Examining the effect of TOE model on cloud computing adoption in Egypt

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Abstract

Cloud computing is becoming increasingly important, with its varying models and types, as it is assumed to be cost saving and a source of minimizing efforts. It has also enabled organizations and governmental authorities to overcome traditional obstacles in providing the technology needed to ensure interoperability, standardization and availability of information between those trade stakeholders. There are several cloud computing benefits that could be defined, like providing customs solutions, expanding opportunities, global trade and economic growth on the strategic, management and operational level. Despite the fact of having several forms of cloud computing with wide range of benefits, there are several barriers for cloud computing which represent challenges for its adoption. Such challenges are like internet service outage, loss of governance as applications and services will be managed on third party environments leaving organizations with limited control over the functionality and execution of the hardware and software. Accordingly, this research considered the TOE model to examine the cloud computing adoption in Egypt, as one of the developing countries facing the problems of telecommunication infrastructure, as well as the security of information over the cloud services in favor of the maturity and performance issues facing the country nowadays. A questionnaire is directed to employees of IT departments in the Egyptian companies to be able to explain the cloud computing adoption in Egypt. The analysis had been conducted using structural equation modeling to respond to the research hypotheses and results show an overall significant effect on cloud computing adoption.

The research contribution was found to be clear in the significance of Maturity and Performance Issues, which let IT departments adopt to cloud services due to the obstacles faced by other options of having IT services. Also, internet service providers and telecommunication infrastructure were found to be significantly affecting cloud computing adoption.

1. Introduction

Cloud computing is the software and hardware pooled in a hosted infrastructure provided by a vendor that can be accessed remotely over the Internet (Tarn, 2012). A cloud computing user does not necessarily own network resources such as software, hardware, systems or services but can obtain IT services from remote data centers on a subscription basis (Garg, et al., 2013a).

Cloud computing also has four deployment types that include private clouds, hybrid clouds, community clouds, and public clouds. Those models facilitate the on-demand availability of the technology. Cloud computing adoption is expected to increase over the next decade (Rupani 2016), as it is a newly devised solution to deliver Information Technology (IT) services. Instead of being provided on the user's premises, the servers and storage could be located in a data center operated by a company that acts as a supplier for the servers and it is responsible of managing such servers.

As a result, organizations can focus on their business and outsource the technology to a Cloud service provider (Cohen, 2012). However, the concern about security is the biggest fear for many organizations among other factors to take the decision to adopt cloud computing. Cloud computing is most likely to continue, having an impact on the environment in which organizations operate. It has

numerous potential business benefits. Thereby, it is a computing technology, which organizations should seriously consider. Williams (2010) tackled all the types of benefits, which are technological, financial and operational benefits. They include relative advantage such as costs reduction by minimizing processing time associated with IT services, using "Pay as you Go" approach for the server/service usage when it happens. In addition to this, cost is reduced for hardware investment, maintenance costs, flexibility and collaboration for digital environments because this will be accessible to any mobile devices at any location over the world, as well as improving reliability, processing throughput, flexibility and collaboration for digital environments (Gutierrez et al., 2015).

This research is concerned with Egypt's telecommunication infrastructure, as it is not as reliable as it should be. This is due to old telecom exchange buildings and obsolete cabling structures. Thereby, the internet service provider companies are not able to sustain the high availability and consistent required speed which is the core factor in cloud computing technology. Lastly, it is depending on the providers since it is often extremely difficult, if not impossible to move to another provider, once you have already started a commercial relationship with one. If a cloud computing user wished to switch to another provider then the transfer of significant data volumes from the old to new provider could be a painful and costly process (Loayza and Odawara, 2010).

2. Literature Review

Behrend et al. (2011) examined the factors that impact technology adoption in a higher education setting, where it was found that background characteristics such as the student's ability to travel to campus affected the usefulness perceptions, while ease of use was influenced by first-hand experiences with the platform, and instructor support. Overall, students' use of cloud computing was determined by ease-of-use perceptions, and the students' access to alternative tools.

Gutierrez et al. (2015) studied the factors influencing managers' decision to adopt cloud computing in the UK and results showed that competitive pressure, complexity, technology readiness and trading partner pressure are the key factors out of the technology, organization, environment (TOE) model are the factors affecting technology adoption. On the other hand, Alshamalia et al. (2013) studied the cloud computing adoption process by SMEs in the North-East of England. The research questions aimed to assess which factors and to what extent each of these factors impact the cloud adoption decision making by SMEs, but evidence was not revealed that competitive pressure was a significant determinant of cloud computing adoption. The author through conducting the hypothesis testing will relate to their findings regarding competitive pressure significance in the TAM-TOE integrated model.

