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CLOUD STORAGE SECURITY AND RELIABILITY: A STRUCTURAL EQUATION MODELING APPROACH AMONG IT PROFESSIONALS IN PAKISTAN'S TECH ECOSYSTEM

Anjum Ara[*1], Syed Ahmed Raza[2], Yasir Ali Mari[3], Javed Ahmed Dahri[4]

*[*1]Phd Scholar, Department of Computer Science, Qaid-I-Azam University, Islamabad*
[2]Lecturer, Department of Computer Science, Shaheed Zulfiqar Ali Bhutto Institute of Science and Technology (SZABIST) University, Hyderabad Campus
[3]Lecturer, Department of Information Technology, Sindh Agriculture University, Umerkot Campus
[4]Lecturer, Department of Computer Science, Shaheed Zulfiqar Ali Bhutto Institute of Science and Technology, (SZABIST) University Hyderabad Campus.

[*1]anjumara@cs.qau.edu.pk, , [2]ahmed.raza@hyd.szabist.edu.pk, , [3]yamari@sau.edu.pk, [4]javed.dahri@hyd.szabist.edu.pk

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Corresponding Author: *
Anjum Ara[*1]

Abstract
In this study we try to find out IT professionals' perceptions about cloud storage security and reliability within the domain of Pakistan's tech ecosystem and specifically in Hyderabad city. The research on how perceived data backup habits, perceived risks, perceived reliability of a cloud storage provider, and perceived trust in that provider directly and indirectly affect the cloud storage adoption intentions is conducted using the Structural Equation Modeling approach. The data was collected from 144 IT professionals working in software houses, academic institutions and tech startups using a structured questionnaire. It is found that perceived risk and behaviors regarding data backup significantly reduce perceived reliability while the perceived trust significantly increases perceived reliability. Additionally, belief in reliability is strongly linked to intention to use cloud storage solutions. A mediation analysis is used to confirm that perceived reliability is a mediator of these relationships between trust and risk and adoption intention. These insights provide some valuable implications for cloud service providers and policymakers interested in encouraging adoption of cloud services so that they can address concerns on reliability and build user trust.

INTRODUCTION

The cloud storage has become an indispensable discipline of digital infrastructure that allows businesses access to data, collaborative work and business continuity in all sectors. In the era of digital transformation, cloud services are being more and more depended on in terms of data storage, retrieval and scalable. One of the emerging trends in the tech landscape in Pakistan, in the form of software houses, academic institutions, startups, cloud storage adoption can be both an opportunity and a challenge in the current landscape of Pakistan. Users' perceptions around trust, reliability and risk involved with these systems create the challenge not only on technological integration, but also (Ahmad et al., 2025; Al-Qerem et al., 2025).

As per several studies, it has been highlighted that there is a need to comprehend the psychological and behavioral aspects that are responsible for the cloud

adoption intentions of the end users (Chanda et al., 2024; Soomro et al., 2024). The willingness to adopt cloud solutions depends on factors like the perceived trust in service provider, habit of practicing, or even a fear (or concern) of data breach or access to the data by unauthorized persons. These elements are critical to how perceived reliability (which may mediate between trust, risk, and adoption behaviors) (Kineber et al. 2022) is perceived. The timely and relevant consideration of these perceptions at the user level is due to the fact that digital transformation is a continuous process which is reshaping the business and academic environment in Pakistan. Structural Equation Modeling (SEM) is used in this study to examine how perceived trust, data backup habits and perceived risks would affect the intention to use cloud storage through perceived reliability as the mediating factor.

