Journal of Enterprise Information Management

The adoption of software-as-a-service (SaaS): ranking the determinants

Fariba Safari Narges Safari Alireza Hasanzadeh

Received 25 February 2014
Revised 5 May 2014
17 July 2014
Accepted 18 July 2014

The adoption of software-as-a-service (SaaS): ranking the determinants

Fariba Safari
Department of Information Technology Management, Tarbiat Modares University, Tehran, Iran
Narges Safari
Department of Information Technology Management, Sistan and Baluchestan University, Zahedan, Iran, and
Alireza Hasanzadeh
Department of Information Technology Management, Tarbiat Modares University, Tehran, Iran

Abstract

Purpose – Software-as-a-Service (SaaS) has the potential to provide substantial opportunities for organizations to improve their information technology without cost and management concerns. However, organizations have not utilized it to the desired level because it is very challenging for them to completely transform their basic conventional methods of running software into SaaS as a high-tech method. On the other hand, organizations have doubt which factors should be mostly considered if they want to move to SaaS. Therefore, investigating the adoption of SaaS can contribute organizations to benefit from this technology. The purpose of this paper is to provide a good insight into SaaS technology adoption.

Design/methodology/approach – Considering Technology, Organization and Environment (TOE) framework and diffusion of innovation (DOI) theory as the basis, 22 university experts expressed their idea about the proposed model of SaaS adoption. Then, 30 IT professional in 15 IT enterprises that had adopted SaaS were asked to fill the questionnaire related to fuzzy Analytic Hierarchy Process (AHP) based on linguistic preference relations (LinPreRa) in order to rank the submitted criteria.

Findings – The findings demonstrate that all attributes of Technology (relative advantage, compatibility, complexity, trialability, observability and security and privacy), Organization (IT resource, sharing and collaboration culture) and environment (competitive pressure, social influence) are influential in the adoption of SaaS. Moreover, the top five influential factors are relative advantage, competitive pressure, security and privacy, sharing and collaboration culture and social influence based on adopter's opinions.

Research limitations/implications – For researchers, this study provides a useful literature, which can help them in related subject. In addition, it applies IT adoption theories in SaaS context that can be extended in future studies. For organizations, this study derives priority of factors by which they can make strong decisions about adoption of SaaS.

Originality/value – This study contributes to the adoption of SaaS technology using well-known IT adoption theories. A version of Fuzzy AHP based on LinPreRa was used in order to cover the limitations of previous methodologies of ranking the criteria.

Keywords Fuzzy AHP, Cloud computing, DOI theory, Fuzzy LinPreRa, Software-as-a-Service (SaaS), TOE framework

Paper type Research paper

Journal of Enterprise Information Management
Vol. 28 No. 3, 2015
pp. 400-422

1741-0398
DOI 10.1108/JEIM-02-2014-0017

This research was financially supported by Tehran Industrial Estates Co.

1. Introduction

Cloud computing is a new information and communication technology that helps organizations to use new IT development with affordable costs (Sultan, 2011). Cloud computing brings salient benefits for companies. For instance, in cloud platform it is more convenient to support infrastructure (software, hardware) rather than in-house IT. Cloud computing services typically falls into three groups: Software-as-a-Service (SaaS) providing applications via internet (e.g.: www.salesforce.com), Platform-as-a-Service (PaaS) supporting software developers through the whole software life-cycle (development, test and deployment) (e.g.: www.windowsazure.com), and Infrastructure-as-a-Service providing necessary infrastructure by which organizations would not need to purchase servers, datasets and network resources (e.g.: www.gogrid.com) (Jadeja and Modi, 2012). Among these services, SaaS is the most applicable service through which the necessity for software installation as a common task in in-house IT will be diminished (Jadeja and Modi, 2012). SaaS uses a model of payment called pay-as-you-use, which brings cost saving especially for companies facing lack of financial resources such as small and medium enterprises (Marian and Hamburg, 2012). SaaS has attracted most IS executives as it is mature and easy-to-use and it provides flexible access via internet-based interfaces (Benlian *et al.*, 2009). Despite the fact that SaaS has provided undeniable benefits for organizations, they have not adopted it to an acceptable level. For example, studies have shown that 30 percent of IT organizations in Europe use SaaS and 70 percent have no plan to use this service (Marian and Hamburg, 2012). It seems that SaaS adoption is very challenging for organizations especially when there is no specific attributes to be considered in moving to SaaS. Therefore, investigating affecting factors for the adoption of SaaS is of great importance.

The previous study on the adoption of SaaS in Korean organizations was employed based on Political, Economic, Social and Technology (PEST) analysis and the economic factor was decisive in the adoption of SaaS (Lee *et al.*, 2013). One limitation of PEST analysis is that it ignores the internal environment of the organization (Henry, 2008). In the study of (Wu, 2011) TAM framework along with security and trust were explored among which the social influence, perceived usefulness and the security and trust were significant factors. He mainly focussed on user (individual) acceptance of SaaS. As can be realized, there is a lack of research for the SaaS adoption based on Technology, Organization and Environment (TOE) characteristics. Therefore, this study focusses on TOE characteristics of SaaS based on TOE framework. In addition, most studies have focussed only on determining factors that are influential in the adoption or not and no study has attempted to weight influential factors. Since ranking the determinants of SaaS adoption based on adopter preferences is effective in the adoption decision, this study seeks to weigh the determinants of SaaS adoption. Ranking the influential factors without any systematic method is difficult given the large number of experts. Generally, ranking the determinants is regarded as a Multiple Criteria Decision-making (MCDM) problem where decision makers choose or rank several criteria based on the goal. Among MCDM methods (Multiple Attribute Utility Theory (MAUT), Outranking and Analytic Hierarchy Process (AHP)), AHP has the advantages of flexibility, ease-of-use by arranging the decision factors in a hierarchical structure which simplifies the problems (Paksoy *et al.*, 2012; Ramanathan, 2001). This technique has been widely used in weighting the preferences in previous studies (Lee *et al.*, 2012). The conventional AHP was proposed based on crisp values by Saaty (1979). Crisp values in ranking the determinants has a shortcoming since they cannot cover the uncertainty of judgments (Paksoy *et al.*, 2012). As experts' judgments and preferences always are ambiguous, this study uses Fuzzy AHP in order to rank the criteria many versions of Fuzzy AHP (Chang, 1996; Buckley, 1985; Van Laarhoven and Pedrycz, 1983) used in ranking the determinants. However, these widely used versions of Fuzzy AHP were criticized for the large number of questions in questionnaire (expert comparisons) and high possibility of expert's inconsistent comparisons (Wang *et al.*, 2008). In order to solve this problem, this study has used Fuzzy AHP based on linguistic preference relations which was proposed by Wang and Chen (2008) in which few pair-wise comparisons are required and the consistency of comparisons is guaranteed. The remainder of this paper is structured as follows: Section 2 describes the research model; Section 3 is an overview of fuzzy AHP. Section 4 is research methodology; the results of the analysis are discussed in Section 5. Finally, the implications of the study and directions for future research are presented in Section 6.