Ratten (2014) conducted a research with the purpose to examine factors determining consumer's adoption intentions with regards to cloud computing in the USA and China. The acceptance for the independent variables perceived usefulness and perceived ease of use was revealed, which confirmed with previous studies regarding the technology acceptance model. Bruner and Kumar (2005). Prior research by Venkatesh et al. (2000) demonstrated that perceived ease of use determines an individual's perception about use of technological innovations, which conforms with the results of this study.

Moreover, the influence of consumer innovativeness was confirmed in the USA but was rejected in China, which is an interesting finding since previous research by Gao et al. (2012) revealed that all consumers are open to new technology innovations. The result of the privacy concern contrasted with previous research by Chen and Chang (2013) which revealed that privacy affects an individual's decision to adopt a technological innovation. This may highlight that as cloud computing is still in its early stage people do not have privacy concerns as they take adequate safety measures.

Ibrahim (2014) carried out a quantitative research to identify and analyze the problem of low adoption rate of cloud computing in small and medium size enterprises. The analysis proved that both performance and security influence IT managers and professionals' intention to use cloud computing through both perceived usefulness and perceived ease of use. However, the external variables compatibility and adaptability were found to have a combined influence only on perceived usefulness. In addition, Perceived usefulness and perceived ease of use both exhibited a significant correlation with the dependent variable intention to use cloud computing.

Doherty et al. (2015) conducted an exploratory research to identify the drivers and barriers to cloud computing adoption by SMEs in Ireland. The sample was developed through the use of a stratified random sampling technique. Their research findings revealed that cost is a very important factor in driving cloud computing adoption decision. This is reflected in reducing the costs the firm incur as they no longer purchase, maintain, resource and secure their own IT infrastructure. However, these costs are shifted to the service provider under the cloud model.

In addition to cost, organizations favor the cloud as it offers some benefits such as increased flexibility, productivity, increased resource utilization and portability for the organization – making them more adaptive in a turbulent business context. In respect of barriers, SMEs indicated that their biggest concern is the Internet/connection as they may not be able to access their crucial data and services in case the connection is interrupted. Firms are also fearful that their service provider may for some reason have an outage.

Their findings suggested that Irish SMEs could gain the needed confidence to adopt the cloud services – if the government ensured adequate investment and continued to adopt a strong interventionist mechanism ensuring the functioning of a high-speed, reliable, broadband infrastructure. Additionally, the government has a role to play in order to provide businesses with the necessary confidence in the security and compliance of their business and operations critical data through increased standardization and improved technology integration practices regarding the cloud.

Low and Chen (2011) conducted their research in Taiwan and their findings showed that relative advantage, top management support, firm size, competitive pressure, and trading partner pressure characteristics have a significant effect on the adoption of cloud computing. Some pitfalls interrupt the benefits and usefulness of cloud computing. One factor is the contemplation of failure downtime, which differs among providers, and can happen during server maintenance or as unforeseen outages occur. Another concern is the complexity and compatibility of cloud computing implementation.

Gangwar et al. (2015) integrated in their study the TAM model and TOE framework for cloud computing adoption at organizational level. They developed their conceptual framework using technological and organizational variables of TOE framework as external variables of TAM model while environmental variables were proposed to have direct impact on cloud computing adoption. Analysis revealed that relative advantage, compatibility, complexity, organizational readiness, top management commitment, and training and education are important variables for affecting cloud computing adoption using perceived ease of use (PEOU) and perceived usefulness (PU) as mediating variables. In addition, competitive pressure and trading partner support were found directly affecting cloud computing adoption intentions. The model explained 62 percent of cloud computing adoption.

Tashkandi and Al-Jabri (2015) conducted a cross-sectional exploratory empirical research based on technology–organization–environment (TOE) framework, targeting higher education institutions in Saudi Arabia. findings revealed that the variable relative advantage had a significant and positive effect on cloud computing adoption. While, compatibility, top management support, peer pressure and vendor lock-in did not have a significant effect on cloud computing. As for complexity and data concern, they had a significant and negative effect on cloud computing. This confirmed that complexity and data concern are obstacles to cloud computing adoption. The reason behind the complexity could be the scarcity of technical skills needed for successful implementation of cloud computing. The research investigated government regulations and revealed that Saudi law neither provides sufficient protection for nor facilitates the use of cloud computing.