Literature Review

User behavior toward the adoption of cloud service is determined by that of perceived trust. Users' perceptions of reliability and security can be largely derived from users' trust in cloud providers based on cloud providers' reputation, data handling transparency, and past performance (Chanda et al., 2024; Al-Qerem et al., 2025). If the users can be convinced that providers will be in compliance with the fundamentals of confidentiality and operational integrity, they are more willing to perceive service as reliable and move towards adoption (Ali, Thyberg, Lin, & Chau, 2024). In the case of IT professionals, this trust has become much more important, because they are experts in terms of deep technical knowledge and higher set of standards for service and the protocols of data protection. Another important behavioral factor in the cloud storage adoption is data backup habits. If someone does this, it means capturing them frequently and methodically taking initiative to backup their data. Such habits can distribute user trust in cloud storage, since cloud storage is incorporated into users' existing backup routines (Kineber et al., 2022; Laila et al., 2023). Furthermore, the method of backup and responsibility either personal or organisational leads to differences in the perception about convenience and dependability of cloud platforms and users (Ahmad et al., 2025).

However, the biggest hurdle to the adoption of cloud remains, of sorts, perceived risk — specifically of data breaches, regulatory compliance and unauthorized access. The studies discovered that although there is presence of technical safeguards, users' subjective perceptions of vulnerability make it difficult to trust cloud storage (Waqar et al., 2023 and Soomro et al., 2024). In such regions where digital literacy or legal frameworks on data privacy are evolving, fear of risk becomes a key factor in technology adoption models (Khan et al., 2024). In the adoption process, perceived reliability based on uptime, access assurance and disaster recovery performance is defined as a critical mediating variable. Users trust a system more if they feel that it is reliable and are less prone to notice some of the perceived risk (Chanda et al., 2024). SEM based studies reveal reliability could aid the positive effects of trust and weaken the negative consequence of perceived risk on technology adoption intentions (Ali et al., 2024; Khan et al., 2024). By doing so, perceived reliability is a conduit and a predictor of cloud adoption dynamics.

The significance of cloud attraction in developing countries such as Pakistan is backed by the digital divide and a lack of organizational capacity. There are some institutions that have the ability to deploy and manage cloud services with the help of advanced capability but there are also institutions with financial and infrastructural limitations that can not deploy and manage cloud service (Ahmad et al., 2025). Practical insights for cloud vendors, policymakers, and IT decision makers to design inclusive and secure cloud ecosystems within the region can be gained from the understanding of how the perceptions of the individual levels will interact with broader system level issues (Soomro et al., 2024; Khan et al., 2024).

Conceptual Model

The framework of this study is conceptual to test how perception at individual level will affect intention of usage of cloud storage service by IT professionals. The three independent variables of the model are Perceived Trust, Data Backup Habits, and Perceived Risk. Trust is perceived as data confidentiality and the provider reputation (Carbass, Jus, & Hull, 2007). Frequency, method, and user

responsibility of data backup on a regular basis are captured in Data Backup Habits. Perceived Risk alleviates the worry of data breach, access to the database without permission, and its consistency with the security regulations. Three factors, observed and hypothesized to have both direct as well as indirect effects on the dependent outcome, Cloud Storage Adoption Intention, are defined as user's willingness and readiness to adopt the cloud-based storage solutions.

