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REVIEW

A Conceptual Framework for the Adoption of Cloud Computing in a Higher Education Institutions

Un Marco Conceptual para la Adopción de la Computación en Nube en las Instituciones de Enseñanza Superior

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ABSTRACT

Today, with significant improvements of computing capacities, the world is witnessing significant technological advancements. Cloud computing especially, is increasingly becoming an advantageous tool, in developed countries especially, and these countries have invested substantially in cloud computing systems to enable the implementation of hi-tech advancements in many of their industries. On the other hand, in developing and underdeveloped countries, the adoption of cloud computing is still in the early stages; as can be observed, there has been some form of digital transformation of data systems in these countries. In Jordan, the factors affecting cloud computing adoption among higher education institutions were still underexplored, especially on the issues pertaining to cloud computing adoption. Therefore, major factors with potential impact on user adoption of cloud computing were hence reviewed in this study. A conceptual framework of cloud computing adoption based on Extended Technology-Organizational-Environmental (TOE) framework by Tornatzky and Fleischer was proposed. The framework includes individual factors as the theoretical base for cloud computing adoption, to provide an inclusive comprehension on the factors that could affect behavioral intention and use of cloud computing.

Keywords: Cloud Computing; Adoption; TOE Model; Human Factors; Jordanian Higher Educational Institutions.

RESUMEN

Hoy en día, con la mejora significativa de las capacidades informáticas, el mundo es testigo de importantes avances tecnológicos. Especialmente en los países desarrollados, la computación en nube se está convirtiendo en una herramienta cada vez más ventajosa, y estos países han invertido sustancialmente en sistemas de computación en nube para permitir la implementación de avances de alta tecnología en muchas de sus industrias. Por otro lado, en los países en vías de desarrollo y subdesarrollados, la adopción de la computación en nube se encuentra aún en sus primeras fases; como puede observarse, en estos países se ha producido algún tipo de transformación digital de los sistemas de datos. En Jordania, los factores que afectan a la adopción de la computación en nube entre las instituciones de educación superior aún no se han explorado lo suficiente, especialmente en lo que respecta a las cuestiones relativas a la adopción de la computación en nube. Por lo tanto, en este estudio se examinan los principales factores que pueden influir en la adopción de la computación en nube por parte de los usuarios. Se propuso un marco conceptual para la adopción del cloud computing basado en el marco extendido Tecnología-Organización-Entorno (TOE) de Tornatzky y Fleischer.

El marco incluye factores individuales como base teórica para la adopción del cloud computing, con el fin de proporcionar una comprensión global de los factores que podrían afectar a la intención de comportamiento y al uso del cloud computing.

Palabras clave: Computación en Nube; Adopción; Modelo TOE; Factores Humanos; Instituciones Jordanas de Enseñanza Superior.

INTRODUCTION

Cloud computing has proven its ability in providing exceptional and flexible educational facilities to students at very reasonable cost. Cloud computing, amidst its varied definitions, essentially involves the sharing of computing technology that offers user with accessible computing resources that include storage, computing control and application, via the Internet.[1,2,3,4] Cloud computing, as described by the National Institute of Standards and Technology (NIST), can be pictured as a model that allows convenient, on-demand network access to a shared pool of configurable computing resources like networks, servers, storage, applications as well as services, which can be provisioned and released quickly with minimal user effort and service provider interference.[5,6,7] Among the most popular sharing services and platforms today are Google Drive and Dropbox.

Rashid et al.[8] described cloud computing as a technology comprising a set of accessible web services that primarily deal with the access and storage of data and information. In essence, cloud computing can be perceived as a web-based tool that allows data and information storage and retrieval through the Internet.[9] In Alzaabi et al.[10], cloud computing was described as a system comprising three main forms of cloud computing service: infrastructure as a service (IaaS), software as a service (SaaS), and platform as a service (PaaS). Figure 1 illustrates the details.

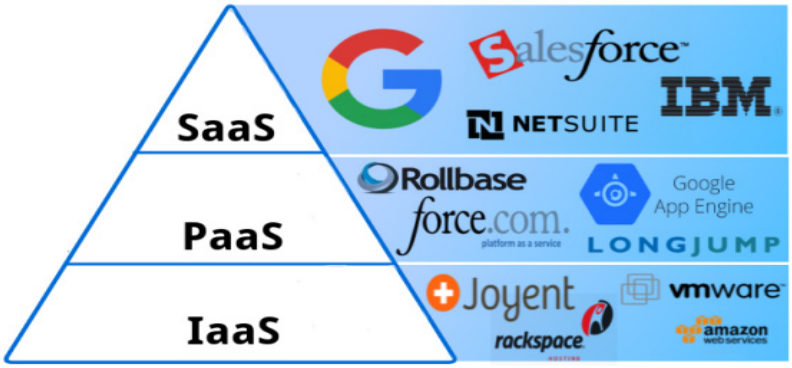

Figure 1. Forms of cloud computing services[10]

Cloud computing has benefits for many domains including the domain of education. Furthermore, as online learning is increasingly common and popular, it is increasingly necessary that the issues and challenges facing this form of learning is overcome especially within the context of e- learning environments.[5,11] As mentioned, cloud computing offers cost efficiency, and so, the use of this technology could make e-learning more cost effectiveness,[12] particularly among higher education institutions.

Today, with significant improvements of computing capacities, the world is witnessing significant technological advancements. Cloud computing especially, is increasingly becoming an advantageous tool, in developed countries especially, and these countries have invested substantially in cloud computing systems to enable the implementation of hi-tech advancements in many of their industries. On the other hand, as reported by Hiran et al.[13], in developing and underdeveloped countries, the adoption of cloud computing is still in the early stages; as can be observed, there has been some form of digital transformation of data systems in these countries. Notably, lack of financial and human resources, which is a common problem in these countries, has contributed to the establishment of private or public sector information systems. Developing countries clearly could benefit from cloud computing technologies but this is not always the case.[14,15,16]

It is helpful to have a targeted conversation on cloud computing acceptance in higher education. To determine the critical elements influencing cloud computing deployment in higher education institutions and to address issues that could result in acceptance obstacles, research on the acceptance of various users in these settings is vital.[17,18] Review studies are beneficial because they provide an overview of previous research and highlight the key areas that need scholarly attention.[19] Studies known as Systematic Literature Reviews (SLRs) can be helpful in providing an overview of current knowledge in a field of study[20] and in identifying knowledge

gaps that require future research.[21] As far as we are aware, this is one of the first evaluations that looks at the current state of research on the adoption of noisy computing in higher education and offers suggestions for potential directions for future study.