Senyo *et al.* (2016) provided insights into Cloud computing adoption (CCA) across different industries in a developing country environment. Their study is arguably the first kind of empirical research into CCA in a developing country context. They investigated CCA determinants through the lens of the technology, organization and environment (TOE) framework. The data analysis revealed support for six variables only which are Relative advantage, Security concern, Top management support, Technology readiness, Competitive pressure and Trading partner pressure.

Yuvaraj (2016) investigated the determining factors for the adoption of cloud computing in through conducting a case study on Indian academic libraries. he independent variables perceived ease of use, usefulness and abundant availability of the enabling technology are strong drivers of the adoption of

cloud computing technology in the libraries. Moreover, attitude is significantly correlated with the behavioral intention to adopt cloud computing services. The study confirmed a high level of correlation between the cloud computing-perceived attributes and the librarian's intention to use cloud computing technology. In addition, the independent variable security risk is reported to be the most significant issue that has been affecting the behavioral intentions.

Alharbi et al. (2016) examined and identified the factors that influence the adoption of Cloud Computing in Saudi healthcare organizations. They integrated the TOE framework with the Information System Strategic Triangle (IS Triangle) and the HOT-fit (Human–Organization– Technology) model to provide a complete evaluation of the determinants of Cloud Computing adoption in healthcare organizations. study results showed that the business context was the most significant context among the five contexts. Both factors (i.e. soft financial analysis and hard financial analysis) in this context have high values which represent the importance of business concerns on the adoption decision. This is followed by Technology then by Organizational. The least important were the Environmental and Human contexts. Moreover, there are five most critical factors affecting the decision of Cloud Computing adoption which are: soft financial analysis, relative advantage, hard financial analysis, attitude toward change and business ecosystem partners' pressure.

Ishola (2017) conducted a nonexperimental, correlational quantitative research to find out, measure, and manage cloud computing adoption barriers. The researcher tested an Enhanced Technology Acceptance Model through the external independent variables; quality of Internet connection (QIC), security/privacy (SP), and perceived awareness (PA). The researcher managed to compare these variables to the core TAM constructs of perceived usefulness (PU) and perceived ease of use (PEU) through four stages of analysis. the research showed the quality of Internet connection and security/privacy were possible additional variables to TAM as factors influencing perceived usefulness and perceived ease of use, nevertheless, the independent variable quality of Internet connection significantly influenced perceived usefulness but not the perceived ease of use of cloud computing.

Asadi et al. (2017) studied the factors affecting cloud computing adoption in the Malaysian banking sector from the customers' perspective who are online banking users. Therefore, the study sampling was purposeful. The results supported that trust, cost, security and privacy could be successfully integrated within the TAM-TDM.

The security and privacy constructs showed strong positive effect on perceived ease of use, perceived usefulness, and trust. Further, their study shed light on the importance of perceived usefulness, perceived ease of use, cost, attitudes toward cloud and trust as they significantly influence users' behavioral intention to adopt cloud computing services. Moreover, the study recommended that there is a necessity for clients to feel trust to the cloud providers in the same way they would trust banks to protect their money. Meanwhile, cloud providers must focus on gaining the trust of users by proving reliable and trustworthy services.

The above discussion shows that there is a debate in literature in the factors affecting cloud adoption. Also, few research examined these factors in the developing countries, especially Egypt. Thus, this research aims at examining the effect of TOE model on cloud computing adoption to identify the factors affecting the decision making of cloud computing adoption in Egypt. Accordingly, the next section comprises the research methodology and method. It justifies the survey as the chosen research strategy. The theoretical framework and conceptual model are discussed. Furthermore, the developed questionnaire and its items adoption process is identified in the empirical collection of data for this study.

3. Research Framework

This research framework is identified using Figure 1 below, where the relationship are examined through the hypotheses shown. A questionnaire was adopted to test the assigned relations using a probability sampling of IT employees in different companies in Egypt who are using IT in their systems. Thus, a simple random sampling was considered in which all elements have an equal chance of being chosen as the subjects, which is an advantage findings generalizability (Sekaran, 2016).

