

# Cloud Computing as a Tool for NGOs in India and Pakistan

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**Abstract**—Cloud computing has emerged as an important trend that has been used in the delivery of computer services to different entities. It relies on different technologies such as the internet, virtualization, grid computing and Web services with an aim of providing scalable and cheap on-demand computer infrastructures that offer better quality of services from a cloud. This paper provides a framework on how cloud computing can be used in the management of NGOs in India and Pakistan in order to achieve their objectives. It showed how these communities have had lasting impacts by using or failing to use the cloud computing to solve the social issues, in this case their health care needs. This was achieved through the use of case studies of two NGOs in India and Pakistan and a comparison with the available scholarly work. It was found that cloud computing has got more benefits than losses; enhances the services for the general and better welfare of the population; users need to have adequate knowledge of the manner in which their organizations can benefit; and proper training of the staff and the upgrading of their management principles is imperative. NGO's must choose only the vendors that can guarantee the security of the data while at the same time maintaining the confidentiality. Cloud computing technology has been integral in ensuring that the NGOs in India succeed, contrary to this, the NGOs in Pakistan particularly HOPE has failed to be operationally efficient as it has not migrated to the cloud computing technology.

**Keywords**— *cloud computing, semantic interoperability, e-Health, NGOs*

## I. INTRODUCTION

Cloud computing has been referred to as the next frontier in the use of information technology but it should be noted that it is not just a technology. Rather, it is also a platform and hosting provider as well as an application hosted as a service that also provides storage services on the internet. A cloud is a flexible execution environment that includes resources and multiple stakeholders that coordinate in order to provide information technology to a specified level of quality of service [1]. Therefore, cloud computing is a model that facilitates the convenient access to a network on demand to a shared pool of computing resources for example health care records [2] that have been configured within a cloud. These include; networks, servers, storage, applications and services that can be provided promptly with minimal input from the management of the entity and the interaction with the service provider.

In the information technology sector, cloud computing has become an integral component that offers a great possibility of enhancing the social and economic

development of an entity even with limited resources [3]. In nations such as India and Pakistan, agencies such as Non-Governmental Organizations (NGOs) have not leveraged on the use of information technology such as cloud computing in order to achieve their goals due to the complex nature and costs of the deployment and the management of such a system. Presently, as the information technology has undergone a major shift with the use of internet as a platform of carrying out almost every task, new opportunities have emerged of doing this in an affordable and convenient manner. This paper will seek to show how an NGO in India has used cloud computing to improve healthcare provision and subsequent failure by a Pakistan NGO in failing to achieve its objectives as they have not implemented cloud computing in its operations. It is divided in sections that give the background of the research problem, literature review, empirical evidence, research aims and objectives and the research questions. In subsequent chapters it will offer the algorithmic trading / derivatives to show how the cloud computing has been integral in achieving this aim.

### A. Background

Despite the tremendous growth that has been registered in almost every quarter of the world, prosperity in terms of the change of the socio-economic welfare of states such as India and Pakistan has not been registered. This is because most of the people in these two nations still live in abject poverty due to the inequalities and economic imbalance. Further, these nations have not met their Millennium Development Goals of the reduction of poverty, the provision of universal primary education and the provision of health care. Part of the reason for these failures is that the organizations within these nations including the Non-Governmental Organizations (NGOs) have failed to embrace information technology in the running of their affairs.

Information technology and the revolutions that it brings are important in fostering growth in any nation. Beginning the period spanning 1970s until 1990s, sectors that invested heavily in information technology have become more competitive and improved on their operations. However, the higher costs of setting up IT systems within organizations through the investment in infrastructure and their maintenance have made the use of IT to be rare amongst entities.

The present world set up, however, has witnessed a change in the manner in which information technology can be used to increase the efficiencies of organizations.

There is a new “utility” model of information technology that uses the internet that makes it cheaper and affordable to tap into IT capabilities and solutions over the internet regardless of their physical location. The cloud computing therefore allows the individuals and processes within the organization to interact remotely as they can tap into the computing power within a cloud facilitated by the internet. The advantage of this cloud is that it comes with the benefit of economies of scale, hence reducing the cost of setting up and maintenance of the IT system. It also eliminates the technical complexities and the long cycles that are involved in the planning, installation, maintenance and the upgrading of information technology systems.

In India and Pakistan, Non-Governmental Organizations have embraced the use of cloud computing in order to enhance their services. This is because of the realization that this platform provides ease and power of personalizing content. These NGOs therefore use these Web-based services in the management of their different operations that may include their financial operations, logistics, customer relations and human resources amongst others. In addition to this, these organizations have realized that the services within the cloud are present in remote data centers rather than individuals’ computers or the entity’s servers. The costs have also reduced drastically as the organizations are buying or leasing computing power that includes a server and the storage capacity that can be used to run their resources and processes over the internet. The advantage of this is that the NGOs only pay for the amount of capacity that it has utilized leading to massive cuts in costs. Additionally, the utility model that comes with the cloud computing is that the organization may benefit from the sophistication of the cloud computing with regard to security of data [4], ability to recover data in case of loss or when it has been compromised while at the same time benefitting from its reliability.

### B. Research Aims and Objectives

Despite The aim of this research paper is to show that cloud computing can be used by NGOs in India to successfully manage their health care needs. Similarly, the successes in India will be contrasted with an organization based in Pakistan that has failed to use cloud computing in its system leading to failure. In order to achieve this aim, the following objectives shall be accomplished:

- To show the level of adoption of cloud computing in India and Pakistan amongst the NGOs in the management of their health care needs.
- To identify and critically analyze the current cloud computing health care concerns that prevent NGOs from trusting and adopting cloud computing mechanisms within India and Pakistan.
- To find out the efficacy of cloud computing in aiding NGOs in the management of their health care systems within India.
- To evaluate the level of failures that an NGO based in Pakistan may suffer from for failing to adopt cloud computing in its systems.

