The Role of Cloud Storage in Rebuilding Governmental Data After Conflict: A Case Study of Sudan 2023

Sabah Abdellatif Hassan Ahmed

Assistant Professor, College of Computers and Information Technology, University of Bisha, Kingdom of Saudi Arabia

sahmad@ub.edu.sa

Abstract

The aim of this research is to assess the Role of Cloud Storage in Rebuilding Governmental Data After Conflict, with a deeper insight into Sudanese case.

To investigate the role of cloud storage in rebuilding governmental data after conflict in Sudan, this study employs a quantitative research methodology. The primary data collection instrument is a structured questionnaire designed to gather insights and perspectives from 80 participants of key stakeholders involved in the cloud storage adoption and data reconstruction efforts in Sudan, including (IT professionals and data management experts, Senior-level government officials and policymakers, Representatives from cloud service providers, End-users and data consumers from various government agencies).

The collected data underwent accurate statistical analysis, including descriptive and inferential techniques, to identify patterns, trends, and relationships among the variables under investigation. Quantitative data was analyzed using "SPSS" statistical software.

The findings of the research revealed that, a total of 18 participants representing (22.5%) agree that there is a high level of awareness and understanding of cloud storage technologies among government agencies in Sudan, while 28 participants

representing (35%) disagree. Which indicates the need of spreading the awareness and understanding of cloud storage technologies among government agencies in Sudan. Furthermore, Pearson Chi-Square test was used to measure the role of cloud storage in rebuilding governmental data after conflict in Sudan, a significance value of (0.021) which is less than (p-value=.05) suggests that there is a significant role of cloud storage in rebuilding governmental data after conflict in Sudan.

Keywords: Cloud Storage, Data Rebuilding, Governmental Data, Conflict, Sudan.

Introduction

In the ever-evolving landscape of global affairs, conflicts and political upheavals have become an unfortunate reality, leaving nations grappling with the arduous task of rebuilding and restoring their infrastructure, both physical and digital [1]. One such nation that has endured the scars of conflict is Sudan, a country situated in northeastern Africa, whose recent history has been marred by civil strife and turmoil. In the wake of these tumultuous events, the Sudanese government has been faced with the daunting challenge of reconstructing its data repositories, a vital component of any modern nation's governance and administrative framework [2].

The advent of cloud storage technology has emerged as a beacon of hope, offering a robust and resilient solution to safeguard critical data against the ravages of conflict and ensure its seamless recovery [3]. This paper delves into the pivotal role that cloud storage has played in the reconstruction of governmental data in Sudan, a nation that has witnessed firsthand the devastating consequences of data loss and the imperative need for secure and reliable storage solutions.

As the world becomes increasingly interconnected and reliant on digital information, the preservation and accessibility of governmental data have taken on paramount importance [4]. Government agencies, from ministries to local administrative bodies,

generate and maintain vast troves of data encompassing a wide range of domains, including citizen records, financial transactions, legal documents, and policy formulations. The loss or corruption of such data can have far-reaching implications, hindering the effective delivery of public services, undermining transparency and accountability, and impeding the nation's progress towards sustainable development [5].

In the aftermath of conflict, the physical infrastructure that houses traditional data storage systems is often severely compromised or outright destroyed, rendering the retrieval and restoration of vital information a formidable challenge [6]. This is where cloud storage technology has emerged as a game-changer, offering a secure and distributed approach to data storage that transcends geographical boundaries and physical limitations [7].

Cloud storage providers, with their vast networks of data centers and redundant storage systems, offer a level of resilience and redundancy that is unparalleled in traditional on-premises storage solutions [8]. Through leveraging the power of cloud storage, governments can effectively mitigate the risks associated with data loss due to conflict, natural disasters, or other unforeseen circumstances. Moreover, the inherent scalability and flexibility of cloud storage solutions enable governments to adapt to evolving data storage needs seamlessly, ensuring that critical information remains accessible and retrievable as the nation rebuilds and progresses [9].

In the context of Sudan's post-conflict reconstruction efforts, the adoption of cloud storage has proven to be a crucial step towards safeguarding the nation's digital heritage and paving the way for a more resilient and transparent governance structure [10]. This paper will delve into the specific challenges faced by the Sudanese government in recovering and consolidating its dispersed data repositories, the

process of migrating to cloud-based storage solutions, and the measures implemented to ensure data integrity, security, and compliance with relevant regulations.