The questionnaire was sent to around 700 employees. The received responses were 550; thus, the response rate was 78.57%. Out of 550, total 432 responses were found suitable for analysis, after deleting questionnaires with missing values.

The following hypotheses were developed from theoretical framework, as follows:

H_1: There is a significant relationship between Technology and Cloud Computing Adoption.

H_2: There is a significant relationship between Organization and Cloud Computing Adoption.

H_3: There is a significant relationship between Environment and Cloud Computing Adoption.

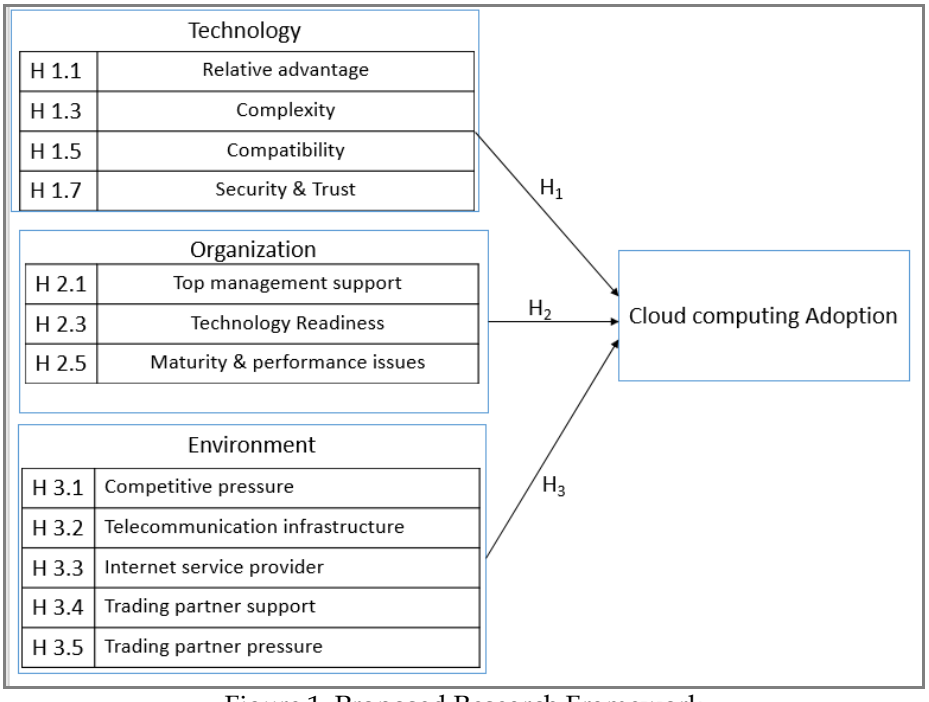

Figure 1: Proposed Research Framework

4. Results and Findings

This section shows the results and findings for the data under study. As a preliminary step, reliability and validity were computed for the sample data. Reliability is concerned with estimates of the degree to which a measurement is free of random or unstable error. It is measured with Cronbach's coefficient alpha. Cronbach's coefficient alpha is "the ratio of the sum of the covariances among the components of the linear combination (items), which estimates true variance, to the sum of all elements in the variance-covariance matrix of measures, which equals the observed variance" (Nunnally & Bernstein, 1994, p. 212). The minimum acceptable level of Cronbach's alpha coefficient was suggested as 0.70 (Hair et al., 1998).

The content validity of a questionnaire relates to the extent to which measurement scales provide sufficient coverage of the investigative questions (Cooper & Schindler, 2006). Klenke (1992) defined construct validity as "the degree to which the test measures a theoretical construct". Table 1 shows that all AVEs and factor loadings are beyond the cutoff values, which means that the validity is on the acceptable level. Also, the reliability scale of Cornbrash's alpha exceeds the cutoff value of 0.7, which means that the data is ready to perform the required analysis.

