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Empirical Analysis of Factors in User Control Model for Cloud Data Migration

Ishak Iskandar[1]*, Imbaji Injuwe Danga[2], Hamidah Ibrahim[1], and Fatimah Sidi[1]

[1]Department of Computer Science, Faculty of Computer Science and Information Technology, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia
[2]Department of Information and Communication Technology, Taraba State University, 660213 Jalingo, Taraba State, Nigeria

ABSTRACT

This study aims to develop, with empirical validation, a model of the factors influencing user control during on-premises-to-cloud data migration in Software-as-a-Service (SaaS) environments. The model is grounded in the technology-organisation-environment framework and control theory. The research examines how security, cost, legal compliance, and personnel knowledge affect user control outcomes through standards and performance as control metrics. A quantitative research approach was employed, using survey data collected from 55 cloud computing professionals selected through purposive sampling. The data were analysed using descriptive statistics in SPSS, and their structural relationships were evaluated through Partial Least Squares Structural Equation Modelling (PLS-SEM) in SmartPLS. The results indicate that cost significantly influences both standards and performance, while security significantly affects standards but not performance. Legal compliance shows a significant relationship with performance but not standards, whereas personnel knowledge does not exhibit a significant effect on either standards or performance. Additionally, standards were found to have a significant impact on performance, confirming their role as a critical control mechanism. The measurement model demonstrated strong reliability and validity, with Cronbach's alpha values ranging from 0.753 to 0.955 and factor loadings for all indicators exceeding 0.7, confirming validity. The study contributes to the cloud computing domain by providing a proposed model for assessing user control during migration execution, extending beyond traditional cloud adoption frameworks. Practically, the findings offer guidance to organisations in prioritising cost management, legal compliance, and structured standards in managing cloud data migration processes.

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E-mail addresses:
iskandar_i@upm.edu.my (Ishak Iskandar)
Imbaji.danga@tsuniversity.edu.ng (Imbaji Injuwe Danga)
hamidah.ibrahim@upm.edu.my (Hamidah Ibrahim)
fatimah@upm.edu.my (Fatimah Sidi)
* Corresponding author

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The model can be applied as a diagnostic and decision-support tool for improving transparency, accountability, and performance in cloud data migration projects.

Keywords: Analysis, hypothetical model, on-premise, SaaS, structural equation modelling (SEM), user control

INTRODUCTION

The continuous adoption of cloud computing by organisations has necessitated efficient and controlled migration processes to maintain data integrity, ensure security, and optimise operational performance. This study analyses the research constructs of the hypothetical model of the user control framework for on-premises to cloud data migration, focusing on the identified user control constructs: standards, performance, security, legal, cost, and personnel knowledge. The research further investigates its findings by means of Structural Equation Modelling (SEM), enquiring whether there is an association between the identified user control constructs and their affecting factors, as asserted by the hypothetical model.

While studies like Pahl and Xiong (2013) have explored the technical aspects of cloud data migration, leaving a gap in addressing the user visibility and control during the migration process. The trend in cloud migration frameworks has been on the Cloud Service Provider's (CSP) offerings, scalability, performance, optimisation, and cost-related issues, without a clear-cut on user involvement (Abou_el_ela Abdou Hussein, 2021; Islam et al., 2017; Khan & Khan, 2019). This has led to the clamouring concerns about user visibility and control of the data migration process, as limited user involvement, reduced visibility, and control in the process persist. It is based on the premise of the challenges that this study intends to address the problem through a critical analysis of factors affecting user control in the process of cloud data migration. By focusing on user control affecting factors and the control metric, the proposed framework should guide users on how to monitor key factors that affect the cloud data migration process, as it intends to enhance visibility and control.

Factors that are seen in the data migration process affecting user control can be explained in terms of technology, organisation, and environmental standpoint. This aligns with the Technology-Organisation-Environment (TOE) framework, hence, investigating the factors within the TOE framework. Additionally, the measurement of the outcome of the user control factors is grounded in the control theory, thereby providing the basis for evaluating the extent to which users have control during the data migration process. The two models together (TOE and control theory) provide a theoretical foundation for analysing the factors in two different contexts. Particularly, the TOE framework serves as a model that projects the understanding of how technology adoption in organisations moving to cloud are implementation, vis-a-vis how innovations are shaped by factors within the technological perspective, and the organisational, and environmental (Pochyla, 2019).

It is therefore suitable for identifying factors affecting user control in this study due to their popular usage in computer science research, particularly in cloud migration and cloud adoption case studies (Kamal et al., 2020; Murtezani & Metin, 2016; Zboril & Svata, 2022). While Control theory is known for its basis in designing and implementing effective control measures that are inherent to organisational processes. It also lay the emphasises on the importance of the establishment of standards, procedures, and performance metrics. These are vital components of the management control process (Dědečková,2020).

This approach tends to ensure that operational activities in control processes are aligned with strategic objectives. Thereby, experience the efficiency and effectiveness of the control process. Standards as a vital metric of control process represent the available predefined criteria for performance evaluation and ensuring organisational goals are consistently evolving. This attribute of standards makes it a reference point for measuring actual performance outcomes; furthermore, standards provide the basic control measures needed for organisations to refer to when performance is required.

Contextually, the use of standards in the cloud data migration process includes compliance with industry requirements, strategy, and best practices, by ensuring that migration processes align with standard procedures in achieving organisational objectives. For example, adherence to security standards like ISO/IEC 27001 guarantees data integrity throughout the migration process. Resulting in user control and trust issues due to the service reliability experienced (Laurent de la Vaissière, 2011). Performance metric, on the other hand, measures how standards in the management control process can provide quantitative measures to evaluate and monitor user control in the data migration process. This emphasises the application of performance metrics in domains like: database systems, real-time systems, and cloud computing (Abdelzaher et al. 2008). Making it easy to identify deviations from expected outcomes.

