

A Grounded Theory of Security and Technical Barriers to the Continuance Use of Cloud Storage by SMEs

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Abstract This study utilized Glaser's classic grounded theory to investigate the critical security and technical barriers to the continuance use of cloud storage services by small and medium enterprises (SMEs) and to also determine which of these factors was of higher priority to decision-makers. In addition to observation, research data was collected through a semi-structured interview of twenty IT specialists with current cloud storage service experience. Participants were decision-makers directly in charge of technology adoption in SMEs based in the United States. Results from the data analysis uncovered the major security and technical concerns of cloud storage service users. Furthermore, the results indicated that security vulnerability was of higher concern and the most influential barrier to the continuance use of cloud storage service by SMEs. This study expanded discussions on the security and technical inhibitors or barriers to the continuance use of cloud storage service from the perspective of IT decision-makers.

Keywords: cloud storage, continuance use, security threat, SMEs, grounded theory

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1. Introduction

Studies have shown that cloud storage facilities are soft targets for cyber-criminals who deliberately intrude into information technology (IT) infrastructure to steal sensitive corporate and personal data. Concerns such as infrastructure vulnerability, data loss, data privacy breaches, cyber-attacks from internal and outsider threats are security-related barriers to the continuance use of cloud storage services. Scholars have argued that these security-related concerns have far-reaching effects on user's willingness to adopt cloud computing. However, these are not the only concerns of small and medium-sized enterprises (SMEs) using cloud storage facilities. Recent studies have also identified technical concerns such as complexity of architecture, vendor lock-in, compatibility with internal applications, integration and migration challenges as technical-related barriers to the continuance use of cloud storage services [1].

While there have been numerous researches on the security and technical barriers to the continuance use of cloud computing, there are still some unsupported assumptions regarding the actual perceptions of IT decision-makers about the kind of influence security and technical related barriers have on their organization's decision to continuously deploy cloud storage services for their business operations.

Additionally, there is a gap in knowledge regarding which of the security and technical barriers to the continuance use of cloud storage service by SMEs is of higher concern to IT decision-makers. Thus, this study examined the security and technical barriers to the continuance use of cloud storage services by SMEs and also determined which of these factors was of higher concern to IT decision-makers.

This study utilized a classic grounded theory method of qualitative research. As articulated by [2], a grounded theory approach does not require formal research questions. However, this study posed three relevant research questions that served only as a guide for data collection and analysis. This did not introduce any bias, preconception, or restriction to this study and the research process. The aim of the research questions was to explore security and technical barriers to the continuance use of cloud storage services by SMEs and explore those considered to be of higher significance to the participants based on their experiences.

The three research questions for this study are:

1. What are the security and technical barriers to the continuance use of cloud storage services?
2. How do these security and technical barriers influence the continuance use of cloud storage services by SMEs?
3. Which of these security and technical barriers is of higher significance or influence to the IT decision-maker with respect to the decision to continuously use cloud storage service?

2. Literature Review

2.1. Cloud Computing

The concept of cloud technology evolved around 2007 and was a term used to describe virtual machines capable of running like “utility services over the network” [3]. Cloud computing refers to an on-demand, shared service, and rapidly provisioned infrastructure that can be quickly deployed and maintained with minimal effort from users [4,5]. According to the United States National Institute of Standard and Technology, the key features of cloud computing are “rapid deployment”, “convenience”, “simplicity”, “on-demand”, and “shared resources”. Studies have shown that cloud technology has consistently advanced in performance, reliability, and user acceptability.

Cloud computing has four deployment models-public, private, community, and hybrid cloud [6,7]. A private cloud is a virtual infrastructure dedicated for private use, but a public cloud is an infrastructure created in a utility model platforms for multiple users to share [8]. A community cloud is a cloud available for a group of firms with common interest whereas a hybrid cloud is a mix of both private and public clouds [6]. There are also three popular service models for cloud computing, namely: software as a service (SaaS), platform as a service (PaaS), and infrastructure as a service (IaaS) [4,9].