Cloud Computing in Jordan Universities

Universities are the bodies responsible in delivering education to students, while also engaging in other activities such as researches. Challenges have been faced by universities, those in developing countries especially, in delivering the needed level of Information Communication Technology (ICT) in fostering teaching, learning, and research development especially.[22] ICT is important as it allows universities to keep abreast with technological progressions in order to match the existing technological environment.[23] Universities are currently facing increasing operating cost, in addition to having to increase the fund for support and maintenance of its technological infrastructure, for instance, for software and hardware updates.[24,25]

For universities, the use of cloud computing could reduce their operational cost; the technology of cloud computing provides users with reliable enhanced IT services at any time and from anywhere, utilizing the pay-per-use method.[26] Services become better, faster and simpler with cloud computing technology; the same is also observed with the IT services that are furnished to users and institutions (e.g., universities). Still, in certain sectors, cloud computing adoption has not been examined as adequately – this can be observed happening in the sector of education, as higher education was still demonstrating reluctance in the use of this technology (cloud computing).[23,25]

In higher education institutions, the use of cloud computing systems eliminates the need for support staff on campus while also alleviating the overhead associated with hardware and software installation, upgrade and configuration to keep the system updated, in addition to removing the geographical constraints so that user could still access the system outside of campus.[27] The system management of cloud computing is the responsibility of the system providers, and for users, they only need to have devices with the Internet browser to access the system, from anywhere. The use of cloud model among many educational institutions in managing their online coursework, and among the commonly used applications are Moodle and Blackboard.[27] Additionally, cloud has also been used by some higher education establishments to deliver their courses, and among the used cloud computing systems for such purpose are WebEx and Skype.[27]

In Jordanian higher education institutions (HEIs), not much is known pertaining to the factors affecting cloud computing technology or the role of this technology in increasing the quality of educational outcomes, considering the lack of academic works that propose a conceptual framework for innovative technology (e.g., cloud computing) adoption. As such, major elements affecting cloud computing adoption in HEIs in Jordan need to be ascertained, and then, an appropriate conceptual framework needs to be constructed with the factor of quality under consideration.[28,29] Factors affecting adoption or non-adoption of cloud computing have been reported as well,[16] and such discoveries may facilitate the formation of an adaptation roadmap for cloud computing within the context of HEIs in Jordan.

METHOD

This study's main goal is to present a thorough analysis of the researches that have already been done on the cloud computing acceptance and variables influencing its acceptance in higher education institutions. The "Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)" standards served as the foundation for the review approach that was employed. Despite following PRISMA criteria, we did not use meta-analysis methods. PRISMA provides a comprehensive framework for data gathering and aids in locating possible study topics and research frameworks. As explained below, the review procedure for this study is based on a two-stage planning and execution methodology.

Planning stage

Developing the research questions and establishing the study's scope are the first steps in this phase. This study's main objective is to provide a thorough assessment of the literature on the acceptance of cloud computing in higher education institutions. Thus, in order to derive relevant insights, the scope entails compiling and evaluating papers on cloud computing acceptance in the higher education institutions.

How much has been written on the acceptance and adoption of cloud computing acceptance in the Jordanian higher education institutions? is the main research question.

There are other sub-questions that support this primary question:

1. What research methods have been employed in these studies?
2. In these investigations, which samples were the focuses of the participant groups?
3. Which theories or models of technology acceptance have been applied in these studies?
4. What factors affect whether cloud computing technology is accepted at universities?

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Conducting stage

Choosing databases, formulating a search plan, and establishing inclusion/exclusion criteria were all part of this phase. An electronic search of the Scopus database was done to find studies on the acceptability of cloud computing in higher education institutions. These databases were used for this study: Web of Science, IEEE, ScienceDirect, Scopus, Emerald, and Springer.

In order to construct a search string that was specific to the search mechanism of each database, the research topic was divided into a number of keywords and combined with Boolean operators and wildcard symbols. Initially, only works published during the last seven years were eligible for inclusion. Nevertheless, these were used later in the search process because certain databases did not enable additional criteria (such article type or language) at this time. The shortlist contained articles with the term "cloud" or similar terms like adopt∗, accept∗, factors, paramet∗ (for parameter or parameters), and determin∗ (for determinant and determinants) in the title.

The scope of the search was limited to full-text accessible journal articles, conference papers, and book chapters written in English. After the first search, 200 studies were found. The number of articles was then whittled down to 40 via a preliminary screening of titles and abstracts, which led to the next stage. The final selection of publications for review in this study was then guided by a set of inclusion and exclusion criteria, as shown in table 1.

Table 1. Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Empirical research on cloud computing acceptance in higher education institutions was conducted for the study.	Research that discussed cloud computing acceptance in postsecondary educational settings but lacked empirical data collection.
The research included mixed-methods, quantitative, and qualitative approaches.	Papers not in English
Full text.	

Following the evaluation of document eligibility and the removal of extraneous articles in accordance with the inclusion and exclusion criteria, 22 articles were found to be appropriate for a thorough study. The method of doing a systematic review is depicted in figure 2.

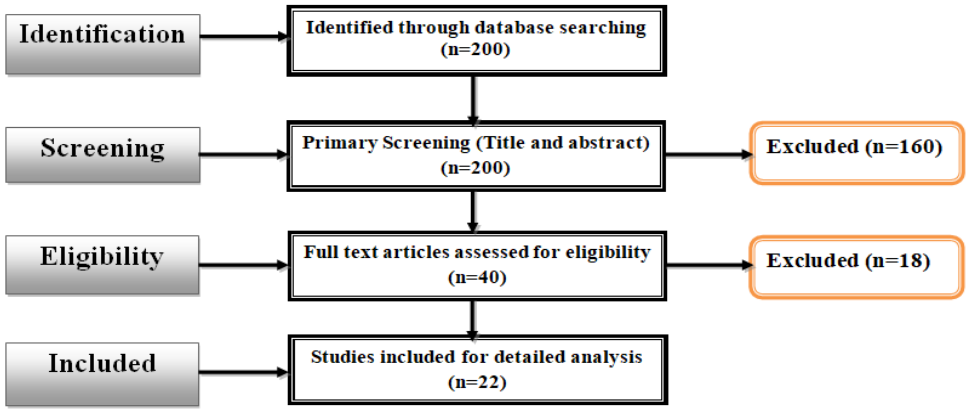

Figure 2. The flowchart of the selecting papers process

RESULTS

According to the databases index, this study evaluated the present state of cloud computing acceptance research in higher education institutions. Table 2 presents an overview of all the examined studies, including information about the author, the study's nation, scope, methods, theories/models used, and existing gaps. In 2019, there was just one (n=1) publication found; this number climbed eight times to eight (n=8) in 2019 and 2020; in 2021, there were two (n=2) papers found; and in August 2024, there were five (n=5) publications found. This indicator demonstrates the recent increase in cloud computing acceptance in higher education institutions. Based on the target population in the research that were analyzed, seven nations were identified. Two countries—Pakistan and Iran—each have two papers. Each of the other twelve nations—Kenya, Yemen, Malaysia, Saudi Arabia, Jordan, Lebanon, Ethiopia, South Korea, India, China, Somalia and Indonesia—has one paper. To address the stated research topics, we have included the findings of the 22 studies that were reviewed in this study.