Furthermore, the paper will explore the broader implications of cloud storage adoption for governmental data management, highlighting its potential to foster collaboration, enable remote access, and streamline workflows among various government agencies and stakeholders. Through leveraging the power of cloud computing, Sudan has the opportunity to not only rebuild its data infrastructure but also to modernize its administrative processes, enhancing efficiency and transparency in service delivery [11].

The case study of Sudan's experience with cloud storage adoption in the aftermath of conflict serves as a valuable exemplar for other nations grappling with similar challenges [12]. By disseminating the lessons learned and best practices derived from this endeavor, this paper aims to contribute to the broader discourse on data resilience and inform future strategies for rebuilding and safeguarding governmental data in post-conflict scenarios [13].

In a world where data has become the lifeblood of governance and societal progress, the role of cloud storage in rebuilding governmental data after conflict cannot be overstated [14]. This paper seeks to shed light on the transformative potential of this technology, providing insights and recommendations that can guide policymakers, technology experts, and stakeholders in their collective efforts to ensure the preservation and accessibility of critical data, even in the face of adversity.

Problem Definition

The loss or inaccessibility of governmental data in the aftermath of conflict can have severe and far-reaching consequences for a nation's ability to effectively govern, deliver public services, and ensure transparency and accountability. This problem is

particularly acute in post-conflict environments, where the physical infrastructure housing traditional data storage systems may have been compromised or destroyed, leading to the dispersal or erasure of vital information.

In the case of Sudan, years of civil strife and political turmoil have taken a significant toll on the nation's data infrastructure. Government agencies and ministries across various sectors, including finance, healthcare, education, and public administration, have grappled with the challenges of data fragmentation, loss, and corruption. Critical citizen records, financial transactions, legal documents, and policy formulations have been scattered or rendered inaccessible, hindering the efficient functioning of governance and hampering the delivery of essential services to the population.

Research Objectives

The primary objectives of this research are as follows:

1. To evaluate the efficacy of cloud storage solutions in safeguarding and recovering governmental data in the aftermath of the civil conflict in Sudan.

2. To assess the challenges faced by the Sudanese government in migrating to cloud-based storage systems and consolidating dispersed data repositories.

3. To investigate the impact of cloud storage adoption on enhancing data accessibility, collaboration, and transparency among various government agencies and stakeholders.

4. To examine the measures implemented to ensure data integrity, security, and compliance with relevant regulations during the cloud migration process.

Research Domain and Limitations

This research is primarily focused on the domain of governmental data management and storage solutions within the context of post-conflict reconstruction efforts. Specifically, the study investigates the role of cloud storage technology in addressing the challenges of data loss, fragmentation, and inaccessibility faced by the Sudanese government in the aftermath of civil strife.

While the findings and insights derived from this research may have broader implications for data resilience and cloud computing adoption in various sectors, the scope of the study is primarily centered on the public sector and governmental agencies within Sudan.

It is important to acknowledge several limitations that may influence the generalizability and applicability of the research findings:

Geographical limitation: The study is conducted as a case study focused on Sudan, a nation with a unique socio-political and economic landscape. The specific challenges and experiences encountered in Sudan may differ from those faced by other countries undergoing post-conflict reconstruction, limiting the direct transferability of the findings to diverse contexts.

Temporal limitation: The research reflects the circumstances and technological landscape at the time of data collection and analysis. As cloud computing and data storage technologies continue to evolve rapidly, the findings may require periodic updates and re-evaluation to remain relevant and applicable.

Sample size and representation: While the study sample aims to capture a diverse range of stakeholders, the sample size of 80 participants may not be representative of the entire population involved in Sudan's data reconstruction efforts. Additionally,

the selection of participants may introduce potential biases or limitations in capturing a truly comprehensive understanding of the phenomenon under investigation.

Data collection limitations: The use of a questionnaire as the primary data collection instrument may impose inherent limitations, such as the potential for response bias, misinterpretation of questions, or the inability to capture nuanced or complex perspectives fully.

Scope limitation: The research focuses specifically on the role of cloud storage technology in rebuilding governmental data. While this technology may be a critical component of the data reconstruction process, it is important to acknowledge that other factors, such as governance structures, human resources, and financial considerations, may also play a significant role in the overall success of these initiatives.

