

# A User Control Framework for Cloud Data Migration in Software as a Service

Danga Imbaji Injuwe<sup>1</sup>, Hamidah Ibrahim<sup>2</sup>, Fatimah Sidi<sup>3</sup>, Iskandar Ishak<sup>4</sup>

Department of Information and Communication Technology, Taraba State University, Jalingo, Nigeria<sup>1</sup>

Department of Computer Science, Universiti Putra Malaysia, Selangor, Malaysia<sup>2,3,4</sup>

**Abstract**—Cloud computing represents the overarching paradigm that enables organizations to leverage cloud services for data storage and application deployment. Nowadays, organizations that use the cloud services can migrate their data using software as a service (SaaS). The organizations' data and application are deployed over the cloud through the cloud data migration process of the on-premise to cloud migration; referring to the transition process from the legacy, locally hosted systems to cloud environment. Several data migration frameworks have emerged to guide users in the migration process. While numerous studies have addressed the importance of granting control to users during the cloud data migration process, a user control framework is yet to be created. Thereby, depriving user of visibility and sense of ownership, customization to meet users need, compliance and governance, and training. This paper aims at achieving this by proposing a conceptual user control framework for cloud data migration process in SaaS. The framework is constructed based on a comprehensive analysis conducted over existing research works that are related to cloud data migration with the aim to identify the steps/phases of data migration process, the factors affecting the user control with regard to the identified phases, and the control metrics of each identified factor. An initial conceptual user control framework is constructed based on the analysis of the literatures and further enhancement of the framework is made based on the expert reviews.

**Keywords**—Comparative analysis; cloud computing; cloud data migration; on-premises to cloud migration; user control; Software as a Service

## I. INTRODUCTION

Cloud computing is better comprehended by examining its fundamental functionalities which are universal connectivity, open access, reliability, interoperability, user choice, security, privacy, economic value, and sustainability, as outlined by study [1]. These functionalities are delivered through the three major cloud service delivery models, namely: Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS); which typically reduce the capital expenditures through the "pay-as-you-go" model [2] [3]. The service models are described by study [4] as dependant stack layers with IaaS at the base, providing virtualized computing resources such as servers, storage, and networking; followed by PaaS, providing a platform for application development, deployment, and management; and SaaS at the top, offering fully managed applications accessible over the Internet.

Among the cloud service models, SaaS model records the

unprecedented migration of organizations from on-premises to cloud platform with market growth at 17% percent per annum [5]. According to the public cloud worldwide forecast [4], SaaS growth and market size are expected to exceed 147 million US dollar by year 2022. Despite the fact that SaaS is growing in popularity due to its diverse benefits, organizations find the process of migrating data from on-premises to cloud platforms to be complex [6].

Data migration process is not free from challenges, including those related to planning, costing, application dependency, security, compliance, data, and service downtime [7]; while outage, backup, destination identification, automation capabilities, lack of knowledgeable staff are among other challenges affecting the data migration process from on-premises to cloud [8]. As a result, these have an impact on the degree of user control over the data migration process. User control is the ability for the user to determine what information can be disclosed or hidden during processing, transferring, or migration, as well as who can access it [9].

Various organizations have hosted their data and applications on-premise while others hosted theirs in the cloud; nonetheless the migration schemes are in three facets, namely: on-premise to cloud, cloud to cloud, and cloud to on-premise [10] [11]. The migration of data and applications hosted on-premises to the cloud in SaaS platform is the focus of this study. This is mainly due to the fact that the recent advancement in cloud computing and the advantage gained during the Covid-19 lockdown has accelerated the data migration of on-premise to cloud [12] [13].

Moreover, the process of migrating data to cloud has improved over the years with notable researches leveraging on existing data migration process and frameworks.

As of right now, no study has reviewed the existing cloud data migration process of on-premise to cloud and conducted comparative analysis with the goal of improving user control over the process, in order to give the user the ability to feel ownership, customize the process to meet their needs, ensure compliance and governance, and provide adequate training that comes with cloud data migration process. Thus, this study attempts to fill this gap. In brief, the main contributions of this study are as follows:

1) We conducted a comparative analysis on the different phases of data migration from on-premise to cloud that were proposed by previous studies to finalise the cloud data

migration phases that will be incorporated into the proposed conceptual framework;

2) We identified the factors that affect the user's control of cloud data migration process according to the phases identified in (a) in order to determine the user control measures; and

3) We constructed a conceptual user control framework based on the factors identified in (b) above.

This paper is organized as follow: Section II presents the background related to the study and discusses the related works that emphasized on the phases of cloud data migration process. It also deliberates on the factors affecting user control in cloud data migration process, as presented in several works. This is then followed by Section III which discusses the research methodology that is employed by this study in realising the conceptual user control framework for cloud data migration in SaaS. The result and discussion section is presented in Section IV and the summary with the plan of future work are given in Section V.

## II. BACKGROUND AND RELATED WORK

This section starts by elaborating on the general definition of data migration process focusing on on-premises to cloud. It then discusses the different steps/phases as proposed by the studies [5][12 – 17]. Meanwhile, through the following studies, [3] [13] [16][20][24 – 37], the factors affecting user control in cloud data migration are analyzed and discussed in this section.

Data migration process starts with analysing data from the legacy/old system and ends in the uploading and normalizing data in new application. In study [14], cloud data migration is defined as the process of moving data, localhost applications, and services to the distributed cloud processing framework. Meanwhile, [15] argued that data migration is not just a process of moving data from an old data structure or database to a new one; it is also a process of correcting errors and improving overall data quality and functionality.

Nowadays, data migrations are usually influenced by organizations keenness to optimize or transform their company through moving from on-premises infrastructure and applications to cloud-based storage and applications [16]. Furthermore, when migrating to SaaS platform, there is a need to first identify the key prerequisite that will be relocated to the cloud and break them down in accordance with the current architectural requirement [14].

### A. Phases in Data Migration Process

Over the years, researchers and practitioners have devised different data migration phases which have made the process of data migration flow in a systematic order, with each step preceding another. A number of data migration phases were proposed by different studies [5] [12 – 17], to support data migration from on-premise to cloud as shown in Table I.