2. Research model

TOE framework is one of the most applicable innovation adoption frameworks in organization level in which three contexts of TOE are mentioned as influential factors in the process of innovation adoption (Tornatzky *et al.*, 1990). In order to evaluate technological characteristics of SaaS, Rogers' (1995) diffusion of innovation (DOI) theory with five attributes consisting of relative advantage, compatibility, complexity, trialability and observability, which affect innovation adoption are considered (Lin and Chen, 2012). In addition to DOI attributes, security and privacy of the technology is considered because of the special nature of SaaS technology (Subashini and Kavitha, 2011; Wu, 2011). The organization context includes sharing and collaboration culture (Gupta *et al.*, 2013), size of IT resource (Misra and Mondal, 2011) and the environmental context includes competitive pressure (Low and Chen, 2011) and social influence (Benlian *et al.*, 2009; Wu, 2011). Figure 1 represents the proposed model for SaaS adoption described as follows.

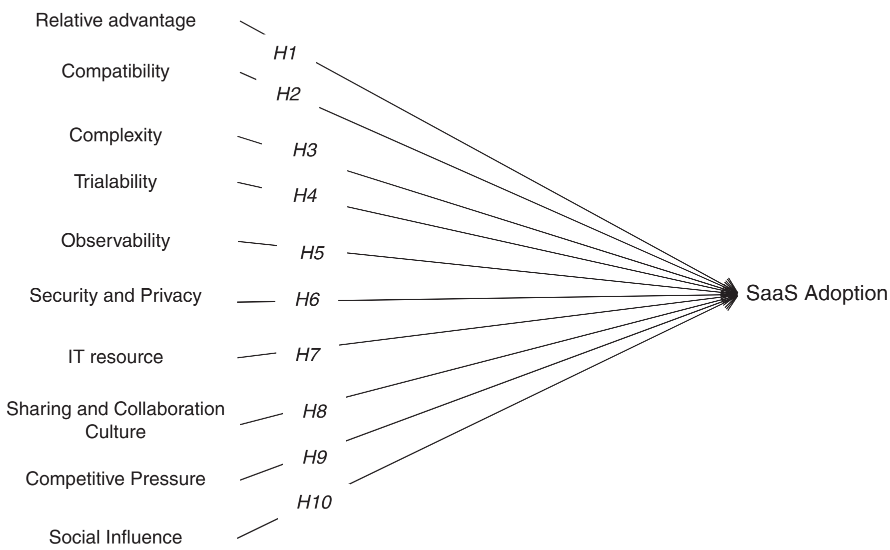

Figure 1.
Research model

2.1 Technological context

Relative advantage. Relative advantage means the degree to which an innovation is perceived to benefit the organization in comparison with the existing technology (Rogers, 1995). SaaS technology can bring organizations the benefit of cost saving and flexibility in using IT resources via easy-to-use internet-based interfaces (Benlian *et al.*, 2009). In SaaS, pay-per-use model of payment eliminates the cost of software licensing and installation (Chunye *et al.*, 2010). Moreover, being able to use applications that are developed by IT giants like Salesforce CRM (Customer Relationship Management) or SAP's Business ByDesign ERP (Enterprise Resource Planning) that are available over the internet is a benefit for companies with lack of qualified IT developers (Gupta *et al.*, 2013; Misra and Mondal, 2011). Another advantage is that in SaaS, the customers do not manage the underlying infrastructure such as servers, operating systems and storages and the applications are accessible from various client devices (Price, 2011). It seems that organizations adopt a technology as long as it brings them relative advantage (Alam, 2009). Therefore, it can be predicted that:

H1. Relative advantage of SaaS is an influential factor for its adoption.

Compatibility. Compatibility means the degree to which a new technology is adaptable with current technologies, values, previous experiences and potential needs of organization (Rogers, 1995). In adoption of cloud computing technology in Taiwan Software Company, compatibility of cloud computing with quality and security measures of the company was found to be a significant factor (Lin and Chen, 2012). In investigating the Taiwanese enterprises, Wu (2011) confirmed that the compatibility of the application with existing platform of organization is a determinant of using the SaaS. Since SaaS services are provided through internet-based user interface (Benlian *et al.*, 2009), organizations should have no problem to work with browser-based applications (Linthicum, 2009). Sometimes the products of SaaS vendors were not compatible. For example, some customers of Salesforce SaaS (release of 2008) had to make the interfaces compatible with user requirements (Xin and Levina, 2008). Thus, it can be predicted that:

H2. Compatibility of SaaS is an influential factor for its adoption.

Complexity. Complexity is the degree to which an innovation is difficult to be understood by its users (Rogers, 1995). In most studies of IT adoption, complexity of understanding the technology has been mentioned as an influential factor (Soliman and Janz, 2004). It is claimed that in SaaS the internet-based interfaces are simple enough and the interactions between web users and providers are more in Web 2.0 (Chunye *et al.*, 2010; Benlian *et al.*, 2009). However, SaaS technology is new which may take time to be perceived by organization. Therefore, the following hypothesis is defined:

H3. SaaS complexity is an influential factor for its adoption.