Research Methodology

To investigate the role of cloud storage in rebuilding governmental data after conflict in Sudan, this study employs a quantitative research methodology. The primary data collection instrument is a structured questionnaire designed to gather insights and perspectives from key stakeholders involved in the cloud storage adoption and data reconstruction efforts.

Numeric data from completed questionnaires will be compiled into a statistical analysis software package. First cycle analysis will encompass descriptive statistics reporting means and distributions. The core analysis will utilize correlation testing to quantify significant relationships between the study variables.

Study Sample

The study sample comprises 80 participants carefully selected to represent various government agencies, ministries, and departments that have been actively engaged in the process of migrating to cloud storage solutions and rebuilding their data repositories in the aftermath of Sudan's civil conflict.

The sample includes:

1. IT professionals and data management experts.

2. Senior-level government officials and policymakers.

3. Representatives from cloud service providers.

4. End-users and data consumers.

Data Collection and Analysis

The questionnaire was developed in consultation with subject matter experts ensure clarity, relevance, and validity of the questions. It encompasses a combination of closed-ended questions, utilizing Likert scales and multiple-choice formats.

The questionnaires were administered through various channels, including online platforms, email, and in-person interviews, to accommodate the preferences and accessibility of the participants. Appropriate measures were taken to ensure the confidentiality and anonymity of the respondents, fostering an environment conducive to honest and transparent responses.

The collected data underwent rigorous statistical analysis, including descriptive and inferential techniques, to identify patterns, trends, and relationships among the variables under investigation. Quantitative data was analyzed using "SPSS" statistical software.

Literature Review

The absence of a centralized, secure, and resilient data storage solution has exacerbated these issues, leaving Sudan's governmental data vulnerable to the ravages of conflict, natural disasters, and other unforeseen events. Rebuilding and consolidating these dispersed data repositories has become a pressing priority for the Sudanese government, as it strives to restore order, transparency, and accountability in its administrative processes [15].

Moreover, the lack of a robust data backup and recovery strategy has compounded the challenges faced by Sudan in the aftermath of conflict. Traditional on-premises storage solutions, while reliable under normal circumstances, are susceptible to physical damage and data loss in the event of infrastructure destruction or compromised access. This vulnerability underscores the need for a more resilient and distributed approach to data storage, one that can withstand the adverse effects of conflict and ensure the continuous availability and integrity of governmental data [16].

A study conducted by [17] examines the potential of cloud storage for data recovery, highlighting advantages such as off-site storage, scalability, and accessibility. However, concerns regarding data security, privacy, and internet connectivity are also discussed. The results indicate that cloud storage can effectively preserve and restore government data in post-conflict situations, but a hybrid approach is necessary to address security and connectivity challenges. The review recommends a hybrid approach combining cloud storage with on-premises backups, robust security protocols, and investments in reliable internet infrastructure.

A study conducted by [18] explores these challenges, including limited infrastructure, skilled personnel, and budgetary constraints, as well as the potential benefits of cloud storage's cost-effectiveness and scalability. The results show that

while there are significant challenges, cloud storage can provide a viable solution for government data management in developing countries like Sudan. Recommendations include conducting thorough assessments, implementing phased adoption plans with pilot projects, and prioritizing capacity building and training for government personnel.

A study conducted by [19] investigates the role of cloud storage in enabling rapid data recovery and minimizing downtime, examining best practices and strategies for cloud-based disaster recovery plans. The results demonstrate the effectiveness of cloud storage in enabling disaster recovery and business continuity for government agencies, particularly in post-conflict situations. The review recommends developing comprehensive disaster recovery plans that integrate cloud storage solutions and conducting regular testing and updates.

A study conducted by [20] analyzes relevant laws, regulations, and policies in Sudan, identifying gaps and the need for a robust legal framework that addresses data sovereignty and security concerns while enabling cloud technology adoption. The results highlight the lack of a comprehensive legal and regulatory framework for cloud computing in Sudan, which can hinder adoption and raise concerns about data protection and security.

A study conducted by [21] explores the potential of cloud storage in preserving and providing access to such data in post-conflict situations. Case studies and literature on digital preservation using cloud storage are examined. The results indicate that cloud storage can play a crucial role in safeguarding and providing access to digital archives and cultural heritage data, which are often at-risk during conflicts. Recommendations include collaborating with international organizations and cultural institutions to develop cloud-based preservation strategies.