Table 1 Reliability and Validity Tests

Variable NO	Variable	Item NO	Factor loading	AVE	Cronbach's Alpha
1	Relative Advantage	1 2 3	Rephrased 0.648 0.648	64.781	0.752
2	Complexity	1 2	0.529 0.529	52.933	0.737

Variable NO	Variable	Item NO	Factor loading	AVE	Cronbach's Alpha
3	Compatibility	1 2	0.765 0.765	76.512	0.792
4	Security and Trust	1 2 3 4	Rephrased 0.656 0.656 Rephrased	65.583	0.875
5	Top Management Support	1 2	0.679 0.679	67.939	0.828
6	Technology Readiness and Manpower	1 2 3 4	Rephrased 0.627 0.743 0.734	70.138	0.787
7	Maturity and Performance Issues	1 2	0.5 0.5	50.029	0.721
8	Telecommunication Infrastructure	1 2 3	0.465 0.672 0.754	56.459	0.721
9	Internet service Provider	1 2 3	0.58 0.58 Rephrased	58.017	0.858
10	Trading Partner support	1 2	0.675 0.675	67.474	0.771
11	Trading Partner Pressure	1 2	0.591 0.591	59.109	0.799
14	CC	1 2	0.793 0.793	79.257	0.755

Table 2 shows the frequency tables for the research variables, where it could be observed that responses vary between strongly disagree and strongly agree, which means that not all responses are in the zone of agreement. In other words, the sample under study are not satisfied with the different specifications in cloud computing, which might a reason beyond the shortage in cloud computing adoption.

Table 2 Descriptive Analysis for the Research Variables

				Frequency				
Variable	**N**	**Mean**	**Std. Deviation**	**1**	**2**	**3**	**4**	**5**
RA	432	3.8704	0.73168	0	14	105	236	77
Complexity	432	3.6134	0.74067	0	20	174	191	47
Compatibility	432	2.5671	0.61318	28	131	273	0	0
ST	432	4.2153	0.85487	0	24	49	169	190
TMS	432	2.8032	0.65032	12	94	305	9	12
TR	432	3.4745	0.61633	0	12	219	185	16
MPI	432	3.5324	0.88759	5	45	153	173	56
CP	432	3.7407	0.79873	4	24	112	232	60
TI	432	3.0648	1.11745	44	80	156	108	44
ISP	432	3.0162	0.96684	16	121	164	102	29
TPS	432	3.7477	0.70381	0	8	151	215	58
TPP	432	3.2176	0.63455	3	35	265	123	6
CCA	432	3.6389	1.11691	5	92	69	154	112

Table 3 shows the SEM model for the effect of Technology Dimensions on Cloud Computing. It was observed that there is a significant effect of Relative Advantage, Complexity, Compatibility, and Security and Trust, with estimates of 0.308, 0.364, 0.413, and 0.268 respectively and P-values of 0.000. Also,

the R Square is 0.412, which means that Technology Dimensions explain 41.2% of the variation in Cloud Computing Adoption.

Table 3 SEM Model for the Effect of Technology Dimensions on Cloud Computing Adoption

			Estimate	P	R Square
CCA	<---	RA	.308	***	0.412
CCA	<---	Complexity	.364	***	
CCA	<---	Compatibility	.413	***	
CCA	<---	ST	.268	***	

The model fit indices are described as minimum discrepancy (CMIN), goodness of fit index (GFI), comparative fit index (CFI), incremental fit index (IFI), Tucker-Lewis index (TLI), and root mean square of approximation (RMSEA). It was found that CMIN/df = 1.579, GFI = 0.970, CFI = 0.984, AGFI = 0.950 and RMSEA = 0.037 are all within their acceptable levels (see Table 3.8, P. 77).

Figure 4-1 shows the SEM model for the effect of Technology Dimensions, as the independent variables, on Cloud Computing Adoption, as the dependent variable.