### C. Research Questions

This paper seeks to find out the use cloud computing as a tool for NGOs in India and Pakistan to manage their healthcare, and therefore answers the following questions:

- What are the advantages of having cloud computing in an organization and does it improve the efficiency in the management of processes and resources?
- Does the existing literature on cloud computing offer evidence of successful implementation of cloud computing in healthcare in India and Pakistan?
- What type of cloud computing concepts is dominant in the chosen countries (public clouds, private clouds or hybrid clouds)?
- What type of cloud computing services is more dominant than the others (e.g. infrastructure as a service, software as a service, and platform as a service)?
- Is there evidence in the case of India and Pakistan that cloud computing in health care has got benefits and advantages associated with cost-savings?
- What barriers should be overcome in order to make cloud computing in India and Pakistan to be a successful technology in the provision of healthcare by NGOs in India and Pakistan?

### D. Summary

The increasing demands of the non-governmental organizations (NGOs) operating in the field of provision of health care in India and Pakistan has necessitated that they use the information technology solutions in the provision of this important service. This is because they need this critical information in the formulation of their policies and to reach their targets. The advent of smart technologies such as cloud computing has helped these NGOs to operate in a field where there are limited resources in a faster way as it enables the coordination of the health care services in a cost effective way. This research paper will attempt to highlight the obvious pros of cloud computing as used by an NGO based in India while also making a comparison with a failed NGO in Pakistan that has not adopted this groundbreaking technology. Throughout this chapter, the researcher has endeavored to offer a critical but incisive discussion on problem background, research questions, objectives, scope and the research aims that help in answering the question. It lays the ground for the discussion and modeling that may be obtained from different derivatives that will be discussed in subsequent chapters before a conclusion is made at the end of the paper.

## II. LITERATURE REVIEW AND EMPIRICAL EVIDENCE

### A. Introduction

In the data collection process, it is important to review the previous research papers before the collection of the empirical data. This research paper firstly reviews the previous investigations and thereafter makes a comparison between these findings and the empirical data that will be collected through the literature review.

## B. Cloud Computing

In the field such as that of information systems that include cloud computing, the data keeps on changing such that a qualitative research like the present one requires the use of extant research. Moreover, an overview of the previous research offers the reader or researcher the opportunity to have a deeper and detailed understanding of how cloud computing affects the operations of organizations. This in turn helps us in the preparation for the empirical process of collecting data so that the outcomes that are obtained are more reliable and valid. In addition, the information derived from the literature can help in hastening the research process as it is easier than obtaining the empirical data. For the purpose of this research paper, the researcher used preliminary sources such as peer-reviewed journals, books and information from websites as well as conference papers on cloud computing. The search for these relevant materials had the objective of finding materials that are focused on cloud computing and is broad. This literature was thereafter synthesized and analyzed so that the important results are extracted to be used in the analysis of the data on the use of cloud computing by two NGOs, one operational in India and the other in Pakistan.

As already discussed in the introduction, cloud computing has the advantage of having a huge capacity for storing data. The motivation to use cloud computing is always influenced by several factors such as the lack of or inadequate information technology experts, lack of budgets to implement the cloud computing systems and infrastructure installation, the difficulty in evaluating the expected returns on the investment and the lack of support for the management and supervision of the software and the hardware. As this literature review will indicate, the cloud computing can be used in order to manage the health care of a particular community in the area in which the NGO carries out its operations.

Cloud computing can be used as a framework for the sharing of healthcare information in what can be referred to as e-Health. To this end, [5] came up with a framework that can be used to collect health care data using sensors that have been attached to medical equipment and their storage in a cloud accessible by authorized health care workers only. Other studies such as [6] [7] [8], have proposed and used national level frameworks, that can store and use health records within a cloud. For instance, [8] argued that using a cloud-based mode at a national level can help in the management and use of health care records of patients especially those in the rural settings. Therefore, through the encouragement of persons in remote and rural locations to upload their healthcare information in the cloud, they can be provided with the relevant health care services in terms of diagnosis and supervision amongst other health care services [9]. There are other frameworks for applying cloud computing in the provision and management of healthcare services but these target specific areas of healthcare management. For example, [10] targeted self-management of the patient by using the cloud computing method.

The above examples show the application of the cloud computing can lead to increased accessibility, availability and reliability that makes it an important tool for any organization such as NGOs to use it to manage

healthcare interoperability challenges. Therefore, most organizations are likely to use cloud computing for sharing, processing and management of health care data. The application by Wooten et al can help the organizations to foster the sharing of information within the patient community and the ability of patients to support each other.

In addition to this, [11] has designed a Health Exchange (HCX) system that can share the records of patients between themselves and the services offered which offers some level of privacy and confidentiality. In order to underscore the importance of the privacy of such record, [12] came up with an achievement of semantic interoperability that can be used between different kinds of health care information. When carried out in a large scale [13], [14] propose that the cloud-based platform published by HP known as 'Fusion' be used to manage and share the health care information in a large scale. Another means of the use of cloud computing in the management of health care can be is the form where the patient's medical data is stored both in a private and public healthcare cloud. Chen et al states that under this, a mechanism can be set up to ensure that the owners of the medical records can make a decision on when their records can be shared in cases of emergency and in normal situations. Through the study of an NGO dealing in health care provision in India, it shall be shown that the cloud computing has been successful in the management of health care.

As has been shown, the cloud computing can also be used in the provision of service in a sustainable and affordable format. The advantage of this is that it offers the non-functional aspect in that it does not require much storage but can have several concurrent users. This elasticity brings with it the advantage of allowing the incorporation of the resources within the cloud so that they can be accessed by several users. In addition to this, it is reliable in that it can be made to operate continuously without disruptions. Further, the cloud computing ensures that there is quality of the service in that it ensures relevant capability for specific requirements of what the organization intends to achieve. Therefore, contrary to the success of the cloud computing for the NGOs in India, it shall also be shown that Pakistani NGOs that fail to use it may suffer the risk of being inefficient and fail to achieve their objectives and efficiencies.

