBC	.751	.552	.007
ATT, SN, PBC, AFF	.817	.655	.000

(Dependent Variable = Behavioral Intention)

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

We tested for autocorrelation using the Durbin-Watson test. The results ( $d = 1.814$ ) fell within the expected range of 1.5 - 2.5 (Tabachnick and Fidell, 2000).

**Hypothesis 1 is supported.** The correlation between Attitude and Behavioral Intention = +.730. Attitude was entered first into the hierarchical regression equation and explained 52.9% of the variance in Behavioral Intention. It is therefore concluded that Attitude is significantly and positively correlated with the intent of students to use Google Chrome.

**Hypothesis 2 is NOT supported.** The correlation between Subjective Norm and Behavioral Intention = +.142, which is not significant. Subjective Norm was entered second into the hierarchical regression equation and the total variance in intentions explained did not increase. Therefore, we conclude that Subjective

Norm is NOT significantly and positively correlated with the intent of students to use Google Chrome.

**Hypothesis 3 is supported.** The correlation between Perceived Behavioral Control and Behavioral Intention = +.357. Perceived Behavioral Control was entered third into the hierarchical regression equation and the total variance in intentions explained increased to 55.2%. Therefore, we conclude that Perceived Behavioral Control is significantly and positively correlated with the intent of students to use Google Chrome.

**Hypothesis 4 is supported.** The correlation between Affect and Behavioral Intention is +.798. Affect was entered in last into the hierarchical regression equation and the total variance in Behavioral Intention explained increased to 65.5%. Therefore, we conclude that Affect is significantly and positively correlated with the intent of students to use Google Chrome.

## 6. DISCUSSION

The findings initially seem surprising considering the strong support in the literature indicating a significant relationship between subjective norm and behavioral intentions. However, in this study the results may be an indication of a unique relationship between Google's Chrome browser and its users. In this study "affect" relates to an individual's emotional response towards an information technology artifact namely the Chrome Browser. So, influential others (subjective norm) could be of lesser importance than a user's emotional response toward the Chrome Browser.

"Affect" as it relates to emotions attached to an IT artifact measures sentiment. Sentiments are properties or attributes assigned to an object or class of objects, which are generalizations formed through direct experience or through social learning (Frijda 1994). Sentiments are judged by bringing an object to mind and observing the affective reaction (Clore 1994).

Sentiments can persist indefinitely, while emotions and moods are fleeting (i.e., lasting minutes, hours, or days), (Frijda 1994). Therefore, an individual's sentiment towards interacting with an object will motivate them to either seek or avoid opportunities to interact with that object (Brave and Nass 2003). For example, if a computer user says using browser

XYZ is frustrating because it often crashes while accessing web applications, they are essentially stating that through past experience or social learning they have come to expect that interactions with browser XYZ will result in a negative emotional state. As a result of this sentiment, the computer user will likely choose to avoid opportunities to interact with browser XYZ. This is actually the exact scenario which led Google to begin development of a web browser oriented toward the use of web applications (Green, 2008).

Also, events associated with negative emotion tend to be highly arousing, and tend to be remembered better than events associated with positive emotions (Newhagen and Reeves 1991; Reeves, Newhagen et al. 1991; Newhagen and Reeves 1992; Reeves and Nass 1998). Therefore, users may have a strong positive sentiment toward using Google's Chrome browser and/or a strong negative sentiment toward other browsers that often crash while interacting with a web based application.

Web based applications include Google Chrome, Gmail, Google Docs, Facebook, Twitter, and many more popular applications often accessed and utilized on a daily basis. Social sites such as Facebook can also elicit strong emotional responses or sentiments through social interaction. Given Chrome's reported superiority (Green, 2008) in running web applications this could also increase positive sentiments toward the Chrome browser.

Given the highly advertised security features designed into the core of the Chrome browser users may also have a positive sentiment towards using Chrome because it makes them feel safer than other browsers.