The usage of the TOE framework to examine factors that influence organisations' preparedness to adopt and implement technological innovations has been widely used. For example, studies like Yang et al. (2015) and Oladoyinbo et al. (2024) have investigated factors affecting cloud computing adoption or cloud migration. To make it noteworthy, some studies refer to data migration to the cloud as cloud adoption, whereas most studies maintain the data migration in terms of transferring or moving data to the cloud environment. Besides cloud adoption advantages, there is a combination of organisational and technical factors that affects user control in the process of migrating data to the cloud, for users in Software as a Service (SaaS). The affecting factors are not limited to personnel skills, legal, and security requirements that become issues of concern looking at the organisational perspective. Similar studies have also, in an effort to integrated organisational and technical factors in SaaS, highlighted the challenges of data migration and found that the technical expertise of the staff involved in the process plays an important role in determining user control (Iqbal & Colomo-Palacios, 2019).

Conclusively, the TOE framework offers the foundation for identifying the user control affecting factors for a successful cloud data migration process, by addressing key factors that influence the process. When combined with control theory and focusing on user control, this approach conceptualises the factors in user control in the cloud data migration process.

Related Research Works

This subsection examines related works and provides insight into the research constructs Grob & Schill (2012) proposed a user-centric governance and control framework. Their work significantly contributes to understanding how governance can shape data migration practices. However, a major limitation is the neglect of user experience as part of regulatory compliance considerations. Perra (2015) explored integrated user control mechanisms, such as predefined permissions and automated decision-making during data migration. The study shows that while these mechanisms enhance user control in security and privacy matters, they simultaneously reduce user involvement in certain functionalities. The multi-step process of data migration, as outlined in Sarmah (2018), shares similarities with a user control framework for cloud data migration in SaaS environments. It involves analysing legacy data, performing quality assurance testing, and executing phased transitions to minimise risks and ensure data integrity.

Patrick & Satyanarayana (2020) examined the optimisation of service level agreements (SLAs) by balancing cloud provider offerings with user experience. Their findings reveal that users typically lack control over their data once stored in the cloud, and SLA issues are only addressed after migration, often through penalties. The absence of pre-migration SLA considerations underscores the need to empower users to define service preferences using quality of service indicators embedded within migration frameworks. The migration to cloud-based services, as explored in Ali et al. (2021), sheds light on various factors influencing the migration to cloud environments. While it identifies critical organisational and technical challenges, the focus remains on adoption rather than on user control mechanisms during migration. Sadoughi et al. (2020), in a review of studies, highlighted cloud migration factors categorised into technological, organisational, environmental, and individual domains. These factors closely align with the factors that affect the implementation of user control in cloud data migration in SaaS. Their work is useful in understanding what drives adoption, but it lacks emphasis on factors affecting user control during data migration. Amin et al. (2021) provide insights into the challenges associated with cloud data migration, particularly focusing on the migration of locally stored data to public cloud platforms.

Al Mudawi et al. (2022) developed the Adoption of Cloud Computing in Government (ACCE-GOV) framework to analyse the critical factors affecting the adoption of cloud computing in Saudi government systems. The study identifies factors such as security,

trust, technology readiness, top management support, and regulatory issues as significant in cloud adoption. While valuable in analysing cloud adoption factors, it does not explore user-specific control elements within cloud data migration contexts. This opens the door for enhancing such frameworks by integrating user-driven control factors to improve transparency and engagement during migration. Vadlamani et al. (2023) explored strategies for cross-platform data migration specifically designed for enterprise data warehouses (EDWs). While these works share common challenges with this work, it leaves a gap for extending such strategies to include user-centric controls for on-premises to cloud migration processes, as shown in Table 1.

Table 1
Summary of related research works

Author	Focus/ Methodology	Findings/ Limitations	Identified Gap	Proposed Contribution
(Grob & Schill, 2012)	User-centric governance and control in data migration	Addresses the cloud provider trust issue, regulatory compliance, and user-controlled migration.	It neglects user experience as part of regulatory compliance.	Ensure user experience as part of the control concern.
(Perra, 2015)	Integrated user control mechanisms like predefined permissions and automated decision-making.	Ensures user control in security and privacy; conversely, limits user involvement in some functionalities.	Absence of visibility into data flows, compliance enforcement, and integrity maintenance during migration.	Extends user control by incorporating legal and security oversight through the process.
(Sarmah,2018)	Multi-step data migration process with risk management and rollback strategies.	Focuses on minimising risks and testing but does not involve user-driven feedback or control mechanisms.	The framework is too general for data migration.	The development of a specific purpose framework for data migration is timely.
(Patrick & Satyanarayana, 2020)	Optimisation of service level agreement	Define a balance between cloud provider offerings and cloud user experience. Users have no control over their data stored in the cloud.	Does not address service level agreement issues before migration, hence uses a penalty as a solution.	Allow the user to determine their service preference through quality service indicators in the framework.