2.2. Cloud Storage Service

Cloud storage service is a cloud model that provides users with the capacity to store data remotely on a shared storage that can be accessed almost anywhere through an internet connection [1]. Apple’s iCloud, Microsoft’s OneDrive, Dropbox, Google Drive, and Amazon S3 are popular cloud storage products or applications with virtual storage solutions available for both personal and commercial users across the globe. In most cloud storage platforms, users are connected to a shared grid where computing resources are allocated as needed in a virtual topology compared to a dedicated, owner-managed traditional storage server [10,11].

Findings in recent studies have indicated that cloud storage users are usually driven by benefits such as infrastructural scalability, architectural elasticity, universal accessibility, and ability to integrate conveniently with web applications [12].

Scalability is the ability to increase or decrease resources based on business need. Cloud storage users are attracted by the ability to scale storage infrastructure as needed to support their business requirements [13]. Architectural elasticity refers to the flexibility of the cloud storage structure that allows users to align this infrastructure with their business requirements [14]. With universal accessibility benefit, cloud storage users can access their cloud resources from anywhere in the world as long as they are connected to the Internet [6]. The unique feature of cloud storage is that multiple access to the storage infrastructure. Finally, another benefit of cloud storage service is that users can conveniently integrate it with their applications [12]. However, there have been reports of compatibility issues and failure of cloud storage service to integrate with custom web applications [7].

Although cloud storage service is attractive to users, it also brings different levels of risks to users [10]. Studies have shown that there could be security and technical related risks or concerns for cloud storage users [7,15]. Thus, one of the aims of this study is to explore the barriers to the continuance use of cloud storage services.

2.3. Factors Influencing Cloud Adoption

Recent studies have shown that cloud storage users can be influenced by multiple factors. In a study, [16] investigated factors that influenced students to utilize mobile cloud storage services for education purpose. Using a technology adoption model (TAM) as a theoretical framework, [16] developed an integrated model that tested students’ attitude toward adoption of mobile cloud storage. Findings of the study indicated that users of mobile cloud storage are influenced by “perceived usefulness”, “trust”, and “ease of use”. On the barriers to student’s adoption of mobile cloud storage, the study identified security and privacy issues as a major challenge. The implication of the findings is that a cloud user may be disinclined to use cloud mobile storage service whenever they feel concerned about the security of their personal data stored on the cloud.

In another study, [17] investigated the technical factors influencing a user’s intention to implement cloud computing. The study identified security threats and data privacy breaches as some of the most crucial factors that affect the adoption and continuous usage of cloud computing. Therefore, according to [17], the user’s decision to adopt cloud products are consistently threatened by security threats. The researchers also found that security issues were the higher concern for the majority of cloud users.

A research by [18] surveyed 200 Taiwanese SMEs and used a technology organization environment (TOE) framework to explore determinants of cloud adoption. The focus of the study was to investigate the “multi-faceted nature” of the user’s intention to use cloud computing. Findings of the study indicated that business concern plays a significant role in the decision to deploy cloud computing. Items under “business concern”, according to [18], include sensitive concerns such as security, privacy, and confidentiality of private information. The study found security issues as a crucial concern that can ultimately influence the decision of organizations using cloud products.

Exploring factors driving user’s continuance intention to adopt cloud storage, [1] integrated technology acceptance model (TAM) and the task-technology fit (TTF) theory to measure respondent’s perception of critical inhibitors of cloud storage service. Amongst other findings, their study indicated that users are more inclined to use a cloud storage service when their private data and privacy are protected. Conversely, cloud storage users become concerned if they believe their data are less likely to be protected in the cloud. Thus, their study concluded that when cloud users perceive a higher level of insecurity about cloud service, they lower their continuance intention to use the technology. The study, therefore, advocated for a collaboration between cloud users and service providers to explore strategies-including data encryption-to minimize security risks on the cloud storage service.