A study conducted by [22] investigates these risks, including data breaches, unauthorized access, and potential surveillance or misuse of data by third parties. The results highlight the security and privacy risks associated with storing government data in the cloud, particularly in post-conflict situations. Recommendations include implementing robust encryption and access controls, developing clear data governance policies, and considering hybrid or private cloud deployments for sensitive data.

A study conducted by [23] explores the potential of cloud-based collaboration platforms and information-sharing protocols in post-conflict environments. The results show that cloud storage and collaboration tools can facilitate information sharing, coordination, and knowledge management among various stakeholders involved in post-conflict reconstruction efforts. The study recommends the adoption of such tools along with clear access control protocols and user training.

A study conducted by [24] analyzes cost-benefit studies, economic models, and case studies on the financial aspects of cloud computing adoption in the public sector. The results indicate that while cloud storage can offer cost savings and operational efficiencies, upfront investments in infrastructure, training, and migration may be required. Recommendations include conducting thorough cost-benefit analyses, developing sustainable funding models, and exploring opportunities for public-private partnerships or collaboration with international organizations.

A study conducted by [25] examines the role of cloud computing in enabling secure and accessible storage of citizen data and online service delivery. The results demonstrate that cloud storage can serve as a foundation for e-government services and digital transformation initiatives in post-conflict situations. Key recommendations include developing a comprehensive e-government strategy leveraging cloud storage solutions and prioritizing digital literacy and capacity

building initiatives to ensure effective adoption and utilization of e-government services.

Overall, the problem of governmental data loss and inaccessibility in post-conflict environments is not unique to Sudan; it is a challenge shared by many nations grappling with the aftermath of civil unrest, armed conflicts, or natural disasters. Addressing this problem is crucial not only for the effective functioning of government but also for fostering transparency, accountability, and trust among citizens. Without reliable access to accurate and up-to-date data, the delivery of public services, policy formulation, and decision-making processes can be severely impaired, potentially exacerbating existing societal tensions and impeding the nation's progress towards stability and development.

In light of these challenges, the adoption of cloud storage technology has emerged as a potential solution, offering a secure, distributed, and scalable approach to data storage and management. Through leveraging the power of cloud computing, governments can mitigate the risks associated with data loss due to conflict, natural disasters, or other unforeseen circumstances, while also benefiting from the inherent advantages of cloud storage, such as enhanced accessibility, collaboration, and cost-effectiveness.

Data Analysis and Results

Through using a 5-point Likert scale, these closed-ended questions allow respondents to indicate their level of agreement or disagreement with each statement or question, providing quantifiable data for analysis.

First: Descriptive Statistics:

Cloud storage can facilitate the rebuilding and restoration of governmental data after a conflict situation

Table (1): rebuilding and restoration of governmental data after a conflict

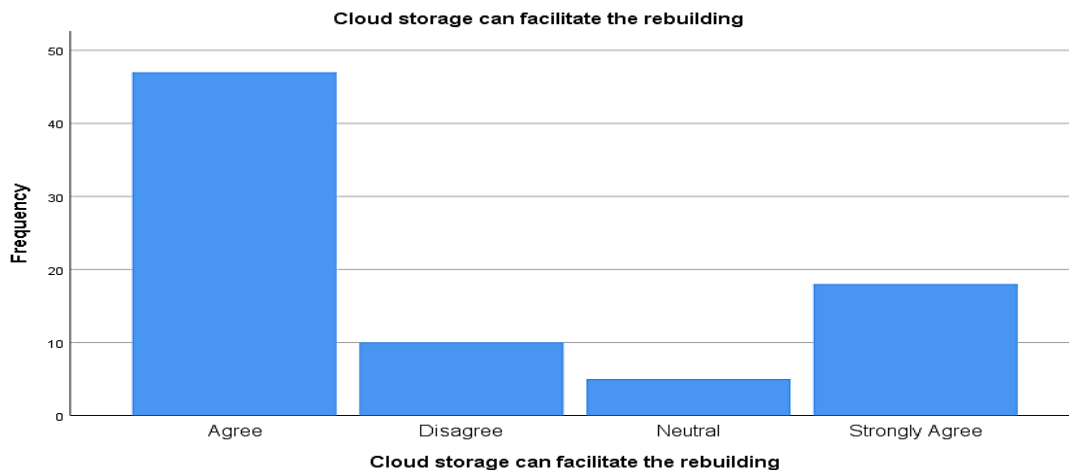| Cloud storage can facilitate the rebuilding					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	47	58.8	58.8	58.8
	Disagree	10	12.5	12.5	71.3
	Neutral	5	6.3	6.3	77.5
	Strongly Agree	18	22.5	22.5	100.0
	Total	80	100.0	100.0	