Trialability. Trialability is the degree to which an innovation can be tested by user in a limited scope before actual adoption (Rogers, 1995). Chong (2004) has concluded that in adoption of e-commerce the trialability of the technology is a significant factor as it reduces the uncertainty about the technology. Organizations prefer to have their in-house IT rather than SaaS in case of uncertainty (Xin and Levina, 2008). In the study of cloud computing adoption in SMEs, adopters claimed that trialability affects their decision positively (Alshamaila *et al.*, 2013). The majority of the current successful SaaS providers, such as Salesforce CRM, Google SaaS are providing a trial version (typically 30 days) to make customers more certain in their adoption decision. Therefore, it can be concluded that:

H4. Trialability of SaaS is an influential factor for its adoption.

Observability. Observability (visibility) is the degree to which the result of using an innovation is visible to others which reduces uncertainty and makes the adoption possible (Rogers, 1995). Observability has been a significant factor in many studies of IT adoption (Lin and Chen, 2012). Lin and Chen (2012) realized that companies are unlikely to adopt the cloud as long as successful business cases and models are not clear enough. Today, successful SaaS providers such as Salesforce.com have a dedicated section in their web sites to introduce customer success stories. Therefore, it can be predicted that:

H5. Observability of SaaS is an influential factor for its adoption.

Security and privacy. Security and privacy is the top concern of 50 percent of organizations in their cloud computing adoption decision (Gupta *et al.*, 2013). Therefore, it is essential to consider the security and privacy along with DOI attributes in SaaS adoption. Most concern about the security and privacy is about availability (access to information), confidentiality (unauthorized disclosure of information) and integrity (unauthorized manipulating and destroying information) (Stine *et al.*, 2008). Therefore, SaaS providers need to ensure the security and privacy in order to overcome threats such as broken authentication since the huge amount of personal and sensitive data will be moved to the cloud platform (Subashini and Kavitha, 2011). SaaS vendors should guarantee security, availability and performance through clear service level agreement (SLA) in which a common understanding about service, priorities, responsibilities and guarantees between service provider and client is determined (Linthicum, 2009). Therefore, the following hypothesis is defined:

H6. Security and privacy is an influential factor in the adoption of SaaS.

2.2 Organizational context

Sharing and collaboration culture. Most of SaaS solutions bring the ability to collaborate and share information with teammates from any location using only a web-browser with minimum IT investments. In fact, sharing and collaboration through SaaS applications (such as Dropbox and Google App) is an advantage of SaaS that organizations must utilize (Lin and Chen, 2012). Dropbox as one of the best SaaS storage solutions facilitates sharing via folders and links inside and outside of the organization. Google App facilitates the sharing and collaboration through its productivity and communication suites such as Gmail, Google talk, calendar, docs and video (Sultan, 2011). Therefore, having the culture of sharing and collaboration with colleagues and even with external clients can act as a determinant of the SaaS adoption:

H7. The sharing and collaboration culture in organization is an influential factor for the adoption of SaaS.

Organizations' IT resource. By SaaS, the organization frees itself from the process of purchasing and maintaining hardware and software (Sultan, 2011). For organizations with large and sophisticated IT resources (number of users, hardware and software, IT expertize) it is not profitable to leave the internal infrastructure and move "outside the walls" (Misra and Mondal, 2011). In fact, sufficient number of internal or external users can bring efficiency and effectiveness for company in employing software resources internally rather than using SaaS. To be more precise, organizations with large number of users are less likely to adopt SaaS model because of its pay-per-use model of payment in which the total cost will increase with the rise in the number of users. In addition, organizations with professional IT department have the sufficient IT capabilities to implement and manage in-house IT efficiently. Therefore, if the organization has invested on the sophisticated IT infrastructure and capabilities, it is not economically reasonable for them to move to SaaS (Misra and Mondal, 2011). Therefore, we hypothesize:

H8. The organizations' IT resource is an influential factor in the adoption of SaaS.

2.3 Environment context

Competitive pressure. Competitive pressure as the degree of competitiveness between companies in each industry is an incentive for research, development and innovation in organizations (Vives, 2005). Fortunately, IT has provided competitive advantage by presenting new solutions for organizations that are acting in the competitive marketplace. Based on Porter competitive strategy, it is argued that SaaS can create both the competitive advantages of leadership and differentiation since the business become an internet-business by adoption of SaaS (Jeol, 2008). Therefore, it can be concluded that in competitive environment companies are highly dependent on IT technologies such as SaaS to stay competitive. Thus:

H9. Competitive pressure is an influential factor for SaaS adoption.

Social influence. In the basic definition of social influence by Rhoads (1997) we have two concepts: an agent and a target. The target is the one who is influenced by the agent in its action. In the case of organizational studies, the agent is the public such as mass media, experts and the word-of-mouth while the target is the business organization whose action is affected by the agent (Rhoads, 1997). In fact, social influence is about the perception of public or competitors about the standing of the organization, which is the adoption of SaaS in this study. It is suggested that companies should pay attention to the positive/negative picture about the SaaS adoption, which is drawn by experts and other social agents (Wu, 2011). In determining drivers of SaaS adoption, social influence (subjective norm) was an influential factor in SaaS adoption (Benlian *et al.*, 2009). Therefore:

H10. Social influence is an influential factor for SaaS adoption.