Table 1 (*continued*)

Author	Focus/ Methodology	Findings/ Limitations	Identified Gap	Proposed Contribution
(Ali et al., 2021)	Analysis of factors influencing cloud adoption, including compatibility, complexity, cost, and security.	Identifies key organisational and technical challenges but focuses on adoption rather than user-centric control mechanisms for migration.	No emphasis on user control factors over cloud data migration.	Consider user control factors.
(Sadoughi et al., 2020)	Factors influencing cloud adoption are categorised into technological, organisational, and individual domains.	Highlights adoption factors but lacks focus on user-centric control factors during the migration process.	Limited focus on engaging users to manage cloud data migration challenges.	Investigate more factors affecting user-centric control migration workflows.
(Amin et al., 2021)	Insights into cloud data migration challenges, focusing on the migration of locally stored data to the public cloud.	Highlights the importance of planning, impact analysis, and visibility into security, but lacks mechanisms for real-time user control in SaaS environments.	Lack of user control and transparency during migration processes in SaaS platforms.	Introduces user-centric tools like dashboards to enhance visibility and control in cloud migration workflows.
(Al Mudawi et al., 2022)	ACCE-GOV framework addressing adoption factors like security, trust, and technology readiness.	Analyses adoption factors but does not explore factors that are user specific.	Lack of integration of user control factors in cloud data migration contexts.	Enhances the adoption framework by integrating user-driven control factors.
(Vadlamani et al. ,2023)	Strategies for cross-platform data migration for enterprise data warehouses (EDWs).	Addresses data compatibility and integration complexities. No user control mechanism.	The study did not cover on-premises to cloud migration.	Consider on-premises to cloud migration.

THEORETICAL BACKGROUND OF CONSTRUCTS

To investigate measures of user control in cloud data migration, this study integrates the TOE framework and control theory to develop a theoretical model of the research constructs. Traditionally, cloud migration models focus on CSP prospects, technical efficiency and cost-effectiveness, often neglecting user control measures that enhance transparency, compliance, and security. This study aims to establish a structured model that effectively

evaluates measures of user control in cloud migration processes by leveraging the TOE framework and control theory

Technology-Organisation-Environment (TOE) Framework

The TOE framework, presented by Tornatzky (1990) Classify the factors influencing technology adoption into three dimensions, namely: technological factors; security, performance, and adherence to standards influence the technical feasibility of cloud migration. Organisational factors, such as cost, personnel knowledge, and operational readiness, affect the organisation's ability to manage migration effectively. And environmental factors: legal and regulatory compliance, market pressures, and industry standards impact the decision-making process.

Control Theory

Control theory provides a foundation for measuring control outcomes within the cloud migration processes. It establishes the user control metrics (standards and performance) as integral components of the management control process (Dedeckova, 2020). Control, as an element of managerial process, requires setting up practical standards for organisational activities, evaluating actual performance based on the set standards, and identifying possible deviations by comparing actual outcomes against the predetermined standards (Manyuchi & Sukdeo, 2021). Standards are inherent to certain specifications, such as ISO/IEC 27001, where compliance with security and data integrity protocols is essential, thereby strengthening user trust in cloud migration (Laurent de la Vaissière, 2011). The use of performance metrics to assess projects of cloud data migration ensures that organisations monitor and assess how users can control the migration process.

Integrating TOE and Control Theory in the Cloud Data Migration Process

This study makes three primary theoretical contributions to cloud computing and user control in cloud data migration. First, while prior studies are grounded in the TOE framework and primarily examine determinants of cloud adoption readiness, intention, or migration feasibility, this study shifts focus from the adoption decision to data migration with user control in focus. It conceptualises user control not as an adoption outcome, but as a measurable construct during the transition phase of on-premises to cloud data migration. Secondly, this study integrates TOE determinants with principles from control theory to develop a structured evaluative model. Unlike prior models that treat technological, organisational, and environmental factors as independent factors of cloud adoption, this framework connects these factors to control outcome metrics, standards and performance. Thirdly, the study further positions user control as a measurable multidimensional construct

validated empirically using PLS-SEM. Existing literature discusses visibility, trust, governance, and compliance in conceptual terms, but rarely provides validated indicators for measuring user control during migration execution. This study addresses that gap by offering validated constructs that can serve as a foundation for future empirical work in cloud governance research

The factors of TOE are integrated with metrics of the control theory to allow for a comprehensive fusion and analysis of user control measures in cloud data migration. This is done by aligning the technological, organisational, and environmental factors with control measures. The aim is to identify and measure key indicators of user control. Using the proposed model through empirical testing with SEM, the study offers a theoretical foundation for gaining an understanding of how user control factors are measured in the process of migrating on-premise data to the cloud.

The Study Objectives

The study aims to identify the factors that affect user control in cloud data migration, analyse the relationships among the identified factors, and propose a model for user control in the cloud data migration process.

The Proposed Model of the Research

The Research model for user control affecting factors in cloud data migration is developed based on the technology organisation environment framework and the control theory. The model defines key factors influencing user control and hypothesises the relationships among them.

The integration of technological, organisational, and environmental factors, as outlined in the TOE framework, establishes a structured approach for understanding the dynamics of factors of user control in cloud migration. Additionally, control theory provides a foundation for measuring performance and standards metrics as outcomes for user control in the data migration process. The proposed model was tested for reliability, and a pilot study was carried out before the data collection stage. This is to ensure that the measurement instruments are aligned with the objectives of the empirical study. The research model put forward the relationships among the constructs, including security, cost, legal compliance, personnel knowledge, standards, and performance, in determining the extent to which users are involved in the control of the migration project.

The proposed model will be tested using SEM to examine the relationships between the identified factors and validate the model's effectiveness in improving user control mechanisms. Figure 1 illustrates the hypothesis model of the user control framework.

