



## **Adoption of Cloud Computing Services in Healthcare Sectors: Special Attention to Private Hospitals in Colombo District, Sri Lanka**

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### **Authors' contributions**

*This work was carried out in collaboration between both authors. Author ALMA designed the study, managed the literature searches, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author DA managed the analyses of the study and checked all the worked performed regarding this study. Both authors read and approved the final manuscript.*

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### **ABSTRACT**

Cloud computing is the most important part of information technology that provides solutions to improve healthcare sectors. This innovation helps organizations to enhance or redesign the services at less expensive charges. The study investigates the integrated factors that impact in adopting Cloud computing technologies in healthcare industries in order to adopt innovation benefit. This study was conducted using quantitative method and questionnaires were distributed among 125 employees who are working in the IT departments of the private hospitals to evaluate their capability and readiness to embrace cloud computing services. Different techniques were used to analyse and decide whether Technology, Organizational, and Environmental Factors (TOE) influenced a major role in healthcare sectors' decision making to consider cloud computing technology services as an effective investment. The findings of this study have significantly impacted the willingness of private hospitals in Sri Lanka to follow the cloud computing technologies.

*Keywords: Cloud computing; healthcare sectors; adoption benefits; TOE framework.*

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## 1. INTRODUCTION

Worldwide rivalries are competing globally in this rapidly changing environment, making companies increasing their spending, increasing profits and increasing productivity [1]. To improve the bottom line of an organization, the companies decision makers has to strengthen Information technology adopting in order to reduce cost and maintain competitive benefits and improvements [2,3]. The use of information technology can increase the efficiency of businesses and provide companies with positive advantages [4]. Most of the services offered by Information Technology (IT) service providers are expensive and time consuming due to delay in updating their existing technologies, adoption of cloud computing has advanced as a noteworthy technological development to reduce these handling costs that occur time to time [5,6]. Cloud Computing has been introduced as a key technological innovation to minimize the processing cost by improving the reliability, flexibility, availability and processing [6]. Lately, cloud computing in the IT industry is an important consideration; it is perceived as an imperative piece of IT venture [7]. Cloud computing is viewed as another wonder, which provides opportunities for companies, collects easily accessible virtual system resources [6], there is an opportunity to facilitate economic growth by providing the already existing infrastructure for implementation of computing and data management that needs with low capital investment for organizations.

Cloud computing technologies have become a serious target in the Information Systems Development Industry; it provides companies with different advantages such as resource pooling, quick flexibility, wide network access...etc. [8]. The use of new technologies such as cloud computing allows many companies to gain competitive efficiency and allow them to increase efficiency and productivity [9]. The appropriation of the most up to date advances, similar to cloud computing, assumes a basic part in the capacity of organizations to keep up an aggressive position in the market, and has turned into a center system to guarantee powerful administration of IT resources [10]. Whether or not to follow the cloud computing model is often complicated by challenges and uncertainty about anticipated business value associated with new technologies [11]. Various studies have been discussed about the Technological, Organizational and Environmental factors (TOE) that impact the cloud computing

adoption. Though, analysis of this technology is still essential in various business segments for better understanding of cloud computing [12].

Since the end of the civil war in 2009, healthcare sectors have been regarded as one of the profitable sectors in Sri Lanka on the account of increased consumption of healthcare services and growing investment flowing from both private and public institutions. Although this industry has grown in recent years, it still faces many challenges, issues, growth and diversification in managing information such as pressure, bottomless competition, integration of people and organizations to reduce costs. There are many studies that have studied cloud computing architecture, potential use and advantages and costs. Unfortunately, there are some empirical studies that have learned about the use of cloud computing in general and in South Asian context. Due to the lack of such studies, this study provides clear understanding to the impact of TOE factors on the adoption of cloud computing and to explore how TOE factors are understood to affect cloud computing adoption in organizations [13].