Accordingly, it is important to note that the cloud can be classified as private, public or hybrid [15] [16]. In a public cloud, the public can access the cloud computing resources for public use even though the facilities are owned by the organization that sells the cloud services. This implies that the cloud services infrastructure is available to the public but its ownership belongs to the company that offers the cloud services. On the other hand, the private cloud offers the users the chance to access the computing resources that are hosted within the infrastructure owned by an organization. In such a cloud, it may be operated solely by the organization or a third party that has been appointed by it, which may be based on the premises or outside the premises. In hybrid clouds, the clouds combine one or more public clouds as well as one or more private clouds through technology that enables the use of the data and its migration from one forum to the other.

In the achievement of the above type of clouds, there are different models of delivery cloud computing services within a cloud. These include but not limited to the Infrastructure as a Service (IaaS) Database as a Service (DaaS), Software as a Service (SaaS) and Platform as a service (PaaS) [17]. In IaaS, the hardware resources and computing power are procured and offered to customers as a service and this allows them to rent or buy services that are located within servers and networking equipment rather than only buying them. The DaaS is used specially for storing database capability as a service where the data of many users are stored within the same physical table. The SaaS model has software applications that are offered over the internet as services rather than as software packages that can be bought by respective customers. Finally, this may be offered as PaaS that provides the facilities that can be used in buttressing the application development cycle such as the designing, deployment, operation and support of the entire system of the cloud.

Having laid the basis for the research through the analysis of different scholarly works on cloud computing, the next section lays the basis for the methodology used in coming up with the results for this study.

### III. METHODOLOGY

#### A. Introduction

This chapter will discuss the practical application of cloud computing as a tool for enhancing the provision of health care by an NGO based in India. It gives insights on the research purpose, research design, methods of data collection, validity and reliability, ethical consideration and challenges encountered.

#### B. Research Purpose

A research can be carried out in several ways but this mostly depends on the knowledge that is initially held by the researcher. Therefore, the research may either be: explanatory, descriptive or exploratory. In the exploratory research, the researcher evaluates certain aspects that are pertinent to the main investigation in order to develop ideas. It is preferable when the researcher has limited knowledge about the subject. On the other hand, descriptive research describes the phenomenon under study in order to have a generalization of the outcome from which theories can be developed. Explanatory research can be used to develop a concrete theory in order to explain the empirical generalizations. This type of study is preferred whenever there is likelihood for a cause-effect relationship whereby specific factors lead to specific effects.

Judging from the purpose of this research, it is quite evident that it is an explanatory study as it attempts to show how cloud computing can be used as a tool for enhancing the provision of healthcare by non-governmental organizations in India and the failure of another NGO in Pakistan that fails to adopt it. In this case, two variables exist: the independent variable (cloud computing applications) and the dependent variable (impact of cloud computing in enhancing the management of healthcare by the NGO).

#### C. Study Design

This study involved the case studies of NGOs based in India and Pakistan. Data was collected from these NGOs and how efficient they have used the cloud computing tool to run their health care activities. This study was carried out at a particular time and was found more favorable as this issue is as significant as it is thriving.

#### D. Methods of Data Collection

This Qualitative and quantitative data was collected to be used in this study. The quantitative data was collected by administering questionnaires amongst the NGO managers while secondary data as well as interviewing was used in the collection of the qualitative data. In the interviewing sessions, the researcher visited the two case study NGOs in India and Pakistan and conducted face-to-face interviews. The interviews involved asking open-ended questions on the perceptions of the NGO managers on the use of cloud computing in the management of their health care needs. On the other hand, the questionnaires were used to obtain the specific information on health care management

In addition to the above, a systematic review of secondary data was used in defining the specific meanings and use of cloud computing as a tool for enhancing healthcare operations by the NGO in India and Pakistan. This involved drawing of insights from government reports, business databases, articles and newspapers were reviewed so as to get information that can help in determining the impact of cloud computing in improving the health care system of the targeted area.

### IV. FINDINGS OF CASE STUDIES

#### A. Case Study: Smile Foundation (India)

Smile Foundation is a non-governmental organization based in India that focuses on providing a wide range of promotion, preventive and curative health care to the less privileged members of the society in India. Its vision is to provide affordable, accessible and advanced health care services to the locality of these underprivileged members of the society. It has adopted cloud computing as a means of enhancing its health care services through the use of the Data Capture and Auto Identification Reference – DACAR). DACAR possesses software components and services that can be used in the management of different health care needs and applications that include the; authentication, authorization, data capture and persistence, data integrity, data confidentiality and audit trail. It is therefore a cloud system that offers this NGO the tool for facilitating the development, integration and deployment of e-health services to the patients or targeted population. The DACAR is hosted on three layers.

#### B. Top Layer

The top layer consists of four elements. The data bucket holds the data on the patient's and offers the NGO the ability to support the creation, reading, updating and the deletion of the patient's data when necessary. The second element is the identity mapping service that resolves the user and the object and uses pseudonyms to hide the real identities of the patients. The real identities of such patients

can only be revealed to authorized individuals, roles and the services as may be required at any given time. The third layer is the access control service that enables a patient to create, edit and remove information sharing policies that pertain to their personal attributes. The implication of this layer is that it regards the patients or the targeted population as the real owners of their medical data. The fourth layer is the audit trail service that collects the log-ins that has been made through different applications and shows the identity of such a user and the type of operations performed by such a user.

### C. Middle Layer

This is the Single Point of Contact (SPoC) that is used to fulfill the authorization requirement and is issued in the form of a service or data ticket. It also enhances the security of the system.

### D. Bottom Layer

This is the security and confidentiality mechanism that fulfills the requirements for authentication, data integrity and confidentiality requirements.