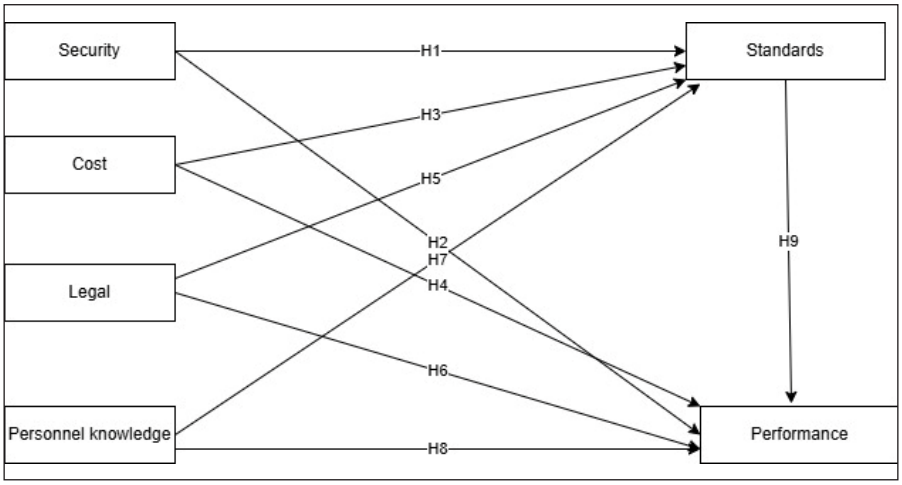

Figure 1. Hypothesis model of the user control framework

Hypothesis Formulation

The research basis for this empirical investigation proposes nine hypotheses to examine the relationships between the key factors influencing user control in migrating on-premises data to the cloud. The hypotheses explored the impact of the relationship among the user control measures, security, cost, legal, and personnel knowledge on standards and performance.

Impact of Security on Standards and Performance

Security is a crucial issue in the data migration process. Considering measures like: data integrity, ensuring that data is complete, accurate, and consistent as it moves from source to target (Yang et al., 2015); confidentiality, referring to the protection of sensitive information from unauthorised access, disclosure, or theft (Fisher et al., 2023) data doss, the permanent or temporary unavailability of data during the transition process (Dziadosz et al., 2021) and privacy, monitoring of privacy in cloud data migration is essential to ensure security and compliance (Maniah et al., 2021). Hence, users need to adhere to security measures to ensure that data migration standards are met, which in turn affects the entire performance of the data migration process. Thus, the following hypotheses are inferred:

H1: Security has a significant effect on standards in the user control of the data migration process.

H2: Security significantly influences performance in the user control of the data migration process.

Impact of Cost on Standards and Performance

Cost considerations are essential in determining the feasibility and sustainability of user control in the cloud data migration process. Managing data migration costs could contribute to standards and migration performance in measures like application and data cost, storage cost, connectivity cost, and consultancy cost (Bhatt & Sehgal, 2024; Islam et al., 2023; Mansouri et al., 2019; Varma, 2024). Based on the assertion, the following hypotheses are considered:

H3: Cost has a significant effect on standards in the user control of the data migration process.

H4: Cost has a significant effect on performance in the user control of the data migration process.

Impact of Legal Factors on Standards and Performance

User control is affected by certain legal factors that users must consider to ensure compliance and mitigate risks (Chowdhury, 2024). Legal considerations are important to the successful implementation and operation of cloud services; they comprise policy adherence, service level agreements (SLAs), compliance with regulations, and governance frameworks (Rahulamathavan et al., 2014)**.** This has become necessary to ensure that data migration processes align with established standards, procedures and performance measures. The following hypothesis statements reflect the significance of legal factors on standards and performance:

H5: Legal compliance has a significant effect on standards in the user control of the data migration process.

H6: Legal compliance has a significant effect on performance in the user control of the data migration process.

Impact of Personnel Knowledge on Standards and Performance

The expertise and knowledge of personnel involved in cloud data migration directly influence the implementation of control measures. Trained personnel acquire skills that could enhance adherence to certain standards and improve performance. Hence, diverse skills, including: technical, technical requirements for monitoring the systems (Malouche et al., 2017) communication, coordination among teams and departments, making everyone involved to understands the goal, timeline, and responsibility (Rao et al., 2021) and business skills, strategic business acumen can align the data migration process objectives, with the business goals (Alkhalil et al., 2013) to ensure a seamless migration project. Consequently, the following hypotheses were formulated:

H7: Personnel knowledge has a significant effect on standards in the user control of the data migration process.

H8: Personnel knowledge has a significant effect on performance in the control of the data migration process.

Impact of Standards on Performance in Data Migration

Standards usually, is the benchmark for evaluating the success of cloud data migration by ensuring that user control factors adhere to established standards. This helps users to maintain consistency throughout the migration process by exploring various user control measures related to how standards impact performance. This tests the significance of standards on performance using the hypothesis statement below:

H9: The standards of the data migration process have a significant effect on its performance.

The hypotheses H1, H2, H3, H4, H5, H6, H7, H8, and H9 tend to outline the theoretical foundation of the empirical investigation, so that the proposed research model could be validated through SEM.

MATERIALS AND METHODS

Research Design

This study employs a largely the use of quantitative research approach and the qualitative research approach in limited cases for the investigation of factors that influence user control in data transitioning to the cloud. It analyses the key control measures such as security, cost, legal compliance, personnel knowledge, standards, and performance from the integrated TOE framework and control theory. A survey was carried out to collect data from respondents who are computer scientists, particularly cloud computing professionals. The study further allows for the use of suitable statistical techniques and analytical software applications to test the relationships among variables.