Table 2. The Summary of previous work or studies

Study	Theory/ Model	Factors investigated	Scope	Method	Future work/existing gaps
[30]	TOE	NA	Kenyan educational institutions	Questionnaire distributed to 69 accredited universities and colleges in Kenya	This study recommended that future studies explore other factors affecting cloud adoption among colleges and private and public universities and colleges. This study recommended that future studies rank the influence level of the individual factors that impede cloud computing adoption.
[31]	TOE	Culture	Yemen	Quantitative research involving Yemeni higher educational institutions	This study was limited because it only covered public and private universities. Owing to the complex structure of Yemeni communities, community colleges were not covered in this study. Hence, the findings had restricted generalizability and directions for future research. The study focus was HEIs in Yemen, and so, the findings could not be generalized to other sectors or geographical regions.
[5]	TAM	Trust & security, Need and Innovativeness	Malaysian universities	Questionnaire distributed to265 cloud-based e-learning participants	Considering the newness of the cloud computing-based e-learning and the lack of understanding of this technology among many, this study highlighted the need of having more studies exploring this domain of technology.
[3]	TAM	Knowledge sharing, Knowledge application, Learnability, Self-efficacy and Perceived enjoyment	Full-time students of different universities of Faisalabad (Pakistan)	Questionnaire distributed to 322 Students	The findings of this research had limited generalizability because this study was carried out in the universities of Faisalabad (Pakistan). Hence, this study recommended that similar studies are carried out in other settings to make the findings more generalizable. This study recommended that future studies examine the impact of other variables related to cloud technology adoption and predict the academic performance. This study recommended that future studies use the model proposed in this study, with the inclusion of mediators and moderators, to verify the effect of the variables on cloud computing adoption and the performance of students. This study recommended that future studies employ the psychological factors in the prediction of outcomes, and also in expanding TAM.
[32]	TAM	Quality of service, perceived security, perceived privacy, trust, relative advantage.	Public universities in Saudi Arabia.	Questionnaire distributed to 210 academic staff in various departments	The model proposed in this study included major technological factors with potential impact on the adoption of mobile cloud. This study recommended that future studies include other factors such as social, cultural and organizational factors into the model, to increase generalizability of the findings. Considering that this study was focusing on only public universities, this study recommended that future studies consider investigating mobile cloud adoption in private universities, and then make comparison with the outcomes obtained in public universities in Saudi Arabia. This study only employed academic staff as participants, and so, this study recommended that future studies include other groups of participants relevant to the field such as the IT staff as they generally have better comprehension on IT related systems such as cloud computing. This will allow researcher to gain better insights into matters that are crucially linked to cloud computing adoption.
[33]	TPB	NA	Tabriz University of Medical Sciences, Iran	Questionnaire distributed to 260 faculty members	The study was limited because it employed respondents from a specific educational setting – they were all faculty members in an Iranian medical university. Hence, this study recommended that future studies consider employing participants from other settings as this will affirm the validity and reliability of the study scale. With some minor amendments, the Theory of Planned Behaviour-Cloud Computing Services use Questionnaire employed may be employed in the evaluation of cognitive determinants of Cloud computing services use, in other populations.

[34]	NA	Cloud Data Security, Availability and Reliability, Customizable SLA, Cloud Services, Network Bandwidth, Technological Compatibility, Smart Device Adoption, Technical Support, Management Support, Human Readiness, Social Media Usage, Utilization Complexity, Cost Flexibility, Ease of Use, Relative Advantage and Design of Innovative Services	NA	ISM and MICMAC analysis	This study recommended model reliability enhancement by way of statistical validation through survey-based study and structural equation modelling (SEM).
[35]	UTAUT	Trust	University students in Jordan	Questionnaire delivered to 460 students	Based on the limitations of this study, future studies may examine the implementation of cloud computing technology in a developing country. Considering the newness of cloud computing adoption in Jordan, this study recommended that longitudinal studies be conducted to find out the variations in terms of behaviours and patterns of people pertaining to acceptance growth of cloud technology. This study additionally recommended that future studies add new factors and moderators to increasing the understanding of the dynamics of cloud computing, with the hope to speed up the adoption and acceptance of this technology, in developing countries particularly. This study recommended that this study be replicated on other users and in other regions, in order to increase the generalizability of the findings.
[25]	DOI, TAM and UTAUT	NA	Four universities in Lebanon	Questionnaire distributed to 422students	The use of random sampling made the findings generalizable to the population but this study was focusing on private universities only. Hence, to increase generalizability, this study recommended that similar study be carried out in public universities. Data in this study were obtained from only one group of respondents namely students. Hence, this study recommended that future studies include academic and non-academic staff as well. This study also recommended that future studies include the technological factors, including the factors of privacy, security, and trust.
[36]	TOE-DOI	NA	Ethiopia	A qualitative approach, with questionnaire distributed to 35 staff respondents	The Ethiopian higher education (EHE) sector was the only focus of this study, making this study limited. Hence, this study recommended that similar studies be carried out in other countries. Additionally, this study employed a rather small sample size, and so, this study recommended that future studies employ larger and heterogeneous samples to achieve better outcomes.