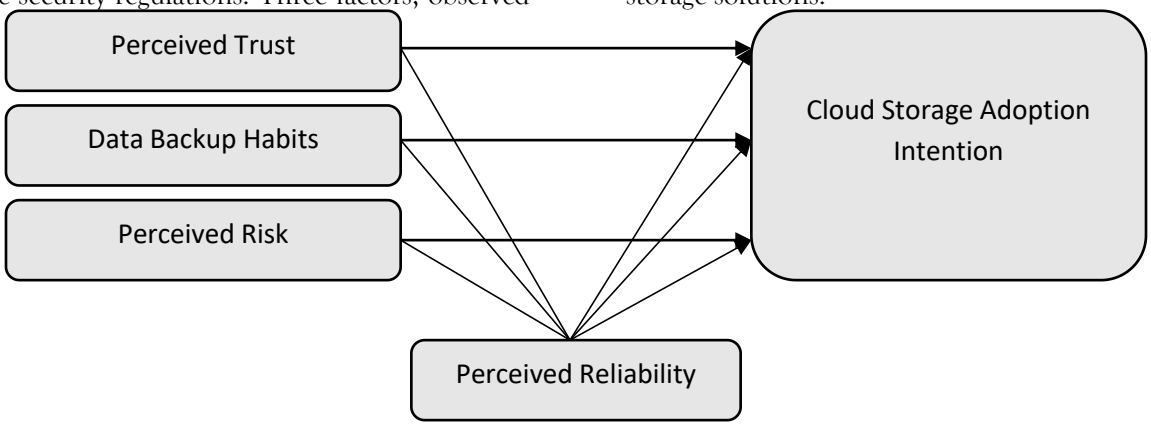

Figure 1. Conceptual model hypothesized by study.

Also, the model puts forward Perceived Reliability as mediating variable and this variable is very important for the link between independent variables and adoption intention. Perceived reliability is users' perception of system uptime, access until they get it and potential capability of the cloud service to provide disaster recovery. The model argues that perceived risk decreases reliability perceptions, but trust and backup habits enhance them positively. Secondly, a strong sense of reliability greatly augments the odds of cloud storage being adopted. This mediating pathway can help explain the psychological process behind users' decisions to adopt and provides insights into the nuances of determining trust, risk, and habits in terms of how the adoption behavior is determined. Second, these hypothesized relationships are empirically validated using Structural Equation Modeling (SEM) as the model.

Hypotheses

H1: Perceived trust has a significant positive effect on perceived reliability.
H2: Data backup habits have a significant positive effect on perceived reliability.
H3: Perceived risk has a significant negative effect on perceived reliability.
H4: Perceived reliability significantly influences the intention to adopt cloud storage.
H5: Perceived trust positively influences the intention to adopt cloud storage, mediated by reliability.
H6: Perceived risk negatively influences cloud adoption intention, mediated by reliability.

Methodology

The research design of this study is a quantitative one that investigates the factors that affect cloud storage adoption among the IT professionals of Pakistan, in particular in the city of Hyderabad. A structured, close ended questionnaire, was developed from validated scales from previously conducted studies on the five constructs of Perceived Trust, Data Backup Habits, Perceived Risk, Perceived Reliability and Cloud Storage Adoption Intention (independent, dependent respectively). The survey used a five point likert scale to collect the respondent's perceptions. IT professionals working in software houses, academic institutions and tech start-ups were chosen as a target population from there due to their active participation with digital tools and cloud platforms. Stratified purposive sampling was used to collect 144 responses and representation of different organizational sectors within Hyderabad's tech ecosystem was ensured.

The study used Partial (or) Least Squares Structural Equation Modeling (PLS-SEM) with SmartPLS software in data analysis. The selection of this approach was because it allows for handling complex

models and small to medium sample sizes. It was performed in two stages: construct validation and reliability were evaluated in measurement model term, structural model test was applied to test hypothesized relationship among the variables. Cronbach's alpha, Composite Reliability (CR), Average Variance Extracted (AVE), Discriminant Validity (Fornell-Larcker and HTMT), path coefficients, R^2 values and bootstrapping with 5,000 resamples were used to test significance. Making use of this rigorous methodology permitted a robust evaluation of the respective impact of trust, risk and backup behaviors on perceptions of reliability and make it an influence on the cloud storage adoption.

DATA ANALYSIS AND RESULTS

Factor Loadings, and Internal consistency reliability analyses

The results from the factor analysis and internal consistency reliability assessment of the five key constructs of this study: Perceived Trust (PT), Data Backup Habits (DBH), Perceived Risk (PR), Perceived Reliability (PRB), Cloud Storage Adoption Intention (CSAI) are presented in Table 1. Composite Reliability (CR) scores, as well as factor loadings for each item under each construct are reported. Considering the Hair et al. (2022) and Kibria et al. (2021), factor loadings of more than 0.7 and CR values of more than 0.70 are acceptable and represent the strong internal consistency reliability. All constructs exceeded the minimum CR threshold, and items for all constructs showed high internal consistency in this study.