## 7. LIMITATIONS

It is important to note several limitations which could have biased the results of this research study. First, the data collected from the survey instrument is self-reported data. This data relies on the accuracy of the participants' perceptions of their own behavior and behavioral intentions rather.

Second, there is strong evidence within the research literature indicating that behavioral intention is a reliable predictor of actual behavior (Ajzen, 1991; Ajzen 2001; Fishbein and Ajzen, 1975). However, actual behavior could

potentially vary from self-reported behavioral intentions.

Lastly, the use of students as surrogates in social science research is a controversial issue and has often been debated within the IS research literature. Burnette and Dunne (1986) suggest that students should only be used as subjects when they represent the subject of interest. Bass and Firestone (1980) note that research findings which are not widely generalizable beyond a specific population, can provide evidence of causal relationships and testable hypotheses that can be extended to other subject populations. Despite the controversy, previous social science research seems to indicate that it is suitable to use students as surrogates when the participants' skills and experiences are considered appropriate for an experimental task (Chi and Glaser 1985; Hughes and Gibson 1991). Undergraduates are required to use web browsers extensively for various tasks related to coursework. Therefore, the participants seem suitable as research subject for this research study.

The participants in this study are undergraduate students from a medium sized southeastern university, and consequently they represent a relatively homogenous demographic group. Therefore, it should be noted that the homogeneous nature of the research subjects may limit the generalizability of the results.

## 8. CONCLUSION

Google Chrome has quickly become one of the most popular Internet browsers since its release in September 2008. The results of this study provides evidence suggesting two of the three independent factors shown to influence behavioral intention within the Theory of Planned Behavior (Attitude and Perceived Behavioral Control) are significantly and positively correlated with a person's intentions to use the Google Chrome Browser. We found that Subjective Norm is not significantly correlated with Behavioral Intention in this domain. However, our findings indicate that Affect, a construct not measured in the Theory of Planned Behavior, significantly influences intention. Future research in this area should further examine the role of Affect since it was a significant predictor in this study.

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# Study of User Behavior in Image Retrieval and Implications for Content versus Concept Based Access

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## Abstract

This paper explores the terms assigned by users to images for retrieval purposes in image databases. In order to determine how users conceptualize meaning for image retrieval, sixty-one participants provided potential retrieval terms for 40 images divided into 4 types of images. The categories include landscape, portrait, news, and city photography. The terms provided were analyzed for levels of meaning and relationships between terms supplied and the type of image described are explored. Results indicate significant findings in the level of meaning of terms assigned to images and relationships existed between the type of image viewed and the number and levels of terms provided. The implications for content and concept based retrieval schema are discussed.

**Keywords:** image retrieval, context based retrieval, concept based retrieval, databases

## 1. INTRODUCTION

With the proliferation of digital cameras and camera phones combined with the reduction in cost of producing images, the number of images being produced today will likely continue to grow. How these images are being stored and retrieved from databases has been a subject of interest for a number of professional fields from traditional library science to computer science. Originally, two camps emerged as image databases became prevalent. One side championed the manual assignment of retrieval terms by a trained professional using controlled vocabulary while the other faction researched the abilities of computers to determine the means of retrieval to images. In the recent growth of social media, other models have emerged that allow groups or communities to determine how images will be accessed. Key to

this argument is the user experience and how the users actually interact with the databases and think about their approaches to retrieval. This research examines user interaction with images and how their behavior fits into these models of retrieval.

## 2. BACKGROUND

The first group embraces the traditions of library science and assigns text descriptors for the image, relying on traditional text-based information retrieval systems. As the field grew, best practices began to emerge and systems or rules such as the *Anglo-American Cataloging Rules, Revision 2*, *Art and Architecture Thesaurus*, and *Library of Congress Thesaurus of Graphic Materials* were developed to guide indexers in preparing images for retrieval (Jørgensen, 1999). This approach can be time



consuming, expensive, and ineffective in many cases as demonstrated by studies of relevance in image retrieval (Shatford, 1984).