From Table I, the following can be observed:

1) Different phases of data migration process have been identified by the authors, with each phase comprising specific activities,

2) Assessment, planning, design, migration, testing, and post-migration are the common activities as reflected in these various studies,

3) Security remains an important consideration as demonstrated in the phases of these studies,

4) Most studies present an intent to address both business and technical issues that may arise from the identified phases.

### B. Factors that Affect User Control in Cloud Data Migration

Based on the review conducted on [3] [13] [16] [20] [24 – 32] [35 – 37], the control of data migration process is affected by several factors, namely: security [3] [13][24 – 27], cost [18], legal [19], and personnel knowledge [20][37] as presented in Table II. In the following each of these factors are further discussed.

Security of data means measures, controls, and procedures applied on ICT systems in order to ensure integrity, authenticity, availability and confidentiality of data and systems [21]. This is important to data in transit and data at rest [7]. To ensure a high level of security, a set of techniques including data segmentation, error control/correction, encryption, decryption, and data hashing are used [22]. Measures for data security are confidentiality, integrity, availability and compliance of the data during the migration process [17] [23]. The control measures should ensure that the data are not compromised during the migration process and that they remain secure in the cloud environment.

Cost is the service charge required for moving data and application from the old on-premise deployments to the new cloud infrastructure [24] [25]. Minimizing various cost of downtime, minimizing the cost of resources required for the migration, and ensuring that the overall cost of the migration is within budget as this is always the aim of an organization [26]. However, [27] earlier reported that internal cost of labour for administrative personnel takes 50% of the budget.

Data migration to the cloud offers numerous benefits but also entails legal challenges in terms of SLA compliance and adherence to cloud regulations [48]. To mitigate these challenges, organizations should carefully negotiate and review their SLAs with Cloud Service Providers (CSPs), ensuring they address critical aspects of data security, privacy, ownership, and control [49]. Moreover, organizations must understand and comply with the relevant cloud regulations governing data protection, privacy, cross-border data transfers, and industry-specific requirements [50]. By proactively addressing these legal challenges, organizations can ensure a smooth and legally compliant data migration process to the cloud.

Personnel knowledge plays a vital role in the success of data migration processes. Technical knowledge is essential for understanding data architecture, infrastructure, and security measures; communication knowledge helps to convey the information to all parties involve while, business knowledge ensures compliance, smooth business operations, and effective data analysis [51].

TABLE I. PHASES AND ACTIVITIES OF EXISTING DATA MIGRATION PROCESS FROM ON-PREMISE TO CLOUD

Reference	Step/ Phase	Data Migration Phase	Activity
[4]	1	Data assessment	Identify sources, run queries, review, revise, plan, scope, strategy, validate, and milestones.
	2	Data cleansing	Analysis, preparation, cleaning, formatting, extracting of data that will be migrated.
	3	Extract, Test and, Load (ETL)	Create mappings, extract data, automate, clean, execute mock load, validate, report, and delivery of data.
	4	Final extract and load	Execution of final extracts from the current systems, loading of data extracts using ETL tools into target system.
	5	Migration validation	Verify if all the required data are transferred according to the requirements.
	6	Post migration activities	Planning, creating backups, quality testing, and documentation of reports.
[26]	1	Define migration portfolio	Understand organizational context and identify migration portfolio (migration goals, business process, policies, strength and knowledge gap, application and data profile).
	2	Risk identification	Understand the risk associated with cloud migration (loss of governance, disaster recovery, and security incident report).
	3	Requirement and assurance analysis	Identify requirement, assurance, and control measure.
	4	Cloud migration decision and strategy	Decision to migrate to the cloud is taken and the migration strategy is defined (migration type, service/deployment model, migration assessment index, data store and hosting type, adaption action, migration testing, adaption constraint, roles, and responsibility).
[27]	1	Discovery and assessment	Financial assessment, assessment of existing IT within, and identify legacy system security assessment tools and licenses requirement.
	2	Proof of concept	Build a pilot support within the organization, automate migration task from any source to target, and test performance, backup, and recovery.
	3	Planning and design	Identify data source, location and, sensitivity. Plan security at all layers and, hybrid migration strategy.
	4	Cloud migration	Leverage different storage options by replicating source data to public cloud and test migrated workloads.
	5	Operations and optimization	Monitor usage and logs performance to review re-engineering.
[28]	1	Definition	Evaluate business needs through cost benefit analysis, define cloud migration strategy, and define migration roadmap.
	2	Design	Identify cloud vendor and assess cloud readiness based on migration plan.
	3	Migration	Build the cloud migrate resources and migrate applications.
	4	Manage	Monitor application and train staff to manage the process.
[29]	1	Assessment	Evaluation, feasibility study, and technical and functional requirement.
	2	Blueprint solution	Design, built, validate, and deploy.
	3	Migration	Data mapping, tool, migration plan, strategy, execution, and, verification.
	4	Post-migration	Performance testing, improvisation, and maintenance.
[30]	1	Discover	System data analysis.
	2	Prepare	Data migration strategy.
	3	Explore	Design and build.
	4	Realize	Data verification and change management.
	5	Deploy	Data ready management.
	6	Go live	Operating.
[31]	1	Data strategy, planning, and preparation	Analysis of data requirements and business goals, data cleansing, mapping, security implementation, and migration planning.
	2	Data extraction and transformation	Data are retrieved from the source system, undergoes preparation and transformation.
	3	Data load and validation	Data are loaded into the target system or cloud environment.
	4	Testing and go-live	Data are tested in a staging environment before transitioning to the cloud. Continuous monitoring and maintenance to ensure data quality and security.
[32]	1	Road mapping	Assess the scope of work by evaluating the existing architecture and application capabilities and build a roadmap using research, analysis, and strategic planning.
	2	Design	Determine whether they need to completely redesign their existing architecture, database, and codebase.
	3	Change management	Span the entire migration process to increase the adoption of new systems through training and feedback loops.
	4	Testing	Applications, integrations, and systems are tested for performance and stability to ensure a smooth migration process.
	5	Data migration	Implementation and deployment.

