The Effects of Perceived Functionality and Usability on Privacy and Security Concerns about Adopting Cloud Application Adoptions

Makoto Nakayama
mnakayama@cdm.depaul.edu
School of Computing
College of Computing and Digital Media
243 South Wabash Avenue
Chicago, IL 60604, USA

Charlie Chen
chench@appstate.edu

Christopher Taylor
taylorcw@appstate.edu

Computer Information Systems and Supply Chain Management
Appalachian State University
Boone, NC 28608, USA

Abstract

Privacy and security risk are two primary concerns for end-users to consider adopting cloud applications. This study investigates two potential antecedents for these two concerns: functionality expectation and usability. In addition, this study tries to understand whether their relationships exist and are correlated positively or negatively.

An online survey was sent to 211 college users asking their experiences of using Google Docs. Statistical tests were conducted and showed that functionality expectation and usability improve as the length of use increases. Improved usability perception has negative effect on privacy and security concerns, indicating that privacy and security concerns could be reduced over time. On the other hand, increased functionality expectation raises more privacy concerns but does not affect security concern. Academic and practical implications are drawn from the findings to conclude this study.

Keywords: Cloud Computing, Privacy, Security, Risk, Google Docs

1. INTRODUCTION

Cloud applications initially were not considered reliable and practical as users have doubt and skepticism. A recent survey shows that 93% of its respondents are adopting cloud applications (Weins, 2015). The rapid adoption of cloud applications could be caused by their improved features or users' improved perception.

What changes the perception of users on cloud applications depends on possibly many factors. However, it is worth asking how end-user

perceptions change over time on the functionality and usability of cloud-based applications.

The end-user perception change on different non-standard cloud applications would be difficult to examine, given the details of each cloud application vary. However, it is more feasible to assess a standardized, common cloud application than a non-standard, customized one. In this study, we focus on Google Docs as one example of end-user oriented popular cloud applications. Google Docs is "a cloud productivity suite and it is designed to make computer-mediated collaboration easy and natural so that users can access any document they own or that has been shared with them anywhere, any time and on any device" (Sun, Lambert, Uchida, & Remy, 2014, p. 234). Google Docs is easy to use for a wide range of students in different educational settings. A study (Moonen, 2015) reports its successful incorporating even into an elementary school curriculum. At the university level, professors would consider integrating Google Applications into their instructional strategies, provided the appropriate professional development and training (Cahill, 2014). These professors agreed that collaborative technology was an effective teaching tool and assisted students when working on group and individual projects (*ibid*.). However, Google Docs is not limited to educational uses. In fact, it is suited to facilitate collaborations between workers using word processor, spreadsheet, and presentation applications. A recent survey (BetterCloud, 2016) note that more than 40% of cost savings are seen at small to large firms by adopting Google applications including Google Docs. Given the interest and possible business impact, our main research question is twofold: How do functionality expectation and usability of cloud computing affect privacy and risk concerns of users?

The plan of the paper is as follows: We hypothesize that functionality expectation and usability perception affect differently on privacy and security concerns of these cloud application. After describing method and results, we discuss the implications and future research agenda.

2. THEORETICAL BACKGROUND AND HYPOTHESES

Impact of functionality expectation and usability on privacy and risk concerns

Google Docs is "a free Web-based office suite that allows users to collaborate and facilitate conversations as they create and edit live documents" (Woodard & Babcock, 2014, p. 2). Users of Google Docs may have concerns about intentional or unintentional disclosure of personal information as well as the inconveniences or costs due to the temporary or permanent unavailability of documents. This means that users have concerns over privacy and risk.

Merriam-Webster defines privacy as "the state of being alone" or "the state of away from public attention." However, the meaning of privacy is contextual and varies among different academic disciplines (Paul A Pavlou, 2011; Smith, Dinev, & Xu, 2011). Privacy is categorized into value-based or cognate-based (Smith et al., 2011) with the former viewing privacy as a right or commodity, whereas the latter as the state of limited information access. Since the study focuses on the perception of individual cloud-application users, we frame privacy concerns as those about "opportunistic behavior related to the personal information submitted" (Dinev & Hart, 2006, p. 64) through Google Docs.