[37]	TOE	NA		Systematic literature review (SLR)	This study proposed a model to facilitate the empirical tests on the dynamics of the adoption of technology, and recommended that the model be examined in terms of its robustness and reliability in future studies.
[38]	TAM	Dependability attributes (availability, reliability, security, maintainability)	South Korea	Questionnaire, various departments within an organization in various industries.	Scholars are urged to employ comparable research methodologies with other theoretical models (such as TOE and UTAUT) and to incorporate supplementary factors.
[39]	TAM	extrinsic motivation (EM), and intrinsic motivation (IM) as moderators	Pakistan	Questionnaire,	The study added four significant variables to the TAM, but it may have overlooked some additional significant elements that could have also had an impact on the current situation. In order to broaden the TAM in the context of this study, the researcher needs therefore take other elements into account. The study came to the conclusion that in order to improve the adoption process and lessen the effects of resistance to change (RTC), extrinsic motivation (EM) and intrinsic motivation (IM) are essential. Subsequent investigations ought to go deeply into the concepts of EM and IM, as well as identify organizational elements that could potentially enhance employees' levels of IM and EM.
[40]	TOE	NA	India	A qualitative Method (cloud service providers and cloud service users)	Despite its rich and focused data collection, being confined to exclusively ICT firms in India made this study limited. Hence, this study recommended that similar studies be carried out across different sectors in countries with comparable socioeconomic profiles. The qualitative analysis in the proposed CLD underscores the simulation of a quantitative system dynamics model.
[41]	TOE	NA	China	Qualitative Method, involving Chinese SMEs	This study identified and tested only the major antecedents of cloud-computing adoption at the firm level based on past literature. Meanwhile, other factors may also have impact on the decision of firm to adopt cloud computing. Hence, this study recommended that future studies include a more inclusive range of factors. Reliance on a sample from only one country namely China was another limitation of this study, considering that SMEs in other countries may differ in terms of attitudes toward cloud computing, in comparison to those in China, considering that different country may have different legal regulations and technology levels. As such, this study recommended that future studies perform a comparative analysis across multiple regions, in order to improve the generalizability of the findings.
[42]	TOE	NA	Mogadishu-Somalia	Questionnaire distributed among SMEs	This study obtained data solely from Mogadishu which is the capital city of Somalia – Mogadishu has the highest number of SMEs. SMEs in Mogadishu as the study sample may be representative of SMEs in Somalia in general. Still, the study recommended that future studies examine SMEs in other cities like Hargeisa and Bosaso. This is to increase the comprehensiveness of there presentation. Technological development of SMEs in Somalia was highlighted in this study, and so, the study recommended the use of similar research approach in examining cloud computing adoption in other least-developed countries (LDCs), in order to boost technological progressions in their corresponding business markets while also attaining useful insights in dealing with technological disparities while fostering growth in these regions.

[43]	TOE	Individual Factors	Indonesia	Questionnaire distributed to Micro, Small, and Medium Enterprises (MSMEs)	This study recommended that future studies examine owner/manager of micro enterprise whose thinking is nonconventional or developed, and cover more locations in order to generate novel findings. This study also recommended that future studies examine how the indicators impact the intent to adopt cloud computing.
[44]	NA	NA	NA	A systematic review of the literature	Further investigation and examination that considers national development status, geographic borders, and other variables may be possible. Additionally, both qualitative and quantitative methodologies could be used to investigate and model the factors influencing the adoption of cloud computing technologies in the education sector. This strategy could accelerate cloud computing adoption across platforms and colleges, especially in developing nations.
[45]	NA	security, cost-effectiveness, scalability, interoperability, regulatory compliance; and socio-economic, political, and technological factors	Systematic Reviews and Meta-Analyses (PRISMA)	NA	Although cloud computing has many advantages, it also has some significant drawbacks. Important obstacles include depending on a reliable internet connection, possible performance problems like latency, and the possibility of vendor lock-in, which might make migrations in the future more difficult. This emphasizes how crucial it is to have a flexible cloud approach that permits data and application portability. A survey of the literature on the constraints of cloud computing highlights a number of important issues, such as the possibility of bias in the selection of studies and the influence of certain datasets, which may limit the applicability of conclusions. Furthermore, given how quickly cloud technology is developing, it's possible that earlier research doesn't accurately reflect the situation today. Understanding the effects of cloud computing across diverse businesses requires ongoing research, and optimizing its benefits and integrating it effectively need customizing cloud deployment to industry-specific requirements.
[46]	TAM and TOE models	NA	Review paper	NA	Depending on the circumstances, the TAM and TOE frameworks can be applied independently or in combination. Harmonizing the several components of the models that have been proposed and applied in literature will be crucial in the
[47]	TOE	perceived usefulness, and perceived ease of use	Review paper	NA	It is imperative to acknowledge that although the TOE framework expounded in this research provides significant perspectives and directives, it ought to be customized to accommodate the distinct attributes and needs of particular establishments operating in the hospitality sectors of Malaysia and Libya. For the framework to be more effective, more study and empirical validation are required.
[48]	TOE+DI	NA	Iran	Questionnaire distributed to knowledge-based companies of Kerman Science and Technology Park	It is important to find and examine new elements that affect cloud computing adoption in knowledge-based businesses by looking through current scientific research. It is necessary to investigate these variables in other firms as well to guarantee cloud computing compliance.

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A number of studies on the adoption of cloud computing technologies can be found in the literature,[25,32,35,43] but the adoption of such technology by Jordanian higher education institutions (HEIs) has not been examined much.[28,29] In addition, the role of cloud computing technology in generating superior educational outcomes has not been explored as much as well.[28,29] Extant studies were looking into some influencing factors. For the purpose, quantitative and qualitative (interviews) surveys have been employed. In this regard, the use of questionnaire of information technology actors has been often observed. In examining cloud adoption, Technology-Organization-Environment (TOE) framework has often been used.[16]

Technology-Organization-Environment Framework

Technology adoptions can be described as the voluntary usage of a new product or acceptance of a new technology.[13,49] Voluntary adoption of technology as shown by an individual can be explained through many frameworks, algorithms, models, as well as theories.[50,51] Cloud computing adoption is affected by many factors. Hence, these factors need to be evaluated and considered by organization before embarking into the use of cloud-based solutions in its operations.[36,52,53]

Technology-Organization-Environment (TOE) framework delineates the process of innovation within an organization.[54] The framework suggests that innovation adoption is influenced by three aspects: technology, organization, and environment. As posited by the framework, technology encompasses the enterprise's technical knowledge, and this knowledge can be internal knowledge and external knowledge.

The mechanization that may impact adoption potential is also part of the technological aspect. Meanwhile, the aspect of organization encompasses the enterprise's characteristics, and these may include the enterprise's resources and channels of communication . Lastly, the aspect of environment encompasses the external forces, and these include competitions, regulations and market conditions.[55,56,57]

The dependence of businesses towards technology both internally and externally, is explainable by the technological variables, and among the most frequently employed ones are relative advantage, compatibility (both technical and organizational), complexity, trialability (trial/experiment), and observation (visibility/imagination). There are also other constructs being employed in explaining such technological factor, such as (among others): adoption costs affordability, availability of source code, collaborative development and comprehensiveness of feature.[58,59,60]

Organizational factors associated with company business scope have been examined in various studies including.[60,61,62] Among the factors under scrutiny include top management support, organizational culture, managerial structure complexity, human resources quality, formalization, differentiation, and magnitude of problem. Other factors, as mentioned in Tornatzky et al.[54], include the role of informal relations and communication among employees, behaviour of top management leadership, internal slack resources, and size of organization.

