Reliable Cloud Based Framework for the Implementation of ERP

Vikram Gupta, Sarvjit S. Bhatia

*Abstract***:** *Universally, technological innovations act as engine of growth for the developing economy. Technological revolutions act as an accelerator to enhance the economy worldwide. In the present scenario the technology has considerably impacted different aspects of life so that the business environment has changed thoroughly. Simply granting the access to the similar technologies utilized by the large business houses will flourish the business of small scale industries. As result flexibility, scalability, adaptability, availability, cost efficiency characteristics will be attained by adopting the innovation i.e. cloud based ERP in the organizations. Adopting Cloud based ERP system offers highly scalable, reliable, on-demand services with agile management capabilities on an as-needed basis. The present work is based on the concepts of social sciences and latest trends of information technology. In the framework, Diffusion of Innovation (DOI) theory and Technology-Organization-Environment (TOE) framework are synthesized. The framework examines and validates various social, technological, organizational and environmental factors that impact the cloud based ERP adoption. All these factors have significant impact on the adoption. The findings will propose practical recommendations to the successful adoption of cloud based ERP.*

*Index Terms***:** *Cloud Computing, DOI, Enterprise Resource Planning, IaaS, PaaS, SaaS, TOE.*

I. INTRODUCTION

Formerly the organizations contended on the basis of price or quality in the marketplace, but in the recent past, the business and trade surroundings has experienced intense changes. With these changes in the environment of the business, to survive in the market not only demands competitive price and quality but the satisfaction of the customers as well as service flexibility too [1]. To meet these challenges, the whole competitiveness of the enterprises has been extensively enhanced by the ERP systems. The ERP system combines with the latest tool of the information technology i.e. cloud computing leads to the modern era of trade and business and providing the solution towards the flexible, digital, networked and virtual enterprises by enhancing the resource configuration of the enterprise. Cloud ERP is one such modern time technology that lets the users and enterprises to access the internet on demand which is installed on vendor's site and use the ERP software as per requirement [2]. The basic concept of using cloud ERP is that as no initial investment cost is required for the setup of IT infrastructure and pay per use structure, therefore low entry cost may be required while using this framework. The user can access cloud computing environment in three different forms i.e. into public cloud, private cloud and hybrid cloud. Public cloud is a cloud service which can be accessed by the user through the web browser. This service can be called pay as you go, as users has to pay based on the processing power or memory usage e.g. Amazon EC2 charges very few amount for using Virtual Machines. The approach is cost effective and efficient towards purchasing the new system hardware and software. In this kind, hardware system may be hosted in different locations anywhere. Private cloud is a cloud service setup which is hosted for a single client as per his own requirement within an organization. This cloud service is basically owned and managed privately by an individual or an organization. The access of the service is limited to the individual client and its partner network of the organization. Hybrid cloud is a blend of both public and private cloud. Cloud services provide three kinds of services to the users in the form of direct system usability service namely Software as a Service (SaaS), operating system platform service namely Platform as a Service (Paas) and computing infrastructure namely Infrastructure as a Service (IaaS) in public domain. The cloud ERP framework can be implemented and validated phase wise which has already been designed [3].

II. CLOUD ERP FRAMEWORK

The framework is established by using DOI theory and TOE framework. These two theories are synthesized and implemented through ERP using the latest technology of cloud computing. The cloud ERP framework is distributed into three different phases:

1. Phase I The preliminary phase consists of two important factors knowledge and persuasion. These two factors are based on DOI theory:

i) Knowledge

The process of cloud ERP framework starts with the knowledge part. A related person learns about the existence of new innovative idea and look for the information about the same. In this part, the person tries to conclude about the new innovation and also it's working procedure [4].

ii) Persuasion

In this part of the phase, the related person has positive or negative approach towards the new innovative idea, but the creation of positive or negative approach does not always lead to an adoption or rejection of this idea directly or indirectly [4].

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It will persuade to implement the cloud based ERP framework which is the combination of traditional and modern technology.