Findings from a study conducted by [19] added a new dimension to the factors influencing the use of cloud products. The researchers conducted an exploratory study to investigate factors affecting cloud computing adoption by Irish SMEs using an online survey of IT managers. One of the findings of the study is that users who were not currently using cloud computing were unaware of the benefits of the services or were unenthusiastic about using the cloud due to the security threat and privacy issues. Furthermore, the study also found that the absence of support from government to SMEs willing to use cloud computing was a barrier.

In spite of the growing challenges of security and technical issues, there are limited studies available to investigate how these factors (security and technical barriers) influence the continuance use of cloud storage services by SMEs. Furthermore, scholars are yet to show which of these barriers IT decision-makers find most crucial while making the decision to continue using cloud computing. Therefore, this study conducted a qualitative research aimed at exploring the security and technical barriers to the continuance use of cloud storage services by SMEs and identifying the concerns considered to be of higher significance to the IT decision-makers.

3. Methodology

Glaser's classic grounded theory was the most appropriate research design for this study due to the nature of the research idea. Grounded theory is a research design developed by Glaser and Strauss in 1967 as a sociological inquiry where a researcher can validly derive a "general, abstract theory of a process, action, or interaction grounded in the views of participants" [20]. Many researchers in the information technology and management field have also used grounded theory to investigate different research interests including cloud computing [21]. Although the grounded theory is not applicable to all studies, it is useful for providing inductive, process-based approaches to build or expand the body of knowledge [22]. It was on this basis that the grounded theory approach was used for this study.

3.1. Observation

The research process started with a virtual observation of the research sites. The research sites selected for this study were SMEs located in the United States. A description of SME was obtained from the website of the Office of the United States Trade Representative (USTR) and the United States Small Business Administration—a public agency founded to assist SMEs in the United States.

Initial findings from virtual observation and interviews of decision-makers in the twenty SMEs selected revealed that all the enterprises observed utilized cloud storage services for their business operations. Most of the day-to-day operations of these organizations such as email and communication tools, application hosting, customer relationship management (CRM) software, accounting services, and corporate data storage were powered by cloud storage services. Observation also indicated that some of the selected SMEs used cloud services indirectly because their IT service providers are cloud users.

3.2. Interviews

The use of interview as a method of collecting data is a key component of a qualitative research method [20]. It provides an avenue to collect detailed information reflecting the actual perception of participants. Thus, in addition to observations, this study also collected data through direct interaction with participants. The interview mode was semi-structured conducted electronically. A semi-structured interview was preferred in order to eliminate bias [20]. Electronic interview method was adopted because of the busy schedules of the participants and the convenience of the approach. All the participants were contacted through email and phone calls. The participants in this study were IT experts who have a working knowledge of cloud storage services. Some participants requested for the interview questions a few days prior to the interview. Some interviews were also conducted more than once in order to ensure clarity of ideas. In order to meet ethical guideline during the research, no personally identifiable information was collected from any of the participants.

Table 1 below displays a summary of the demographic profiles of the participants interviewed for this study.

Table 1. Demographics of Participants

Number of Participants	20
Data Collection method	Observation and semi-structured interviews
Number of interviews	22
Setting	Telephonic, video, IM chats, email responses
Age Range	28-55 years
Education	Bachelor's degree (8); Master's degree (11); Doctorate degree (1)
Industry	Banking/Finance (4); Education (1); Information Technology (10); Hospitality (1); Social Services (2); Telecommunication (2)
Work Experience	10-25 years
Job Title	CIO/CEO (1); IT Professional (15); Project Manager (4)
Cloud Users	Yes (20); No (0)

3.3. Data Analysis

The process of data analysis immediately followed data collection. In a qualitative research, data analysis involved coding of the research data, determining frequencies of variables, differentiating variables, and estimating the significance of variables based on their frequencies [20]. For this study, the first step in the data analysis process was processing and recording data and identifying themes within the data. Guided by the work of [23], the data analysis process also included a procedure of systematic data recording and identification of important themes.