Figure (1): rebuilding and restoration of governmental data after a conflict

According to table (1) and figure (1), a total of 47 participants representing (58.8%) agree that Cloud storage can facilitate the rebuilding and restoration of governmental data after a conflict situation. Which indicates that most of the sample are appreciating the role of Cloud storage in facilitating the rebuilding and restoration of governmental data after a conflict situation.

There is a high level of awareness and understanding of cloud storage technologies among government agencies in Sudan?

Table (2): awareness and understanding of cloud storage technologies

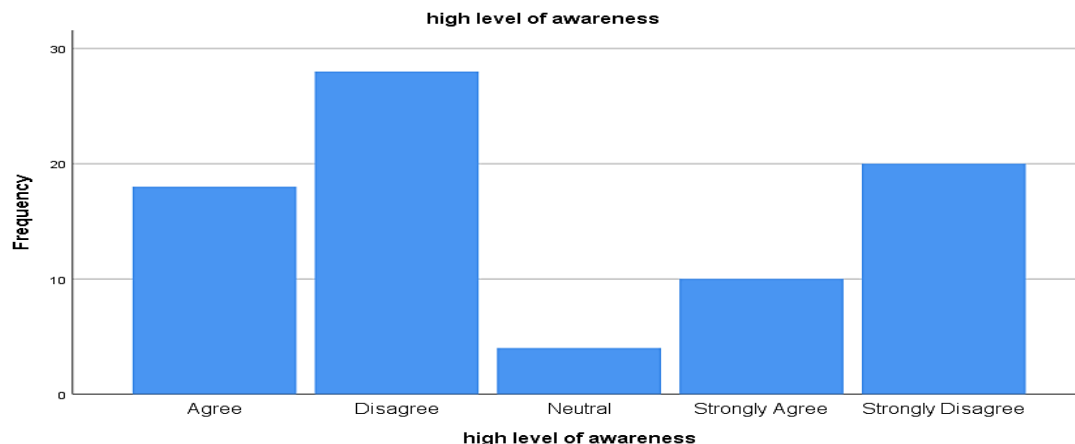| high level of awareness		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	18	22.5	22.5	22.5
	Disagree	28	35.0	35.0	57.5
	Neutral	4	5.0	5.0	62.5
	Strongly Agree	10	12.5	12.5	75.0
	Strongly Disagree	20	25.0	25.0	100.0
	Total	80	100.0	100.0	

Figure (2): awareness and understanding of cloud storage technologies

According to table (2) and figure (2), a total of 18 participants representing (22.5%) agree that there is a high level of awareness and understanding of cloud storage technologies among government agencies in Sudan, while 28 participants representing (35%) disagree. Which indicates the need of spreading the awareness and understanding of cloud storage technologies among government agencies in Sudan.

Your organization addresses security and privacy concerns related to storing government data in the cloud.

Table (3): addressing security and privacy concerns

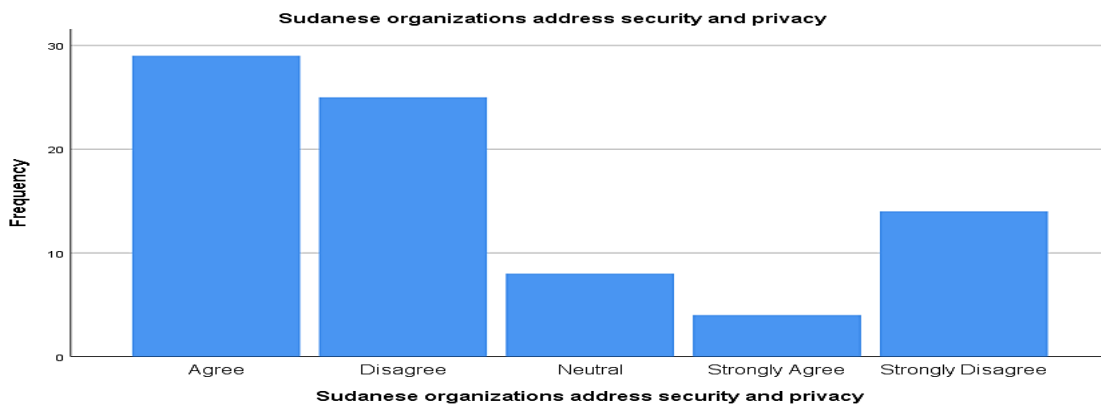| Sudanese organizations address security and privacy					
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	Agree	29	36.3	36.3	36.3
	Disagree	25	31.3	31.3	67.5
	Neutral	8	10.0	10.0	77.5
	Strongly Agree	4	5.0	5.0	82.5
	Strongly Disagree	14	17.5	17.5	100.0
	Total	80	100.0	100.0	