2. Phase II This phase is further divided into three factors i.e. technological, organizational and environmental factors. These factors help the organization to adopt and implement the innovation.

i) Technological

The factors that are considerably related to the internal and external technologies of the business organization are known as technological factors. The internal and external technologies help to implement the cloud based ERP framework. Equipment or practice may be the part of these technologies.

ii) Organizational

The factors that comprise of all the characteristics and resources of the organization are known as organizational factors. The main factors of consideration of this study are size, management support, innovation, IT experience, scalability, upgradability, mobility and security.

iii) Environmental

The factors those are associated with the surrounding elements of the organization in which it conducts the entire business activities are known as environmental factors. The factors under consideration are competition, nature of industry, scope and outside support.

3. Phase III This phase of the framework is divided into three parts i.e. decision, implementation and confirmation.

i) Decision

Decision signifies the condition in which the consumer or any top order decision maker involves in the activities to take a positive or negative decision to adopt the innovative idea. The positive decision means the complete use of an invented idea whereas negative decision means not to adopt this idea [4].

ii) Implementation

It leads to an innovative idea that has to be put into use and practice. After taking positive decision, the concerned or top order decision maker puts this idea into the actual implementation.

iii) Confirmation

Confirmation leads to a state when the concerned or decision maker tries to reinforce and confirm the actual use of innovative idea under consideration or revert back from adopting this decision.
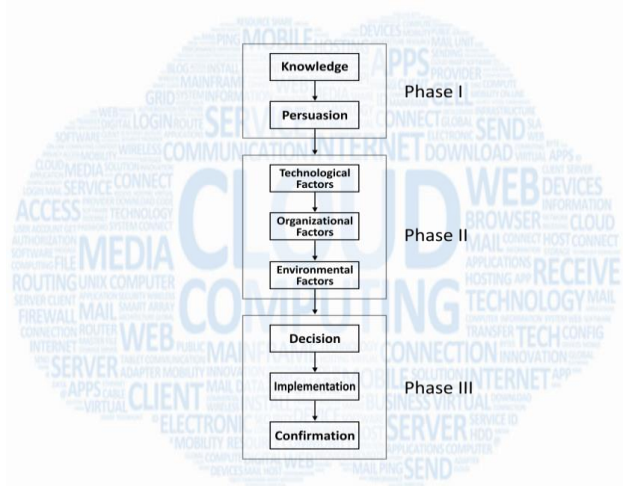
Fig. 1: Cloud ERP Framework

III. EMPIRICAL VALIDATION OF FRAMEWORK

Research Methodology

A research approach can be defined as the arrangements and the measures for research which includes the steps taken based on broad assumptions, comprehensive methods of collecting, analyzing and interpreting data [5]. To validate the present research framework is based on the questions in the questionnaire highlighted the theoretical and practical studies of the factors under consideration. Exploratory factor analysis method in SPSS version 25.0 and Confirmatory factor analysis method in Smart-PLS software (version 3.0) are used to analyze and validate the framework.

Descriptive Statistics

Descriptive statistics is necessary part of data analysis [6]. Respondents and organizations responses can be described using this statistics. In the present paper, SPSS 25 is used to calculate the mean and standard deviation of the variables for the research framework represented in the questionnaire. 5 point Likert scale has been used to measure the variables in the proposed research framework for twenty six factors.

The following table shows the mean level and the range of standard deviation of all the items used to measure the factors in the framework.

TABLE I: DESCRIPTIVE STATISTICS

Variables	Items	Mean	Std. Deviation
	KNOWLEDGE		
V1	IT knowledge is required for the adoption of cloud computing	4.32	1.112
V2	Third party plays role in the adoption of cloud computing	4.18	.911
V3	Outsourcing helps to implement the Cloud based ERP	3.78	1.059
V4	New techniques and innovation methods are required for the implementation of cloud based ERP	4.12	.922
	PERSUASION		
V5	Cloud computing is cheaper than in-house solutions	3.82	.965