The second step was data reduction. This was necessary in order to extract meaningful themes and interconnected patterns [24]. The bulk of data collected were reduced to meaningful concepts and themes that resonated with the research question. This also involved a process of data evaluation in order to discern useful concept from the transcribed data.

Table 2. Key Points and Codes

Key Points	Keywords	Codes	Frequency
"I am not sure my cloud infrastructure is secure"	Security vulnerabilities	Security	20
"Our data can easily be stolen"	Data loss	Security	20
"Hackers could have unauthorized access to sensitive private data"	Data privacy breaches	Security	18
"insider or outsider threat from cloud vendor"	Insider/outsider threat	Security	11
"Complexity of cloud platform"	Complexity	Technical	8
"Fear of vendor lock-in"	Vendor lock-in	Technical	7
"I am not sure my existing platform will be compatible"	Compatibility Issues	Technical	5
"Integration and migration challenges"	Integration and migration challenge	Technical	4

The third step was to code the data by labeling keywords or phrases and then sort the keywords. The fourth step was making comparisons of concepts and ideas. This process guards against bias and assists researchers to achieve precision [23]. Finally, the last stage was organizing the data into a table to facilitate the process of drawing a conclusion.

Table 2 above displays the keywords and codes tabularized and ranked according to their frequencies.

4. Findings

Below are the major findings from the data analysis conducted for this study using a grounded theory research design.

4.1. Barriers to Cloud Storage Deployment

Firstly, the continuance use of cloud storage services by SMEs are influenced by two broad factors-security and technical concerns. Some of these factors were already discussed earlier in the literature review section of this study.

4.1.1. Security Concerns

A security vulnerability was one of the security concerns of IT decision-makers interviewed in this study. When asked about their perception of the causes of cloud insecurity, these were excerpts from the statements of one of the participants reflecting security vulnerabilities while using cloud storage service:

"Security vulnerability is a huge concern for me because a defective architecture can easily allow a hacker to conveniently access my private information. Vulnerabilities Hackers and external attackers to cloud infrastructure can also affect information of our multiple clients even if only one site is attacked" [Interviewee 2].

Another interviewee also identified security vulnerability as the major fear of cloud storage service users because it can expose web applications layers to attacks that will eventually cause data loss. According to the interviewee, *"security vulnerability can expose applications to attacks such SQL injections, cross-site scripting, and malware that could be used by hackers to steal sensitive private and corporate data"* [Interviewee 19]. Consequently, it is important for cloud storage users to ensure that vulnerabilities on the cloud infrastructure are addressed.

This study found that most IT experts interviewed identified security vulnerability as the cause of data loss.

Data analysis indicated that vulnerability in a cloud storage platform is the main cause of data breach and data loss since loopholes in the cloud architecture could easily be exploited by attackers to steal data. All the participants agreed that data loss is a security challenge for cloud storage users. A participant admitted that his organization suffered data loss due to security breach caused by vulnerabilities that were not addressed promptly by the cloud service provider. According to the interviewee: *"Based on experience, I do not consider the cloud secured because my organization has experienced cyber-attacks in the past. Private information was stolen and data privacy was breached. We lost valuable information and some of our high profile clients left because of the incident. So I do not believe the cloud is secure"* [Interviewee 1].

However, the participant stated that security vulnerability can be addressed if there is a strategic collaboration between the cloud users and the cloud service provider through constant monitoring and proactive measures. He suggested that *"cloud service providers must accept responsibility by deploying monitoring tools and initiating periodic security scans that will detect malware and vulnerabilities on the cloud platforms"* [Interviewee 1].

Furthermore, threats from insider and outsider attackers was a security concern for IT experts. Participants agreed that the continuance use of cloud storage services by SMEs can be threatened by attacks from former or current employees of cloud service providers who may have unrestricted access to customer resources without authorization from system owners. The majority of IT decision-makers interviewed during this study identified insider and outsider attacks as critical factors influencing the continuance use of cloud storage services. A participant stated that: *"There is always the fear of malware attacks or intrusion from a hacker. My organization is highly concerned about security vulnerability and we are collaborating with our cloud service provider to address any known vulnerabilities"* [Interviewee 19].