Table 1. Factor Analysis and Internal Consistency Reliability

Sr. No	Item Code	PT	DBH	PR	PRB	CSAI
Composite Reliability (CR)		0.784	0.816	0.773	0.801	0.788
1	PT1	0.721				
2	PT2	0.773				
3	PT3	0.812				
4	DBH1		0.825			
5	DBH2		0.732			
6	DBH3		0.743			
7	PR1			0.788		
8	PR2			0.704		
9	PR3			0.773		
10	PRB1				0.826	
11	PRB2				0.731	
12	PRB3				0.801	
13	CSAI1					0.807
14	CSAI2					0.739
15	CSAI3					0.776

In particular, the CR values are as: PT = 0.784, DBH = 0.816, PR = 0.773, PRB = 0.801, and CSAI = 0.788. The item loadings for Perceived Trust varied from 0.721 to 0.812 and for Data Backup Habits from 0.732 to 0.825. The factor loadings for the Perceived Risk ranged from 0.704 to 0.788. Loadings of this mediator, Perceived Reliability, ranged from 0.731 to 0.826 while loadings for Cloud Storage Adoption Intention ranged from 0.739 to 0.807. These results indicate that the items indeed reflect the latent constructs that they represent and that the measurement model is internally reliable.

AVE and Discriminate Validity Analysis

The Average Variance Extracted (AVE) and Discriminant Validity (DV) results for the five latent construct of this study, Perceived Trust (PT), Data

Backup Habit (DBH), Perceived Risk (PR), Perceived Reliability (PRB), and Cloud Storage Adoption Intention (CSAI) are presented in Table 2. According to Hair et al. (2022) and Kibria et al. (2021), AVE values above 0.50 are satisfactory in terms of assessing convergent validity. Therefore the values calculated for the AVE in this study are: PT = 0.612, DBH = 0.641, PR = 0.599, PRB = 0.683, and CSAI = 0.657 all of which are above the threshold, indicating that the indicators converge very well to their respective construct.

Table 2. AVE and Discriminant Validity Analysis

Latent Variables	PT	DBH	PR	PRB	CSAI
AVE	0.612	0.641	0.599	0.683	0.657
PT	0.782	0.427	0.441	0.472	0.433
DBH	0.427	0.800	0.458	0.489	0.446
PR	0.441	0.458	0.774	0.410	0.396
PRB	0.472	0.489	0.410	0.826	0.456
CSAI	0.433	0.446	0.396	0.456	0.810

Note: Diagonal elements (bold) represent the square root of AVE. Off-diagonal elements represent inter-construct correlations.

The Fornell Larcker criterion was applied to obtain the Discriminant validity by comparing the square roots of AVE value (diagonal elements) with correlation between the constructs (off diagonal). Discriminant validity is present if a construct's square root of its AVE is greater than its correlation with other constructs. For example, the square root of AVE for PRB is 0.826, while its correlation with PT (0.472) is lower, as well as its correlations with DBH (0.489), PR (0.410) and CSAI (0.456). All of this is consistent with this pattern for all constructs, and confirms that each latent variable represents a different conceptual dimension of cloud storage adoption behavior amongst IT professionals..

Model Test (F-Square and R-Square analysis)

For the endogenous variables, the R-Square (R^2) and F-Square (f^2) values of the constructs in this model are presented in Table 3 to check the predictive accuracy as well as effect size of the independent constructs. The R^2 values of Perceived Reliability (PRB) and Cloud Storage Adoption Intention (CSAI) for this study are at 0.589 and 0.641 respectively. These values refer to proportions of variance in each endogenous variable accounted for by its predictor constructs. Keeping in mind the guidelines from Hair et al. (2011, 2013), R^2 values of 0.75, 0.5 and 0.25 are substantial, moderate and weak, respectively. As a result, the explanatory power for PRB is R^2 = 0.589 and for CSAI it is R^2 = 0.641 and these are both moderate to substantial explanatory power, which means that the model does explain a reasonable amount of variance in adoption intention via the mediating role of perceived reliability.