The findings of this research can assist organizations, specifically private hospitals to, firstly, better understand cloud computing itself and, secondly, how Cloud computing can increase effectiveness in the healthcare sectors by adopting this innovative technology and services. Therefore, this study can be considered as a way to influence the practices of whether to invest in accepting the cloud computing model or whether to invest without consequences.

## 2. LITERATURE REVIEW

Several studies so far reveals that the various factors that affects the decision to accept various technologies. For cloud computing, researchers have chosen different ways to explain or encourage companies to adopt cloud computing. Reference [12] and [13], for instance, examined the effect of eight factors: "relative advantage, complexity, compatibility, top management support, firm size, technology readiness, competitive pressure, and trading partner pressure" on the decision of high tech companies to adopt cloud computing. The findings indicated that five of these factors, namely: "relative advantage, top management support, firm size, competitive pressure, and trading partner pressure, significantly affected the adoption of cloud computing".

Furthermore, some studies have examined the influence of TOE framework in adopting cloud computing in a different environment in SMEs and the results witnessed that most of these elements had a significant and positive effect on the adoption of cloud services in SMEs. The only factor that was not found to have any contribution in the process of adopting cloud computing was competitive pressure [14]. Since this factor has not been contributed, as researcher, feel that this factor may have significant influence, because the study set is different from the above cited area of study. In addition, reference [15] used the TOE framework to determine which factors influence the decision of managers to adopt cloud computing in the UK. The results indicated that the following four factors had positive impact on the adoption: "competitive pressure, complexity, technology readiness and trading partner pressure".

Reference [16], studied that, advancement in technology is always required to give vast information for every healthcare professional to give the best quality of the patient care and hospital management. In addition, [17] investigated the effects of various factors in adopting cloud computing of hospitals in Taiwan. The five most important factors in this study were data security, perceived technical skills, cost, excellent manager support and complexity. A study was conducted by reference [18] with the aim of identifying the factors with the most influence on the intention of organizations to adopt cloud services. The study found that the factors of availability, reliability, security, privacy and others had a significant impact on the decision to adopt cloud computing. Reference [19] also tried to understand which factors influenced the adoption of cloud computing in organizations. The researchers used an integrated model composed of both Technology Acceptance Model (TAM) and TOE factors in addition to two mediating variables including perceived usefulness and perceived ease of use to explain the variation in the dependent variable, intention to adopt cloud computing. The findings of the study suggested that relative advantage, compatibility, complexity, organizational readiness, top management commitment, and training and education were the most important variables affecting the adoption.

Therefore, the above citations and facts implies that there are many problems exists with the cloud computing adoption, one of which does not have a clear understanding of the relationship

between TOE factors and cloud computing [20,21]. The adoption of cloud computing will be perceived positively by organizations if they have an adequate budget, human resource support, ample time, good top management involvement and other factors [17].

## **2.1 TOE Framework**

The TOE structure was mainly created by references [22] and was mainly investigated for adoption of information systems in business organizations. This framework is becoming an important theoretical guideline for Information Technology adoption [23]. The adoption of complex IT innovation requires an advantageous technology portfolio, organizational structure, and environmental strategy [24]. The purpose of this study is to require theoretical model to get a better understanding of this technology. The current study suggests that Technological, Organizational and Environmental are the three components that depend on determining organization' intention to embrace cloud computing. The incorporation of TOE elements has leaded it to become more valuable compared to other models in studying technology adoption [25].

### **2.1.1 Technological Factors (TF)**

The Technological context refers to the internal and external technologies that companies can use in their business [12]. Internal Technologies are already being used in the company, externally available in the marketplace and do not use [14] by the company. Technologies that are currently in use by the firm's influence decision of adopting cloud computing because they determine the scope and limit of the technological change that the firm can accept. By adopting new technologies, by the way the companies can develop, technologies and market-access adoptions are not at the end of the adoption. Additional, continuous changes to the deviations made by technologies beyond the boundaries of a company. Technologies that offer additional modifications include new features for existing technologies and are considered to be three of the least risky [6]. Even though the successful adoption of IT depends on a large degree of technical capacity of the organizations and there is a dearth of studies that take technological characteristics into account when studying factors affecting IT adoption decision. Technological factors were discussed in three points; Relative Advantage, Complexity and Compatibility [26].