Cloud computing has the flexibility of changing functionality and can do so at a potentially lower cost than dedicated infrastructure (Ali, Soar and Yong, 2016). Thus, users have a higher functionality expectation for cloud computing. As the degree of functionality expectation on a cloud application becomes greater, the users are essentially expecting the more interactions with the application. A study shows that cloud services with a transparent and adaptable interface can encourage users to spend efforts and time in provisioning privacy requirements before uploading their sensitive data into the services (Henze et al. 2016). Using a cloud application, the user may perceive 1 in 100 chance of having a privacy violation. If the user keeps using the application in the same way more frequently, the same user would feel the higher chance of experiencing a privacy violation. The more the application delivers its functionality to the user with more interactions, the higher the perceived chances of privacy violations. We therefore hypothesize:

H1a: The degree of functionality expectation is positively associated with the extent of privacy concerns.

Risk is defined as "someone or something that may cause something bad or unpleasant to

happen." In our study risk is contextual and depends on subjective perceptions similar to privacy. However, the key difference between privacy and risk relates to the fact that privacy is perceived state of isolation whereas risk hinges on the probability of outcomes. Adapting from Gefen and Pavlou (2012, p. 924), we define security risk as "the belief in a potential of suffering a tangible loss, while transacting with the community of" Google Docs fellow users.

Similar arguments can be made on risk concerns in that the more the user uses a cloud application, the higher the chance of some risk compromise everything being equal. In consumer purchase decisions, risk perception generally continues to fall from the beginning of product purchase intention to post-purchase product evaluation (Mitchell & Boustani, 1994). This is because consumers use risk reduction strategy in their purchase process to minimize two types of uncertainties: knowledge uncertainty and choice uncertainty (*ibid*.). Cloud application users go through a similar process of initial application evaluation to post-adoption evaluation just as consumers go through pre-purchase research to post-purchase evaluation. A survey of past study shows that user experience affects trust (Beldad, de Jong, & Steehouder, 2010). Trust in turn lowers the degree of risk perception (Kim, Ferrin, & Rao, 2008). That is, as Google Docs users continue to use the application, they develop more trust on Google Docs and in turn have lower risk perception. These are driven by the learning of the user through continuous interaction with the cloud application over time.

We therefore hypothesize:

H1b: The degree of functionality expectation is not positively or negatively associated with the extent of risk concerns.

Advances in information technology bring tremendous benefits to the society and yet they could also threaten information privacy and create security risk concerns. Thisdigital dilemma has forced customers to think analytically about how much of personal information to disclose in face of growing usability features). According to privacy calculus theory, consumers feel comfortable of releasing personal information only when they feel that the benefits of doing so can outweigh those potential threats (Milne, Rohm & Bahl, 2004).

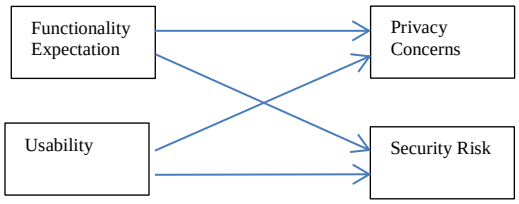
As technologies grow in acceptance, users realize how much they could be susceptible to privacy and security threats. For instance, as users contribute and share more personal information to Web 2.0 site (Facebook) they are more likely to have rich user experiences (e.g. expanded personal network, relevant commercials & latest information about friends). However, the success of these rich online socializing experiences depends on the sharing of personal information (e.g. where to visit, what to buy, how much to buy, whom to meet). Fortunately, a growing number of usable features are easing the process of using Web 2.0 sites. Testing the password strength is now a prevalent feature to assist users in creating a new account. Single sign-on (SSO) feature enable users to access other unfamiliar Web 2.0 sites via their Facebook or Google accounts and passwords. All the contact information on Facebook and Google could be automatically released to other applications (e.g. instant messaging services). Phishing-detection applications with the built-in feature of blacklist-based and whitelist-based anti-phishing toolbars can increase perceived usability and reduce privacy and security concerns for users (Li et al., 2014). Scheduling a personal and business event can be synchronized across Google platform. All these features are integrated on a limited number of platforms with a more sophisticated SSO password. These evidence show that the increase of perceived usability is negating privacy and security risk concerns of users.