Another participant stated that *"internal attacks from employees of cloud service providers is a security threat that should be taken seriously. Cloud subscribers have no control over people accessing their data from the cloud provider's infrastructure since they usually have higher level access that will permit unrestricted entry to the platform"* [Interviewee 2]. Since the cloud storage subscribers do not have access to monitor cloud service provider's employees with elevated privileges, it is highly possible that a mischievous insider could cause damage to their applications without the subscribers detecting.

4.1.2. Technical Concerns

The complexity of the cloud platform is a crucial technical factor identified by participants of this study. Majority of the SMEs experienced difficulty in transitioning to the cloud infrastructure due to its complex nature and failure of the cloud service provider's onboarding process to capture necessary training and orientations required to fully integrate new adopters with the new services. An interviewee stated that *"my employees found the cloud service too complex to use and were not enthusiastic about using the storage service"* [Interviewee 11]. The participant, however, admitted that the perceived initial complexity of the cloud platform was resolved through training and user orientation provided by the cloud service provider at the request of the firm.

A different participant stated that *"our business suffered a loss due to delays in the operation process after moving to the cloud. Employees complained of the complex structure of the cloud storage applications and had to spend their productive time to learn and adjust to the change"* [Interviewee 6]. The participant, however, stated that: *"To be honest, some of these issues were organizational problems and had nothing to do with the cloud infrastructure"*.

Concerns about vendor lock-in is also a key technical factor influencing the use of cloud storage service. According to one of the interviewee, *"concerns about vendor lock-in delayed the deployment of cloud services. My firm spent valuable time to compare cloud providers and choose the platform that will most likely allow easy migration out of the infrastructure to another site."* [Interviewee 15]. A different participant stated that: *"vendor lock-in was a problem for us because the initial cloud provider we preferred did not offer us tools that will assist us to migrate data out of their platform if need be"* [Interviewee 3].

Participants also identified compatibility of the existing business model with the adopted cloud storage platform as a critical challenge identified by IT decision-makers during the interview. One of the participants stated that: *"Before moving to the cloud, we had concerns about the compatibility of the platform with our own custom applications. We were worried about rebuilding our application in order to fit into the cloud."* [Interviewee 12]. Another participant stated that: *"We were concerned about whether our applications will be compatible with the storage options available in the cloud and if we will be able to conveniently export our data out of the cloud platform whenever we decide to move to on-premise infrastructure"* [Interviewee 17].

Another factor uncovered during data collection is the integration and migration challenge on the continuance use of cloud storage. Many SMEs found data migration into the cloud very *"cumbersome and complex"* [Interviewee 4]. The process also required *"a huge input from the cloud service provider"* [Interviewee 19]. An interviewee stated that: *"I have concerns about integration with the cloud. My organization uses legacy storage formats and so far we have not been able to successfully migrate all our data to the cloud platform. We are not even convinced if the cloud will be able to accommodate all the different storage structure our business process requires. If our storage strategies will not be supported in the cloud,*

how do we continue to use cloud storage technologies?" [Interviewee 4].

In agreement with the previous participant, interviewee 16 also stated that: *"We had difficulties during our migration to the cloud. My organization uses a lot of custom codes to store data. Most of the processes dependent on the custom codes stopped working after the migration. We had to work closely with our cloud provider to provision alternate processes and it took six months before we were able to start running those processes again. The major challenge for us was the difficulty of migrating to the cloud"*. Thus, findings from this study indicated that integration and migration challenges are also critical barriers to continuance use of cloud storage services by SMEs.

4.2. Security Vulnerability is the Highest Concern

One of the aims of this study was to determine which of the barriers to the continuance use of cloud storage service was of the highest concern to IT decision-makers. Findings from this study indicated that security vulnerability was the major concern for the IT experts interviewed for this study.