To achieve the objective of the study, the research methodology is structured into five phases to ensure a comprehensive and systematic approach to evaluating the measures of user control in the cloud data migration process. The five phases of the research methodology include:

1. Reviewing existing literature to identify user control metrics, the phases of cloud data migration, and factors that affect user control.
2. The development of a hypothetical model that integrates user control factors from the TOE context and their accompanying outcome in control theory.
3. The development and validation of the research instrument and conducting a pilot study.

4. The data collection and analysis phase.
5. The model validation phase.

Data Collection Instrument

Primarily, the data collection instrument was developed using constructs from existing literature, which were reviewed by an expert before distribution. This is to ensure that ambiguities are removed and items are refined to enhance clarity. Before administering the questionnaire, it was divided into two Sections: Section A has general demographic information (e.g., gender, years of experience, educational background), Section B has indicators of key constructs that measure user control.

First, a pilot study was conducted to ensure content validity and reliability of constructs. Then, a purposive sampling technique was used in selecting the respondents. Purposive sampling is more appropriate for in-depth research where expertise or specific characteristics are critical (Akpan & Piate, 2023). This is to ensure that only experienced professionals participate in the survey. A total of 55 valid responses were collected for the main survey. The adequacy of this sample size is supported by evidence from purposive sampling literature and SEM studies, which indicate that meaningful saturation and reliable parameter estimation can be achieved with similar sample sizes when constructs are well defined (Etikan et al., 2016; Lakens, 2022). The method of sampling and determining the sample size are of great importance in research problems that rely on surveys. Determining the sample size is not an issue in purposive sampling. The survey instruments were administered using online Google Forms; in some cases, direct email contacts were used to reach out to the respondents by targeting cloud professionals globally through their LinkedIn profiles. Responses were then collected and analysed via SPSS and smartPLS.

User Control Measures

The study identified six key measures relevant to user control in cloud data migration:

1. Security: involving issues of confidentiality, integrity, data loss, and privacy.
2. Cost: covers connectivity, storage, application, data, and consultancy expenses.
3. Legal: examines adherence to regulations compliance, service-level agreements (SLAs), governance, and policies.
4. Personnel Knowledge assesses the technical, business, and communication skills of professionals involved in migration.
5. Standards: includes best practices, authentication, strategy, and industry.
6. Performance: evaluates quality of service, reliability, throughput, transfer speed, downtime, and user experience.

Each measure was incorporated into the survey instrument to assess its influence on SaaS users. The distribution of items within the constructs is presented in Table 2.

Table 2
The measure of user control in cloud data migration process

SN	Constructs	Measurement Items
1	Security	SECU1, SECU2, SECU3. SECU4
2	Cost	COST1, COST2, COST3, COST4
3	Legal	LGAL1, LGAL2, LGAL3, LGAL4
4	Personnel knowledge	PKNW1, PKNW2, PKNW3
5	Standards	STND1, STND2, STND3, STND4, STND5, STND6, STND7, STND8, STND9, STND10, STND11, STND12
6	Performance	PERF1, PERF2, PERF3, PERF4, PERF5, PERF6, PERF7, PERF8, PERF9, PERF10, PERF11, PERF12

Respondents

The pilot study targeted professionals involved in the cloud computing field, including cloud users, Cloud Service Provider (CSP), cloud auditors, cloud academics/researchers, and other IT professionals, to assess the reliability of the survey instrument. Shrestha (2021) supposedly pointed out that, reliability measures the consistency of responses within a construct, critical to pilot studies, and is commonly evaluated using Cronbach's alpha.

Questionnaires were distributed via Google Forms, with an expected response range of 15 to 50 respondents, aligning with the minimum requirement for pilot studies (Bujang et al., 2024). The data collection process was closely monitored, and responses were checked at 33 points. At this number, the acceptable threshold for reliability assessment is met. The data collected from respondents were exported to excel sheet for cleaning and coding, followed by further analysis in SPSS. Findings from the analysis evaluated the reliability of the constructs, and the results are presented in Table 3.

Table 3
Reliability value of the constructs

SN	Constructs	Abbreviation in SPSS	Reliability
1	Security	SECU	0.882
2	Cost	COST	0.817
3	Legal	LGAL	0.856
4	Personnel knowledge	PKNW	0.799
5	Standards	STND	0.972
6	Performance	PERF	0.967

The reliability value shows that security has 0.882, cost has 0.817, legal has 0.856, personnel knowledge has 0.799, standards have 0.972, and performance has 0.967. This means that all the constructs have their reliability values within the acceptable threshold.

According to Edeh et al. (2023) Composite reliability or Cronbach's alpha values ranging from 0.60 to 0.70 are acceptable. This implies that the survey instrument demonstrates a high level of reliability. Hence, justifying its usage for the main survey.

Instrument Validation and Data Analysis

Before the field administration of the research instrument, several preparatory steps were taken. These included content validity by experts, identification of the target respondents to be used for the pilot study, selection of an appropriate sample size, administration of the research instrument, and conducting the reliability assessment as reported in the prior section.

Demographic Characteristics

Table 4 presents the demographic distribution of respondents who participated in the study. The data collected provides insight into the professional background, experience, educational qualifications, and familiarity with the on-premises to cloud data migration process.