TABLE II. FACTORS THAT AFFECT THE CONTROL OF DATA MIGRATION PROCESS

Factor	Item	Description	Reference
Security	Confidentiality	Intentional or unintentional destruction of data caused by people and or processes.	[34]
	Integrity	To ensure that data is securely protected during migration from a non-cloud computing environment to the cloud.	[35][36]
	Data loss	The deletion of data, whether deliberate or accidental by individuals or the data migration process.	[5]
	Privacy	Restriction of access to data and other resource in place.	[29][37]
Cost	Application and data cost	Cost of deploying a cloud service.	[38]
	Storage cost	How to exploit these storage classes to serve an application with a time-varying workload on its objects at minimum cost.	[39]
	Connectivity	Cost of connectivity between the user and the cloud service provider.	[40]
	Consultancy	Cloud proprietary tools for migration are usually accompanied by expensive consultancy costs.	[41][42]
Legal	Service level agreement	Level of service required between the consumer and the service provider.	[43]
	Policy	The statement of intent drafted by the organization governing body that will be responsible for all the phases of data migration. It provides users with a policy expressing their preference to data.	[44][45]
	Compliance	Varying cloud regulation across the globe result in risk caused due to violations of the established jurisdictional regulations.	[46]
Personnel Knowledge	Technical knowledge	The staff's technical cloud technology skills.	[18]
	Communication knowledge	Fostering a positive working relationship between IT departments and cloud service providers.	[47]
	Business knowledge	Knowledge of the business process and change management.	[32]

III. METHODOLOGY

The phases of the research methodology are illustrated in Fig. 1. These phases are: (i) Phase 1 in which a review of existing literatures is conducted with deliverables to include identification of the cloud data migration phases, factors affecting user control in the migration process, and control metrics; and (ii) Phase 2 in which the initial conceptual user control framework is developed and further enhancement is made according to the experts' reviews.

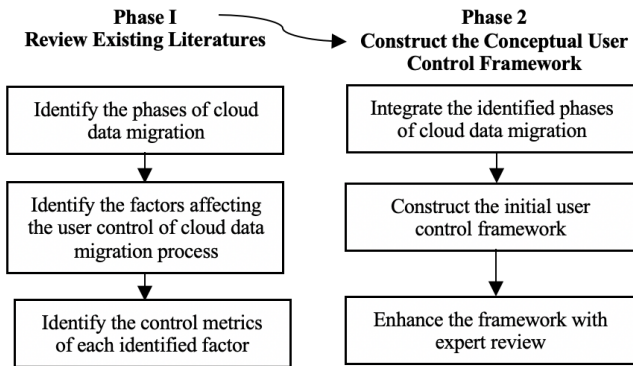


Fig. 1. Phases of the research methodology.

A. Phase 1: Review Existing Literatures

Following the review of existing literatures in Section II, the Phase 1 has the following deliverables:

1) *Identify the steps / phases of cloud data migration.* This is achieved by analysing the following existing works [5] [12 – 17]. The results of the analysis are presented in Table I.

2) *Identify the factors affecting the user control of cloud data migration process.* By analysing the following existing works [3][13][16][20][24 – 32][35 – 37], four factors are identified, namely: security, cost, legal, and personnel knowledge.

3) *Identify the control metrics of each identified factor.* Reviewing the same literatures as in (ii) above, results in the control metrics as listed in Table II, column *Item*. For instance, the identified control metrics of security through the review are confidentiality, data loss, integrity, and privacy.

B. Phase 2: Construct the Conceptual User Control Framework

The construction of the proposed conceptual user control framework involves three main tasks as explained below:

Integrate the identified phases of cloud data migration – The existing steps/phases of cloud data migration proposed by [5] [12 – 17] as shown in Table I of Section II are analyzed, integrated, and renamed in Table III. The table provides a comparison of the cloud data migration phases based on whether certain phases are similar marked as (✓) or not, marked as (X). Apparently, pre-migration planning and analysis and migration execution are the common phases among these studies. Meanwhile, data preparation and cleansing is mentioned only by the works in [6], [36], and [38].

TABLE III. ANALYSIS OF DATA MIGRATION PHASES

Reference	(a)	(b)	(c)	(d)	(e)
[6]	X	✓	✓	✓	✓
[52]	✓	X	X	✓	X
[28]	✓	✓	X	X	X
[29]	✓	✓	X	✓	✓
[30]	✓	X	X	✓	✓
[31]	X	X	✓	✓	X
[32]	✓	X	X	✓	✓
[33]	✓	✓	✓	✓	X
[53]	✓	X	X	X	✓
<b>Number of common phases</b>	<b>7</b>	<b>4</b>	<b>3</b>	<b>7</b>	<b>5</b>

Note: (a) Pre-migration Planning and Analysis; (b) Risk Assessment and Strategy; (c) Data Preparation and Cleansing; (d) Migration Execution; and (e) Post-migration Validation and Optimization

Based on the steps/phases identified in the Phase I and detail analysis conducted on these steps/phases, we have identified the following five phases as the phases of cloud data migration of on-premise to cloud: pre-migration planning and analysis, risk assessment and strategy, data preparation and cleansing, migration execution, and post-migration validation and optimization. At this stage, all steps/phases with similar tasks are grouped together. The phases are explained below:

1) *Pre-migration planning and analysis* – in this initial phase of data migration, understanding the organizational context and identifying data migration plan to the cloud which involves analysing the existing/legacy applications based on available information and parameters with the aim to make informed decisions about migration [14]. This analysis provides understanding on the current state of the application [54]. The planning process should consider parameters such as security requirements, completeness, accuracy, and storage [7]. The planning should also involve selecting a cloud provider and costs estimation [55]. By following a comprehensive pre-migration approach, organization can ensure a well-thought-out migration strategy and minimize the cost and risks associated with data migration to the cloud [56].

2) *Risk assessment and strategy* – this phase involves a comprehensive evaluation of potential risks and the development of a strategy to address and mitigate risks throughout the data migration process [38]. The risk involves extended downtime, budget, and business data [27]. A comprehensive data migration strategy should take into consideration the legacy data, mapping data from the old system to the new system, challenges of identifying source data, interacting with continuously changing targets, adhering to data quality requirements, creating appropriate process methodologies, and employing general migration expertise

[6]. It guides on which cloud application and cloud service to engage [57]. This encompasses project context, necessary actions, assumptions, limitations, architectures, and pertinent information conveying the methodology of the data migration project [58].