3. Fuzzy linguistic preferences based AHP

The basic idea of AHP technique is to illustrate the evaluation criteria in a hierarchy structure. The decision maker's opinions are shown in a pair-wise comparison matrix (Chang, 1996). As mentioned before, AHP is not able to process the ambiguous nature of opinions and Fuzzy AHP is preferred. There are different versions of Fuzzy AHP in literature. Van Laarhoven and Pedrycz (1983) proposed the first extension of AHP in fuzzy context, they used fuzzy triangular numbers and least square method in order to cover the fuzziness nature of opinions. Buckley (1985) used fuzzy trapezoidal numbers and a geometric mean method in his proposed fuzzy AHP, while Chang (1996) applied fuzzy triangular numbers and extent analysis method. These methods have been criticized, as they cannot guarantee the consistency of comparisons. In addition, experts should perform too many comparisons. In order to solve the consistency problem, Wang and Chen (2008) incorporated the consistency measures (Herrera-Viedma *et al.*, 2004) in Fuzzy AHP and proposed fuzzy linguistic preference relation (LinPreRa) based AHP. Their proposed method has received increasing attention in priority-ranking problems like e-learning (Chao and Chen, 2009) and supplier selection (Rezaei and Ortt, 2013). This method has two features: fewer comparisons are performed (n-1 comparisons for n criteria in comparison with $n \times (n-1)/2$ in conventional methods); and 2 the comparisons are guaranteed to be consistent (Wang and Chen, 2008). In order to rank the criteria, an efficient method is necessary to derive correct weights based on consistent comparisons without much difficulty. Therefore, with regard to the mentioned benefits, Fuzzy LinPreRa-based AHP is applied in this study to evaluate the criteria that discussion about them has already been captured.

Before reviewing the technique, it is necessary to describe some preliminaries.

Fuzzy logic (Zadeh, 1965): making appropriate decisions under uncertain environment is difficult without considering vagueness. Fuzzy set theory can handle this by involving ambiguity nature of problems in decision makings (Zadeh, 1965). A fuzzy set is defined by a membership function through which the elements are mapped to a certain interval ([0, 1]). The value of zero shows that the element does not belong to the set while the value of one considers as complete membership of the element to the set. Other values in the mentioned interval indicate a specific degree of membership to the set. In this theory, linguistic terms are represented by fuzzy numbers, usually triangular fuzzy numbers (TFN) shown by specifying "~" character above symbols.

Triangular fuzzy number definition (Van Laarhoven and Pedrycz, 1983): a triangular fuzzy number N is shown as (l,m,u) with $l < m < u$ in which l and u are the lower and upper bounds and m is its value. As the TFNs operational laws are used in this study to compare the judgments of respondents, it is necessary to have an overview on them. For $N1 = (l_1,m_1,u_1)$ and $N2 = (l_2,m_2,u_2)$ we have:

TFNs addition $\oplus$: $$\widetilde{A}_1 \oplus \widetilde{A}_2 = (l_1, m_1, u_1) \oplus (l_2, m_2, u_2) = (l_1 + l_2, m_1 + m_2, u_1 + u_2)$$

TFNs multiplication $\otimes$: $$\widetilde{A}_1 \otimes \widetilde{A}_2 = (l_1, m_1, u_1) \otimes (l_2, m_2, u_2) \cong (l_1 \times l_2, m_1 \times m_2, u_1 \times u_2) \text{ for } l_i, m_i, u_i > 0$$

TFNs division $\oslash$: $$\widetilde{A}_1 \oslash \widetilde{A}_2 = (l_1, m_1, u_1) \oslash (l_2, m_2, u_2) \cong (l_1/u_2, m_1/m_2, u_1/l_2) \text{ for } l_i, m_i, u_i > 0$$

Fuzzy preference relations definition (Van Laarhoven and Pedrycz, 1983): fuzzy preference relations can provide values representing various degrees of preference for one criteria over another. A LinPreRa P is defined based on an alternative set $A = \{a_1, a_2, \ldots, a_n\}$ and membership function P: $A \times A \rightarrow [0,1]$. It is represented via a $n \times n$ matrix $\widetilde{P} = (\widetilde{p}_{ij})$ as shown in Equation (1) where $\widetilde{p}_{ij} = (p_{ij}^L, p_{ij}^M, p_{ij}^R)$ is a TFN which shows the preference of a_i over a_j based on linguistic variables (very poor, poor, medium poor, medium, medium good, good and very good) mapped to TFNs as shown in Table I and Figure 2. The mapping is based on (Wang *et al.*, 2008; Rezaei and Ortt, 2013):(1)

$$\widetilde{\boldsymbol{P}} = \begin{bmatrix} \widetilde{\boldsymbol{p}}_{11} = (\boldsymbol{p}_{11}^L, \boldsymbol{p}_{11}^M, \boldsymbol{p}_{11}^R) & \cdots & \widetilde{\boldsymbol{p}}_{1n} = (\boldsymbol{p}_{1n}^L, \boldsymbol{p}_{1n}^M, \boldsymbol{p}_{1n}^R) \\ \vdots & \ddots & \vdots \\ \widetilde{\boldsymbol{p}}_{n1} = (\boldsymbol{p}_{n1}^L, \boldsymbol{p}_{n1}^M, \boldsymbol{p}_{n1}^R) & \cdots & \widetilde{\boldsymbol{p}}_{nn} = (\boldsymbol{p}_{nn}^L, \boldsymbol{p}_{nn}^M, \boldsymbol{p}_{nn}^R) \end{bmatrix} \tag{1}$$

For a fuzzy LinPreRa matrix there are two propositions that must be applied. The $n-1$ cells of matrix are filled based on expert's opinion and the other cells are filled based on reciprocity and consistency measures explained as follows.