The second approach to image indexing, known as content based indexing, focuses on the use of computers to index images based on content. The computer can index images based on many of its physical characteristics such as shape, color, and texture. There have been many advances in this area and content-based retrieval has been particularly effective in scientific fields such as medicine and astronomy (Goodrum, Rorvig, Jeong, and Suresh 2001). Advances in facial recognition have increased greatly in the past few years and these algorithms are routinely used to determine meaning in images, in this case identity. (Moudani, Shahin, Chakik, Sayed, & Mora-Camino, 2011).

Many researchers are examining ways to find common links between the two fields and use the physical characteristics of an image to convey higher levels of meaning. Colombo, Del Bimbo, and Pala (1999) combine the fields of semiotics with the automatic detection of characteristics to convey meaning. The combination of colors and the resulting emotional states and the implementation of line slope by artists to denote meaning are being explored as possible advances in content based image indexing. However, the discussion of meaning in an image is one that continues to plague both camps and warrants a closer look in any discussion of image retrieval.

What an image is "of" maybe be a different discussion than what an image means. One implies a list of the contents of the image or the subject of the photograph, and one implies a higher level of meaning assigned either by the photographer or the viewer. A simple example that would demonstrate the difference between "of" and "about" might be an image of a young man, a young woman, and a small child posed together. The image is "of" three people of various ages, wearing different clothes, in a certain setting. However, many would also say that the image might be "of" a family, although there are assumptions made to get to this designation. Whether those assumptions are reasonable may depend on a wide variety of factors ranging from perceptual abilities to cultural differences and personal experience. This difference in meaning many times is the

line in the sand between the two approaches to retrieving images from a database.

Many studies have been dedicated to determining how people perceive images, assign meaning, and search for images (Colombo, Del Bimbo and Pala, 1999; Hastings, 1995; Choi & Rasmussen, 2003; Jörgensen ,2004; Jörgensen and Jörgensen; 2005). From these studies, models have emerged that try to assist in determining levels of meaning in images which can ultimately be useful in deciding how to provide access to images in databases. Shatford Layne (1986) expanded on Panofsky's (1955) work in art history for the purpose of developing a model to enhance indexing of images. She loosely adapts Panofsky's three levels in a model that includes, "generic of", "specific of", and about. These three levels of interpretation are then applied to the facets of who, what, where and when. For example, an image at the generic of level might list the contents of an image: a baby, a mother. The specific of might add additional levels of cultural interpretation to include the virgin Mary and the baby Jesus. The highest level of interpretation deals in more abstract concepts which might lead to assigning terms such as salvation. In the discussion of approaches to retrieval, many would argue that content based access would be more effective at the generic level and would be more problematic at the higher levels when the computer was required to provide more interpretation.

Ultimately, however, an understanding of how the user interacts with the database, the data, and sets about the task of retrieving images is an important factor that cannot be overlooked. Using a previously developed model of meaning, search terms provided by participants were analyzed for trends in levels of meaning, from named objects to abstract ideas. In addition to the terms provided, relationships were examined to determine if certain types of images were more likely to generate terms at different levels in Shatford Layne's model. This information could then be used to evaluate improvements in content based retrieval algorithms and their effectiveness in providing access in image databases.

### 3. METHODOLOGY

In this study, 61 undergraduate students at a public university participated in the data collection phase of the study. Students were not required to have any specific subject knowledge

to participate and students were recruited from all backgrounds. All of the students who participated were undergraduate students with an average age of 22.4 years of age ( $SD=4.9$ ). Forty-eight of the students were Caucasian, five African American, four Hispanic, three Asian, and one participant did not disclose their ethnicity. The group was very closely distributed by gender with 29 females, 31 males, and one participant who declined to identify gender.

The students represented a variety of academic backgrounds with the largest number coming from the computer information systems department ( $n=19$ ). Participants rated their computer familiarity with more than half rating themselves at least somewhat familiar with computers. Specifically, 25 students rated themselves as very comfortable, 14 somewhat comfortable, 7 neutral, 5 somewhat uncomfortable, and 10 rated themselves as very uncomfortable.