V6	After implementation of cloud based ERP the profit will increase	3.68	1.112
V7	Saves time and labor	4.30	1.094
V8	Efficiency will increase and it helps to grow the business	4.48	.892
RELATIVE ADVANTAGE			
V9	Cloud ERP helps to perform the tasks more quickly	4.07	1.071
V10	Quality of the work will improve	4.05	1.080
V11	Implementation cost is reduced	4.15	.820
V12	Improvement in the quality of the goods and services	3.93	.899
UNCERTAINTY			
V13	Risk of project failure is always there	3.12	1.427
V14	Risk of security is present as the data is available on internet	2.82	1.621
V15	Fear of people losing their jobs	2.88	1.627
V16	System will collapse if not implemented successfully	3.75	1.174
COMPATIBILITY			
V17	System will collapse if not implemented successfully Implementation of cloud based ERP	2.73	1.313
V18	The working will become easy using cloud based ERP	3.08	1.293
V19	Leads to reduction in execution time	3.33	1.174
V20	Enhances the productivity	3.43	1.047
COMPLEXITY			
V21	Integration of Cloud with ERP leads to difficult situation	2.55	1.371
V22	Technical knowledge is required	2.92	1.139
V23	Execution of ERP application will become difficult as it has to be done through third party	3.33	1.052
V24	To convert the data from traditional ERP method to Cloud based ERP requires extra efforts	2.52	1.308
TRIALABILITY			
V25	The first hand trial is done before the implementation of cloud based ERP	3.12	1.574
V26	The trial has been done module wise	3.75	1.114
V27	The live data trial is mandatory to implement cloud ERP	3.87	1.127
V28	Cloud service providers offer the services on a trial basis	3.82	1.112
BUSINESS COST			
V29	After the implementation of cloud based ERP it reduces operational cost	4.12	.715
V30	Cloud ERP reduces hardware, infrastructure, software, staff and training cost	3.30	.997
V31	The cost of using cloud based ERP is less than installing or developing a technology in house	3.63	1.248
V32	Recurring cost is increased	3.45	.746
USABILITY			
V33	Adopting Cloud ERP has increased Effectiveness	4.32	.748
V34	Efficiency has increased by adopting Cloud based ERP	4.30	.743
V35	Adopting Cloud ERP has increased satisfaction	4.33	.752
V36	It provides better services to customers	4.10	.986
ACCESSIBILITY			
V37	Data can be accessed from anywhere at any time	3.82	1.017
V38	The transactions can be done globally	3.73	1.163
V39	The accessibility will reduce the time to complete the job	3.97	.974
V40	Cloud ERP enables organizations to access the data at affordable cost	4.20	.798
IMPLEMENTATION TIME			
V41	Cloud based ERP takes less implementation time	3.43	.998
V42	Cloud based ERP helps to take the decisions in less time	3.53	1.241
V43	Lesser the implementation time better will be the quality of the product/service	3.77	1.031
V44	Method to implement the cloud based ERP is directly linked with implementation time	3.90	.706
FIRM SIZE			

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V45	The size of the firm affects the implementation	4.13	.769
V46	Firm size affects the services of implementation of Cloud based ERP	4.15	.777
V47	Risk of failure increases with the increase/decrease in the size of the firm	4.07	.841
V48	Firm size affects the decision making	4.13	.791
	TOP MANAGEMENT SUPPORT		
V49	The top management takes the responsibility to implement Cloud based ERP	4.20	1.102
V50	The management formulates the policies to implement it	4.23	1.140
V51	The management provides the appropriate resources	3.90	.752
V52	Cloud based ERP helps top management to take the decisions	4.05	.622
	INNOVATION		
V53	Cloud based ERP automatically develops the new ideas in the business activities	3.50	1.172
V54	It helps to increase the business of the organization	3.02	1.432
V55	The innovation ideas reduce the access time	3.93	.756
V56	Need of expert is increased due to introduction of new idea	3.85	.820
	PRIOR IT KNOWLEDGE		
V57	IT awareness is essential to implement cloud based ERP	3.60	1.368
V58	Awareness of IT/ cloud computing helps in implementing cloud based ERP	4.23	.909
V59	Top management has prior knowledge to implement cloud based ERP	3.27	.972
V60	Training must be given to employees to provide the knowledge about the third party services	4.32	.651
	SCALABILITY		
V61	Cloud Computing helps to expand the business	3.60	1.343
V62	Using cloud computing business grows automatically	3.10	1.337
V63	The quality of services will be affected	3.97	.688
V64	The cost of implementation will be affected	4.17	.526
	UPGRADABILITY		
V65	It reduces the implementation cost	3.02	1.127
V66	It provides better solution than traditional ERP system	2.78	1.236
V67	Implementation of ERP using cloud computing will help the organization to grow globally	3.57	.998
V68	The performance of service/ product will improve automatically	3.23	1.382
	MOBILITY		
V69	It helps to develop the business globally	3.35	1.351
V70	Mobility and cloud technology increases the productivity	3.70	.908
V71	Data sharing is faster and less costly than ERP solutions	3.95	.852
V72	Mobility helps to utilize the resources of the system	4.15	.755
	SECURITY AND PRIVACY		
V73	Security in cloud based ERP is higher than ERP system	2.83	1.486
V74	Security leads to increase the faith in the business activities	3.85	.685
V75	Security and privacy helps to increase the quality of the work	3.85	.685
V76	Security and privacy has the poor impact on scalability	3.67	.968
	COMPETITIVE PRESSURE		
V77	The selection of cloud service provider is done on merit	3.77	.981
V78	CSPs provide the services on a very competitive price	4.02	.624
V79	Cloud computing adoption allows reliable interaction with competitors	4.15	.659
V80	Due to competition in CSPs, the quality of services they are providing will increase	3.48	1.127
	TYPE OF INDUSTRY		
V81	The method of implementing cloud based ERP will be same for the different industries	3.38	1.075
V82	Start-up companies are more likely to adopt cloud based ERP	2.88	1.075
V83	Cloud based ERP provides various alternatives available to business	3.13	.812
V84	The different type of industries has great impact on the implementation of cloud based ERP	3.27	1.274