Reciprocity proposition (Wang and Chen, 2008): a fuzzy LinPreRa $\widetilde{P} = (\widetilde{p}_{ij}), p_{ij} \in [0,1]$ matrix is reciprocal when the following statements are equivalent:

(1) $p_{ij}^L + p_{ji}^R = 1 \forall i,j \in \{1,\ldots,n\}$

(2) $p_{ij}^M + p_{ji}^M = 1 \forall i,j \in \{1,\ldots,n\}$

(3) $p_{ij}^R + p_{ji}^L = 1 \forall i,j \in \{1,\ldots,n\}$

Consistency proposition (Wang and Chen, 2008; Herrera-Viedma et al., 2004): the fuzzy LinPreRa is adopted to improve the consistency of conventional fuzzy AHP. The fuzzy LinPreRa $\widetilde{\boldsymbol{P}} = (\widetilde{\boldsymbol{p}}_{\boldsymbol{ij}}), \boldsymbol{p}_{\boldsymbol{ij}} \in [0,1]$ matrix is consistent when the following statements are equivalent:

(1) $p_{ij}^L + p_{jk}^L + p_{ki}^R = \frac{3}{2}, i < j < k$

(2) $p_{ij}^M + p_{jk}^M + p_{ki}^M = \frac{3}{2}, i < j < k$

(3) $p_{ij}^R + p_{jk}^R + p_{ki}^L = \frac{3}{2}, i < j < k$

(4) $p_{i(i+1)}^L + p_{(i+1)(i+2)}^L + \cdots + p_{(j-1)j}^L + p_{ji}^R = \frac{j-i+1}{2} \forall i < j$

(5) $p_{i(i+1)}^M + p_{(i+1)(i+2)}^M + \cdots + p_{(j-1)j}^M + p_{ji}^M = \frac{j-i+1}{2} \forall i < j$

(6) $p_{i(i+1)}^R + p_{(i+1)(i+2)}^R + \cdots + p_{(j-1)j}^R + p_{ji}^L = \frac{j-i+1}{2} \forall i < j$

Steps of fuzzy LinPreRa-based AHP method are as following (Wang and Chen, 2008):

Linguistic variables	Triangle fuzzy numbers
Very poor (VP)	(0, 0, 0.1)
Poor (P)	(0, 0.1, 0.3)
Medium poor (MP)	(0.1, 0.3, 0.5)
Medium (M)	(0.3, 0.5, 0.7)
Medium good (MG)	(0.5, 0.7, 0.9)
Good (G)	(0.7, 0.9, 1)
Very good (VG)	(0.9, 1, 1)

Table I. Fuzzy linguistic assessment variables

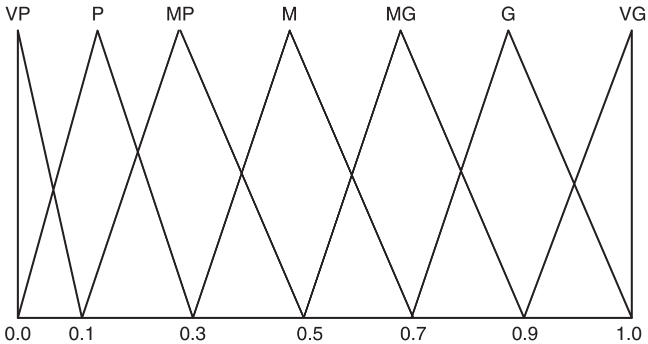

Figure 2. Fuzzy linguistic assessment variables

Step 1: hierarchal structure of the problem – in this stage, hierarchal structure (including goal and criteria) is constructed. The problem goal and criteria are located on the top layer and the sub-layer of hierarchy, respectively.

Step 2: pair-wise comparison matrix – this stage includes the building of comparison matrix$\widetilde{P} = (\widetilde{p}_{\mathrm{ij}}) = \left(p_{ij}^{L}, p_{ij}^{M}, p_{ij}^{R}\right)$ where $\widetilde{p}_{\mathrm{ij}}$is a triangular fuzzy number to show the decision-maker's preference of i over j. Decision makers compare each pair of criteria by fuzzy linguistic variables and build an incomplete consistent fuzzy LinPreRa matrix having just $n-1$ judgments. After constructing the expert-related cells of the matrix $\{p_{12}, p_{23}, \ldots, p_{n-1n}\}$, other cells should be retrieved by adopting reciprocity and consistency statements in order to obtain the complete consistent fuzzy LinPreRa, $\left(\widetilde{P} = (\widetilde{p}_{ij})\right)$.

Step 3: fuzzy linguistic matrix for the criteria – after determining the pair-wise comparison matrix, it will be examined in order to have all elements of matrix in [0,1]. Otherwise, elements should be transformed to [0,1] using a transformation function to preserve reciprocity and consistency f:$[-c, 1+c] \rightarrow [0,1]$. This function can be done based on Equation (2) in which c is the maximum violation from [0, 1]:

$$\begin{aligned} f\left(x^{L}\right) &= \tfrac{x^{L}+c}{1+2c} \\ f\left(x^{M}\right) &= \tfrac{x^{M}+c}{1+2c} \\ f\left(x^{R}\right) &= \tfrac{x^{R}+c}{1+2c} \end{aligned} \tag{2}$$

Step 4: weights of the criteria – here, each criterion weight is calculated using Equation (3):

$$\widetilde{w}_{\mathrm{i}} = \frac{\widetilde{g}_i}{\widetilde{g}_1 \oplus \cdots \oplus \widetilde{g}_n} \tag{3}$$

where $\widetilde{g}_i$ is the mean of the comparison values of row, i and can be calculated as follows:

$$\widetilde{g}_i = \frac{1}{n}\left[\widetilde{p}_{i1} \oplus \widetilde{p}_{i2} \oplus \cdots \oplus \widetilde{p}_{in}\right], i = 1, \ldots, n \tag{4}$$

The final fuzzy weights of criteria should be presented as crisp values to arrange numbers for ranking. Therefore, defuzzification is necessary. The fuzzy mean (FM) method is used to convert the fuzzy weights into crisp values using Equation (5):

$$W_i = \frac{w_i^{L} + w_i^{M} + w_i^{R}}{3} \tag{5}$$

The superiority of criteria is determined based on the value of the fuzzy mean Equation (5). In fact, a higher value of it indicates a criterion with higher priority.