Participants were presented with 40 images on the web, one at a time, and were instructed to provide terms that would be used to retrieve the image being viewed. The entire task took students 30 minutes to 1 hour to complete. Images were selected for this study from a variety of sources encompassing government collections, news agency images, stock photography resources, and images from the researcher's personal collection. The images did not focus on one specific subject area and did not require expert subject knowledge in a field such as art history. Images were selected to represent different categories to determine if there may be relationships between the type of image being viewed and the user's approach to retrieval. The categories used for this study include landscape photography, portrait photography, cityscapes photographs, and news photography. The selection of these categories represents two general types of images, detailed and non-detailed images. Generally speaking, the portrait and landscape images have fewer details included as compared to the news photography and the city scenes.

Once data collection sessions were complete, the data was downloaded into a spreadsheet and two coders working independently analyzed each term provided and assigned it a level of meaning according to Shatford's model. Data that coders did not agree on were not included in the data analysis. However, very few terms were

excluded due to the high level of agreement between coders (98.7%).

#### 4. RESULTS

The mean of terms submitted by participants was 170.97 terms per student. There was a mean of 260.73 terms submitted per image viewed. In order to determine if there was a difference in the means of terms supplied for the different image types, a one-way analysis of variance was performed. The lowest mean number of terms supplied was for the images in the portrait category followed by images in the landscape category. The two highest means belonged to the news and the cityscape categories of images. The results of the ANOVA indicate that there is significant difference between the means of the categories being studied,  $F(3,36)=6.24, p<.01$ .

Using the Tukey HSD post-test to determine the nature of the relationships between the means of the groups, it was determined that the mean of the city scene images was significantly different than the two groups of portrait and landscape ( $p<.05$ ). There was no significant difference between the means of the remaining groups.

When looking at the number of terms that fell into the levels of meaning in Shatford Layne's model, 9,924 provided were at the generic level, 244 at the specific level, and 21 at the abstract level. A chi-square test indicates a relationship between the type of image being viewed and the level of meaning supplied in Shatford Layne's model ( $\chi^2(6, N = 10279) = 224.89, p < .01$ ). Looking at the relationships, the cityscape images were the only category that showed a lower than expected number of generic terms. In the specific category, the cityscape category showed more than twice the expected count while landscape and portrait did not even receive half the number of expected specific terms. The news category received very close to the expected count in each category. Because there were so few abstract terms provided, it is difficult to determine if a relationship might exist in this category.

#### Limitations

Because the research is based on a small sample size taken from a convenient sample, the results of the study are limited. The exclusive use of college students as participants could also affect

the generalization of results to a wider population.

## 5. CONCLUSIONS

The results from the study indicate a heavy reliance on named objects in terms provided by students. The overwhelming number of generic level terms supplied indicate that participants tended towards answering the question "What is the image of?" more than they indicated "What the image is about?" The promise in these results indicate that as improvements in computer analysis of images holds great promise in providing less expensive and less time consuming access to images than the traditional approaches of library science. As computer scientists continue to improve in areas such as facial recognition or pattern recognition in medical imagery, these concepts could also be adapted to identify objects in images for retrieval purposes.

However, one cannot ignore the fact that there were still many terms provided at the higher levels of meaning that could be difficult for computers to accurately assign. One of the most common examples would be the assignment of an emotion to an image, particularly those in the portrait category. Could a computer be programmed to analyze the nuances of facial appearances to determine the difference between a grimace of fear and a smile? Many researchers are making progress in this area but in a general subject image database, cost may be prohibitive in using content based approaches (Sarode & Bhatia, 2010).