The perception of usability is based on how the user interacts with the application as opposed to what functions to use or how much to use the application (McNamara & Kirakowski, 2006). In online banking, better website usability leads to higher trust on the website (Casalo, Flavián, & Guinalíu, 2007). Higher trust can ease risk concerns (Kim et al., 2008). A study (Hart, Ridley, Taher, Sas, & Dix, 2008) on Facebook use note the relation between better usability and more Facebook use while privacy concerns can discourage more Facebook use. A study compares single-factor with two-factor authentication methods in automated telephone banking and finds that users have a higher degree of perceived security with the two-factor method (Gunson et al., 2011). However, the advanced security feature is harder to use and takes longer time for users to complete. Because of its lower perceived usability, users expressed in the study that they are less likely to use the system. This finding indicates that better

usability has direct impact of the intention of system use. In addition, better usability has direct impact on satisfaction and trust (Flavián, Guinalíu, & Gurrea, 2006). Based on the popularity of e-commerce and Facebook, we can surmise that the impact of better usability has overall eased the privacy concerns. Thus, the last set of hypotheses are:

H2a: The degree of perceived usability is negatively associated with the extent of privacy concerns.
H2b: The degree of perceived usability is negatively associated with the extent of risk concerns.

Thus, our theoretical model is shown as Figure 1 below.



	Function	Privacy	Risk	Usability
Function	0.742			
Privacy	0.397	0.701		
Risk	-0.231	0.022	0.926	
Use Length	0.360	0.136	-0.190	
Usability	0.594	0.144	-0.316	0.770

Figure 1. Theoretical model

3. METHOD AND RESULTS

Participants and Procedures

A total of 224 college students in the College of Business of a state university in the southeast region of the United States participated in the study. These students were taking an introductory management information systems course. Participation was voluntary. However, students could earn an extra credit (0.5% of their final grade) if they choose to participate. A final sample of 202 valid questionnaires was used in the present study.

Survey Instrument

We measured the functionality expectation of Google Docs users with a combination of two constructs, collaboration support (Park & Ryoo, 2013) and adoption intention (D. Gefen, Karahanna, & Straub, 2003). We assessed usability by using usefulness (Burda & Teuteberg, 2015) and ease of use (Burda & Teuteberg, 2015) for cloud applications. The user's perceived privacy of using Google Docs was measured using three items adapted from Vannoy et al. (2013). To measure the perceived risk construct, we modified the original questions from Pavlou and Gefen's study (2004) into 3 items.

The partial least squares (PLS; Fornell and Bookstein, 1982) analysis was conducted with the SmartPLS software because it enables a small sample size. An additional benefit of conducting PLS is that it is nonparametric. Therefore, assumptions such as normality and independence are unnecessary (Chin and Newsted, 1999).

After removing items with loadings less than 0.7, we conducted the Cronbach's alpha test. In addition, we conducted convergent and discriminant validity tests based on the average variance extracted (AVE) value for each construct reported (Yoo & Alavi, 2001). This test result indicates that all questions used to measure constructs in the model have high discriminant and convergent validities. Table 2 in the Appendix shows that the square root of these AVEs on the diagonal are larger than the correlations with other constructs. This test result indicates that all questions used to measure constructs in the model have high discriminant and convergent validities.

Hypothesized Relationships	Path Coefficients (Beta)	T-Statistics
H1a: Functionality expectation → Privacy Concerns	0.476	6.208***
H1b: Functionality expectation → Risk Concerns	-0.068	1.166
H2a: Usability → Privacy Concerns	-0.144	1.778*
H2b: Usability → Risk Concerns	-0.256	2.929***

Table 3. Path analysis results

After confirming the acceptance of the reliability and validity of the survey instrument, we entered the data into the path analysis to test our hypothesized relationships. Table 3 shows the path analysis results, including path coefficients and their respective t-statistics. H1a and H1b were also supported, showing that

functionality expectation increases privacy concern (β=-0.476; p<0.1) while it has no effect on security risk perception (β=-0.068; not significant). H2a was weakly supported (β=-0.150; p<0.10), indicating that usability has a negative influence on privacy concern in cloud computing applications. H2b was supported, indicating that usability has a negative impact on security risk (β=-0.256; p<0.05).