Relative benefit is defined as one of the technological factors providing many potential benefits to companies. It is logical for organizations to weigh the benefits that are expected to come from adopting an innovation [27]. The probability of adopting new technologies increases when companies realize a comparative advantage in those innovations [28]. Compatibility means that “the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters” [29]. Perceived compatibility takes into consideration whether current values, behavioral patterns, and experiences of an organization and its members are consistent with a new technology [30]. Complexity means that the understanding of the use of technology. The use of new technologies can be less challenging if new challenges are more challenging because they face challenges that change the processes associated with their business systems. In order to increase the chances for adoption success, technologies should be user friendly, manageable, and easy to use [29,31,32].

### **2.1.2 Organizational Factors (OF)**

Organizational factor can be defined as the resources and characteristics of the firm [33]. In this study the organizational context is composed of two main components that top management support and technological readiness which are important to deliberate. Top management support plays a significant role in initiating, implementing, and adopting of information technology. Top managers can secure enough resources and produce a supportive climate for cloud computing [21]. By obtaining such support, it helps the company to avoid alternative resistance to avoid any internal obstacles. The readiness of infrastructure and IT human resources to affect the adoption of a new technology is known as Technological readiness [25].

### **2.1.3 Environmental Factors (EF)**

Environmental Context means that small environment where the organization runs their business including industry market as well as Technology Service Providers [15]. Environmental context refers to a firm’s industry, competitors, and government policy or intention [26,12]. The environmental factors used in the study include competitive pressure, trust and trading partner pressure.

Competitive pressure is the amount of pressure the company faces from their competitors in the same industry [34]. When technology hits the competition, this competition can play a positive role in accepting any new technology [35]. Therefore, organizations that are first to adopt cloud computing are expected to derive benefits in terms of competitive advantage and survival [19]. Trust is a major factor with high risk and Internet uncertainties in the Internet environment and it is important for online interaction success [36]. In cloud computing, business partners are connected to cloud service providers. When you want to observe cloud services, the business associates are overstaffing, regardless of the size of the company's experiences and capabilities. Organizations that want to adopt cloud services are concerned about the ability of service providers to ensure the availability of data when needed. To ensure the desired level of availability, service level agreements and a combination of precautionary measures can be used [15].

## **3. RESEARCH MODEL AND HYPOTHESES**

The main purpose of these studies is to investigate the influence of TOE entities aimed at companies, especially healthcare industries, to adopt cloud computing technology and services. Hence, the theme of the research, “Intention to adopt cloud computing in healthcare sectors”, which is the dependent variable, and Technological, Organizational, and Environmental factors are the independent variables used to explain the variance in the dependent variable. The research Model of the study is represented in Fig. 1.

Based on the objectives and the research model, the following hypotheses are developed in order to test.

- H1:** There is a negative relationship between technology factors and the intention to Adopt Cloud Computing in private hospitals in Sri Lanka.
- H2:** There is a negative relationship between organizational factors and the intention to Adopt Cloud Computing in private hospitals in Sri Lanka.
- H3:** There is a negative relationship between environmental factors and the intention to Adopt Cloud Computing in private hospitals in Sri Lanka.