The majority of the twenty participants in this study identified security vulnerability as a higher concern while using cloud storage services for their operations. A participant pointed out that *"the fear of unauthorized access and information breaches"* is the major challenge his organization is facing while using cloud storage service [Interviewee 1]. Another participant stated that *"the lack of full control of data in the cloud makes it insecure for users"* [Interviewee 8]. This position aligned with the findings of [7] that security concerns are crucial to cloud adopters.

Therefore, the outcome of the data analysis indicated that security vulnerability was the biggest challenge and higher concern to SMEs using cloud storage services. This discovery reaffirmed the findings in the previous literature reviewed in the earlier segment of this study that security vulnerability is crucial to IT decision-makers. Threats such as cyber-attacks, malware, data loss, data privacy breaches, and insider/outsider threats require vulnerability of the cloud infrastructure. Thus, IT decision-makers must consider the level of security vulnerabilities in their infrastructure when deciding whether to continue using cloud storage services.

Findings from the interviews also indicated that security barriers have considerable influence on the decision-making process of IT experts. The majority of participants in this study stated that their decision to use cloud services was shaped by concerns about the security of cloud computing.

According to an interviewee:

"My organization adopted cloud storage very late because the management spent time considering the impact of security issues like system vulnerabilities and external attacks. We wanted to ensure that the agreement we have with the cloud provider has plans to mitigate security barriers. We took time before deciding to migrate our applications into the cloud platform" [Interviewee 8].

However, in spite of the security concerns, IT decision-makers still find cloud storage services attractive.

Justifying the decision to continue using cloud storage service in spite of the security inhibitors, a participant stated that: “*although cloud storage service is not 100% secure, the alternative platform (traditional physical servers) is also vulnerable to intrusions and threats from hackers*” [Interviewee 11]. Another participant argued that “*the insecurity on the cloud platform is not a peculiar problem; it is a universal problem for all IT infrastructure*” [Interviewee 3]. Therefore, 98% ($n=18$) of the participants indicated interest to continue to use cloud storage services in spite of the security challenges.

5. Conclusion

Cloud storage service is an effective platform for SMEs to quickly set up and scale IT infrastructure for profitability. The high cost of provisioning and maintaining traditional physical storage infrastructure has encouraged the surge in demand for adopting cloud storage services and also made outsourcing of IT operations to other firms (cloud service providers) very attractive to SMEs. Additionally, recent performance improvements on cloud platform have also been impressive. However, SMEs deploying cloud storage services are still susceptible to security concerns that threaten loss and breach of sensitive private corporate or private data safely stored in cloud platforms. These threats could be better managed if IT decision-makers have a better understanding of these issues and make concerted efforts in conjunction with cloud service providers to address the problems.

This study concludes that the continuance use of cloud storage services by SMEs is significantly influenced by security and technical concerns. Furthermore, this study also concludes that security issues are the biggest concerns of SMEs using cloud storage. Although several other factors influence an organization’s decision to implement cloud storage service, the majority of the IT decision-makers who participated in this study signified that security concerns were of higher priority when considering whether to continue using cloud storage services for business operations.

One of the limitations of this study is associated with its strength—the research design. Numerous researches have shown that qualitative researches lack rigor, authenticity, and are usually prone to measurement error [25]. However, efforts were made to ensure that original thoughts depicted in the interviews by the participants were preserved and genuinely represented in the extracted data and results of the study. The beauty of grounded theory research design is that it is systematic in design and thus can lead to a predictive reasoning [23].

Secondly, this study focused on two broad barriers to the continuance use of cloud storage service—security and technical concerns—since studies have shown that they are the most crucial to IT decision-makers [7]. Future studies can explore other factors influencing the decision to adopt cloud storage service by SMEs. By widening the scope, future studies will comprehensively capture other concerns of IT decision-makers that are not related to security and technical structure of cloud infrastructure.

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