Where the real promise lies in the marriage between concept and content based image analysis is the availability of resources via the internet and other databases. For example, a news photograph that showed a picture of George W. Bush received many terms with the specific level name and also many participants assigned the generic term "president". In this example, the specific term might be more easily accomplished by facial recognition than the more generic term which indicates some level of interpretation in what position the person holds. However, these obstacles can be easily overcome with integration of other resources. In a generic image database, facial recognition software could identify the individual and retrieve related concepts from other resources that have been created through more traditional

routes. So in this example, the person George Bush is identified automatically and his role of president or governor of Texas might be retrieved from a concept based controlled vocabulary such as the Library of Congress or even something less formal such as Wikipedia.

A similar technology solution might be applied to common designations for some of the results found in the landscape and city images. It was not uncommon for participants in the study to provide a geographical location for the image, even though it was many times incorrect. With inclusion of GPS enabled devices in smart phones and potentially in other cameras in the future, the GPS metadata attached to digital images can easily be tied to a database to locate the actual geographic name of the place where the image was taken. In addition to retrieving this information, databases could again be shared to provide additional retrieval mechanisms. For example, a picture taken at Shea Stadium in New York could easily retrieve New York City as a geographical access term but also could retrieve similar terms such as baseball or Mets without any assistance from a human indexer.

With the differences in terms provided for the type of image, it may also indicate to the database manager what type of access might be best suited to the content. With the higher number of terms provided for the more detailed images, the time and money might be well spent creating recognition algorithms for databases containing these types of images such as the cityscapes or news photography. These might be less useful and it may be more appropriate to apply more traditional means of providing access in databases that contain portraiture or landscape photography.

One area that poses difficulties for both approaches to providing access to images is the user's personal interaction with the image. Arnheim (1969) and Fischler and Firschein (1987) discuss the interaction of perception with other cognitive abilities such as language, memory, as well as culture when discerning meaning in an image. These influences also appeared in the responses to the tasks. This seems to be the case when terms were assigned that seemed to have no apparent reason for its appearance. A student who assigned 'beer bottle' to the image of the beach and one who assigned the term 'viagra commercial' to an image of an older couple hugging demonstrate

the affect of previous memories and culture. Because these elements are based on the experiences and memories of the viewer, providing this level of access would be difficult for either approach

Although the data in this study provides additional information on how users assign descriptions in an image, translating this information can be difficult when considering search strategies. As Markulla and Sormunen (2000) suggest, the selection of search terms is also influenced by the ultimate use of the image. Participants were asked to assign descriptive terms to images without a context for the activity. The potential exists for a similar difference in terms supplied as seen in a search arena. A quick, small sample of terms assigned to images in two different Internet databases were studied to see if a similar phenomena may exist. A quick, non-scientific review of images in popular Internet image databases shows possible support of this idea. At the website Flickr®, where website users upload their photos to share with other users on the site, the creator of the content is asked to assign the terms for their images. Selecting 40 images at random using the recent photos page and studying the number of terms assigned by the user shows that the average number of terms provided by the creator of the photograph was 8.3. Doing a similar sampling from an online stock photography site where users also supply the search terms there are very different results. The purpose of this website is to sell photography through a community website and the easier it is to find a photograph, the more likely it is to be purchased. As might be expected, the average was much higher at 33.6 terms on average assigned to each photograph. This difference in purpose of the database demonstrates that the lack of context of this study may also have an effect on the number of terms being supplied by participants.

As images continue to be created in large numbers, the storage of said data in databases for retrieval continues to pose problems for professionals in many fields. Attempts to understand how users conceptualize images and potentially attempt to retrieve them should be a driving force in the approaches from both traditional fields of library science as well as more technical approaches of computer science. Interconnectivity between resources produced by both camps could potentially bring higher success in image access. Advancements in these areas have wide reaching implications for

image retrieval beyond specific subject image databases. Currently, many internet search engines and networking sites depend on the provider of the content to provide retrieval access to image data or depend on textual analysis of the document which includes the image. Again, understanding how users search for images and cooperation between both content and concept based retrieval paradigms to solve these problems potentially can be applied to solve image retrieval problems in small subject specific databases or immense databases such as web search engines.

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