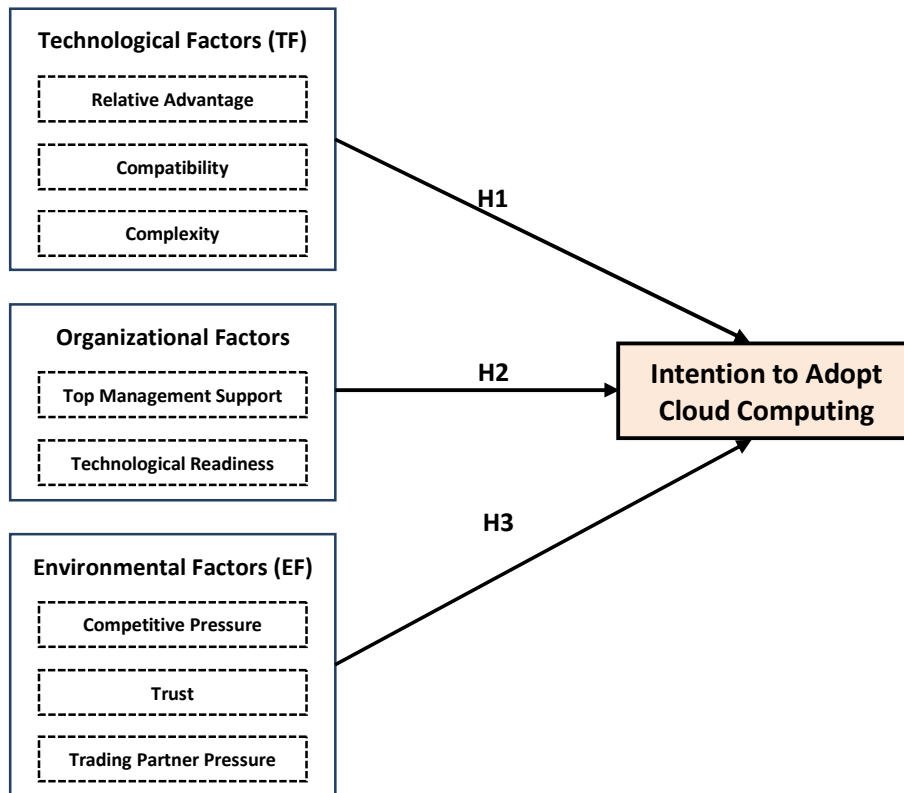


Fig. 1. Research framework of the study

#### 4. RESEARCH METHODOLOGY AND DATA ANALYSIS

A quantitative approach was taken to assess how the technological, organizational, and environmental factors would affect the purpose of adopting the cloud computing service. Data was collected through a self-administered questionnaire. This method, which will attempt to help healthcare sectors gain a better understanding about how these three factors affect their decision to adopt and deploy a cloud computing model. This method is an attempt to help the health sector understand how these three factors influence how to adopt a cloud computing model. This study comprised of 25 private hospitals in Colombo District and 125 questionnaires were distributed to employees working in IT departments. This study focuses on the factors affecting on adoption of cloud computing. So, the target respondents are the decision maker and people from information technology department such as head of information system, chief of information technology office and senior information technology officers.

TOE factors that affect the decision to adopt Cloud computing are measured by 8 variables; Technological factor which includes 3 items; relative advantage, compatibility and complexity as suggested by reference [29], Organizational factor that includes 2 items; top management support and technology readiness are also derived from [15]. Finally, Environmental factor includes 3 items; where competitive pressure, trust and trading partner pressure are derived from a study conducted by reference [29,37,38]. Cloud computing adoption was measured through 3 items based on a study conducted by [21]. Statistical Package for Social Sciences (SPSS) version 21 is used in order to investigate the association of hypotheses and to analyze the data.

#### 4.1 Data Analysis and Results

In order to examine the effect of TOE research model on the intention to adopt cloud computing, 5 points likert scale systems were used.

## 4.2 Demographic Characteristics

The following section present the demographic characteristics of the respondents through two aspects: gender and years of experience using online service.