Figure (3): addressing security and privacy concerns

According to table (3) and figure (3), a total of 29 participants representing (36.3%) agree that their organizations address security and privacy concerns related to storing government data in the cloud, while 25 participants representing (31.3%) disagree. Which indicates the need of addressing security and privacy concerns related to storing government data in the cloud in Sudan.

Your organization has technical infrastructure and skilled personnel for effectively implementing and managing cloud storage solutions

Table (4): technical infrastructure and skilled personnel

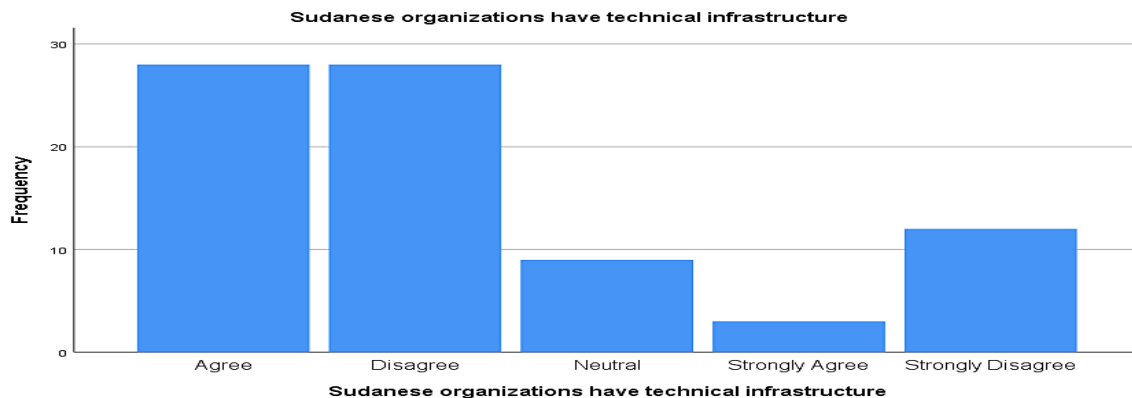| Sudanese organizations have technical infrastructure				
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	28	35.0	35.0	35.0
	Disagree	28	35.0	35.0	70.0
	Neutral	9	11.3	11.3	81.3
	Strongly Agree	3	3.8	3.8	85.0
	Strongly Disagree	12	15.0	15.0	100.0
	Total	80	100.0	100.0	

Figure (4): technical infrastructure and skilled personnel

According to table (4) and figure (4), a total of 28 participants representing (35%) agree that their organizations have technical infrastructure and skilled personnel for effectively implementing and managing cloud storage solutions, while 28 participants representing (35%) disagree.

Government agencies in Sudan are to collaborate and share information using cloud-based platforms during post-conflict reconstruction efforts

Table 5: collaborate and share information using cloud-based

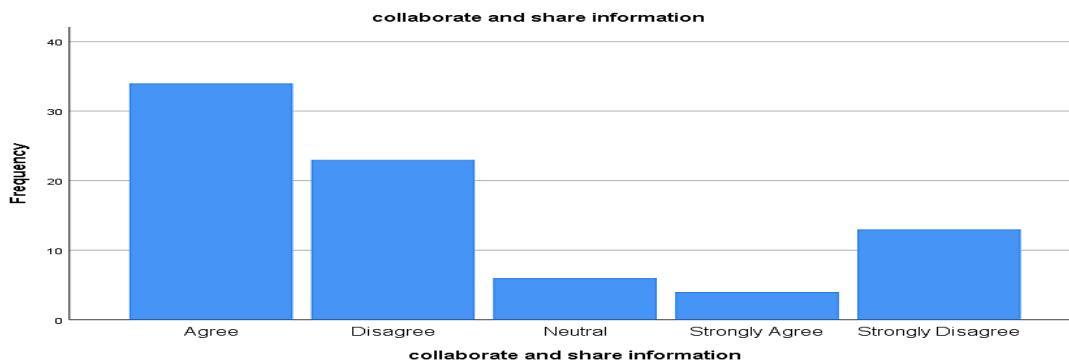| collaborate and share information					
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	Agree	34	42.5	42.5	42.5
	Disagree	23	28.7	28.7	71.3
	Neutral	6	7.5	7.5	78.8
	Strongly Agree	4	5.0	5.0	83.8
	Strongly Disagree	13	16.3	16.3	100.0
	Total	80	100.0	100.0	