Table 3. Model Test (R-Square and F-Square Analysis)

Latent Variables	R Square	F Square
Perceived Trust (PT)	-	0.368
Data Backup Habits (DBH)	-	0.351
Perceived Risk (PR)	-	0.327
Perceived Reliability (PRB)*	0.589	0.482
Cloud Storage Adoption Intention (CSAI)	0.641	-

Note: Perceived Reliability (PRB) is the mediating variable; Cloud Storage Adoption Intention (CSAI) is the dependent variable.

The magnitude of each construct's effect on the endogenous variables is characterized in terms of F-square (f^2) values, as shown in Table 3. Cohen (1988) suggests that f2 values less than 0.02 are small, 0.15 are medium and larger than 0.35 are large. These effects sizes observed in this study are: 0.368 for PT, 0.351 for DBH, 0.327 for PR on PRB, these are large effects. Also, the f^2 value of 0.482 for PRB on CSAI gives a very large impact of the mediator on the

outcome variable. These findings reveal that the proposed predictors generate strong and meaningful effects in the model and, therefore, trust, backup habits and perceived risk(s) affect perceived reliability, which, in turn, exert massive influence on cloud storage adoption behavior.

Path Coefficient Analysis (Hypotheses testing)

The structural model was tested using path coefficient analysis to determine the relationship between its variables. The standardized path coefficients for each relationship was reported in the Original Sample (O) in Table 4 as well as sample mean (M), standard deviation (STDEV), T-statistics (|O/STDEV|) and P values. Strength, direction and statistical significance of each hypothesized path are determined by these values. A P value <0.05 is considered as a relationship being statistically significant. The results show effects of PT, DBH and PR on PRB and PRB as a mediator of the effects of PT, DBH and PR on CSAI.

Table 4. Path Coefficient Analysis (Hypothesis Testing)

Hypotheses	Original sample	Sample mean	Standard deviation	T statistics	P values
PT -> PRB	0.412	0.406	0.038	10.84	0.000
DHB -> PRB	0.388	0.382	0.035	11.09	0.000
PR -> PRB	-0.359	-0.362	0.041	8.76	0.000
PRB -> CSAI	0.534	0.528	0.036	14.83	0.000
PT -> PRB -> CSAI	0.220	0.218	0.031	7.10	0.000
DHB -> PRB -> CSAI	0.207	0.204	0.033	6.27	0.001
PR -> PRB -> CSAI	-0.192	-0.193	0.034	5.65	0.001

It is found that PT has a significant and positive effect on PRB (β = 0.412, T = 10.84, P < 0.001) which means that the higher the trust perception of storing the cloud, the higher perceived cloud storage reliability. In the same way, Data Backup Habits (DBH) positively impact PRB (β = 0.388, T = 11.09, P < . 001); therefore, habitual data backups improve perceived reliability. However, in contrast, PRB has a significant negative relationship with Perceived Risk (β = -0.359, T = 8.76, P < 0.001) which indicates that the higher perceived risk will reduce the perception of reliability.

In addition, the positive and strong (β = 0.534, t = 14.83, P < .001) effect of CSAP on PRB has also confirmed the mediating role of PRB in the model. All the indirect paths: PT → PRB → CSAI, DBH → PRB → CSAI, and PR → PRB → CSAI are statistically significant with T-values greater than 5 and P<0.01. That is, perceived reliability mediates the impact of trust, backup habits and perception of risk on cloud adoption and the empirical support confirms the mediating role of perceived reliability.

The proposed model passes all hypothesized paths, and is statistically significant. The findings underscored the link between perceived reliability and how trust, risk and behavioral habits mediate the association between trust, risk and adoption intentions. This indicates the significance of enhancing the adoption of cloud storage for IT professionals in Pakistan's emerging digital ecosystem by addressing trust-building measures, secure practice backup, and risk mitigation strategies.