**Table 1. Demographic characteristic of the respondents**

Item	Frequency	Percentage
<b>Gender</b>		
Male	69	73.14
Female	37	39.22
<b>Years of experience using online services</b>		
Less than 3 years	28	29.68
Between 3-5 years	46	48.76
More than 5 years	32	33.92

The demographic profile of Table 1 above indicates that majority of the respondents have been participated in the survey are male of 73% and around 39% of the respondents are female. Years of experience in using online services is concerned, around 30% of the respondents are having less than 3 years of experience in using online services, while 49% of the respondents are having experience between 3-5 years. Around 34% of the respondents are having more than 5 years of experience in using online service in their organizations. Therefore, this implies that most of the respondents are having experience in surfing net in order to support the area of the research.

## 4.3 Reliability and Validity

Validity and reliability are two important steps that determine the quality and usefulness of data collected. Validity is about accuracy and whether the instrument measures what it is intended to measure. Reliability is about precision; it is used to check the consistency and stability of the questionnaire. Researcher adopted, scales and items that were previously developed and used by other researchers with similar interests. In addition, a draft of the questionnaire was reviewed by two experts in this area of study to make sure that each item is measuring what is expected to measure, and to avoid any ambiguity or complexity in the phrasing of the questions. The reliability of the instrument was measured by the Cronbach's alpha coefficient. According to

[39], the values of all indicators or dimensional scales should be above the recommended value of 0.7.

**Table 2. Result of reliability test**

Reliability statistics variable	Cronbach's Alpha	N of items
TF	0.815	7
OF	0.832	8
EF	0.756	7
IACC	0.828	3

Generally, the higher value of Cronbach's Alpha illustrates a higher reliability. For reliability test, the normal standard value is 0.7. Therefore, if the value of alpha more than 0.7, then a high reliability has been proved. For the three constructs: Technological Factors (TF), Organizational Factors (OF), and Environmental Factors (EF), Cronbach's Alpha value are 0.815, 0.832 and 0.756, respectively. The alpha value of Intention to adopt Cloud computing (IACC) is 0.828, it is larger than 0.7. Therefore, the questions for each construct are consistent, so that the designed questionnaire has an acceptable reliability to process the research and to perform further analysis.

## 4.4 Hypotheses Testing Results

The value of significance ( $\alpha$ -level) is 0.05, and the probability value (P-value) derived from statistical hypothesis test is also a conclusion to reject the null hypothesis [40]. If the p-value is less than or equal to  $\alpha$ -level, the null hypothesis will be rejected and the alternative hypothesis will be supported. However, if the p-value is greater than the  $\alpha$ -level, the null hypothesis cannot be rejected and the alternative hypothesis will not be supported.

**Table 3. Tolerance and VIF for the independent variables**

Variables	Tolerance	VIF
TF	0.816	1.407
OF	0.704	1.565
EF	0.784	1.433

In Table 3, it can be seen that VIF ranges between 1.407 and 1.565 which are well-below five and the tolerance values range between 0.704 and 0.816 which are above 0.3. Hence, there is no problem of multicollinearity in the regression model.

In addition to VIF and tolerance values, Pearson Correlation Matrix also was computed for the independent variable dimensions to check correlation between them. It is clearly interpreted below in Table 4.

**Table 4. Pearson correlation matrix**

Variables	Pearson correlation		
	TF	OF	EF
TF		0.507	0.489
OF			0.523
EF			

By reference [41], a value of 0.3 and 0.9 suggests high correlation between the variables. The results in the above Table 4, are all between the ranges, thus suggest highest correlation between the variables. Therefore, these findings also show that there is no evidence of multicollinearity problem.

The results of testing the three hypotheses regarding the effect of TOE framework on the intention to adopt Cloud computing are presented in Table 5.

In Table 5, there is a positive correlation between TOE framework and the intention to adopt Cloud computing service, since the multiple correlation coefficient is 0.521. The adjusted R<sup>2</sup> relates to the generalizability of the model. It allows us to generalize the results taken from the respondents to the whole population. According to the results shown in Table 5 the R<sup>2</sup> value is 0.218. The results showed that F-ratio for these data is equal to 27.578, which is statistically significant at p < 0.05. Hence, there is a statistically significant effect of TOE framework on the intention to adopt cloud computing service in private hospitals in Sri Lanka. The  $\beta$  indicates to the individual contribution of each predictors (independent variable) to the model, if other predictors are held constant.