With the above system in place, Smile Foundation has the capability to monitor their patients at their localities and homes and the collection of different data and measurements. These measurements can then be captured remotely and communicated to a central platform, which are its offices. This cloud system also allows the data about the patient to be accessed by the NGO and its officers that are tasked to offer the health care services in their homes and localities. Therefore, when a patient attends any of the clinics run by the NGO or is visited by the organization's health care officers, the measurements that have been captured within the cloud is shown on an easy to read interface.

### E. Equations

Concerning privacy and the ownership of the data, Smile Foundation ensures that its cloud infrastructure supports its healthcare systems in a secure and private manner. To deal with the security and privacy challenges, it has put in place different applications and infrastructure that guarantees such. One of the main challenges that may be experienced is that the system may fail to guarantee the protection of personal data, its usage or distribution. As part of the first processes of securing the data about the patients, it is encrypted before it is uploaded to the cloud. In the encryption of the health data of the patient, his health ( $M$ ) is encrypted by the patient with a secret key by using a symmetric key encryption algorithm (for instance AES). This is as in (1).

$$C_M = E_K(M) \quad (1)$$

The distribution and the management of the secret key  $K$  is only distributed to only persons that have been authorized by the NGO for decryption purposes.

The cryptographic techniques used in the above equation changes the protection of the secret data to the protection of the secret keys ensuring that there is an

efficient management of the health care system. The first step in achieving this may be to encrypt the secret key for the patient  $K$  through the use of the Attribute-Based Encryption ( $CP$ - $ABE$ ) scheme [18] [19] [20] [21] that represent the privacy policy of the patient. This can be represented as (2).

$$C_K = E_{ABE}(K) \quad (2)$$

The distribution In this case, the  $CK$  can be accessible to each and every person and decryption may only be possible if the set of assigned secret keys meet the criteria set for the access policy. Therefore, even though the encrypted data can be downloaded by any person within the cloud, only the parties that have been authorized by Smile Foundation such as the members of the family of the patients or the authorized healthcare professionals can decrypt the data. Alternatively, Smile Foundation can leverage its enterprise rights management (ERM) in order to distribute the secret key  $K$  with licenses and distribute it amongst only authorized list of recipients. This can be represented as (3). Whereby, the license is a function of the identity of the recipient  $ID_i$  and the public key  $PK_i$ , the signature of the patient, and his security and privacy.

$$License_i \leftarrow (ID_i, PK_i, sig_p, Policy) \quad (3)$$

This secret key  $K$  can be encrypted on the basis of the patient's policy through the use of the asymmetric encryption algorithm (for instance RSA) involving the recipient's public key  $PK_i$ , as in (4).

$$CK = E_{PK_i}(K) \quad (4)$$

The use of the ERM-based mechanism makes it possible for the patients within the cloud system of Smile Foundation to be in control of the access and use of their data when they are online or offline. They are therefore in control of the manner in which their healthcare data can be shared and used. In essence, this means that instead of relying on the security protection offered to such data by the communication networks within the infrastructure, the protection of this data is guaranteed at the end points of the communication system. There have been proposals on enhancing this ERM-based protection such as extension concerning the management of licenses and permission evaluation [22] and the ability to transfer the execution of tasks across devices [23].

### F. Cloud Computing Case Study Modeling Outcome

In mathematical modeling and analysis in order to understand the interdependencies involved in cloud computing, it is important to identify the optimal values that can be used to predict the behavior that the research question seeks to address. In evaluating the performance, it is important to evaluate the factors that determine the performance over a period of time when the subject of the research question is implemented. Some authors [24] have attempted to develop an elasticity model for measuring the

efficacy of cloud computing systems by assuming that all the resources can be allocated units that the observer can use different metrical data to measure their efficacy. However, the cloud consumers find it difficult to use the mathematical solutions to solve the underlying challenges of using or not using the cloud computing technologies in their operations. The impact of the use of the cloud computing by Smile Foundation can therefore be made operational into three dimensions that include; strategic benefits, informational benefits, and security enhancement. The strategic benefits refer to the positive effects that are achieved in the long run after the adoption of the cloud computing system such as the ability of the non-governmental organization in India to have a competitive advantage. In showing the efficacy of the cloud computing as a means of enhancing the provision of healthcare in India by Smile Foundation, the researcher adopted a model that has three hypotheses that could be derived from the findings as shown in the Fig. 1.

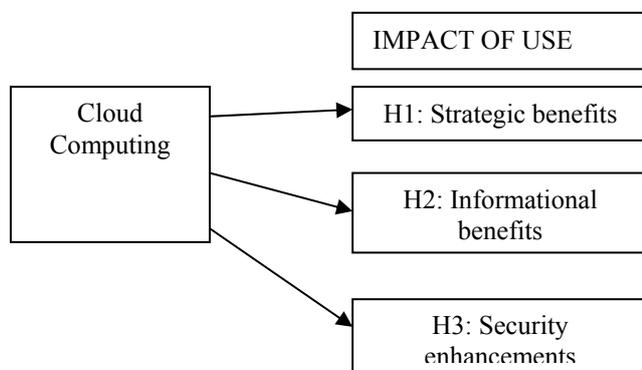


Fig. 1. Cloud computing utilization outcome model.

The derived model aligns the strategies to support the goals of the organization. The informational benefits on the other hand helps in the sharing of information that helps the users (patients) as well as the NGO to use data for faster, reliable and accurate decision-making. The security enhancement in this case will allow the organization to enhance the security of the data that is stored within the cloud, hence maintaining the privacy and confidentiality of the users.