Figure (5): collaborate and share information using cloud-based

According to table (5) and figure (5), a total of 34 participants representing (23%) agree that Government agencies in Sudan are to collaborate and share information using cloud-based platforms during post-conflict reconstruction efforts, while 28 participants representing (28.7%) disagree.

Cloud storage plays a role in enabling e-government services and digital transformation initiatives in Sudan's post-conflict context

Table (6): enabling e-government services and digital transformation

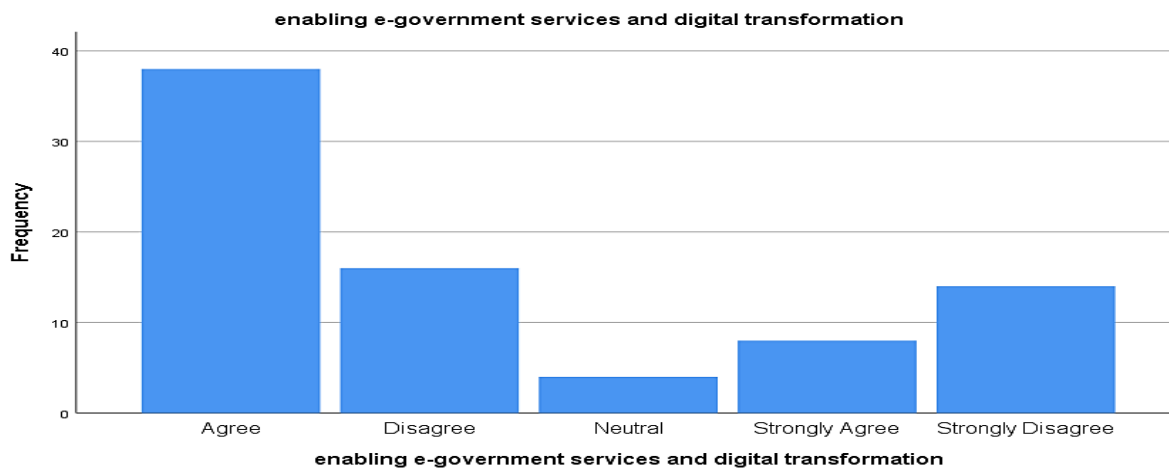| enabling e-government services and digital transformation					
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	Agree	38	47.5	47.5	47.5
	Disagree	16	20.0	20.0	67.5
	Neutral	4	5.0	5.0	72.5
	Strongly Agree	8	10.0	10.0	82.5
	Strongly Disagree	14	17.5	17.5	100.0
	Total	80	100.0	100.0	

Figure (6): enabling e-government services and digital transformation

According to table (4) and figure (4), a total of 38 participants representing (47.5%) agree that Cloud storage plays a role in enabling e-government services and digital transformation initiatives in Sudan's post-conflict context, while 16 participants representing (20%) disagree.

Second: Association between Variables:

Table (7): Pearson Chi-Square test to measure the role of cloud storage in rebuilding governmental data after conflict in Sudan

Chi-Square Tests			
	Value	**df**	**Asymptotic Significance (2-sided)**
Pearson Chi-Square	23.957a	12	.021
Likelihood Ratio	28.877	12	.004
N of Valid Cases	80		
a. 15 cells (75.0%) have expected count less than 5. The minimum expected count is .25.			

Pearson Chi-Square test was used to measure the role of cloud storage in rebuilding governmental data after conflict in Sudan, a significance value of (0.021) which is less than (p-value=.05) suggests that there is a significant role of cloud storage in rebuilding governmental data after conflict in Sudan.

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