3) *Data preparation and cleansing* – this phase involves the initial step of data structuring, improving, and purifying prior to its transfer to a cloud-based system. This phase involves activities like data formatting, eliminating duplicates or irrelevant data, and verifying data accuracy, all aimed at enhancing the effectiveness and dependability of the migration process [59].

4) *Migration execution* – this phase involves the following tasks: execute, mock, load, validate, and report the data migration experience. Load data extracts the data into the target system using the ETL tools and migrate them to the selected cloud data store.

5) *Post-migration validation and optimization* – this phase verifies if all the required data are transferred to the cloud according to the requirements. Hence, the following tasks are to be performed: monitor the application performance and usage, review and re-engineer the migrated workloads, and train the staff to manage the migrated data and application [29].

Construct the initial user control framework – The conceptual user control framework is presented in Fig. 2. It is constructed based on the findings of the reviewed literature. The framework consists of three dimensions that the study found to be pertinent to the user control of data migration process from on-premise to cloud using SaaS. These dimensions include affecting factors at the left hand side, phases of cloud data migration in the middle, and the control metrics at the right hand side of the conceptual framework.

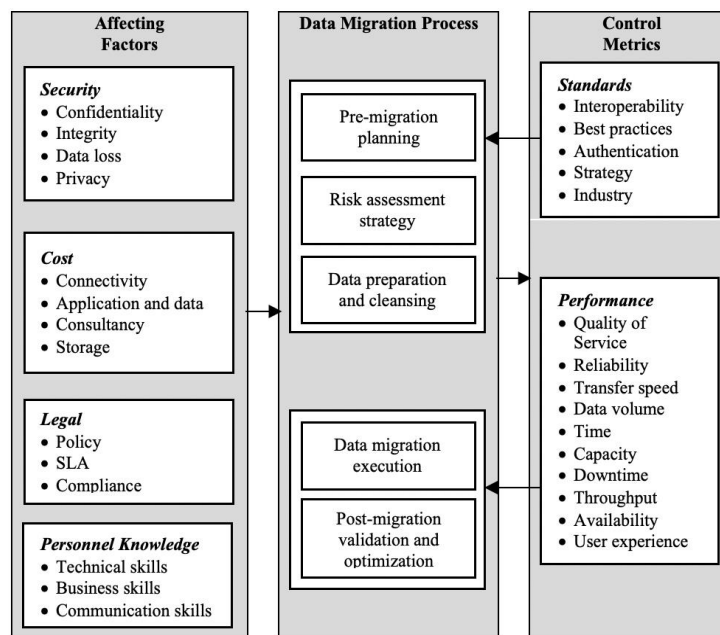


Fig. 2. The initial conceptual user control framework in SaaS cloud data migration process.

Mapping the affecting factors and the control metrics to the cloud data migration process in the conceptual framework, results in 6 constructs, namely: security, cost, legal, personnel knowledge, standards, and performance. The constructs/items are validated by experts through a content validity form with an aim to determine the relevance of the items to the construct that are being measured.

A content validity form (see Appendix A) was administered to five experts. The form consists of 5 sections, namely: (i) Section A: Demographic information (Q1 – Q6), Section B: the perceptions of user control of on-premise to cloud data migration process using SaaS (Q1 – Q6), Section C: the control metrics with the following constructs: standard (Q7 – Q12) and performance (Q13 – Q22), Section D: the affecting factors with the following constructs: security (Q23 – 26), cost (Q27 – Q30), legal (Q31 – Q33), and personnel

knowledge (Q34 – Q36), and Section E: experts’ comments. As presented in Table IV, three of the expert reviewers are from academia and the other two are from industry. Their work experience ranges between 6 to above 26 years.

Expert review analysis – The data collected from the expert review survey are imported into excel sheet and analysed accordingly to calculate the content validity index (CVI). The CVI involved the calculation of two forms of Content Validity Index (CVI): the Item-Content Validity Index (I-CVI) and the Scale-Content Validity Index (S-CVI). The results indicated that the I-CVI yielded a value of 0.85, while the S-CVI produced a result of 0.88. Since, both results fall within the acceptable threshold to consider the items as relevant. The summary of the experts’ review feedbacks is presented in Table V.

TABLE IV. PROFILE OF THE EXPERT REVIEWERS

No.	Position/ Highest Qualification	Description	Location	Sector (Academia/ Industry)	Year of Experience
1	Professor/ Ph.D.	Cloud user	India	Academia	21 - 25
2	Cloud consultant/BSc	Cloud regulator	Malaysia	Industry	11 -15
3	Assistant Professor/ Ph.D.	Cloud researcher/ academics	USA	Academia	6 - 10
4	Database Engineer/MSc	Cloud service provider	India	Industry	Above 26
5	Professor/ Ph.D.	Cloud researcher/ academics	Nigeria	Academia	16 - 20

TABLE V. SUMMARY OF EXPERT REVIEW

Construct	Expert Review
Security	This construct contains 4 items, namely: <i>confidentiality, integrity, data loss</i> and, <i>privacy</i> . All of them were rated relevant by the experts.
Cost	This construct also contains 4 items, namely: <i>connectivity, application and data, consultancy,</i> and <i>storage</i> . The experts rated all the items as relevant.
Legal	There are 3 items for this construct. All of them were rated relevant by the experts. However, one of the experts suggested for additional item: <i>governance</i> . This is being considered because recent literatures have mentioned governance as a factor of data migration process.
Personnel Knowledge	This construct contains 3 items, namely: <i>technical skills, business skills,</i> and <i>communication skills</i> . All the experts rated them relevant.
Standards	There are 5 items for this construct. One item <i>interoperability</i> is rated irrelevant and thus it is removed. The other 4 items, namely: <i>best practice, authentication, strategy,</i> and <i>industry standards</i> are rated relevant.
Performance	There are 10 items for this construct. 9 items, namely: <i>quality of service, reliability, transfer speed, time, capacity, downtime, throughput, availability,</i> and <i>user experience</i> are rated relevant by the experts. One item <i>data volume</i> is removed for being rated irrelevant by the experts.