Environmental factors entail the factors that can be linked to facilities. Pressures from rivals, customers, socio-cultural issues, reassurance from government, and technological infrastructure (e.g., consulting services delivered via ICT). Three environmental related factors were discussed in Tornatzky et al.[54] namely: industry characteristics, government regulations, and technology supporting infrastructure. Industry characteristics can be broken down into competitive pressure and pressure from competitors, where the former is pressure from the risk or losing or maintaining a competitive advantage, forcing the adoption of new technology in replacement of the current organizational strategies. As for the factor of government regulations; this factor has been regarded as the major environmental factor in TOE framework that affects technology adoption.[60,63]

Human components have been included in TOE framework in previous studies.[64,65,67] The inclusion of additional components would expand certain frameworks or models to allow the explanation of certain phenomenon such as adoption of certain technologies.[66] In this regard, personal innovativeness was proposed in this study. In examining technology adoption in higher educational institutions using TOE framework, the inclusion of individual factors will increase the robustness of the model used,[60] consequently increasing the ability of researcher in elucidating the factors that have impact on technology adoption.

Factors Analysis Influencing Cloud Computing Adoption

In determining the intent of organizations towards embracing cloud computing, Gutierrez et al. presented three components as follows: Technological components, Organizational components and Environmental components.[68,69,70,71] Meanwhile, Sadoughi et al.[72] in examining cloud computing adoption in health and non-health sectors, identified and compared the impacting factors through a review involving 541 articles. According to the authors, the factors affecting cloud computing implementation the most are pigeon-holed owing to their linkage to the aspects of technology, organization, environment, and individual, as discussed next:

Technological Aspects

In innovation, the technological context entails the technical characteristics of the innovation. When adopting IT innovation, organizations are affected by two technological factors: the internal and external technological

factors, whereby the former are existing technologies in the organization while the latter encompass factors existing in the marketplace.[73,74] The factors of technology also relate to how the technology impacts the intent to adopt.[43,75] The five innovation characteristics by Rogers have been often used in studies, and the three most commonly used are: relative advantage, compatibility, and complexity.[76]

With respect to the three most frequently explored innovation characteristics by Rogers: relative advantage concerns the degree to which a given innovation or technology shows superiority over the older ones. This characteristic (relative advantage) in the context of cloud-based accounting software, can be understood as the ability in generating financial data in real-time, enhance the quality of the generated financial information, and shorten the duration of accounting process.[64] Compatibility refers to the degree of capability or consistency of the technology with the adopter. This characteristic in the context of this study can be understood as whether or not cloud-based accounting software is compatible with the needs of higher education institutions.[52] The characteristic of complexity can be construed as the level to which the technology in question is perceived as easy to use, and for the context of this study, this characteristic (complexity) can be understood as whether or not cloud-based accounting software is easy to use, which will lead to the increase in the intent to adopt.[77] The following table 3 presents (in summary form) the technological factors that have impact on cloud computing.

Table 3. Technological Factors Affecting Cloud Computing Adoption

	Determinantes	Sources
Technological Factors	Relative Advantage	(30,32,36,37,41,57,60,78,79,80,81,82,83)
	Compatibility	(30,36,37,41,57,78,79,80,81,82,83,84)
	Complexity	(30,37,41,57,60,78,79,80,82,83,84)
	Trialability	(80)
	PU	(3,5,32,79,82,85)
	PEOU	(3,5,32,79,82,85)
	Observability	(80)
	Security	(5,32,37,41,42,57,81,82,83,84,85)
	Risk	(82)
	Need	(5)
	Quality Of Service	(32)

As shown in table 3, Relative advantage, Compatibility, Complexity, Perceived usefulness, Perceived Use of use and Security are the technological factors most often affecting the decision to adopt innovations.

Organizational Aspects

Organizational context is the characteristics of an organization that have impact on the organization's IT innovation adoption.

Table 4. Organizational Factors Affecting Cloud Computing Adoption

	Determinantes	Sources
Organizational Factors	Organization Readiness	(30,36,41,42,57,60,78,82,83,84,87)
	Adequate resource	(41,80)
	Top Management Support	(36,37,42,57,60,78,81,82,84,87)
	Perceived barriers	(30)
	Age	(86)
	Size	(37,78,80,81,83,86)
	Cost	(37,42,57,83)
	KM	(57)
	Maturity & performance issues	(84)
	Training and education	(87)
	Firm Scope	(81)

Among the factors associated with this dimension are: organizations readiness,[83] top management support,[42] adequate resource,[41] age,[86] size,[83] training and education,[87] and perceived barriers.[30] Cost, knowledge management(KM),[57] issues associated with maturity and performance of organization,[84] and firm Scope[81] were also reported as the associated factors in this context. Top management support for instance, allows cloud

technologies adoption, and the adoption is even more facilitated when managers of the adopting organization have good cloud computing experience.[88] The following table 4 accordingly presents the organizational factors that have impact on cloud computing (in summary form), as reported by the extant literature.

Results from past related studies (based on the table 4) show that Organization Readiness, Top Management Support and Firm Size have been the organizational factors with significant impact on the decision of organizations towards innovations adoption.

Environmental Aspects

For an organization, the environmental context comprises the environment of its operations. Stakeholders including customers, suppliers, rivals, governing board members, and government (among others) are the elements that make up the environment of operation of the organization, and according to Rehman et al.[89], these elements have the capacity to affect the decision of organization towards adopting an innovation.

Environment factors are external factors relating to the market, the government, and other relevant parties; these factors support or deter technology adoption. The environment factors in this study include regulatory environment, competitive pressure, and pressure from trading partner.[43,75,81] Table 5 can be referred. As a factor of environment, regulatory environment comprises rules established by relevant parties, and these rules would either support or deter technology adoption. Regulatory environment consists of government support and financial institution rules.[76] Meanwhile, competitive pressure entails the manner in which the presence and actions of competitors result in pressure to the business. This study perceives the factor of competitive pressure as the potential effect of technology adoption by competitor on technology adoption as well as the potential impact of competitive advantage from technology usage on technology adoption.[90] In cloud computing adoption among organisations, pressure from trading partner is an important factor. In this context, trade partners could be persons or organisations that an organisation conducts business with.[81]

Table 5. Environmental Factors Affecting Cloud Computing Adoption

	Determinantes	Sources
Environmental Factors	Competitive pressure	(36,37,41,42,60,78,81,83,84,86,87)
	Government regulation support	(30,36,37,41,42,81,82,83,86)
	Service provider support	(30,41,82,84)
	Telecommunication infrastructure	(84)
	Cloud Locality	(37,83)
	Trading partner pressure	(78,81,87)