	MARKET SCOPE		
V85	The market can be extended from the local to global	3.82	1.017
V86	By growing the size of the market the business automatically grows	3.93	.710
V87	Cost is affected with the increase/decrease in the size of the market	4.03	.688
V88	Globalization of product/services will automatically Increase with the size of the market	3.95	.872
	EXTERNAL SUPPORT		
V89	Technical support is provided by cloud service provider	3.30	1.183
V90	Workshops are conducted by CSP at their premises	3.62	.865
V91	Cloud service providers support in the operations of the business	3.70	.830
V92	Cloud computing services have more interaction in the business than traditional ERP	3.48	1.081
	DECISION		
V93	Cloud based ERP helps in making the policy matters	3.52	1.321
V94	Cloud based ERP helps in making the decisions at the middle level	3.55	1.227
V95	Cloud based ERP helps in taking the decisions at the floor level	3.32	1.081
V96	The decision taken by the industry through cloud based ERP implementation helps to formulate the policies	3.25	1.002
	IMPLEMENTATION		
V97	Investment will reduce considerably	4.05	.723
V98	The time of return of investment lowers down	3.90	.933
V99	Easy to monitor the business activities	4.07	.918
V100	Security and regulations restrict the implementation decision	3.88	.761
	CONFIRMATION		
V101	Ease of use for customers favor the confirmation decision	3.45	1.419
V102	Interlinking of different elements of the system will improve the quality of the product	3.80	.971
V103	Due to cloud based ERP implementation the cost of the product will reduce considerably	3.18	1.200
V104	Overall implementation of cloud based ERP becomes easy	3.95	.928

IV. EXPLORATORY FACTOR ANALYSIS (EFA)

EFA is broadly utilized statistical methodology used in the fields of IS, education, and social science [7]. In the framework, twenty six constructs are taken into the account for the exploratory factor analysis. The factor loadings are used to show the correlation in the constructs and their variables. The factor loading value more than 0.5 for a factor is acceptable; and more than 0.7 is ideal [8]. Communality of a variable is the range to which a variable correlates with all other variables. The communalities with higher values are always better. The communalities for a specific variable between 0.0-0.3 signify that variable may be left because it struggles to load significantly. The first construct 'Knowledge' is measured using 4 variables v1, v2, v3 and v4. The communalities between these variables are 0.338, 0.576, 0.510 and 0.617. The factor loading of these items are 0.581, 0.759, 0.714 and 0.785. So due to its acceptable range, the construct Knowledge becomes valid. Similarly, for the second construct 'Persuasion' is measured using 4variablesv5, v6, v7 and v8. The communalities of v5, v6, v7 and v8 are 0.175, 0.287, 0.601 and 0.779. As the communality value of v5 and v6 are <0.3 so these two variables will not participate in calculating the factor loading. Variables v7 and v8 are considered for calculating the factor loading. By eliminating v5 and v6 the communality values will improve to 0.716 and 0.716 and the factor loading will become 0.846 and 0.846 respectively. With this Persuasion factor will become valid. The similar procedure has been adopted to validate all the constructs. The highest factor

loadings are coming out to be 0.994 for two factors i.e. 'Market scope' and 'Decision' whereas lowest loading is 0.558 for 'Innovativeness', which are highly acceptable. It can be seen from the table II that all the items have factor loadings greater than 0.5 which are highly significant and the constructs are valid.