Table 4
Respondents demographic information

Demographic Variable	Frequency	Percentage
Cloud Profession		
Cloud user	30	54.4
Cloud service provider	2	3.7
Cloud researcher/academic	8	14.6
Cloud auditor	2	3.7
Other IT professions	13	23.6
Total	55	100
Range of Years of Working Experience		
0-5	19	34.5
6-10	17	30.8
11-15	8	14.6
16-20	7	12.7
21-25	2	3.7
Above 26	2	3.7
Total	55	100

Table 4 (*continued*)

Demographic Variable	Frequency	Percentage
Highest Academic Qualification		
Bachelor	17	30.8
Master	29	52.7
PhD.	8	14.6
Others	1	1.9
Total	55	100
Familiarity with the On-premises to Cloud Data Migration Process		
No	17	30.8
Yes	38	69.2
Total	55	100
Level of Understanding of the Cloud Data Migration Process		
Basic	25	45.5
Intermediate	19	34.5
Expert	11	20.0
Total	55	100

Cloud Profession

The study identified most respondents (54.4%) to be cloud users, next to cloud users are other IT professionals (23.6%), this category belongs to computer science, but they are not professionals in cloud computing. 14.6% are either cloud researchers or academics. Whereas, cloud service providers and cloud auditors made the least proportion of the respondents with 3.7% each. The distribution of respondents indicates that the study engaged a diverse group of cloud computing professionals and other IT experts.

Years of Working Experience

The respondents had varying lengths of years of professional working experience. The highest range is 0-5 years (34.5%), followed by 6-10 years (30.8%), 11-15 years (14.6%), 16-20 years (12.7%), while 21-25 years, and above 26 years made the least range of working experience among respondents, with 3.7% each. This clearly indicates that a mixture of early career and seasoned professionals was involved in the study.

Highest Academic Qualification

52.7% of the respondents had a Master's degree, while 30.8% had a Bachelor's degree. 14.6% had PhD degrees, and 1.9% hold other qualifications, other than conventional degree qualifications. The academic composition reflects how well educated the respondents are; this suggests the credibility of their responses.

Familiarity with On-premise to Cloud Data Migration

About 69.2% of the respondents indicated their familiarity with the on-premise to cloud data migration process, while 30.8% indicated a trace of knowledge in on-premise to cloud, but are without practical or prior experience of the process. The percentage highlights that most respondents had relevant knowledge of the research context, which makes their feedback valuable.

Level of Understanding of Cloud Data Migration

In terms of hierarchy of respondents' level of understanding; 45.5% had a basic understanding, 34.5% were rated intermediate in their understanding. While 20% of the respondents are experts. This distribution shows how the varying levels of expertise can provide a balance in assessing the response from different perspective which could reduce bias. The insight from the demographic data confirms the appropriateness of the selected respondents for the investigation and their suitability in all the perspectives of the study objectives.

RESULTS AND DISCUSSION

Summary of Statistics

The outcome of the pilot study provided insights into the reliability of constructs and the distribution of responses among respondents. It also guided the main investigation through the collection of data and analysis for descriptive analysis. The descriptive statistics were employed to summarise demographic variables, including respondents' professional background, years of experience, educational qualifications, familiarity with the migration process in cloud data, and level of expertise.

The sample size consists of 55 respondents. The summary of the percentages of respondents' distribution includes cloud users (54.5%), IT professionals (23.7%), cloud researchers/academics (14.6%), CSP and cloud auditors had 3.6% each. The respondents' working experience ranges from 0-5 years to over 26 years, indicating the inclusion of both high and low professional levels in the study. The highest proportion of academic qualification among the respondents was a Master's degree (52.7%), followed by a bachelor's degree (30.8%). 14.5% have a PhD degree, and the least proportion was other IT professionals with 1.9%.

On the respondents' familiarity with cloud data migration, 69.1% were reported having prior experience in cloud data migration, while 30.9% were only familiar but had no direct practical involvement. Additionally, the respondents' level of understanding about cloud data migration had varying proportions; Those with basic knowledge are 45.5%, intermediate (34.5%), and expert (20.0%).

After the descriptive analysis, the research constructs were tested for reliability, and all the constructs had their Cronbach's alpha value above the acceptable threshold of 0.7.

Particularly, the range falls between 0.799 and 0.972, demonstrating a strong reliability of the constructs. This finding has proven the reliability of the research instrument to be suitable for the main study.

Evaluating the Measurement Model

The measurement model was assessed for reliability and validity of the constructs and their indicator. Having its basis in the hypothetical model of the measures in the user control framework for cloud data migration, as illustrated in Figure 1, the theoretical foundation for understanding the factors influencing the migration process and their corresponding control metrics was established through the framework. This led to the model that highlights the relationships among the constructs and their impact on each other. The framework also integrates standards and performance metrics as key control measures to ensure an efficient and secure migration process.

The hypothesis testing result as illustrated in the study measurement model shown in Figure 2, demonstrates that 4 out of the 9 hypotheses were not supported. The unsupported hypotheses are found in the relationships between security and performance, legal and standards, and the relationship that personnel knowledge has with both standards and performance. The supported hypotheses alongside their corresponding indicators have their relationship in the proposed framework mapped with a straight line, whereas the unsupported hypotheses are mapped with dotted lines.