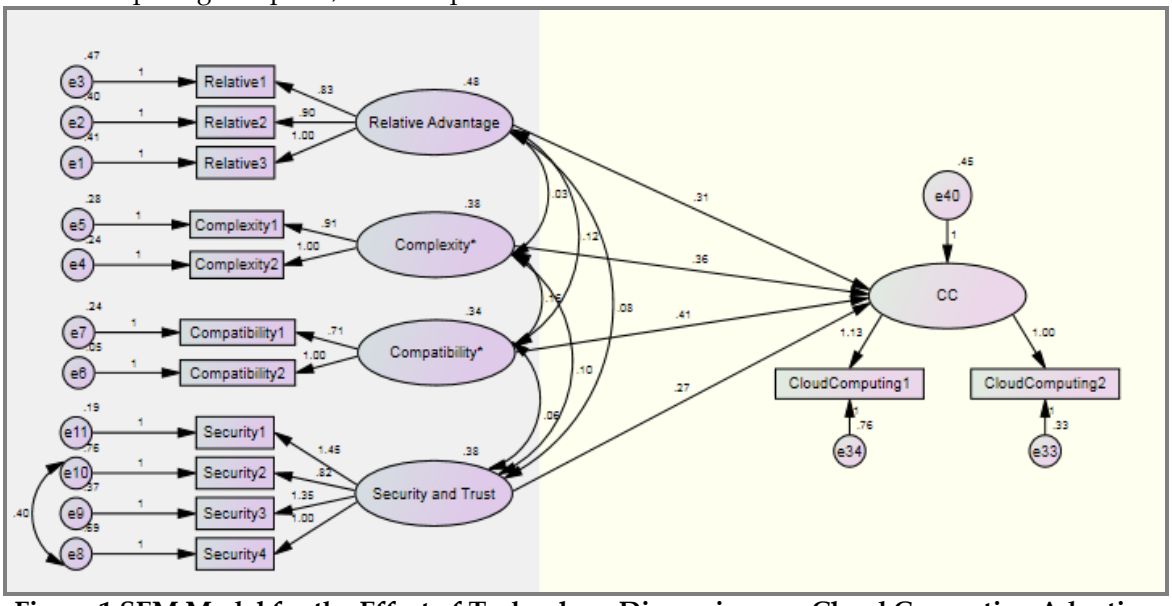

Figure 1:SEM Model for the Effect of Technology Dimensions on Cloud Computing Adoption

Therefore, the first hypothesis that there is a significant relationship between Technology and Cloud Computing Adoption is partially supported.

Table 4 shows the SEM model for the effect of Organization Dimensions on Cloud Computing. It was observed that there is a significant influence of Top Management Support, Technology Readiness, and Maturity and Performance on Cloud Computing, with estimates of 0.187, 0.473, and 0.370 respectively, as well as P-values of 0.006, 0.000, 0.000 respectively. Also, the R Square is 0.609, which means that Top Management Support, Technology Readiness, and Maturity and Performance explain 60.9% of the variation in Cloud Computing.

Table 4 SEM Model for the Effect of Organization Dimensions on Cloud Computing Adoption

			Estimate	P	R Square
CCA	<---	TMS	.187	.006	0.609
CCA	<---	TR	.473	***	
CCA	<---	MPI	.370	***	

The model fit indices; CMIN/df = 2.412, GFI = 0.969, CFI = 0.983, AGFI= 0.942, and RMSEA = 0.057 are all within their acceptable levels (see Table 3.8, P. 77).

Figure 2 shows the SEM model for the effect of Organization Dimensions, as the independent variables, on Cloud Computing Adoption, as the dependent variable.