#### IV. RESULT AND DISCUSSION

The analysis of the validity of the constructs for the proposed conceptual user control framework utilized the procedure provided by [60], which include the following 6 steps: (i) preparation of content validation form, (ii) selection of the review panel of experts, (iii) conducting content validation, (iv) reviewing domain and items, (v) providing score on each item, and (vi) calculating the Content Validity Index (CVI). Steps 1 – 6 are carried out successfully. The data collated from the experts were used to calculate the content validity index CVI.

Furthermore, the conceptual model is enhanced by removing the items which fall below the threshold of the content validity index, CVI. As outlined by [60] the threshold established as standard for CVI should be within the range of 0.78 and 1. The CVI value of each item is presented in Table

VI. The table shows that the CVI values for interoperability and data volume are less than the standard threshold value, i.e. at 0.6 and 0.4, respectively. As a result, these two items are removed from the proposed conceptual model. While the CVI values for most items are either 0.8 or 1, all security items have a CVI of 1. On the other side, the experts suggested for the inclusion of the item governance. It was apparently added for its occurrences in recent literature of cloud data migration process. The inclusion of the item governance highlights the importance of regulatory control mechanisms in ensuring data security, compliance, and accountability throughout the cloud data migration process while the removal of the item interoperability signify a significant step towards aligning with the CVI threshold. These adjustments ensure that the conceptual model accurately represents the key items influencing user control during on-premise to cloud data migration. Fig. 3 presents the modified conceptual user control framework for in SaaS cloud data migration process.

TABLE VI. VALUE OF CONTENT VALIDITY INDEX FOR EACH ITEM

Construct	Question	Item	CVI
Standards	Q7	Interoperability	0.6
	Q8	Best-practices	0.8
	Q9	Strategy	0.8
	Q10	Industry	0.8
	Q11	Data transfer	0.8
	Q12	Authentication	1
Performance	Q13	Quality of Service	1
	Q14	Reliability	0.8
	Q15	User experience	1
	Q16	Time	1
	Q17	Data volume	0.4
	Q18	Transfer speed	1
	Q19	Downtime	1
	Q20	Throughput	0.8
	Q21	Availability	0.8
	Q22	Capacity	1
Security	Q23	Confidentiality	1
	Q24	Integrity	1
	Q25	Data loss	1
	Q26	Privacy	1
Cost	Q27	Application and data	0.8
	Q28	Connectivity	0.8
	Q29	Consultancy	0.6
	Q30	Storage	0.8
Legal	Q31	Policy	0.8
	Q32	SLA	1
	Q33	Compliance	0.8
Personnel Knowledge	Q34	Technical skills	0.8
	Q35	Business skills	0.6
	Q36	Communication skills	0.8

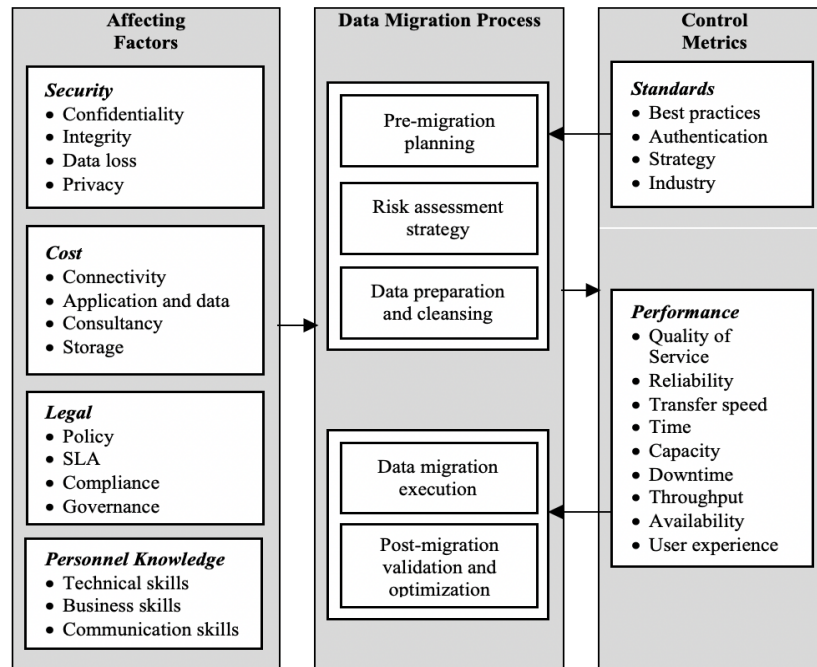


Fig. 3. The modified and proposed conceptual framework for the user control in SaaS cloud data migration process.

## V. CONCLUSION

Cloud computing has evolved tremendously since the advent of Covid-19 lockdown which made it gain advantage: attracting users to migrate data from on-premise to cloud with high number of users leveraging on the cloud SaaS application. In the cloud services, each user can be interacted and offered unique service regardless of location and time while reducing capital expenditure through the “pay-as-you-go model”. Hence cloud computing technologies can help users to experience the benefit that evolves with the technology in terms of research and innovation. This research contributes a conceptual framework for cloud data migration that considers SaaS in a cloud computing environment, with the aim to guide the cloud practitioners and users on preparation, implementation and monitoring the cloud data migration process.

The conceptual framework is proposed based on the antecedent in previous cloud data migration process found in existing literature, expert opinions and a survey on users perception. Having founded that, this study is limited to the knowledge of the expert reviewer and available literature. Future works may involve further refinement of the conceptual framework based on additional expert reviews and practical implementations. Additionally, empirical studies and real-world applications of the framework will be essential to assess its effectiveness and usability in diverse cloud data migration scenarios (see Appendix A). Continuous revises to the framework could be made to accommodate evolving cloud technologies, best practice, and regulations, ensuring its relevance in the evolving environment of cloud computing.

## ACKNOWLEDGMENT

This work was supported by the Tertiary Education Trust Fund (TETFund) and Universiti Putra Malaysia. All opinions, findings, conclusions and recommendations in this paper are those of the authors and do not necessarily reflect the views of the funding agencies.