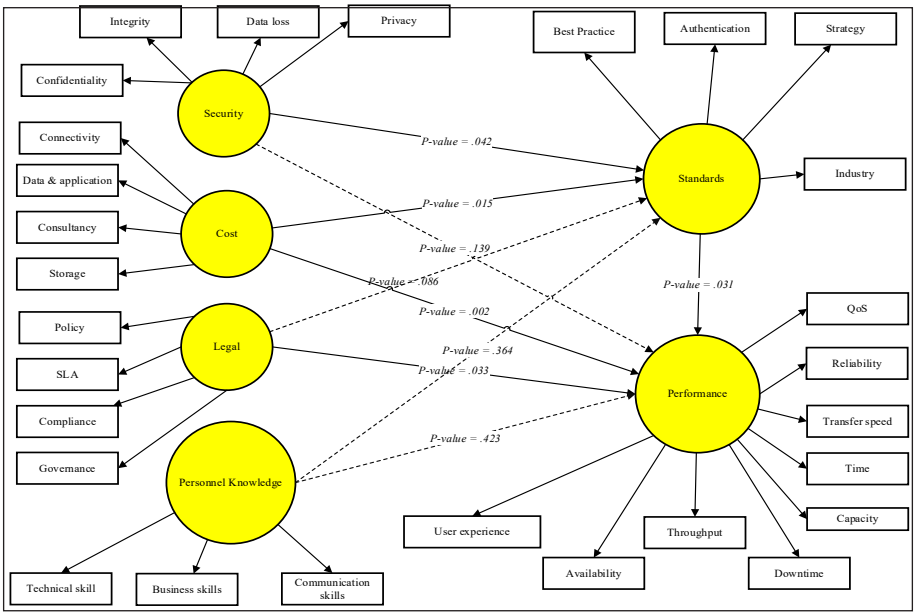

Figure 2. The study measurement model (a structural diagram representing relationships between security, cost, legal compliance, personnel knowledge, and migration success)

Further to this, Table 5 presents the relationships identified among the constructs, and the measurement properties of the measurement model.

Table 5
Reliability and validity of the constructs in the measurement model

Variable	Indicators	Factor Loading	Cronbach's Alpha	Composite Reliability	AVE
Cost	COST1	0.855	0.830	0.887	0.663
	COST2	0.853			
	COST3	0.745			
	COST4	0.800			
Legal	LGAL1	0.730	0.818	0.875	0.637
	LGAL2	0.828			
	LGAL3	0.846			
	LGAL4	0.811			
Performance	PERF1	0.788	0.951	0.957	0.648
	PERF2	0.780			
	PERF3	0.807			
	PERF4	0.818			
	PERF5	0.778			
	PERF6	0.855			
	PERF7	0.799			
	PERF8	0.782			
	PERF9	0.803			
	PERF10	0.825			
	PERF11	0.815			
	PERF12	0.808			
Personnel knowledge	PKNW1	0.751	0.753	0.852	0.650
	PKNW2	0.896			
	PKNW3	0.806			
Security	SECU1	0.793	0.854	0.901	0.696
	SECU2	0.835			
	SECU3	0.877			
	SECU4	0.829			

Table 5 (*continued*)

Variable	Indicators	Factor Loading	Cronbach's Alpha	Composite Reliability	AVE
Standards	STND1	0.839	0.955	0.961	0.674
	STND2	0.773			
	STND3	0.843			
	STND4	0.857			
	STND5	0.704			
	STND6	0.884			
	STND7	0.866			
	STND8	0.910			
	STND9	0.805			
	STND10	0.747			
	STND11	0.765			
	STND12	0.834			

Reliability Analysis of Constructs

Sequel to the Confirmatory Factor Analysis (CFA) results, the convergent validity, discriminant validity, and reliability of all the multi-variate constructs were analysed, based on the upheld guidelines from existing literature**:** (Ab Hamid et al., 2017). The Composite Reliability (CR) was assessed in terms of the degree to which construct indicators are free from random error and yield consistency at a range from 0.753 to 0.955, which justifies the degree to which the indicators are free from random error. Therefore, consistency in the constructs is upheld.

Using another technique of the measurement model, the discriminant validity, also known as divergence validity, was assessed through the Fornell and Larcker criterion cross-loadings, and the Heterotrait-monotrait ratio (HTMT) as the primary criterion for discriminant validity assessment. The HTMT paired matrix values for all the constructs are presented in Table 6. The validity results show that the HTMT values are below 0.9; as such, discriminant validity has been established. This is also reported so in Roemer et al. (2021) and Yusoff et al. (2020) where the HTMT criterion analysis was used for the validity of constructs.

Table 6
Discriminant validity - the HTMT paired matrix values of constructs

	COST	LGAL	PERF	PKNW	SECU	STND
COST						
LGAL	0.682					

Table 6 (*continued*)

	COST	LGAL	PERF	PKNW	SECU	STND
PERF	0.947	0.543				
PKNW	0.773	0.762	0.637			
SECU	0.564	0.713	0.623	0.663		
STND	0.740	0.656	0.799	0.632	0.682	

On the disposition of the Fornell-Larcker criterion, the square root of the average variance extracted (AVE) presents each latent construct and suggests that they ought to exceed the correlations of all the other latent constructs. Implying to note that the AVE for each construct should exceed its highest correlation with other constructs in the model. It is based on this principle that studies like Henseler et al. (2015) and Hilkenmeier et al. (2020) leveraged on the Fornell-Larcker criterion to establish their claims.

Hypothesis Testing

The result of the hypotheses tested in a relational model using Structural Equation Modelling (SEM), as presented in Table 7 and Figure 2, showed that security has a significant influence on standards, with a p-value of 0.042, at a 0.05 significance level. Therefore, H1 was supported. This finding highlights the importance of implementing security measures by addressing confidentiality, data loss, data integrity, and privacy concerns in accordance with cloud standards to enhance user control in the data migration process. For H2, which suggested that security has a significant impact on performance in the control of the data migration process, with a p-value of 0.139, indicating that there was no support for the hypothesis, hence security has no impact on the performance of users in the control of the migration project. H3, has it that cost is effectively high on standards in the control of the data migration process, with a p-value of 0.015; the hypothesis was supported. Similarly, H4 cost shows a significant effect on performance in the control of the data migration process, with a p-value of 0.002; hence, the hypothesis was supported. Whereas H5 postulated that legal factors have a significant effect on standards in the control of the data migration process. The hypothesis was not supported due to a p-value of 0.086. Legal factor, however, shows a significant effect on performance, hence H6 is supported with a p-value of 0.033. The hypotheses related to personnel knowledge (H7 and H8) are not supported, with p-values of 0.364 and 0.423, respectively. Suggesting that personnel knowledge has no significant influence on either standards or performance. This implies that personnel knowledge may

be a baseline competency in cloud environments; thus, variance may be insufficient to predict control outcomes. Alternatively, structured standards may mitigate dependence on individual expertise. Finally, the impact of standards on performance (H9) is supported, with a p-value of 0.031, indicating that standards significantly contribute to performance outcomes in the model.