Research model

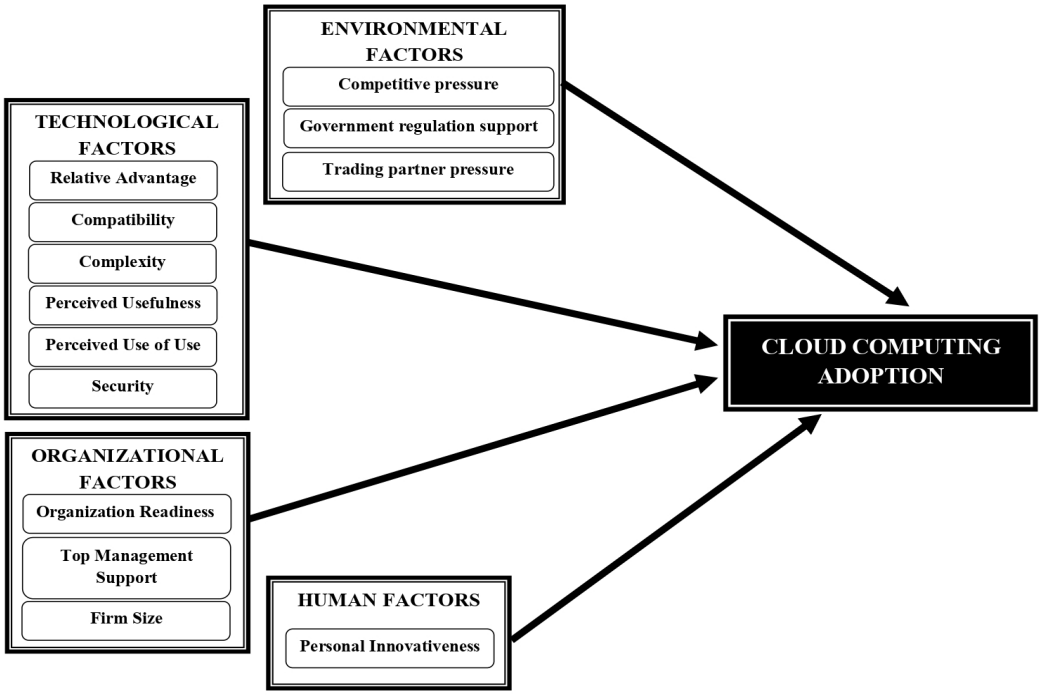

Figure 3. Proposed Research Model

A framework is necessary in illuminating cloud computing adoption, and a correct framework, not only will it provide a good understanding, but will also have theoretical contributions. Jordanian higher education institutions (HEIs) were the focus of this study, and therefore, the use of TOE as a theoretical framework in examining Jordanian HEIs is appropriate. Still, it should be noted that TOE framework has been mainly used in examining technology adoption,[91] A conceptual model was proposed in this study (see figure 3), and it includes five dimensions (technological factors, organizational factors, environmental factors and human characteristics) with potential impact on cloud technology adoption in higher education institutions particularly Jordanian HEIs.

Research Hypotheses

In studies, formal research hypotheses are often established using theoretical findings. In this study, past works were reviewed to develop the study hypotheses. The details are as discussed as follows:

Relative Advantage

Among the main indicators of new IS innovation adoption is relative advantage. This indicator, according to Rogers[92], can be understood as the level to which a given technological factor is viewed as providing better benefit for organisations. As such, users past experience will decrease the uncertainty level during new technology adoption.

Relative advantage has been examined in various studies, especially on its impact on technology adoption by organisations. Lumsden et al.[93] and Alshamaila et al.[52] in their study reported that the perception of businesses of relative advantage of an innovation will likely lead to increase in adoption. In cloud computing adoption in the context of technology, Shirpoor et al.[83] found relative advantage as a very influential factor; this factor encourages adoption of technology. Furthermore, cost reduction results in the increase in cloud services penetration among users and consequently the increase in cloud computing adoption. Additionally, technological progressions have made cloud a secure environment to keep organization data. The degree of relative advantage can be ascertained through economic profitability, social prestige, and technology benefits of technology. In their study, Sayginer et al.[94] mentioned that faster adoption rate of cloud computing will increase its adoption potential. When companies see relative benefits of cloud computing, the potential adoption of the technology will increase among these companies. Somehow, considering the newness of cloud computing, Lian et al.[95] mentioned that the organizations may show reluctance towards its implementation. Atobishi[96] further added that it may take a long time for users or adopters to understand and adopt new technology in their operations. The following hypothesis was proposed:

- Hypothesis 1 (H1): relative advantage will be positively associated with the adoption of cloud computing.

Compatibility

Based on Rogers[92], compatibility means the level to which a given innovation is viewed as in line with the present values, previous experiences, and needs of likely adopters. The factor of compatibility has indeed been reported as a vital factor in new IS innovation adoption. Alshamaila et al.[52] mentioned the likelihood of organisations towards considering cloud computing adoption if it is perceived as compatible with the organizations' existing work application systems and values.

According to Alharbi et al.[97] and Atobishi[96], the integration of technology into the organization and its business function can be made easier with improved compatibility between the innovation and the needs of adopters. Similarly, Sayginer et al.[94] concluded that increased compatibility will increase the cloud computing adoption potential among companies. Contrariwise, the likelihood of adoption of cloud computing will be reduced when there is lack of compatibility, considering that cloud computing adoption requires organization to significantly upgrade its knowledge and make major adjustments in its processes.[78,98] The impact of compatibility on cloud computing adoption has been reported by Lynn et al.[99] as well. Previous findings imply that the increase in compatibility between the technology and the values, beliefs and existing systems of organization will increase the likelihood of the organization to consider adopting the technology in its current business practices.[96] The following hypothesis was hence proposed:

- Hypothesis 2 (H2): compatibility will be positively correlated with the adoption of cloud computing.

Complexity

According to Rogers[92], it is not likely that organization will adopt new IS innovations if the usage of the innovations is perceived to be more challenging. In addition, it is not uncommon for organizations to have to undergo major changes in their business systems and processes before adopting new technologies, and such requirements may cause problems to them.[93] Meanwhile, cloud technology fosters commonality across business functions and automated management, resulting in simpler IT services.[100,101]

The least companies have complexity, the less possibility of CC adoption companies will have.[94] Organizations show more inclination towards adopting new technologies that are easy to use. On the other hand, technologies

that are perceived as complex are less likely to be adopted. Aside from cloud computing,[99,102] the factor of complexity has also been used in examining the adoption of other cutting-edge technologies including ERP[103] and RFID;[104] complexity is a factor from DOI theory. A technology should therefore be manageable, user friendly and easy to use, in order to increase the likelihood of adoption. However, the factor of complexity in Gangwar et al.[87] was regarded as an independent construct. Relevantly, Atobishi[96] mentioned that the factor of complexity is inversely proportional to the factor of perceived usefulness and the factor of perceived ease of use, and thus, the following hypothesis:

- Hypothesis 3 (H3): complexity will be negatively correlated with the adoption of cloud computing.