4. Research methodology

In the first step of this study, hypotheses are tested. Data collection tool was questionnaire with ten items and on five-point Likerts scale. Due to the limited number of experts in the cloud computing field, the snowball sampling method was used. The 30 questionnaires on Likert's five points scale (strongly agree = "5," agree = "4," neutral = "3," disagree = "2," strongly disagree = "1") were distributed out of which 22 completed questionnaires were sent back. All the experts had PhD in related field. The previous studies of model validation by experts used small samples. For example, Dyba (2000) used 11 experts to conduct the review process, and Beecham *et al.* (2005) used 20 completed questionnaires of experts to validate the research model (Beecham *et al.*, 2005). Therefore, the validity of the model was submitted based on 22 experts' opinion. In order to evaluate the reliability of the questionnaire, Cronbach's α coefficient should be above 0.7. Calculated Cronbach's α for this study was 0.782, which shows the sufficient level of reliability. Hence, we decided to rank the variables in IT enterprises that were using SaaS in their business. Therefore, in this step, a number of 30 IT professionals in 15 IT enterprises filled second questionnaire related to fuzzy AHP as one of the best multi criteria decision-making (MCDM) approaches. Figure 3 illustrates the research methodology of the paper.

4.1 Data analysis

In order to test the hypotheses (*H1-H10*), the binomial test (significance level = 0.05, cut point = 3) was conducted using SPSS software. Table II shows the results of binomial test.

As shown in Table II, the significance level values for all factors are lower than 0.05 and the number of observations for the group 1 (>3) is greater than group 2 ($\leqslant 3$) for all hypotheses. Therefore, all hypotheses (*H1-H10*) are confirmed with 95 percent of confidence.

4.2 Ranking factors

In order to determine the weights of the criteria, fuzzy AHP is applied. Using fuzzy AHP, decision makers represent their judgments subjectively about the preference of one criterion over the other. Subjective judgments are based on linguistic variables (very poor, poor, medium poor, medium, medium good, good and very good). Then, these linguistic variables should be mapped with a fuzzy triangular number in interval of [0, 1]. Table I and Figure 2 show these linguistic variables for pair-wise comparison of criteria. A number of 22 IT professionals who their companies have adopted SaaS are selected to complete the questionnaire related to fuzzy AHP:

- Step 1: at the first step, a hierarchal structure should be constructed based on the main goal and criteria. In this context, the hierarchal structure is in two-layer format. In the top layer, we have SaaS adoption as the main goal of the problem while in the second layer ten discussed variables, submitted by experts in model validation section, are placed as shown in Figure 4.
- Step 2: After establishing the hierarchal structure, 22 IT professionals who their organization have adopted SaaS, conduct a pair-wise comparison to express their preferences. They express their idea according to linguistic variables (see Table I) to show the preference of one criterion over another. As this study has ten criteria ($n = 10$), experts have to fill only $n-1 = 9$ places in matrix, $\{p_{12}, p_{23}, p_{34}, \ldots, p_{910}\}$, to construct the incomplete fuzzy preference relation. Table III shows the judgments of 22 respondents which constitutes nine cells of matrix. After converting expert's idea to TFNs, since the number of experts is more than one in this study, we proceed to accumulate expert's idea based on Equation in which m is the total number of experts:

$$\bar{\tilde{p}}_{ij} = \frac{\sum_{k=1}^{m} \bar{\tilde{p}}_{ij}^{(k)}}{m}, \forall i, j \tag{6}$$

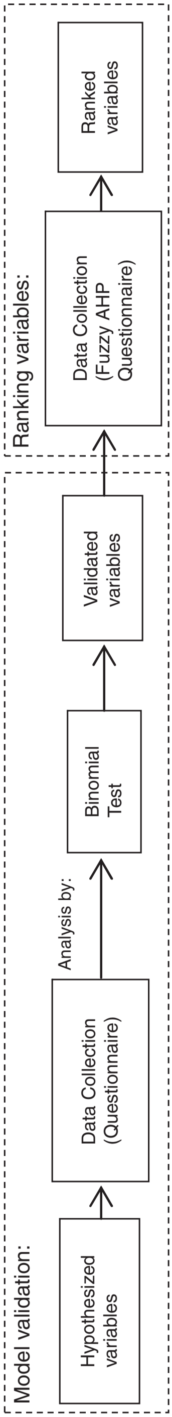

Figure 3.
Research methodology

Hypothesis	Constructs	Groups	Category	N	Observed Prop.	Exact Sig. (one-tailed)	Reject/confirm the hypothesis
H1	Relative Advantage	Group 1	⩽3	2	0.1	0.000[a]	Confirm
		Group 2	> 3	20	0.9		
		Total		22	1.0		
H2	Compatibility	Group 1	⩽3	4	0.2	0.000[a]	Confirm
		Group 2	> 3	18	0.8		
		Total		22	1.0		
H3	Complexity	Group 1	⩽3	6	0.3	0.002[a]	Confirm
		Group 2	> 3	16	0.7		
		Total		22	1.0		
H4	Trialability	Group 1	⩽3	3	0.1	0.000[a]	Confirm
		Group 2	> 3	19	0.9		
		Total		22	1.0		
H5	Observability	Group 1	⩽3	7	0.3	0.007[a]	Confirm
		Group 2	> 3	15	0.7		
		Total		22	1.0		
H6	Security and Privacy	Group 1	⩽3	0	0.0	0.000[a]	Confirm
		Group 2	> 3	22	1.0		
		Total		22	1.0		
H7	IT Resource	Group 1	⩽3	4	0.2	0.000[a]	Confirm
		Group 2	> 3	18	0.8		
		Total		22	1.0		
H8	Sharing and Collaboration Culture	Group 1	⩽3	7	0.3	0.007[a]	Confirm
		Group 2	> 3	15	0.7		
		Total		22	1.0		
H9	Competitive Pressure	Group 1	⩽3	1	0.0	0.000[a]	Confirm
		Group 2	> 3	21	1.0		
		Total		22	1.0		
H10	Social Influence	Group 1	⩽3	4	0.2	0.000[a]	Confirm
		Group 2	> 3	18	0.8		
		Total		22	1.0		

Table II. The result of hypotheses testing with sig. level of 0.05

- In order to derive the complete fuzzy preference relation, the empty cells of matrix are filled with consistency and reciprocity measures as follow. Table IV shows the complete Fuzzy comparison matrix. Consistent fuzzy preference relations on the incomplete fuzzy preference relation ensure that the decision maker's ideas are consistent.