Table 7
Path coefficient analysis and hypotheses testing

Hypothesis	P-value	Decision
H1: SECU → STND	0.042	Supported
H2: SECU → PERF	0.139	Not supported
H3: COST → STND	0.015	Supported
H4: COST → PERF	0.002	Supported
H5: LGAL → STND	0.086	Not supported
H6: LGAL → PERF	0.033	Supported
H7: PKNW → STND	0.364	Not supported
H8: PKNW → PERF	0.423	Not supported
H9: STND → PERF	0.031	Supported

Effect Size of Variables

Table 8 presents the effect size (F-square values) of independent variables, showing their impact on Performance (PERF) and Standards (STND) in the model.

Table 8
Effect size of variables

Variable	F^2	Effect Size
COST → PERF	0.977	Large
COST → STND	0.213	Moderate
LGAL → PERF	0.066	Small
LGAL → STND	0.021	Small
PKNW → PERF	0.002	No effect
PKNW → STND	0.001	No effect
SECU → PERF	0.055	Small
SECU → STND	0.141	Small
STND → PERF	0.288	Moderate

The F^2 from the Table based on Cohen (1988) guidelines, an effect size is considered small if F^2 is ≥ 0.02 and < 0.15, moderate if ≥ 0.15 and < 0.35, while F^2 is considered large if it is 0.35 or above. While an effect size of < 0.02 means no effect. Thus, the path

from COST to PERF shows a large effect size ($F^2 = 0.977$), suggesting that cost has a substantial and dominant influence on performance within the model. The paths COST to STND, SECU to STND, and STND to PERF all demonstrate small and moderate effect sizes ($F^2 = 0.213$, 0.141, and 0.288, respectively), indicating that these relationships have meaningful, though not dominant, impacts on the associated dependent variables. On the other hand, LGAL to PERF ($F^2 = 0.066$), LGAL to STND ($F^2 = 0.021$), and SECU to PERF ($F^2 = 0.055$) display small effect sizes, showing that legal considerations and security contribute modestly to performance and standards. Notably, the paths from PKNW (Personnel Knowledge) to PERF ($F^2 = 0.002$) and PKNW to STND ($F^2 = 0.001$) exhibit negligible effect sizes, implying that personnel knowledge has no impact on performance or standards in this context.

Practical Application of the Proposed User Control Framework

The proposed user control framework provides a structured and practical approach for assessing and managing user control throughout the cloud data migration lifecycle. It aligns with key migration phases: pre-migration planning, risk assessment, data preparation, migration execution, and post-migration validation and optimisation. while embedding a dedicated user control module that ensures continuous evaluation and intervention. This module projects user control by integrating measurable constructs, including standards (e.g., best practices, authentication, and strategy), performance (e.g., reliability, transfer speed, and availability), and influencing factors such as security, cost, legal compliance, and personnel knowledge.

A key practical feature of the framework is the computation of a User Control Level (UCL), which provides a quantitative basis for decision-making. The UCL is evaluated against a defined threshold range to determine whether migration conditions are adequate. When the control level meets the acceptable threshold, migration activities can proceed with confidence. However, if the control level falls below the required standard, the framework triggers a feedback mechanism, prompting users to reassess and improve relevant control measures before continuing.

This iterative evaluation process makes the framework directly applicable as a decision-support and diagnostic tool for organisations. It enables practitioners to monitor readiness, identify weaknesses in control mechanisms, and implement corrective actions in real time. By translating abstract control concepts into measurable indicators and actionable steps, the model enhances transparency, accountability, and effectiveness in cloud data migration processes.

CONCLUSION

This study examines the factors that influence user control in the cloud data migration process and analyses the relationships between the constructs and their indicators. The reliability values of the constructs of the model show internal consistency with a Cronbach's alpha value greater than 0.80; this value exceeds the recommended threshold of 0.70, indicating consistency (Sarstedt et al., 2019). The constructs of this study were also validated through the measurement model. Additionally, the convergent and discriminant validity of all constructs/indicators were established through AVE and CR. The final model was tested in SEM to validate the hypotheses and examine the effect of each construct on the data migration process. Results from further analysis highlight constructs that are supported by the hypothesis statement, showing the significance of the relationship among constructs of user control affecting factors and the control metric that measures their outcome. This provides users with key constructs to consider in the cloud data migration process. The proposed model could provide a comprehensive framework for user control measurement in cloud data migration. The implications of this study also extend to industry practitioners, policymakers, and researchers, based on the multidisciplinary context that was integrated to support the model development. This suggests that future research could translate the framework into actionable guidance.

Although cloud service provider size was not examined in this study, it represents an important contextual variable that may moderate the relationship between TOE factors and user control outcomes. Future research should investigate cloud service providers' size as a moderating variable, to better understand how providers size can affect customers' support and user experience. Potentially through multivariate analysis comparing large and small cloud service providers.

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