The hypothesis derived in this case study, therefore, indicates that cloud computing by the NGO Smile Foundation based in India guarantees strategic benefits (H1), facilitates informational benefits (H2), and results in security enhancement (H3). In this research work, a seven point Likert scale was used, whereby (1) indicates strongly disagree to (7) strongly agree, for cloud computing impact. In addition, all the constructs were modeled as reflective. For validity purposes, construct reliability, convergent validity, and discriminating validity was used to examine the constructs as shown in TABLE I and II. In addition, the construct reliability was assessed through the use of composite reliabilities (CR), with the CR for all measures exceeding the recommended minimum value of 0.70. However, the convergent validity was examined through the use of the AVE value, where a value of more than 0.50 indicated convergent validity.

TABLE I. MEASUREMENT MODEL

Construct	Scale	Item	Loadings	AVE	CR		
Cloud Computing Use	Reflective	USE	1.000	1.000	1.000		
		Strategic Impact	Reflective	SB1	.890	.843	.970
				SB2	.934		
				SB3	.947		
				SB4	.923		
				SB5	.926		
SB6	.889						
Informational Impact	Reflective	IB1	.879	.815	.957		
		IB2	.928				
		IB3	.883				
		IB4	.916				
		IB5	.908				
Security Enhancement Impact	Reflective	SE1	.830	.725	.959		
		SE2	.831				
		SE3	.848				
		SE4	.717				
		SE5	.920				
		SE6	.786				
		SE7	.892				
		SE8	.900				
		SE9	.918				

The discriminate validity was assessed through an examination of the square root of the average variance extracted (AVE) whereby all the inter-construct relations were compared. The square roots of the AVE were greater than the correlations between the correlations and square roots of AVE) showing discriminate validity.

TABLE II. DISCRIMINATE VALIDITY

	USE	INFOR	SECUR	STRA
Cloud computing use (USE)	1.000			
Informational benefits (INFOR)	.260	.903		
Security enhancement (SECUR)	.132	.858	.852	
Strategic benefits (STRA)	.268	.843	.702	.918

G. Case Study of Health oriented preventive Education (HOPE) in Pakistan

The case of Pakistan is quite the opposite as compared to the successes of cloud computing in India. This is because most NGOs in Pakistan still use the conventional methods of provision of services rather than using modern technology and cost effective tools that can provide efficient services for the population. The NGOs operating in Pakistan continue to carry out their functions manually and this has the effect of slowing down the delivery of important services to the targeted population.

Most NGOs in Pakistan lack effective information and technology infrastructure to support their operations, especially in the health care sector. Because of the manual system that most of these organizations use, their facilities are in most instances overcrowded, have unsatisfactory patient care and at certain times they are inaccessible to the population. This implies that the Pakistani organizations are uncompetitive as they are unable to share information with their clientele in real time or through online transmission. Further, the failure by these NGOs to use technology such as cloud computing to provide real-time online experience has made them incur massive costs that are not commensurate with the services that they should have offered.

Based on the above analysis, it is therefore not surprising that Pakistan NGOs are not competitive as compared to those that have adopted cloud computing and operate in India. This is because the absence of a cloud computing technology system disempowers them from providing immediate and accessible tools, technologies, infrastructure and services that can be used to improve the existing systems of operation. These organizations have also failed to appreciate the fact that cloud computing is both cost effective and does not require the initial capital costs as users only have to pay for the services that are hosted within the cloud.

In addition to missing out on the advantage enjoyed through the virtualization technology that maximizes the sharing of data amongst several users, Pakistan organizations have not shown any resolve to adopt cloud computing as a means of achieving their objectives. They have equally failed to appreciate that cloud computing can help the NGO to cut on costs as they can negotiate with the vendors to meet the computing demands of the customers. This can be achieved by the organization offering remote services that can conveniently reach more than one geographical location at the same time. Similarly, these organizations fail to appreciate the fact that the cloud computing infrastructure offers them identical opportunities in order to conveniently deal with their objectives of providing equitable and accessible health care infrastructure.

An important observation is that cloud computing has been known to offer the users the ability to use affordable but dumb terminals or workstations that make it more convenient and economical. It is also user-friendly in that it conceals the complexities that may be experienced in the management of the infrastructure from the users. It also ensures that there is continuity and availability of the services that ensures that data can be replicated from one geographical position to another even when one server fails to work.

Despite the above obvious advantages of cloud computing that NGOs can tap, Pakistan NGOs have continuously failed to adopt it hence making most of their operations costly and inefficient. This is manifested in the late delivery of services and resources to the target population as the expensive manual systems lead to further constraints on the operations of the NGO making it not to achieve its core mandate. HOPE is one of such organizations in Pakistan that has not actively embraced the

use of cloud computing in the provision of health care to its target population.

HOPE which is an organization based in Pakistan is an NGO that provides health and education services to the poor and the needy in Pakistan. The health care provision is majorly conducted in hospitals and maternal and child health care centers as well as in vocational training institutions. In the present case, all the 55 registered centers that it is affiliated to participated in the study. 37% of these respondents were managers of the healthcare institutions and majority of them had at least a professional qualification. A large number of participants were IT professionals, because this study was about the use of information technology to facilitate faster provision of services. Several factors have been shown to affect the utilization of cloud services by NGOs in Pakistan including HOPE. These can be represented as lack of ICT staff, the lack of budget to implement the cloud computing technology, the difficulty in evaluating the return on investment that the cloud technology brings to the organization. In addition to these, there are also security concerns, the absence of management support and use of outdated hardware and software that is very common in Pakistan. Therefore, all these can be said to be the lack of both technical and management oriented support for the cloud computing technology to be used within the organization.

An important observation is that even though the NGOs in Pakistan are aware of the services and applications within the cloud computing system, they lack the knowledge on what it encompasses. Therefore, from the graph it can be shown that 55% of the respondents do not utilize the cloud computing services while a corresponding 45% do not utilize the same services.