Table II: Variable Loadings of Constructs

S. No.	Construct	Variables	Loadings
1.	Knowledge	v1 v2 v3 v4	.581 .759 .714 .785
2.	Persuasion	v7 v8	.846 .846
3.	Relative Advantage	v9 v10 v11	.982 .951 .576
4.	Uncertainty	v13 v14 v15 v16	.967 .912 .936 .561
5.	Compatibility	v18 v19	.764 .764
6.	Complexity	v22 v24	.802 .802
7.	Trialability	v25 v26 v27 v28	.801 .963 .967 .956

8.	Business Cost	v29	.637
		v31	.733
		v32	.741
9.	Usability	v33	.966
		v34	.990
		v35	.983
		v36	.839
10.	Accessibility	v37	.866
		v38	.935
		v39	.826
		v40	.659
11.	Implementation Time	v43	.948
		v44	.948
12.	Firm Size	v45	.935
		v46	.881
		v47	.928
		v48	.952
13.	Top Management Support	v51	.918
		v52	.918
14.	Innovativeness	v53	.558
		v54	.828
		v55	.970
		v56	.880
15.	Prior IT Experience	v57	.931
		v58	.931
16.	Scalability	v61	.894
		v62	.703
		v63	.948
17.	Upgradability	v66	.746
		v67	.908
		v68	.839
18.	Mobility	v69	.831
		v70	.923
		v71	.872
		v72	.821
19.	Security and Privacy	v74	.924
		v75	.924
20.	Competitive Pressure	v78	.699
		v79	.934
		v80	.675
21.	Type Of Industry	v82	.932
		v83	.705
		v84	.834
22.	Market Scope	v86	.702
		v87	.994
		v88	.969
23.	External Support	v89	.684
		v90	.990
		v91	.984
		v92	.796
24.	Decision	v93	.947
		v94	.969
		v95	.994
		v96	.810
25.	Implementation	v98	.937
		v99	.937
26.	Confirmation	v102	.901
		v103	.715
		v104	.968

V. CONFIRMATORY FACTOR ANALYSIS (CFA)

CFA approach is used to establish the reliability and validity of the scale. Smart-PLS software (version 3.0) is used in this research. CFA is a constrained model approach in which items belonging to a construct are not allowed to load on to the other construct. Fig. 2 exhibits the CFA measurement model exhibiting the twenty six constructs with their measurement variables measuring the constructs.
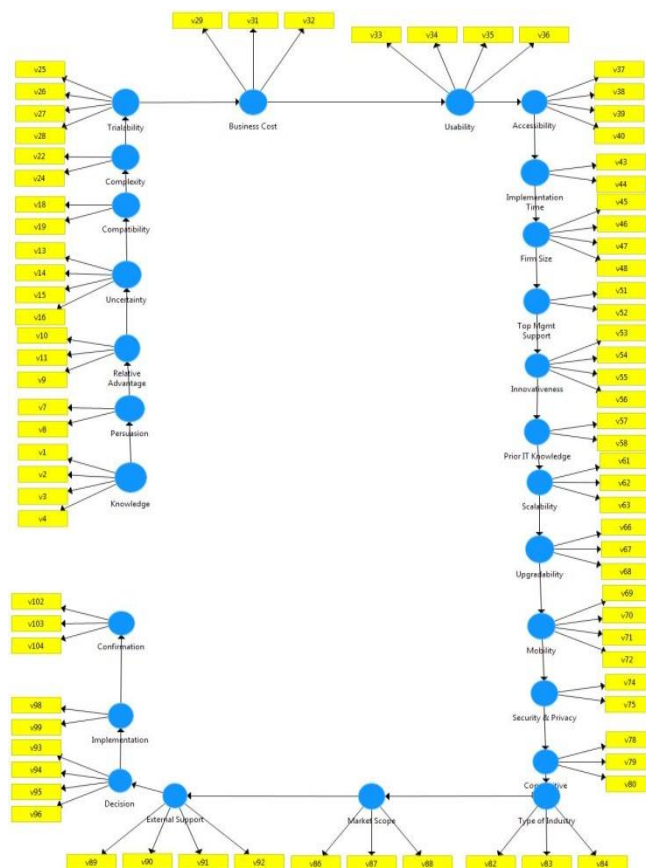