## REFERENCES

- [1] D. C. Wyld, “The Cloudy Future of Government It: Cloud Computing and The Public Sector Around The World David,” *Int. J. Web Semant. Technol.*, vol. 1, no. 1, 2010, doi: 10.4156/jdcta.vol4.issue9.30.
- [2] Ngoc Ha Vy Nguyen, “Saas, Iaas and Paas: Cloud-Computing in Supply Chain Management,” pp. 1–46, 2021, [Online]. Available: [https://www.theseus.fi/bitstream/handle/10024/509445/Vy\\_Nguyen\\_Thesis\\_2021.pdf?sequence=2](https://www.theseus.fi/bitstream/handle/10024/509445/Vy_Nguyen_Thesis_2021.pdf?sequence=2).
- [3] E. Filiopoulou, “Analysis of Pricing Strategies of Infrastructure as a Service (IaaS),” no. May, pp. 1–144, 2020, doi: 10.13140/RG.2.2.28709.12007.
- [4] A. Bouayad, A. Blilat, N. E. H. Mejhed, and M. El Ghazi, “Cloud computing: Security challenges,” *Cist 2012 - Proc. 2012 Colloq. Inf. Sci. Technol.*, no. 5, pp. 26–31, 2012, doi: 10.1109/CIST.2012.6388058.
- [5] P. Dziadosz et al., “Cloud 2030 Capturing Poland’s potential for accelerated digital growth,” *McKinsey*, pp. 1–58, 2021.
- [6] A. Abdou Hussein, “Data Migration Need, Strategy, Challenges, Methodology, Categories, Risks, Uses with Cloud Computing, and Improvements in Its Using with Cloud Using Suggested Proposed Model (DMig 1),” *J. Inf. Secur.*, vol. 12, no. 01, pp. 79–103, 2021, doi: 10.4236/jis.2021.121004.
- [7] D. K. Kearn, “Planning & Management Methods for Migration to a Cloud Environment Author:,” no. 17, 2018.

- [8] A. MadhuriC, R. MeghaS, and B. Manjuprasad, “Data Migration Techniques in Cloud,” undefined, pp. 215–220, Jun. 2018, doi: 10.21467/PROCEEDINGS.1.37.
- [9] C. Perra, “A framework for user control over media data based on a trusted point,” in 2015 IEEE International Conference on Consumer Electronics, ICCE 2015, Mar. 2015, pp. 1–2, doi: 10.1109/ICCE.2015.7066294.
- [10] Prakash Kumar and Sourav Kumar Upadhyay, “Cause and Effect of Data Migration in Cloud Computing,” *Int. J. Innov. Sci. Res. Technol.*, vol. 7, no. 8, 2022.
- [11] S. Nikita, “On-Premise to Cloud Migration: A Step-by-Step Guide, Benefits, Challenges 2023,” 2023. <https://www.cloudpanel.io/blog/on-premise-to-cloud-migration/> (accessed Dec. 07, 2023).
- [12] R. Abdelazime and M. Marie, “Effects of Coronavirus Crisis in Organizations Decisions to Adopt Software as a Service,” vol. 3, no. 3, 2021.
- [13] M. Zboril and V. Svatá, “Cloud Adoption Framework,” *Procedia Comput. Sci.*, vol. 207, pp. 483–493, 2022, doi: 10.1016/j.procs.2022.09.103.
- [14] R. Amin and S. Vadlamudi, “Opportunities and Challenges of Data Migration in Cloud,” *Eng. Int.*, vol. 9, no. 1, pp. 41–50, 2021, doi: 10.18034/ei.v9i1.529.
- [15] O. Azeroual and M. Jha, “Without data quality, there is no data migration,” *Big Data Cogn. Comput.*, vol. 5, no. 2, 2021, doi: 10.3390/bdcc5020024.
- [16] W. Z. Latt, “Data Migration Process Strategies,” *Seventeenth Int. Conf. Comput. Appl. (ICCA 2019)*, pp. 295–300, 2019.
- [17] A. H. Shaikh and B. B. Meshram, “Security Issues in Cloud Computing,” *Lect. Notes Networks Syst.*, vol. 146, pp. 63–77, 2021, doi: 10.1007/978-981-15-7421-4\_6.
- [18] K. Cresswell, A. D. Hernández, R. Williams, and A. Sheikh, “Key Challenges and Opportunities for Cloud Technology in Health Care: Semistructured Interview Study,” *JMIR Hum. Factors*, vol. 9, no. 1, pp. 0–11, 2022, doi: 10.2196/31246.
- [19] R. Kemp, “Legal aspects of cloud security,” *Comput. Law Secur. Rev.*, vol. 34, no. 4, pp. 928–932, Aug. 2018, doi: 10.1016/J.CLSR.2018.06.001.
- [20] Mike Fillinich, “Data Migration Roadmap Guidance Document Version Control,” 2019.
- [21] N. Petrovova and M. E. G. Smihily, “ICT usage in enterprises in 2019 ICT security measures taken by vast majority of enterprises in the EU,” no. January, pp. 6–10, 2020.
- [22] M. Alkhonaini and H. El-Sayed, “Optimizing Performance in Migrating Data between Non-cloud Infrastructure and Cloud Using Parallel Computing,” *Proc. - 20th Int. Conf. High Perform. Comput. Commun. 16th Int. Conf. Smart City 4th Int. Conf. Data Sci. Syst. HPCC/SmartCity/DSS 2018*, no. 1, pp. 725–732, 2019, doi: 10.1109/HPCC/SmartCity/DSS.2018.00125.
- [23] J. Varia, “Migrating your Existing Applications to the AWS Cloud This paper has been archived For the latest technical content , refer t o the AWS Wh i t e papers & Guides page : This paper has been archived For the latest technical content , refer t o the AWS Wh i t e,” no. October, pp. 1–23, 2010.
- [24] L. Jiang, J. Cao, P. Li, and Q. Zhu, “A Mixed Multi-tenancy Data Model and Its Migration Approach for the SaaS Application,” pp. 295–300, 2012, doi: 10.1109/APSCC.2012.16.
- [25] Matt Tanner, “What is Data Migration? A Guide to Solutions And Planning | Arcion,” 2022. <https://www.arcion.io/blog/data-migration-solutions> (accessed Mar. 30, 2023).
- [26] S. K. Birthare and R. N. Sharma, “Study on Migration of on-Premise ERP tO SAAS Product,” vol. 02, no. 12, pp. 913–916, 2020.
- [27] P. Allaire, J. Augat, J. Jose, and D. Merrill, “Reducing Costs and Risks for Data Migrations,” *Methodology*, no. February, p. 31, 2010.
- [28] M. Indrawan-Santiago, A Decision Framework Model for Migration into Cloud: Business, Application, Security and Privacy Perspectives Shareeful. 2014.
- [29] S. Kumar, “Cloud Migration Strategy and Benefits,” pp. 1–32, 2019.