Perceived Usefulness

For the context of this study, the factor of perceived usefulness (PU) can be understood as the level to which a higher education institution owner is confident that the usage of IS innovation will result in better job performance. In addition, Suki[105] found significant role of system practicability in the use of technology among users. In the deliberation on the intention towards system usage, perceived usefulness plays a significant role.[106] Furthermore, in adoption models such as TAM, this factor has been known as the most significant predictor of behavioural intention towards adoption.[107]

Higher education institutions (i.e., universities) were demonstrating confidence towards cloud computing adoption; this technology is expected to increase their ease and efficiency in their operations. For higher education institutions, cloud technology could benefit them because this technology is low cost, faster, mobile, flexible, scalable, and allows shared resources.[9,108] These benefits or advantages of cloud computing are worthy of scrutiny, particularly on their potential impact on perceived usefulness, and consequently the adoption of cloud computing among higher education institutions. As such, this study proposed the hypothesis below:

- Hypothesis 4 (H4): perceived usefulness will be positively correlated with the adoption of cloud computing.

Perceived Ease of Use (PEOU)

Perceived ease of use (PEOU) is the belief of a person on system use.[109] A person is not likely to use a system if using the system will require the person to make so much effort to learn the needed skills for using the system (providing that other factors are kept constant).In the context of this study, PEOU can be described as the degree to which owner of higher education institution beliefs that the use of IT innovation is easy.[9,110,111,112] PEOU has been shown to significantly affect the behaviour of individual towards the use of new technology (see: Davis[113]; Koivumäki et al.[114]; Sreenivasan et al.[115]; Zhou et al.[116].

In higher education institutions, Effort Expectancy (EE) denotes the amount of efforts to be made (by the institutions) in acquiring the skills required in using the new technology and in actually using the technology. User is more likely to adopt the new technology if the user feels that integrating the new technology into user's educational activities would be easy. In their study, Khayer et al.[108] found that universities consider cloud computing use as easy because universities have a lower technical workforce in the usage of innovative and complex technology. Hence, the following hypothesis was put forth:

- Hypothesis 5 (H5): perceived ease of use (PEOU) will be positively correlated with the adoption of cloud computing.

Security

Security in cloud technology relates to how far cloud technology is viewed as having higher level of security when compared to other computing models. Cloud service providers (CSPs) have the ability to provide organizations (user) with better and stronger security level on their (the organizations') data and on the organizations themselves.[67,100,117] On the other hand, many organizations were demonstrating reluctance towards adopting cloud services, and such reluctance could be associated with the fact that cloud services have no identity management and neither do these services have standard security protocols. As such, for organization, shifting to cloud could make data security more complicated, and this has impact on the decision of organization towards cloud computing adoption.[75]

Identity management remains a difficult issue in cloud environment. For organizations, this situation makes them reluctant to adopt. Even though cloud computing can be a solution to a problem, its lack of credential management and integrated identity provisioning have impeded adoption.[118] As such, additional complexity on data security will make the shift to cloud less promising, and this influences the decision of organization towards new technology adoption.[67,96] The hypothesis below was proposed:

- Hypothesis 6 (H6): data security concerns will be negatively correlated with the adoption of cloud computing.

Organization Readiness

Technological readiness affects organisations decision to adopt IT innovations. It comprises technological

infrastructure and IT human resources.[78] In the process of implementing and integrating a new cloud computing service, the IT human resources play an important role as they are the ones providing the skills, experience and knowledge needed. As for technological infrastructure, it is the enterprise systems and network technologies that are already in place, and these systems and technologies becomes the platform for the establishment of the new cloud computing applications.[93,119,120]

Organization readiness has strong impact on the decision of organization towards change in terms of their strategy, program, or any new trends.[121] In their study, Weiner et al.[122] described the factor of organizational readiness as the degree to which employees of organization have the readiness towards engaging in organizational change. Readiness of organization should be evaluated. This is to understand the readiness level of an organization towards change and towards implementing new innovation ideas.[123] For instance, organizations need to have certain elements in place before adopting cloud computing, like governance, improvement and process analysis, standardization of hardware and software, and rationalization and modernization.[124] The importance of organization readiness was also mentioned by Gangwar et al.[79], among decision makers, towards cloud computing adoption. Hence, the following hypothesis was proposed:

- Hypothesis 7 (H7): technological readiness will be positively correlated with the adoption of cloud computing.

Top Management Support

Organization that seeks to establish a supportive environment and provide the right resources for cloud computing services adoption will require top management support. According to Lumsden et al.[93], support from top management will facilitate organisations in dealing with internal hurdles and oppositions to change. In their study, Shirpoor et al.[83] reported significant impact of top management support on cloud computing adoption. For organizations, this factor indeed has been perceived as the most effective factor in their cloud computing adoption. Top management that understands the advantages of using cloud computing is likely to support the adoption of this technology. In fact, top management awareness affects cloud adoption positively. Hence, top management plays a crucial role in cloud adoption, among developing organizations particularly. On the other hand, cloud adoption is less likely if top management lacks the awareness of the technology, because lacking the awareness will decrease the likelihood of top management towards supporting the technology to be adopted by organization.

Cloud computing adoption needs the right resources and a supportive environment.[125] When top management is involved in the decision to adopt and in implementing cloud computing, it can be guaranteed that resources will be allocated to facilitate implementation,[52] while the value of adopting will be made known in the entire organization.[78] Top management facilitates the integration of services, resources allocation and process re-engineering for cloud computing, and so, top management plays a key role in cloud computing adoption.[75,78]

Top managers would provide support to their company because they do not want people to resist change, in addition to preventing potential internal hurdles.[96] In this regard, increase in top management support will increase the likelihood of cloud computing adoption among companies.[94] Ali et al.[100] carried out a study involving LGA in Queensland, Australia to ascertain the determinants of cloud technology adoption. In LGA, top management comprised mayors, deputy mayors, councillors and C-suit executive officers, but only IT Managers and staff were selected as the study respondents as they were the ones reporting to the CEO or the CTO of the local government area. Clearly from past findings, support from top managers facilitates the establishment of a competitive environment. Also, top managers are the ones with the capability in providing the resources required in cloud services adoption. Hence, this study proposed the following hypothesis:

- Hypothesis 8 (H8): top management support will be positively correlated with the adoption of cloud computing.

Firm Size

The profile of organization as innovator is majorly shaped by its size.[92] It has been reported by Lumsden et al.[93] that large organisations are more likely to adopt IT innovations, because large organizations are generally more flexible and they have more capacity in taking risks. Somehow, past studies were reporting inconclusive findings, pertaining to the link between size of organisation and adoption of IT innovation. For instance, Ali et al.[100] and Pan et al.[126] were among those who found positive link between size and technology adoption. In a related study, Jambekar et al.[127] reported that smaller organizations seem to be less positively predisposed to the adoption of new technologies, and smaller organizations seem to have less flexibility in changing their path. Furthermore, larger organizations seemed to have more capability in taking risks, and so, their inclination towards innovation adoption is greater.[100,128] Hence, in cloud computing adoption evaluation, the factors of firm size and top management support must be considered. The larger the company, the more likelihood to adopt cloud computing.[94]

- Hypothesis 9 (H9): firm size will be positively correlated with the adoption of cloud computing.