4. IMPLICATIONS

One major implication is that improved perceptions functionality expectation and usability may change privacy and risk concerns. Security concerns will ease as the usability perceptions of standardized cloud applications will improve while using these applications more. As predicted, the perceptual changes on functionality expectation do not have significant impact on security perceptions. The more use may increase security risks, but the reciprocal habituation effect may ease security concerns at the same time. However, the model of this study posts that the usability improvement is likely to ease both privacy and risk concerns. A growing number of regulators and system developers are collaborating to develop systems by using the concept of "privacy by design" or "build in" privacy (Rubinstein and Good, 2013). This emerging concept further affirms the importance and impact of increased perceived usability on reducing security and privacy concerns.

For the developers of cloud applications, these results highlight the importance of continuous usability improvements not only give the end-users better application experience but also accelerate the adoption of cloud applications by pacifying the concerns on privacy violations and risks. The developers should also be aware that the end-users are likely to appreciate more the functions of standardized cloud applications.

For researchers, the results of this study provide research opportunities on investigating our hypothesized relationships over time. Scholars of human computer interactions should study more how much influence reciprocal habituations have on functionality expectation and usability of standardized and non- standardized cloud applications.

One limitation is the study is rooted in the use of Google Docs in the higher educational settings. However, the participants of the study were mostly adults. Future studies could use participants with broader profiles. Another limitation is rooted in the nature of Google Docs. It is a productivity suite as well as collaboration tools (Sun et al., 2014). Future studies need to focus on other types of business and consumer applications.

5. CONCLUSION

This study examines the potential effect of functionality and usability on security and privacy concerns of using Cloud applications. Based on the survey of 211 users of Google Doc., this study finds that improved usability perception eases both privacy and security concerns. In contrast, increased functionality expectation raises more privacy concerns but does not affect security concern. These findings provide implications about promoting standardized cloud applications, such as Google Docs.

6. REFERENCES

Ali, O., Soar, J., & Yong, J. (2016). An investigation of the challenges and issues influencing the adoption of cloud computing in Australian regional municipal governments. Journal Of Information Security And Applications, 27-28(Special Issues on Security and Privacy in Cloud Computing), 19-34.

Amer, T., & Maris, J.-M. B. (2007). Signal words and signal icons in application control and information technology exception messages-hazard matching and habituation effects. *Journal of Information Systems, 21*(2), 1-25.

Beldad, A., de Jong, M., & Steehouder, M. (2010). How shall I trust the faceless and the intangible? A literature review on the antecedents of online trust. *Computers in Human Behavior, 26*(5), 857-869. doi:http://dx.doi.org/10.1016/j.chb.2010.03.013

BetterCloud. (2016). *The 2016 State of Cloud IT Report*. Retrieved from New York, NY: http://blog.bettercloud.com/google-apps-vs-office-365/

Brender, N., & Markov, I. (2013). Risk perception and risk management in cloud computing: Results from a case study of Swiss companies. *International Journal of Information Management, 33*(5), 726-733.

Burda, D., & Teuteberg, F. (2015). Understanding Service Quality and System Quality Success Factors in Cloud Archiving From an End-User Perspective. *Information Systems Management, 32*(4), 266-284.

Cahill, J. L. (2014). University Professors' Perceptions About the Impact of Integrating Google Applications on Students' Communication and Collaboration Skills. *Journal of Research Initiatives, 1*(2), Article 7.

Casalo, L. V., Flavián, C., & Guinalíu, M. (2007). The role of security, privacy, usability and reputation in the development of online banking. *Online Information Review, 31*(5), 583-603.

Chin, W.W., and Newsted, P.R., Structural Equation Modeling Analysis with Small Samples Using Partial Least Squares, Statistical strategies for small sample research, 1(1), 307-341, 1999.

Dinev, T., & Hart, P. (2006). An extended privacy calculus model for e-commerce transactions. *Information Systems Research, 17*(1), 61-80.

Flavián, C., Guinalíu, M., & Gurrea, R. (2006). The role played by perceived usability, satisfaction and consumer trust on website loyalty. *Information & management, 43*(1), 1-14.