A clear observation of the above disparities is that most of the NGOs in Pakistan including HOPE have no budgets for the development and maintenance of their ICT infrastructure that may include the cloud computing technologies. They also do not find the cloud computing technologies as integral in the reduction of the running costs that the organization incurs in the management of its affairs. There are also reservations about the privacy and the security of the data, whereby most NGOs have a problem in entrusting their data for storage by third parties. This implies that most users of the cloud computing system must be aware of the standard procedures of disclosure and inspection of user's data [25].

Importantly, HOPE as an NGO operating in Pakistan has had a challenge in the adoption of the cloud computing technologies as its management does not support or have favorable attitude towards this important system. It is therefore desirable that the top management of an organization such as this NGO retain the significance of possible change through having a vision for the organization and the importance of adopting cloud computing technology [26].

In normal circumstances, a failure denotes the condition in which a system deviates or fails from fulfilling the intended functionality or the behaviour that is expected. The failure occurs due to an error or a significant impairment of the system.

The ability to tolerate the performance of the functions by the system is important in ensuring that the system behaves in a desirable manner. In this section, it is shown that the inefficiency of HOPE as an NGO operating in Pakistan is due to the absence of a cloud computing system that can enhance its operations. In order to analyze the failures, it is first important to analyze the architecture of a fully functioning cloud computing system presented in Fig. 2.

Management Services	Fault tolerance Services	Software as a Service (SaaS) Distributed Programming, Mashups, Social Computing, Scientific Models
		Platform as a Service (PaaS) Web 2.0 Interfaces, APIs
		Infrastructure as a Service (IaaS) Virtual Machine Management and System Management
Physical Hardware Hosting Platforms		

Fig. 2. Layered architecture of cloud computing.

Failure in any given layer of the above architecture of cloud computing, affects the services that are offered by the layers above the failed one. In order to illustrate the failures that HOPE, an NGO in Pakistan, currently uses in the management of its systems, a Markov model can be used. This helps in the determination of the reliability and availability of such a system which takes into account the failures of such a system. In the model, each state can be represented by  $(x, y)$  where  $x = 1$  shows that it is functional while  $x = 0$  shows that it has failed. Similarly,  $y$  can be used to represent the working condition of the system. The system also remains in state  $(1, 1)$  at the normal execution process when the system is working optimally as shown in Fig.3.

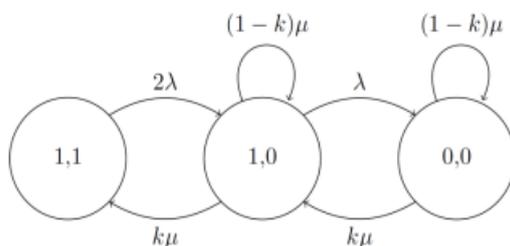


Fig. 3. Markov model of a system

As discussed, the systems within HOPE that do not use cloud computing are subjected to failures hence affecting the applications of the users within the system. For example, it may experience breakdown in communication that eventually affects the overall

functionality of the NGO. In the introduction of the representative replication scheme to determine the efficiency of a cloud system, it would be possible to determine the advantages that would be enjoyed by an organization that adopts cloud computing. Cost can be incurred in a system that has not adopted cloud computing as a measure of running the affairs of an organization. The drawbacks of the above cost is that the absence of cloud computing may make it impossible to determine the achievements of the organization.

H. Analysis of the Findings

HOPE has failed in utilizing the available ICT initiatives as has been indicated; there is no person that drives the use of cloud computing initiatives within the organization. This indicates that the management does not support the cloud computing and this explains why most respondents (55 %) stated that there was no driver for the use of cloud computing within the organization. While the results indicate that only 17 % of the IT executives drive the agenda for the use of the cloud computing service, another 8% believe that only 8% can be behind the use of the cloud computing technology in the Pakistani NGO.

The above results show that cloud computing have significant and positive relationships with the strategic and informational benefits that Smile Foundation hopes to achieve in the provision of health care within India ( $p < 0.05$  and above). This therefore supports the position held by H1 and H2 in that it aligns both its strategic needs and the use of the information to improve services and links between it and the community. With regard to the informational benefits, cloud computing has been shown to lead to faster access to information which can help in improving the decision making within an organization. However, when it comes to security and confidentiality, H3 has not been supported as ( $\beta = .418, p > 0.05$ ) has not found that it significantly leads to the enhancement of the security of the data about the patient. In order to change this, the NGO may have to secure its cloud computing infrastructure and utilize the encryption options earlier discussed. Therefore, these findings have indicated that the cloud computing can help in making Smile Foundation, an NGO that provides health care services in India to achieve its strategic aims as well as share information for improving the health care of patients.

From the foregoing, it is important to note that it has been shown that the use of cloud computing by the NGO in India has been successful in achieving the objectives of the organization. This is because it has helped in the achievement of the strategic and informational needs of the organization. However, for the case of HOPE in Pakistan, the organization has failed to achieve its objectives as it still uses the conventional methods of reaching its target population. This is because in the absence of the cloud computing service, the organization cannot operate virtually and has to be physically present in the areas of operations to reach the patients. Having given the findings, the next section makes a discussion of the findings and how they affect future research.

## V. DISCUSSION

Cloud computing is one of the most important revolutions that have occurred on how institutions can use this technology to transfer, store and possess data. This technology has been found to be more desirable as it is possible to share applications and information without the rigors of costly and complex software and hardware. It also enhances the functionality and features that are available within the cloud which can reach a broader group of people. In as much as the cloud computing systems have been found to be advantageous to organizations that adopt them, it is worth noting that they also come with challenges that border on the possible breach of security and privacy of the data belonging to patients within the particular cloud.

This paper has shown that cloud computing is one of the emerging technologies that can be used by organizations including non-governmental organizations (NGOs) to provide on-demand service. This helps in the delivering of resources and services that range from storing and accessing data through computation and software provisioning. Typically, the NGO in this case Smile Foundation has used cloud computing both as Infrastructure as a Service (IaaS) and Software as a Service (SaaS) to provide on-demand services that comes with benefits such as scalability, cost reduction, data availability, reliability and resilience.