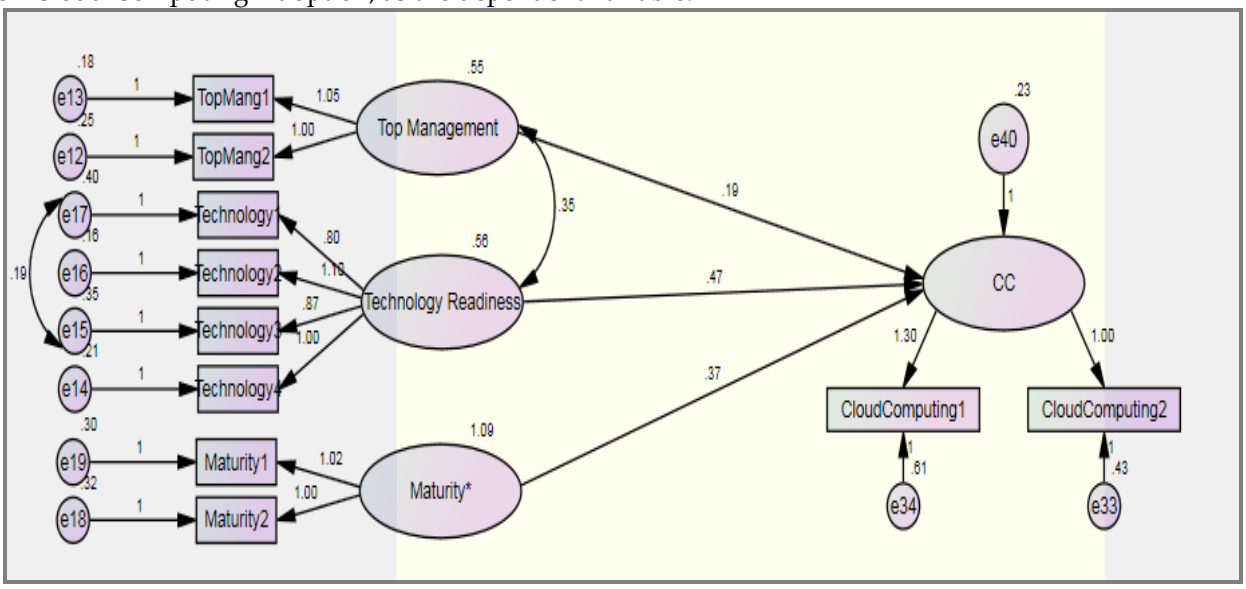

Figure 2: SEM Model for the Effect of Organization Dimensions on Cloud Computing Adoption

Therefore, the second hypothesis that there is a significant relationship between Organization and Cloud Computing Adoption is partially supported.

Table 5 shows the SEM for the effect of Environment Dimensions on Cloud Computing. It was observed that there is a significant influence of Telecommunication Infrastructure, ISP, Trading partner Support, and Trading Partner Pressure on Cloud Computing, with estimates of 0.304, 0.142, 0.350 and 0.445 respectively and P-values of 0.000, 0.044, 0.000, and 0.000 respectively. Also, the R Square is 0.409, which means that Environment Dimensions explain 40.9% of the variation in Cloud Computing. While, there is insignificant effect of Competitive Pressure on Cloud Computing. With, p-value of 0.254.

Table 4. 1 SEM Model for the Effect of Environment Dimensions on Cloud Computing Adoption

			Estimate	P	R Square
CCA	<---	CP	.048	0.254	0.409
CCA	<---	TI	.304	***	
CCA	<---	ISP	.142	0.044	
CCA	<---	TPS	.350	***	
CCA	<---	TPP	.445	***	

The model fit indices; CMIN/df = 3.607, GFI = 0.930, CFI = 0.931, AGFI= 0.894, and RMSEA = 0.078 are all within their acceptable levels (see Table 3.8, P. 77).

Figure 3 shows the SEM model for the effect of Environment Dimensions, as the independent variables, on Cloud Computing Adoption, as the dependent variable.

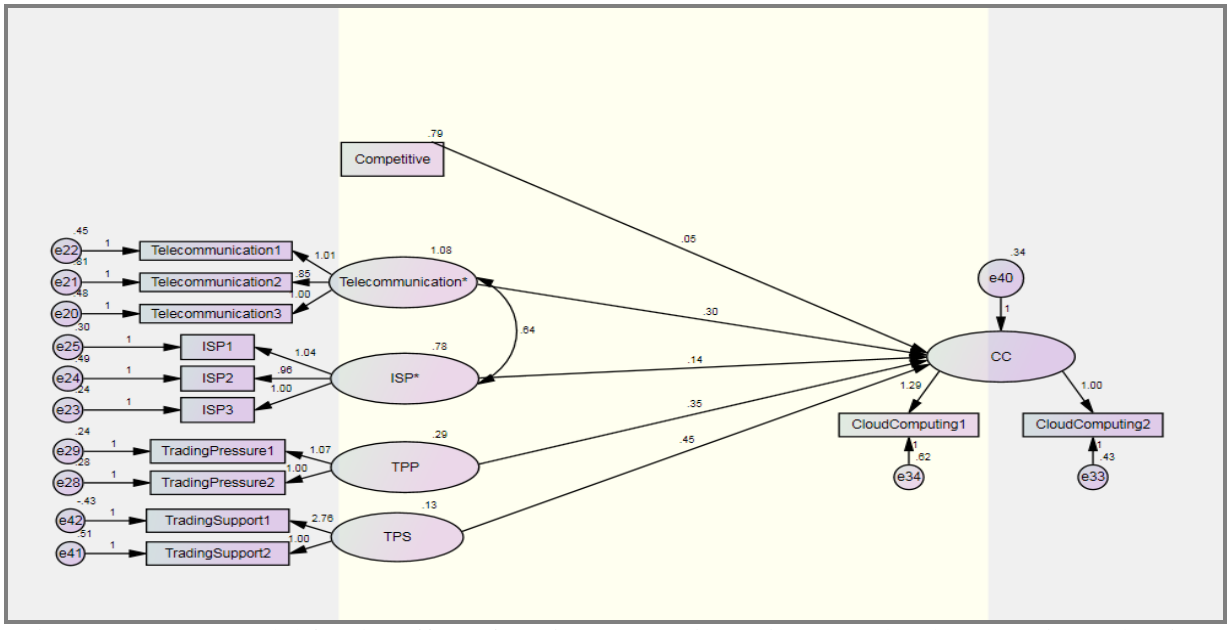

Figure 4- 1:SEM Model for the Effect of Environment Dimensions on Cloud Computing Adoption