Competitive pressure

The decision of organization is directly affected by the organization's external environment. Competitive pressure, as part of the external environment, is the level of pressure from the rivals that an organization faces – these rivals are from the same industry.[93] Competitive pressure can be regarded as a strong incentive and this factor also can drive adoption. In industries where changes occur rapidly, the organisations within would be faced with pressure constantly, compelling these organizations to adopt new technologies similar to their rivals. In cloud computing adoption, the impact of competitive pressure was found significant.[129,130] This finding may be attributed to the fact that the study was limited to one industry sector[78] or to a small number of industry sectors.[79] For companies, the increase in competitive pressure will increase the likelihood of cloud computing adoption.[94] Therefore, this study proposed the following:

- Hypothesis 10 (H10): competitive pressure will be positively correlated with the adoption of cloud computing.

Government Regulation support

Regulatory support, as mentioned by Zhu et al.[131], could be in the form of government support that eases the enterprises' IT innovation. In a study on cloud computing adoption carried out by Asiaei et al.[75], regulations and laws could have a significant impact. Regulatory support as part of the environmental dimension, affects cloud computing adoption among organizations. Here, service adoption rate among rivals has strong positive impact on the organization's cloud computing adoption. Organizational factors, top management support and organizational inertia especially, significantly impact cloud computing adoption.

Clearly, for businesses, laws and regulations imposed by government could either ease or impede their cloud computing adoption. As an example, in US and Europe, policies that protect organizational data have been enacted. Additionally, Asiaei et al.[75] mentioned that requiring businesses to meet the standards and regulations of cloud computing (imposed by government)will increase the interest towards cloud computing adoption among businesses. As concluded by Sayginer et al.[94], for companies, the increase in regulatory support will increase their likelihood of cloud computing adoption. Hence, this study proposed the hypothesis below:

- Hypothesis 11 (H11): regulatory support will be positively correlated with the adoption of cloud computing.

Trading Partner Pressure

It has been reported by Low et al.[78] that organisations generally would seek the assistance from their trading partners (and cloud vendors) in designing their IT and in executing their tasks. In their study, Lumsden et al.[93] reported pressure from trading partner pressure as main determinant for the adoption and usage of IT. In adopting cloud computing services, all organizations, no matter their size, are dependent on the expertise and skills of their trading partners. Activities of marketing and previous projects performed by the trading partners of organization can significantly impact the decision of organisations towards adoption or non-adoption of new IT innovations.

Companies pressurised by fast technical changes and external pressure that results from these changes are more likely to adopt innovations because these companies want to preserve their long-term competitiveness.[78] The competitive pressure of the industry has positive impact on innovation adoption among companies, especially when competing with the major rivals is the companies' strategic requirement. Relevantly, Gangwar et al.[79] found that companies whose cloud computing adoption is at an advanced stage seem to have high operational efficiency, market visibility and more fitting data collection – all these are the advantages of adopting cloud computing.[96] As such, the hypothesis below was formulated:

- Hypothesis 12 (H12): trading partner pressure will be positively correlated with the adoption of cloud computing.

Individual Factors (Personal Innovativeness)

The individual factor has been added to TOE framework in examining the intent to adopt cloud-based accounting software in MSME. The addition of this factor, aside from extending the framework, has allowed researcher in gaining better understanding of the subject at hand. Business activities in MSME are still primarily executed by owner/manager. For this reason, the individual factors (relating to the owner/manager) should be taken into account in the determination of technology adoption, particularly on how these individual factors affect decision.[43,64] Individual factors in this study can include the following: innovativeness of owner/managers, technology knowledge, and accounting knowledge. Innovativeness of owner/manager is an important factor because technology adoption requires knowledge of user, so that user could gain better understanding of the technology. Within the context of MSME, cloud-based accounting software is still being developed. In achieving competitive advantage, innovative owner/manager is likely to show higher inclination towards trying out new technology. Knowing the technology is important before adopting it, to allow optimal usage of the technology. Hence, knowledge of owner/manager is important to the study context, particularly on technology and accounting.[132]

Human factors are associated with the viewpoints of human on the technology. Personal innovativeness is the person's openness towards new technology, and as indicated by past studies,[95,133] the perceived innovativeness of a person can affect the response of the person towards the new technology. Personal innovativeness therefore has the potential to predict if a person has the intention to adopt an innovation earlier than others.[52,133] In HPC, cloud computing adoption seemed to fall behind. Hence, arguably, adoption is more likely among innovative decision makers. Significant impact of human factors on cloud computing adoption has been reported in a number of studies (see: Lian et al.[95], Liang et al.[134]; AlKharusi et al.[135]. As such, this study proposed that:

- Hypothesis 13 (H13): personal innovativeness is positively related to the adoption of cloud computing.

Contributions

Results of this study have significant implications to academic works on cloud computing, in Jordanian higher educational institutions (HEIs) especially. Using TOE model with the addition of human factors has allowed the understanding of the factors affecting Jordanian HEIs in cloud computing services adoption. The inclusion of the human factors also expanded the model. This can be regarded as one of this study's significant contributions. For top management in Jordanian HEIs, the findings of this study could facilitate in maneuvering the adoption of cloud computing, as the findings could facilitate top management in ascertaining the key factors in their institutions. The theoretical model proposed in this study was validated, affirming what affects HEIs when adopting cloud computing services. Hence, decision-makers in HEIs in Jordan could take on the informative decisions on what affect the viability of cloud computing services in these institutions.

CONCLUSIONS

Adoption of cloud computing is not without challenges and issues. For higher education institutions, these challenges and issues may be tackled through understanding the factors that affect the adoption process. Good planning and performing cloud adoption analysis using the factors identified would allow organization to ascertain the best deployment and service models and the best cloud provider as well. The literature has shown that the adoption of cloud computing is significantly affected by the factors of technology(Relative Advantage, Compatibility, Complexity, PU, PEOU and Security), the factors of organization (Organization Readiness, Top Management Support and Firm Size), the factors of environment (Competitive pressure, Regulation support and Trading Partner Pressure) and the factors of human(Personal innovativeness).

In essence, this study examined the impact of the aforementioned factors on cloud computing adoption in Jordanian higher education institutions. In the course of the study, several commendations have been established. First of all, this study saw the need to evaluate the proposed model in terms of its applicability and significance in illuminating cloud computing adoption in higher education institutions in other developing countries. Secondly, Technology-Organization-Environment (TOE) model was employed in this study, with the inclusion of the human factors (i.e., Personal innovativeness). For future studies, the use of other applicable theories is commended. Lastly, other variables should be considered, particularly those that may impart comparable impact on the adoption of cloud computing.

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CONFLICT OF INTEREST

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