[30] J. Jayachandran, "Cloud {Migration} {Methodology}," p. 7, 2016.

[31] Ajith George, "Migration of Dynamics On-premise to D365 cloud Online," 2021. <https://blog.sysfore.com/migration-of-dynamics-on-premise-to-dynamics-365-cloud-online/> (accessed Apr. 01, 2023).

[32] S. Jha, "The Masterplan to Optimize your Data Migration Journey to the Cloud," 2022.

[33] M. Lach, "Cloud Data Migration Process: A Step-by-Step Guide to Transferring Data to the Cloud," 2023. <https://nexocode.com/blog/posts/cloud-data-migration/> (accessed Jun. 17, 2023).

[34] M. Ansar, M. W. Ashraf, and M. Fatima, "Data Migration in Cloud: A Systematic Review," Am. Sci. Res. J. Eng., 2018, [Online]. Available: <http://asrjetsjournal.org/>.

[35] N. Shah and S. Chauhan, "Secure Data Migration in Cloud Providing Integrity and," vol. 1, no. 12, pp. 1208–1212, 2015.

[36] C. Yang, F. Zhao, X. Tao, and Y. Wang, "Publicly verifiable outsourced data migration scheme supporting efficient integrity checking," J. Netw. Comput. Appl., vol. 192, no. November 2020, 2021, doi: 10.1016/j.jnca.2021.103184.

[37] D. Sullivan, "Chapter 12 Migration Planning," 2020.

[38] N. K. Bansal, "A COBIT based approach for migrating legacy systems to cloud infrastructure," no. April, 2020, [Online]. Available: <https://era.library.ualberta.ca/items/a040ab88-d656-493b-90e7-60613c5aac93>.

[39] Y. Mansouri, A. Nadjaran Toosi, and R. Buyya, "Cost Optimization for Dynamic Replication and Migration of Data in Cloud Data Centers," IEEE Trans. Cloud Comput., vol. 7, no. 3, pp. 715–718, 2019, doi: 10.1109/TCC.2017.2659728.

[40] Y. Sun, J. Zhang, Y. Xiong, and G. Zhu, "Data Security and Privacy in Cloud Computing," International Journal of Distributed Sensor Networks, vol. 2014. Hindawi Limited, 2014, doi: 10.1155/2014/190903.

[41] AltexSoft, "Data Migration: Process, Strategy, Types, and Key Steps | AltexSoft," 2020. <https://www.altexsoft.com/blog/data-migration/> (accessed Jun. 12, 2023).

[42] N. Nussbaumer and X. Liu, "Cloud migration for SMEs in a service oriented approach," Proc. - Int. Comput. Softw. Appl. Conf., pp. 457–462, 2013, doi: 10.1109/COMPSACW.2013.71.

[43] H. Terfas, "The Analysis of Cloud Computing Service Level Agreement ( SLA ) to Support Cloud Service Consumers with the SLA Creation Process by in Partial Fulfillment for a Master ' S Degree," 2019.

[44] H. Srivastava and S. A. Kumar, "Control Framework for Secure Cloud Computing," J. Inf. Secur., vol. 06, no. 01, pp. 12–23, 2015, doi: 10.4236/jis.2015.61002.

[45] K. Fatema, P. D. Healy, V. C. Emeakaroha, J. P. Morrison, and T. Lynn, "A user data location control model for cloud services," in CLOSER 2014 - Proceedings of the 4th International Conference on Cloud Computing and Services Science, 2014, pp. 476–488, doi: 10.5220/0004855404760488.

[46] Maniah, B. Soewito, F. Lumban Gaol, and E. Abdurachman, "A systematic literature Review: Risk analysis in cloud migration," J. King Saud Univ. - Comput. Inf. Sci., no. xxxx, 2021, doi: 10.1016/j.jksuci.2021.01.008.

[47] H. Malouche, Y. Ben Halima, and H. Ben Ghezala, "Enterprise preparation for cloud migration: Assessment phase," Proc. IEEE/ACS Int. Conf. Comput. Syst. Appl. AICCSA, vol. 2017-October, pp. 652–659, 2018, doi: 10.1109/AICCSA.2017.23.

[48] G. Madhukar Rao et al., "A Secure and Efficient Data Migration Over Cloud Computing," IOP Conf. Ser. Mater. Sci. Eng., vol. 1099, no. 1, p. 12, 2021, doi: 10.1088/1757-899x/1099/1/012082.

[49] S. Strauch et al., "Migrating Application Data to the Cloud Using Cloud Data Patterns This publication and contributions have been presented at CLOSER 2013 Migrating Application Data to the Cloud using Cloud Data Patterns," 2013.

[50] M. Cunningham, "Complying with International Data Protection Law," Univ. Cincinnati Law Rev., vol. 84, no. 2, pp. 421–450, 2016.

[51] M. Fahmideh, J. Yan, J. Shen, A. Ahmad, D. Mougouei, and A. Shrestha, "Knowledge Management for Cloud Computing Field," pp. 1–16, 2022, [Online]. Available: <http://arxiv.org/abs/2202.07875>.

[52] Natalie Gagliardi, "SaaS Migration: Why You Should and How to Do It," Oracle, 2023. <https://www.oracle.com/cloud/saas-migration/> (accessed Oct. 30, 2023).

[53] J. Amorim, "Migração de dados para a Cloud em implementações ERP," 2020, [Online]. Available: <https://recipp.ipp.pt/handle/10400.22/16896>.

[54] S. K. Yadav, A. Khare, and C. Kavita, ASK Approach: A Pre-migration Approach for Legacy Application Migration to Cloud, vol. 1042, no. April. Springer Singapore, 2020.

[55] K. C. Ferris, "Planning a Cloud Migration Effort," Jt. Softw. IT Cost Forum 2020, no. September, pp. 1–43, 2020.

[56] V. Bandari, "Optimizing IT Modernization through Cloud Migration : Strategies for a Secure , Efficient and Cost-Effective Transition," 2022.