Fornell, C., and Bookstein, F.L., "Two Structural Equation Models: LISREL and PLS Applied To Consumer Exit-Voice Theory," *Journal of Marketing Research*, Vol. 19, No. 74:440-452, 1982.

Gefen, D., Karahanna, E., & Straub, D. W. (2003). Trust and TAM in online shopping: An integrated model. *MIS Quarterly, 27*(1), 51-90.

Gefen, D., & Pavlou, P. A. (2012). The Boundaries of Trust and Risk: The Quadratic Moderating Role of Institutional Structures. *Information Systems Research, 23*(3-part-2), 940-959. doi:doi:10.1287/isre.1110.0395

Gunson, N., Marshall, D., Morton, H., and Jack, M. (2011). User perceptions of security and usability of single-factor and two-factor authentication in automated telephone banking. *Computers and Security*, 30(4), 208-220.

Hart, J., Ridley, C., Taher, F., Sas, C., & Dix, A. (2008). *Exploring the facebook experience: a new approach to usability.* Paper presented at the 5th Nordic conference on Human-computer interaction: building bridges.

Henze, M., Hermerschmidt, L., Kerpen, D., Häußling, R., Rumpe, B., & Wehrle, K. (2016). A comprehensive approach to privacy in the cloud-based Internet of Things. Future Generation Computer Systems, 56701-718.

Iyer, B., & Henderson, J. C. (2010). Preparing for the future: Understanding the seven capabilities cloud computing. *MIS Quarterly Executive, 9*(2), 117-131.

Kim, D. J., Ferrin, D. L., & Rao, H. R. (2008). A trust-based consumer decision-making model in electronic commerce: The role of trust, perceived risk, and their antecedents. *Decision Support Systems, 44*(2), 544-564.

Koay, K. L., Syrdal, D. S., Walters, M. L., & Dautenhahn, K. (2007). *Living with robots: Investigating the habituation effect in participants' preferences during a longitudinal human-robot interaction study.* Paper presented at the 16th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN 2007) Jeju Island, Korea.

Li, L., Berki, E., Helenius, M., and Ovaska, S. (2014). Towards a contingency approach with whitelist- and blacklist-based anti-phishing applications: What do usability tests indicates? *Behaviour & Information Technology*, 33(11), 1136-1147.

Matsubara, N., Matsumoto, S., & Nakamura, M. (2011). *Characterizing user habituation in interactive voice interface: experience study on home network system.* Paper presented at the 13th International Conference on Information Integration and Web-based Applications and Services.

McNamara, N., & Kirakowski, J. (2006). Functionality, usability, and user experience: three areas of concern. *ACM Interactions, 13*(6), 26-28. doi:10.1145/1167948.1167972

Mitchell, V. W., & Boustani, P. (1994). A Preliminary Investigation into Pre- and Post-Purchase Risk Perception and Reduction. *European Journal of Marketing, 28*(1), 56-71. doi:doi:10.1108/03090569410049181

Moonen, L. (2015). 'Come on guys, what are we really trying to say here?': Using Google Docs to develop Year 9 pupils' essay-writing skills. *Teaching History*(161), 8-14.

Nansen, B., Vetere, F., Robertson, T., Downs, J., Brereton, M., & Durick, J. (2014). Reciprocal habituation: a study of older people and the Kinect. *ACM Transactions on Computer-Human Interaction (TOCHI), 21*(3), Article 18.

Park, S. C., & Ryoo, S. Y. (2013). An empirical investigation of end-users' switching toward cloud computing: A two factor theory perspective. *Computers in Human Behavior, 29*(1), 160-170. doi:http://dx.doi.org/10.1016/j.chb.2012.07.032

Pavlou, P. A. (2011). State of the information privacy literature: where are we now and where should we go? *MIS Quarterly, 35*(4), 977-988.

Pavlou, P. A., & Gefen, D. (2004). Building Effective Online Marketplaces with Institution-Based Trust. *Information Systems Research, 15*(1), 37-59.

Petter, S., Straub, D., & Rai, A. (2007). Specifying formative constructs in information systems research. *MIS Quarterly, 31*(4), 623-656.