Smile Foundation has adopted cloud computing in order to easily reach its target markets as it helps it to focus on increasing the quality of delivered healthcare as well as the simplification of the information sharing amongst its institutions and personnel. This is very important in the provision of health care in that it enables the NGO to achieve both its strategic missions and informational needs that can be used to align its operations.

Unfortunately as discussed earlier and in this section, cloud computing does not come with advantages only. This is because the transfer and storage of the sensitive data about the patient within the cloud can pose serious security and privacy risks to such data and its confidentiality. Therefore, the healthcare provider such as the non-governmental organization in question must devise ways of retaining and sharing the patient's data about his health care. In the present case, Smile Foundation has developed an advanced cloud infrastructure that can enhance the security, privacy and resilience while at the same time being cost efficient and scalable. These are the advantages that the cloud computing system that has been developed by this NGO in enhancing its health care services to its targeted population.

In this paper, the researcher has presented one of the recent results that have been achieved by an Indian non-governmental organization in the implementation of a cloud computing system in order to manage its health care systems. Smile Foundation which deals with the provision of health care to the less privileged members of the Indian society have found the cloud computing system to be integral in the achievement of their strategic and informational interests hence making it one of the most successful NGOs that are operational in this area.

The cloud computing that has been designed by Smile Foundation is meant to achieve the obvious advantages of a cloud computing system. As has been shown in the practical test of the infrastructure and the literature review, Smile Foundation through its e-health cloud system benefits from the five advantages of a cloud system. Firstly, it has ensured that it has on-demand services for both the health care institutions, personnel and patients attached to its system hence achieving the informational benefit criteria. The cloud system has also enabled Smile Foundation to have a broad network access and the pooling of resources that helps it minimize its costs as well as achieves a competitive advantage. Further, Smile Foundation has been able to benefit from rapid elasticity of the system and the advantages that are associated with measured service.

Smile Foundation continues to offer automated self-managed services through its e-health cloud system that relies on attributes such as availability, multi-tenancy, scalability, resilience, reliability, adaptability, security and privacy, and cost reduction. However, in the achievement of these, it relies on the cloud service providers that must ensure that only legitimate protocols are performed within the cloud. In addition, the health records of the target population are usually stored in a highly distributable data stores within the cloud that are also managed through complex systems and architecture to guarantee the efficiency of the cloud.

Hence in the cloud system operated by Smile Foundation, it can be shown that data can be accessed through a variable set of parties from different segments but with differing rights and obligations. For instance, the health care personnel from Smile Foundation can access the cloud for the healthcare data of the patients while the targeted population can continuously update the cloud for ease of operations. The NGO also continues to receive timely and available medical records of the patients and manages such data in an efficient and private manner in order to protect the identity of the patients.

More importantly, Smile Foundation has continued to ensure that there is patient-centric transparency in that the targeted patients are made aware of their privacy rights and they can specify or delegate the level of access to their data. This ensures that there is confidentiality of the medical records that have been stored by this non-governmental organization in its cloud computing system. It also guarantees the integrity of the data held within the cloud in that it ensures that it is correct and the NGO can be accountable for the services that it offers to its targeted areas based on the data provided within the cloud.

This paper also proposes an application of cloud computing for a health care system as well as addressing the privacy and security challenges that such a system may pose to its users. In the first instance, the researcher set the scene through investigation of the use case scenario of a cloud system for health care including the proposed architecture of a healthcare system for the NGO. In addition, the researcher identified the challenges that may be encountered in ensuring the security and privacy of the proposed cloud system for Smile Foundation that would be used in the enhancement of the health care system in the areas that it operates in.

Further, there was a description of a comprehensive methodology that integrates the security and privacy of the proposed cloud for the health care system. Particularly, the researcher used the most desirable architecture that can be applied to the cloud system to analyze the threats that may compromise the security and privacy of the cloud system. Moreover, an infrastructure plan was drawn that integrated the healthcare functionalities into the entire cloud. Further, a mitigation strategy for the threats to security and privacy of the patient data was offered by highlighting the fact that the patient can encrypt their own data before uploading them to the cloud as a measure of ensuring that only the authorized personnel can access them. Pursuant to this, two strategies were offered that could address the protection and distribution of the security keys that involved the application of the attribute-based encryption schemes as well as enterprise rights management technologies as preliminary steps in guaranteeing privacy and security of data.

## VI. CONCLUSION AND RECOMMENDATIONS

From this research it has become quite evident that cloud computing has got more benefits than losses when implemented by a non-governmental organization in countries with almost similar demographic patterns as India and Pakistan. In India, it has been shown that the cloud computing when applied in the health care sector has the probability of enhancing the services for the general and better welfare of the population that is served by the NGO. From the discussion above, it is noted that the users need to have adequate knowledge of the manner in which their organizations can benefit if they use cloud computing in the running of their healthcare initiatives. In the case of the Pakistan NGOs, there is need for proper training of the staff and the upgrading of their management principles so that they can appreciate the importance of cloud computing as a tool for guaranteeing efficient operations. In the evaluation of vendors for the cloud computing technology, there is the need to choose only the vendors that can guarantee the security of the data while at the same time maintaining the confidentiality of the data that is stored within the cloud. It is also important to have a clear strategy of how the NGOs intend to implement the cloud computing technology and the costs that are associated with this technology. Therefore, from the study herein, it has been shown that the cloud computing technology has been integral in ensuring that the NGOs in India succeed in the provision of health care to its catchment areas.