The values of  $\beta$  for Technology Factors (TF), Organizational Factors (OF), and Environmental Factors (EF) are 0.211, 0.201 and 0.207 respectively and are all positive. The level of effect of these variables depends on the  $\beta$  value,

the higher  $\beta$  value the higher the effect on the dependent variable. It can be concluded from the values of beta that the variable has the highest contribution in the model is Technology Factors, followed by Organizational Factors and finally the Environmental Factors.

## 5. DISCUSSION AND CONCLUSION

### 5.1 Discussion

The main purpose of this research is to determine the effectiveness of the healthcare sectors to adopt new findings by the recommended factors through the TOE framework in Cloud computing, particularly in Sri Lanka. The results of the study indicates that the three factors proposed by the framework (Technology, Organization, and Environment) played a role in making decision to adopt cloud computing in healthcare sectors in Sri Lanka. The first hypothesis of this study states that “There is a negative relationship between technology factors and the intention to adopt Cloud Computing in private hospitals in Sri Lanka”. This hypothesis was rejected; it was found that the Technology factors have had a positive significant impact on the intention to adopt cloud computing. This factor has made much impact on the decision to accept this new findings. This decision also supports the findings of other researchers [5,25,19,14].

The second hypothesis states that “There is a negative relationship between organizational factors and the intention to adopt Cloud Computing in private hospitals in Sri Lanka”. Results showed that the organizational factors did have an influence on the decision to adopt cloud computing. As suggested by previous studies [42,43] these factors could affect the process of adoption new technology. Some studies witnesses that top management support has significant influence on the adoption [44,45]; without top management support, organizations are less likely to adopt new technologies. It suggests that top management support may be a major driver that affects intention adoption techniques and effects [6,21].

**Table 5. Study model summary**

Variables	R	R <sup>2</sup>	F	Sig (f)	$\beta$	t	Sig (t)
TF	0.521 <sup>a</sup>	0.218	27.578	0.000 <sup>a</sup>	0.211	2.918	0.004
OF					0.201	2.380	0.014
EF					0.207	2.840	0.005

<sup>a</sup>Predictors: (Constant), TF, OF, EF; <sup>b</sup>Dependent variable: Intention to adopt cloud computing services

The third hypothesis, "There is a negative relationship between organizational factors and the intention to adopt Cloud Computing in private hospitals in Sri Lanka", was rejected as this factor was found to have a positive impact on the decision to adopt cloud computing. Reference [12,25,16] agree with the findings of this study. These indicate that companies facing strong competition are more actively implementing the changes and are quick to operate in a competitive environment. When competitors implement cloud computing as a competitive tool, other organizations face strong competition and thus feel pressure of adopting cloud computing so as to maintain a competitive edge and tough competition forces organizations to shift to cloud computing [44].

## 5.2 Conclusion

Considering the above facts, this study makes an effort to test the suggested adoption model presented in Fig. 1. The results of this research proved that the three factors of this framework (Technology, Organization and Environment) are connected to each other and have a significant impact on the decision of organizations, especially private hospitals in Sri Lanka, to adopt Cloud computing.

TOE factors have been identified as key factors in these studies. The findings of the research would be useful to, firstly, to the healthcare sector to create cloud computing adoption plans and, secondly, for the ICT service providers, finally the research model can help them to understand clearly how and why choose to adopt cloud computing services. In addition, companies can evaluate how complex the service is and how it can be applied to their systems and how to implement them. While researching to maintain excellent cloud computing in other areas, this paper can be used as a base for future research. Furthermore, in many countries, particularly in healthcare sectors, not only sought to acquire cloud computing, but further research should be made to generalize the results of research in Sri Lanka context.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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