[57] M. Pulkkinen, "MSc thesis Cloud migration strategy factors and migration processes," 2020.

[58] J. Bryan, "Data migration strategy guide," Jarrett Goldfeder, pp. 207–237, 2009, [Online]. Available: [infomig.co.uk/Data Migration Strategy Guide r1.pdf](http://infomig.co.uk/Data Migration Strategy Guide r1.pdf).

[59] S. S. Sarmah, "Development of a General Data Migration Framework in a Case Organization," Sci. Technol., vol. 8, no. 1, pp. 1–10, 2018, doi: 10.5923/j.scit.20180801.01.

[60] M. S. B. Yusoff, "ABC of Content Validation and Content Validity Index Calculation," Educ. Med. J., vol. 11, no. 2, pp. 49–54, 2019, doi: 10.21315/eimj2019.11.2.6.

APPENDIX A: CONTENT VALIDITY FORM

Section A: Demographic information

Q1 Name of Company

Q2 Which of the following best describes you?  
 Cloud user  
 Cloud service provider  
 Cloud researcher/academics  
 Cloud regulator  
 Cloud auditor  
 Cloud broker  
 Other: please specify

Q3 Select the range of years of working experience that best apply to you.  
 0–5  6–10  11–15  16–20  21–25  Above 26

Q4 What is your highest academic qualification:  
 Bachelor  Master  PhD  Other: please specify

Q5 Are you familiar with on-premise to cloud data migration process?

Yes

Q6 How would you describe your level of understanding on cloud data migration process?

Basic (a beginner that is familiar with the fundamentals)

Intermediate (performs data migration activities)

Expert (advanced in knowledge and practice of data migration process)


Please use the following Likert scale to indicate the degree of relevance of each item to the construct it is representing by checking (✓) the appropriate box in the table below:

Key to the degree of relevance:

1 = the item is not relevant to the measured domain

2 = the item is somewhat relevant to the measured domain

3 = the item is quite relevant to the measured domain

4 = the item is highly relevant to the measured domain

Section B: The questions in this section is focused on the perceptions of user control of on-premise to cloud data migration process using SaaS.

	Items/Options	Rating				Comment
		4	3	2	1	
1.	Data migration process consists of the following phases: <i>pre-migration planning, risk assessment and strategy, data preparation and cleansing, data migration execution, and post-migration validation and optimization.</i>					
2.	The phases of data migration are orderly and easy to understand.					
3.	User control of cloud data migration process brings about transparency and confidence in both the user and cloud service provider.					
4.	Control of cloud data migration process is beneficial for any organization that is migrating data from on-premise to cloud.					
5.	Measuring the level of user control in cloud data migration process is essential in the control of data migration process.					
6.	I believe that this study will make a valuable contribution to the cloud data migration process globally.					

Section C: Measures (standard and performance) for evaluating the user control in cloud data migration process.

Standard: refers to established measure for achieving common goal.						
	Items/Options	Rating				Comment
		4	3	2	1	
7.	The cloud data migration process has no interoperability issues arising from interaction between technologies.					
8.	The cloud data migration process is carried in accordance with best-practices.					
9.	The cloud data migration process suits the intended cloud strategy.					
10.	Industry standards allows for seamless cloud data migration process.					
11.	The data migration process is with minimal issues related to data transfer from on-premise to cloud.					
12.	Access to the process is only allowed by users through authentication.					
Performance: is signified in measurable metric that enables the assessment of how well the processes conform to standards.						
	Items/Options	Rating				Comment
		4	3	2	1	
13.	The Quality of Service (QoS) indicates that the process is under control.					
14.	The cloud data migration process is under user control if the reliability of the service is as designed.					
15.	Satisfactory user experience is based on ease of use of the application and data accessibility.					
16.	Control demonstrates how data migration from on-premise to cloud is carried within expected time.					
17.	Data volume should not attract extra cost.					
18.	How fast on-premise data moves to cloud indicates the transfer speed.					
19.	Control is shown when downtime does not interfere with business transactions.					
20.	The amount of data that is transferred to cloud in a given time indicates throughput.					
21.	Being that data is available as it were before migration indicates control.					
22.	Capacity utilization of workload in the cloud data migration process is an important aspect of control.					

Section D: The affecting factors (Security, Cost, Legal, and Personnel Knowledge) of user control in cloud data migration process.

<b>Security:</b> means measures put in place in order to ensure integrity, confidentiality, prevent data loss and ensure privacy of data and application.						
Items/Options		Rating				Comment
		4	3	2	1	
23.	Security is a shared responsibility for both the cloud service provider and the user to ensure confidentiality.					
24.	The migrated data should remain correct, validated and perform well in business continuity to ensure integrity.					
25.	Confidentiality is ensuring that data is backup before migration in case of unintentional data loss in the data migration process.					
26.	User concern towards compliance with data privacy laws should be addressed.					
<b>Cost:</b> the cost associated with moving data and application to cloud, including connectivity, consultancy, and storage cost.						
Items/Options		Rating				Comment
		4	3	2	1	
27.	Cost of transiting to cloud is within budget.					
28.	Cost of network connectivity related to bandwidth.					
29.	Consultancy fee associated to professional services.					
30.	Cloud charges for data storage.					
<b>Legal:</b> relates to jurisdictional laws, service level agreement, and policies made by governing organizations.						
Items/Options		Rating				Comment
		4	3	2	1	
31.	The control of cloud data migration process is affected by how organizational policy aligned with cloud standards.					
32.	How users of SaaS ensure that cloud service providers adhere to the <i>Service Level Agreement (SLA)</i> influences the control of cloud data migration process.					
33.	Actualizing user control is affected by compliance to cloud standards and best practice.					
<b>Personnel knowledge:</b> this include knowledge of the cloud technology, business process, and the knowledge of the data migration process.						
Items/Options		Rating				Comment
		4	3	2	1	
34.	How the technical skills of personnel matches the requirement of cloud data migration process.					
35.	The business skills of the organizations' personnel that will perform the data migration process.					
36.	The communication skills required by the personnel to report and document the data migration process.					

Section E: Comment

Please feel free to drop any comment that could aid the success of this research.

.....  
 .....  
 .....

Name:

Sign:

Date:

Thank you