Fig. 2: CFA Model

Reliability and Validity of Scale

The reliability of scale of various constructs is established using Composite reliability and Cronbach's alpha and validity is performed using convergence which is as shown in table III.

i) Composite Reliability (CR)

Composite reliability is the measure of reliability of factor scores ranging from 0 (completely unreliable) to 1 (perfectly reliable). The minimum recommended value of CR is 0.7. The constructs are said to be adequate when the CR scores are greater than the recommended cut-off of 0.7 [9]. As shown in table III, the minimum reported CR is 0.854 for construct 'business cost' whereas maximum CR is reported to be 0.978 for the construct 'Usability', which in both cases are very high and therefore these are significant. For all the constructs CR scores exceed 0.7, and thus, the model is considered reliable.

ii) Cronbach's Alpha

Cronbach's alpha is the measure of reliability of scale. The reliability or internal consistency of all the factors towards the Cloud ERP adoption in this research has been observed using Cronbach's alpha. Alpha coefficients are evaluated as the value greater than equal to 0.7 acceptable, greater than 0.5 poor and less than equal to 0.5 unacceptable [10].

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From table III, it is shown that the lowest and highest reported alpha is coming out to be 0.738 and 0.970 respectively for 'Compatibility' and 'Usability' constructs which are found to be highly acceptable and significant. For all other constructs also, alpha scores exceed 0.7, thus the model is considered to be reliable.

iii) Convergent Validity

Convergent validity is the measure in which variables of a particular construct shares variance in common. The scale has been established by calculating Average Variance Extracted (AVE) value for each of the construct. The minimum recommended value of AVE is 0.5 to achieve the validity. As shown in the table III, the minimum reported AVE value 0.613 is related to the construct 'Knowledge' and is above the minimum threshold value of 0.5, which means that the variables of the constructs are more than 61% of variance of each construct, which is very strong support to the convergent validity.

Table III: Reliability and Validity Analysis

S. No.	Constructs/ Factors	Cronbach's Alpha (α)	Composite Reliability	Average Variance Extracted (AVE)
1.	Knowledge	0.801	0.863	0.613
2.	Persuasion	0.835	0.923	0.857
3.	Relative Advantage	0.866	0.920	0.793
4.	Uncertainty	0.904	0.935	0.787
5.	Compatibility	0.738	0.882	0.789
6.	Complexity	0.783	0.901	0.821
7.	Trialability	0.957	0.949	0.823
8.	Business Cost	0.745	0.854	0.661
9.	Usability	0.970	0.978	0.919
10.	Accessibility	0.891	0.925	0.755
11.	Implementation Time	0.947	0.974	0.949
12.	Firm Size	0.959	0.970	0.890
13.	Top Management Support	0.915	0.959	0.921
14.	Innovativeness	0.880	0.913	0.731
15.	Prior IT Experience	0.929	0.965	0.933
16.	Scalability	0.882	0.926	0.808
17.	Upgradability	0.869	0.919	0.790
18.	Mobility	0.920	0.943	0.807
19.	Security & Privacy	0.922	0.962	0.927
20.	Competitive Pressure	0.808	0.886	0.722
21.	Type of Industry	0.862	0.914	0.779
22.	Market Scope	0.914	0.947	0.856
23.	External Support	0.919	0.944	0.810
24.	Decision	0.962	0.973	0.899
25.	Implementation	0.935	0.969	0.939
26.	Confirmation	0.893	0.902	0.757

From the above, a reliability and validity of scale has been established to measure the factors affecting cloud ERP adoption in various organizations. The scale is measured for twenty six valid constructs in the study. All the constructs have good level of reliability and high level of validity.

VI. CONCLUSION

Global challenges forces the academic innovators to make the revolutionary changes in the business. The combination of the theories of social sciences and the latest trends of IT creates the drastic changes in the present market scenario. The findings of the study promotes the use of cloud based ERP using the components of DOI and TOE theory. The framework has been validated with good level of reliability and high level of validity using the exploratory and confirmatory factor analysis. For academia, this research provides very useful reference for future studies in the subject area of social sciences and cloud based ERP, especially in developing countries.

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