- Step 3: in this step the complete fuzzy preference relation should be evaluated to have entries between the interval of [0, 1]. As it is clear in Table IV, some entries are not in the interval [0, 1]. Therefore, Equation 2 is used to convert Table IV entries into [0, 1]. The results are shown in Table V in which all entries are between 0 and 1.

- Step 4: After the transformation, the fuzzy weights of criteria are calculated based on Equations (3) and (4). As is mentioned earlier, the optimum way to rank criteria is to derive crisp weights rather than fuzzy weights. Therefore, fuzzy mean defuzzification method Equation (5) applied to fuzzy numbers. Table VI shows the results. All computations were done using Microsoft Excel.

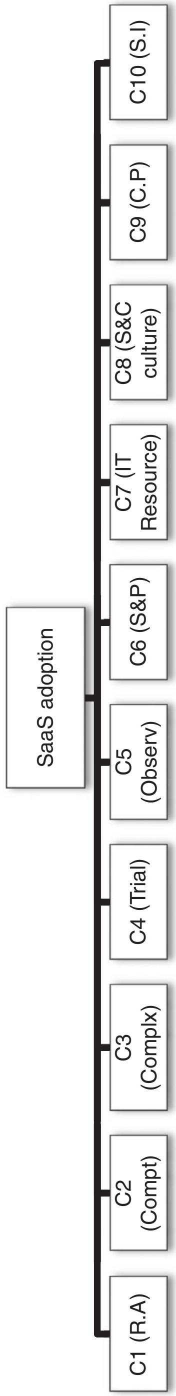

Figure 4.
Hierarchical structure

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
C1		VG, G, VG, …, VG								
C2			VG,VG,VG,…, G							
C3				MP, M, MP, …, MG						
C4					M,MG,P, …, P					
C5						P,VP,P, …, P				
C6							M,MG,VG, …, M			
C7								P,VP,M, …, P		
C8									M,MP,P, …, MP	
C9										M,MG,G, …, VG
C10										

Table III.
Pairwise comparison of ten criteria (number of respondents = 30)

Table IV.
Fuzzy linguistic preference relation matrix of criteria

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
C1	(0.5, 0.5, 0.5)	(0.86, 0.98, 1)	(1.2, 1.44, 1.5)	(0.91, 1.37, 1.6)	(0.7, 1.3, 1.8)	(0.2, 0.88, 1.48)	(0.19, 1.6, 1.8)	(−0.14, 0.92, 1.9)	(−0.4, 0.86, 2.04)	(−0.4, 1.04, 2.37)
C2	(0, 0.02, 0.13)	(0.5, 0.5, 0.5)	(0.81, 0.95, 1)	(0.55, 0.89, 1.33)	(0.34, 0.86, 1.28)	(−0.16, 0.41, 0.98)	(−0.18, 0.58, 1.35)	(−0.51, 0.45, 1.41)	(−0.77, 0.38, 1.55)	(−0.733, 0.56, 1.87)
C3	(−0.49, −0.43, −0.18)	(0, 0.04, 0.19)	(0.5, 0.5, 0.5)	(0.23, 0.43, 0.63)	(0.023, 0.4, 0.78)	(−0.48, −0.05, 0.48)	(−0.49, 0.13, 0.85)	(−0.83, −0.01, 0.91)	(−1.08, −0.07, 1.04)	(−1.08, 0.11, 1.37)
C4	(−0.63, −0.37, 0.08)	(−0.13, 0.11, 0.45)	(0.36, 0.56, 0.76)	(0.5, 0.5, 0.5)	(0.29, 0.47, 0.65)	(−0.21, 0.01, 0.35)	(−0.22, 0.19, 0.713)	(−0.56, 0.056, 0.77)	(−0.82, −0.003, 0.9)	(−0.82, 0.17, 1.24)
C5	(−0.78, −0.33, 0.29)	(−0.29, 0.14, 0.66)	(0.21, 0.6, 0.98)	(0.35, 0.53, 0.71)	(0.5, 0.5, 0.5)	(0, 0.05, 0.2)	(−0.01, 0.23, 0.56)	(−0.35, 0.09, 0.62)	(−0.61, 0.03, 0.76)	(−1.11, 0.21, 1.09)
C6	(−0.48, 0.11, 0.79)	(0.013, 0.59, 1.16)	(0.51, 1.05, 1.47)	(0.65, 0.98, 1.21)	(0.8, 0.95, 1)	(0.5, 0.5, 0.5)	(0.48, 0.68, 0.86)	(0.15, 0.54, 0.92)	(−0.11, 0.48, 1.06)	(−0.11, 0.65, 1.39)
C7	(−0.84, −0.06, 0.81)	(−0.34, 0.41, 1.18)	(0.153, 0.87, 1.49)	(0.28, 0.8, 1.22)	(0.44, 0.77, 1.01)	(0.14, 0.32, 0.52)	(0.5, 0.5, 0.5)	(0.16, 0.36, 0.56)	(−0.09, 0.3, 0.7)	(−0.1, 0.47, 1.03)
C8	(−0.9, 0.07, 1.14)	(−0.41, 0.55, 1.51)	(0.09, 1.01, 1.82)	(0.23, 0.94, 1.56)	(0.38, 0.91, 1.53)	(0.08, 0.46, 0.85)	(0.44, 0.64, 0.84)	(0.5, 0.5, 0.5)	(0.24, 0.44, 0.64)	(0.24, 0.62, 0.97)
C9	(−1.04, 0.13, 1.4)	(−0.55, 0.61, 1.77)	(−0.05, 1.07, 2.08)	(0.08, 1, 1.82)	(0.24, 0.97, 1.61)	(−0.06, 0.52, 1.11)	(0.3, 0.7, 1.09)	(0.36, 0.56, 0.76)	(0.5, 0.5, 0.5)	(0.5, 0.68, 0.83)
C10	(−1.37, −0.04, 1.4)	(−0.87, 0.44, 1.77)	(−0.38, 0.89, 2.08)	(−0.24, 0.82, 1.82)	(−0.09, 0.79, 2.11)	(−0.39, 0.34, 1.11)	(−0.03, 0.52, 1.09)	(0.03, 0.38, 0.76)	(0.5, 0.32, 0.17)	(0.5, 0.5, 0.5)