Contrary to this, the NGOs in Pakistan particularly HOPE has failed to be operationally efficient as it has not migrated to the cloud computing technology. In most of its operations, HOPE has continued to use the conventional or traditional method of reaching its targeted population which in some cases is usually far-flung from its sphere of operations. Without adopting cloud computing, it has to manually collect and tabulate the health care records of its population so that it acts on them. This takes considerable costs and time to reach the patients which negates the key objectives of this NGO in the provision of health care to less privileged members of the Pakistani population. Had this organization adopted and joined a cloud, it would easily access these patients at the touch of a button and at their

own convenient places so that it offers them cheap and reliable health care. Perhaps this research would provide a basis for the adoption of a cloud computing service by HOPE in its operations in Pakistan as has been adopted by Smile Foundation in India due to the numerous advantages associated with it.

### A. Future Work and Implications

The discussion in this paper has underscored the importance of cloud computing in enhancing the provision of healthcare to less privileged members of the society. Even though the cloud computing has been found to be effective in achieving and enhancing the operations of a non-governmental organization, they have also been found to pose challenges especially with regard to the privacy and security of the data held within the cloud. This research paper only discussed preliminary measures that can be used to address the privacy and security challenges that affect the protection of the data held by the patient.

However, it should be observed that the encryption and distribution of the encryption keys within a cloud may be inadequate in guaranteeing a secure health system within a cloud. This implies that more mitigation techniques should be integrated within the cloud for the cloud-based health care system to be secure. Therefore, it may be important to design trust protocols that may strengthen the privacy and security systems of the cloud in question. Further, the solutions that were designed to address the key management procedures such as the revocation of the secret key and its renewal as well as the updating of the policies for the cloud health care system still remain a big challenge.

It is also still debatable whether a health service provider should be fully trusted with the private data of patients within a cloud. This is because of the fact that as long as the health care provider can collect activity data that is being monitored by the NGO in India (Smile Foundation), it can still analyze them and uses them for purposes other than the ones desired by the organization. As a consequence, a mitigation solution that addresses this challenge needs to be adopted in order to facilitate the anonymity of the patients or the targeted population in order to ensure that their data remains confidential. For instance, this can be achieved through the use of anonymous credentials such as the basic anonymous attribute verification and single-use [27], delegation [28], or endorsement [29] so that patients can generate anonymous tokens and at the same time access the health care system anonymously. The advantage of this is that these anonymous systems will not reveal the identity of the patient or his personal information and it is impossible to know whether the tokens were generated under the same credential. From a perspective of implementation, the proposed infrastructure that Smile Foundation uses to enhance the provision of health care to less privileged members of the Indian society has not reached an advanced stage and may still require practical evaluation in order to boost its operability.

In the case of Pakistan, it has been shown that the NGOs in the nation have continued to operate without the incorporation of cloud computing within their operations. This has made it impossible, like in the case of HOPE to

increase access and enhance the quality of health care and manage the costs of the health care. This NGO has been shown to have failed to embrace cloud computing which would help it to manage its health care services remotely hence benefiting the targeted population in the provision of health care.

In Pakistan, the NGO has shunned the use of the cloud computing technologies also due to the fact that the health care workers feel that they are subjected to unwarranted oversight that can be carried out within a cloud. This is despite the fact that the electronic records that are within a cloud provide a user-friendly interface within which they can store and transfer data. The upshot of this resistance is that the cloud computing has not been popular in Pakistan despite its obvious advantages, even though issues of privacy, confidentiality and security issues have been raised [30].

The findings from this research into the adoption of cloud computing by an NGO based in India and the failure by a corresponding NGO in Pakistan have also had serious implications for future research. A careful examination of the depth of the preparation of NGOs in the adoption of cloud computing suggests that there is a gap between literature and the actual implementation of cloud computing technology. For the NGOs that have failed to adopt it, there is a clear misunderstanding of the strategic intent and objectives of having a working cloud computing system within its operations. Even though the NGO in India set up cloud computing to determine its operations while the Pakistan NGO failed to implement the same, it is virtually impossible to assess the readiness of these organizations to adopt cloud computing technology. This low level of readiness to adopt cloud computing technology corresponds to the findings in the literature review that small organizations do not have the organizational readiness to have systems that would improve their operations.

As found and discussed in this study, most non-governmental organizations are inherently different from bigger organizations or multinationals that readily adopt cloud computing. Therefore, in as much as an organization may desire to migrate to a cloud computing platform, they mostly find it difficult to implement such due to the high costs and nature of moving into a cloud computing system. This may necessitate the setting up of simple cloud computing frameworks that that emphasize and increase the awareness as well as preparedness to join a cloud computing system. Given that the data found that the case in India is far much different to Pakistan in terms of adoption of cloud computing technology, the data analysis found limited evidence of the use of cloud computing in a health care setting, especially in Pakistan.

In future, as a means of enhancing the adoption of cloud computing for NGOs, it would be important to have cloud systems that should be reflective and operational in the context of small organizations such as NGOs. This includes a consideration of the nature, degree of complexity and the inherent characteristics of non-governmental organizations. This is based on the recognition that NGOs have limited resources that can be used in the planning and execution of cloud computing systems. Recognizing that non-governmental organizations have limited resources to

implement cloud computing technologies, low level of command structures as well as faster decision-making processes, any attempt at addressing cloud computing should entail few steps that can be understood and implemented easily. Similarly, such a model for implementation of cloud computing technology must also focus on ensuring that the adoption of cloud computing adopts less documentation, planning and setting up of cloud computing infrastructure. Further, the findings showed that the reasons for non-adoption of cloud computing in Pakistan are due to the lack of awareness of the benefits of the cloud computing technology. For instance, the GO in Pakistan did not have adequate resources to support the migration to a cloud platform while other also lacked the requisite expertise and time resources to be part of a cloud. Despite these observations, it has been shown that the cloud computing technology can help an organization achieve its objectives in a prompt and efficient manner as opposed to an organization that has not adopted it. This research paper forms a basis for future research on the use of cloud computing for small organizations such as non-governmental organizations (NGOs) to reach the targets in populous nations such as the case of India and Pakistan or even China.

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