Rankin, C. H., Abrams, T., Barry, R. J., Bhatnagar, S., Clayton, D. F., Colombo, J., . . . Thompson, R. F. (2009). Habituation revisited: An updated and revised description of the behavioral characteristics of habituation. *Neurobiology of Learning and Memory, 92*(2), 135-138. doi:http://dx.doi.org/10.1016/j.nlm.2008.09.012

Rubinstein, I.S., and Good, N. (2013). Privacy by design: A counterfactual analysis of Google and Facebook privacy incidents. *Berkeley Technology Law Journal*, 28(2), 1333-1413.

Sanchez, R., & Sudharshan, D. (1993). Real-time market research. *Marketing Intelligence & Planning, 11*(7), 29-38.

Smith, H. J., Dinev, T., & Xu, H. (2011). Information privacy research: an interdisciplinary review. *MIS Quarterly, 35*(4), 989-1016.

Sun, Y., Lambert, D., Uchida, M., & Remy, N. (2014). *Collaboration in the cloud at Google.* Paper presented at the 2014 ACM conference on Web science, Bloomington, Indiana.

Urbach, N., Smolnik, S., & Riempp, G. (2010). An empirical investigation of employee portal success. *Journal of Strategic Information Systems, 19*(3), 184-206.

Vannoy, S. A., Chen, C. C., & Medlin, B. D. (2013). Investigating the impact of differences in kind upon resource consumption in web-based social networks. *Social Network Analysis and Mining, 3*(3), 437-456.

Weins, K. (2015, February 18). Cloud Computing Trends: 2015 State of the Cloud Survey. Retrieved May 29, 2016, from http://www.rightscale.com/blog/cloud-industry-insights/cloud-computing-trends-2015-state-cloud-survey

Woodard, R., & Babcock, A. (2014). Designing Writing Tasks in Google Docs that Encourage Conversation: An Inquiry into Feedback and Revision. In R. S. Anderson & C. Mims (Eds.), *Handbook of Research on Digital Tools for Writing Instruction in K-12 Settings* (pp. 1-29). Hershey, PA: Information Science Reference.

Yoo, Y., & Alavi, M. (2001). Media and group cohesion: Relative influences on social presence, task participation, and group consensus. *MIS Quarterly, 25*(3), 371-390.

APPENDICES

Variable	Construct	Reference
Length of Use	How long have you used Google Docs? [year]	
Functionality expectation α = 0.859	The extent of collaborative interaction among users is increased by using Google Docs. The extent of sharing information among team members is increased by using Google Docs. The openness to share data among team members is increased by using Google Docs. Overall, the extent of collaboration is increased by using Google Docs. I would use Google Docs to archive my class assignments. I am very likely to archive my class assignments using Google Docs. I intend to use Google Docs for archiving class assignments in the future.	collaboration support (Park & Ryoo, 2013) adoption intention (D. Gefen et al., 2003)
Usability α = 0.863	Google Docs enables me to archive and retrieve my class assignments faster. Google Docs enhances my effectiveness in archiving and retrieving my class assignments. I find Google Docs useful for archiving my class assignments overall. Google Docs is easy to use. It is easy to get Google Docs to do what I want it to do. Learning to operate Google Docs is easy.	usefulness (Burda & Teuteberg, 2015) ease of use (Burda & Teuteberg, 2015)
Privacy Concern α = 0.751	I need to think twice before providing personal information to Google Docs. It is my concern if Google Docs collects too much of my personal information. Google Docs should not disclose any personal information, unless they are explicitly given the right to do so. Google Docs should not use personal information for any reasons other than the only purpose of information sharing. Google Docs should never sell personal information from its database to any other organizations.	privacy (Vannoy et al., 2013)
Security Risk α = 0.917	There is a high potential for loss involved in using Google Docs for archiving class assignments. There is a considerable risk involved in using Google Docs for archiving class assignments. A decision to use Google Docs for archiving class assignments is risky.	risk (Paul A. Pavlou & Gefen, 2004)

	Function	Privacy	Risk	Use Length	Usability
Function	0.742				
Privacy	0.397	0.701			
Risk	-0.231	0.022	0.926		
Use Length	0.360	0.136	-0.190	n.a.	
Usability	0.594	0.144	-0.316	0.425	0.770

Table 2. Convergent and discriminant validity test results