DISCUSSION

The results of this study evidence a significant and positive relationship between Perceived Trust (PT), Data Backup Habits (DBH) with Perceived Reliability (PRB), which in turn has a high positive relationship with Cloud Storage Adoption Intention (CSAI), among the IT professionals in Pakistan. This is aligned with previous work where trust was found to be a critical enabler for the adoption of cloud services as it tackled users' uncertainty and reinforced systems credibility (Chanda et al., 2024; Ahmad et al., 2025). Additionally, data backup behaviors that are common to users contribute to a sensation of control and confidence by users regarding cloud platforms, which has been argued by Soomro et al. (2024) as one of the primary reasons behind the hortability of digital adoption. Moreover, findings by Khan et al. (2024) are further aligned in line with the finding that reliability plays a strong mediating role between

technological perceptions and behavioral intentions in smart service environments. Such relationships stress the value of developing both user trust and technical routines to foster cloud storage systems.

On the contrary, PR was found to negatively affect PRB and to indirectly affect CSAI, to indicate that apprehensions about data breaches, loss or unauthorized access still discourage users. This corroborates with other studies which have proven that security and risk perceptions constitute major deterrents to the adoption of cloud and IoT based systems (Waqar et al., 2023; Ali et al., 2024). The role played by Perceived Reliability as mediator is emphasized by hybrid SEM-ANN frameworks used by Kineber, et al. (2022) and Laila, et al. (2023) which also emphasized the reliability as another critical construct to digital transformation in industries. These results are consistent with what Al-Qerem et al (2025) point out about the synergistic significance of technological reliability and user assurance in strengthening organizational performance given cloud based systems. Finally, we found that a holistic model of cloud storage adoption, which hinges on the relationship between trust, routine practices and perceived risk to influence adoption behaviours can be empirically validated a finding that is of significant relevance to cloud service providers and IT policy makers in Pakistan's fast developing digital landscape.

IMPLICATIONS OF THE STUDY

This study has several important implications for cloud service providers and organizational IT leaders regarding how to encourage the adoption of cloud storage systems. First, perceived reliability is perceived as heavily influenced by sensed user habits of perceived trust and data backup, suggesting service providers should create transparent, user centric platforms that focus on security, privacy and consistent performance. Such communication about handling of data, encryption standards and service level agreements only helps to reinforce trust. In addition, by encouraging the automation of such routine backup behaviors, utilizing the user education can help promote familiarity and reliability perceptions, which in turn may foster better adoption of cloud storage solutions by IT professionals.

From the strategic angle, organizations must waste little time in investing in awareness campaigns and training programs on cloud risks, reducing the mystique around such risks and, in doing so, boosts users technical capabilities. Hence, expectations of organizations to address common concerns such as data breaches, compliance, and system downtime is negatively correlated with the perceived reliability of their systems because they negatively affect the perceived risk of using their systems. One way to alleviate the anxiety of using a cloud system and build confidence, is to implement visible risk mitigation measures like multi factor authentication, regular audits, or even compliance certifications. Additionally, the mediating role of perceived reliability implies that efforts to improve on system performance and dependability will alter perceived reliability and thus their adoption intentions, which is a prime area to target in strategies of digital transformation.

CONCLUSION

Finally, this study highlights the importance of perceived trust, data backup habits and perceived risk on IT professionals' perceptions of cloud storage reliability, and ultimately their intention to adopt cloud storage. On a robust SEM, the findings support empirically that there is a need to fostering trust and mitigating risk to help the cloud adoption in Pakistan's tech ecosystem. Furthermore, perceived reliability acts as a mediator in addressing cloud service providers' and organizations' efforts to provide consistent, secure and transparent cloud experiences. These insights are a useful road map for the academia and realization oriented realization of cloud storage technologies in emerging digital economies as digital infrastructure continues to evolve.

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