Therefore, the third hypothesis that there is a significant relationship between Environment and Cloud Computing Adoption is partially supported.

5. Discussion and Conclusion

The current research identifies the research objectives as; identifying which TOE variables have influence on IT decision's maker decision to adopt Cloud computing in Egypt and developing a framework that cope with cloud computing adoption to solve the current problem faced by companies relying on IT services. TOE model identifies some variables that may have influence on IT decision's maker decision to adopt cloud computing in Egypt.

The researcher was testing the effect of TOE on Cloud Computing, where it was found that the technology variables; relative advantage, compatibility, complexity, and Security were directly affecting cloud computing adoption. The result of the significant effect of relative advantage is consistent with Lal and Bharadwaj (2016), who claimed that some of the small and medium enterprises with less costly IT infrastructure, as they have shown to be more courageous and adventurous in adopting cloud-based services. Another important issue included in relative advantage and is a contribution to this research is the Manpower, which has both; a direct and indirect effect on cloud computing adoption. This will change the approach of company management as the organization chart developed for IT departments will definitely change accordingly. This proves an evidence of the research contribution regarding the relative advantage of IT manpower downsize if cloud computing adoption takes place. It is worth noting that results of complexity are consistent with Gutierrez et al. (2015) due to their claim that there is a positive utilization of the TOE towards the cloud computing adoption.

This research describes complexity in terms of efficiency of data transfer, interface design, and system functionality. Cloud computing is found easy to learn and taking lesser time in performing tasks of employees. It identified that complexity of cloud computing has negative effect on organizational beliefs that lesser the complexity in using cloud computing, more is the enhancement in their job performance and the ease of using it.

Also, security and trust variable was shown to be important dimension for cloud computing adoption. Unfortunately, this dimension is not well controlled by the Egyptian law in a form that guarantee secured information on cloud. The copywrites are not perfectly considered in the Egyptian context so as to be able to adopt in a safe way to cloud services. Thus, this is a second role of the government that has to be perfectly done by introducing and activating rules that prevent copywrites and secure information with the needed system so as to encourage users of IT services to adopt to cloud computing.

Similarly, the organization variables; Top Management Support, Technology Readiness, and Maturity and Performance were found to be directly affecting cloud computing adoption. It could be claimed that top management has an effective role in convincing their employees with their persuasions and motivating their work behavior. It demonstrates commitment and continuous support for developing conducive implementation environment (such as by providing necessary resources such as time, space, equipment and people) for cloud computing adoption. The results of technology readiness are consistent with Gutierrez et al. (2015).

As Technology Readiness shows a significant effect on cloud computing adoption, it could be claimed that training to employees is thus important to enable them to understand functional and technical perspectives of cloud computing, and to gain first-hand information and experience. It makes them well-educated, experienced, responsible and knowledgeable to effectively use cloud computing. Thus, it becomes easy for them to use and understand its relevance in their job performance. Thus, managers develop strong and effective training modules so that cloud computing can be effectively implemented in their organizations. This improves necessary technical know-how of the employees and develop a dedicated manpower for cloud computing.

In the same way, the environment variables; Telecommunication Infrastructure, Internet Service Provider, Trading Partner Support and Trading Partner Pressure were found to be directly affecting cloud computing adoption. Therefore, Competitive Pressure was the only variable showing insignificant effect on cloud computing adoption. As a contribution to the current research, telecommunication infrastructure was proved to have a significant effect on cloud computing adoption. This means that this factor is considered as a barrier to the cloud computing adoption as users are suffering bad services provided with obsolete telecommunication infrastructure. Thus, the Egyptian government has to improve its services through telecommunication so as to make it easy for users of IT services to adopt to cloud services and save high cost of hardware and software.

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