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
C1	(0.5, 0.5, 0.5)	(0.59, 0.62, 0.63)	(0.68, 0.75, 0.76)	(0.61, 0.73, 0.8)	(0.55, 0.72, 0.83)	(0.42, 0.6, 0.76)	(0.41, 0.65, 0.85)	(0.32, 0.61, 0.87)	(0.28, 0.59, 0.91)	(0.25, 0.64, 1)
C2	(0.36, 0.37, 0.4)	(0.5, 0.5, 0.5)	(0.58, 0.62, 0.63)	(0.51, 0.6, 0.66)	(0.45, 0.59, 0.71)	(0.32, 0.47, 0.62)	(0.31, 0.52, 0.72)	(0.22, 0.48, 0.74)	(0.16, 0.46, 0.77)	(0.16, 0.51, 0.86)
C3	(0.23, 0.25, 0.32)	(0.36, 0.37, 0.42)	(0.5, 0.5, 0.5)	(0.42, 0.48, 0.53)	(0.37, 0.47, 0.57)	(0.23, 0.35, 0.49)	(0.23, 0.4, 0.59)	(0.14, 0.36, 0.6)	(0.07, 0.34, 0.64)	(0.07, 0.39, 0.73)
C4	(0.2, 0.27, 0.38)	(0.33, 0.39, 0.49)	(0.46, 0.51, 0.57)	(0.5, 0.5, 0.5)	(0.44, 0.49, 0.54)	(0.31, 0.37, 0.46)	(0.3, 0.41, 0.55)	(0.21, 0.38, 0.57)	(0.14, 0.36, 0.61)	(0.14, 0.41, 0.69)
C5	(0.15, 0.27, 0.44)	(0.29, 0.4, 0.59)	(0.42, 0.52, 0.62)	(0.45, 0.5, 0.55)	(0.5, 0.5, 0.5)	(0.36, 0.37, 0.41)	(0.3, 0.42, 0.51)	(0.27, 0.39, 0.53)	(0.2, 0.37, 0.56)	(0.07, 0.42, 0.65)
C6	(0.23, 0.39, 0.57)	(0.37, 0.52, 0.68)	(0.5, 0.64, 0.76)	(0.53, 0.62, 0.69)	(0.58, 0.62, 0.63)	(0.5, 0.5, 0.5)	(0.49, 0.54, 0.59)	(0.4, 0.51, 0.61)	(0.33, 0.49, 0.64)	(0.33, 0.54, 0.73)
C7	(0.14, 0.34, 0.58)	(0.27, 0.47, 0.68)	(0.41, 0.59, 0.76)	(0.44, 0.58, 0.69)	(0.48, 0.57, 0.63)	(0.4, 0.45, 0.5)	(0.5, 0.5, 0.5)	(0.41, 0.46, 0.51)	(0.34, 0.44, 0.55)	(0.34, 0.49, 0.64)
C8	(0.12, 0.38, 0.67)	(0.25, 0.51, 0.77)	(0.39, 0.63, 0.85)	(0.42, 0.61, 0.78)	(0.46, 0.6, 0.72)	(0.38, 0.48, 0.59)	(0.48, 0.53, 0.59)	(0.5, 0.5, 0.5)	(0.43, 0.48, 0.53)	(0.43, 0.53, 0.62)
C9	(0.08, 0.4, 0.74)	(0.22, 0.53, 0.84)	(0.35, 0.65, 0.92)	(0.38, 0.63, 0.85)	(0.43, 0.62, 0.79)	(0.35, 0.5, 0.66)	(0.44, 0.55, 0.65)	(0.46, 0.51, 0.56)	(0.5, 0.5, 0.5)	(0.5, 0.54, 0.58)
C10	(0, 0.35, 0.74)	(0.13,0.48, 0.84)	(0.26,0.6, 0.92)	(0.3, 0.58, 0.85)	(0.34, 0.57, 0.93)	(0.26, 0.45, 0.66)	(0.35, 0.5, 0.65)	(0.37, 0.46, 0.56)	(0.41, 0.45, 0.5)	(0.5, 0.5, 0.5)

Table V. Transformed results of the criteria from Table IV

Table VI.
Decision table

	Fuzzy weights	Defuzzified (final) weights
C1	(0.07, 0.13, 0.22)	0.141
C2	(0.05, 0.1, 0.18)	0.114
C3	(0.04, 0.07, 0.15)	0.09
C4	(0.04, 0.08, 0.15)	0.093
C5	(0.05, 0.08, 0.15)	0.094
C6	(0.06, 0.1, 0.18)	0.118
C7	(0.05, 0.09, 0.16)	0.108
C8	(0.06, 0.11, 0.19)	0.117
C9	(0.05, 0.11, 0.21)	0.122
C10	(0.04, 0.09, 0.2)	0.115

5. Results

At the first step of this study, the hypothesized variables (*H1-H10*) were tested using binomial statistical test. All assumed variables (ten criteria) in three categories of TOE were submitted to be influential in the adoption of SaaS based on significant level and number of observations for each variable as presented in Table II. The significance levels of all attributes were lower than 0.05 and the number of observations for submission (Group 1) was greater than the number of observations for rejection (Group 2).

At the second step, ten submitted criteria were ranked. Based on the results shown in Figure 5 and Table VI, relative advantage (C1: 0.14), competitive pressure (C9: 0.122), security and privacy (C6: 0.118), sharing and collaboration culture (C8: 0.117) and social influence (C10: 0.115) are the five top most influential factors in the adoption of SaaS. Two out of these influential factors belong to either the technology category (C1, C6) or environment category (C9, C10), while only one factor is originated from organization characteristics (C8). Second five influential factors are compatibility (C2: 0.114), IT resource (C7: 0.108), observability

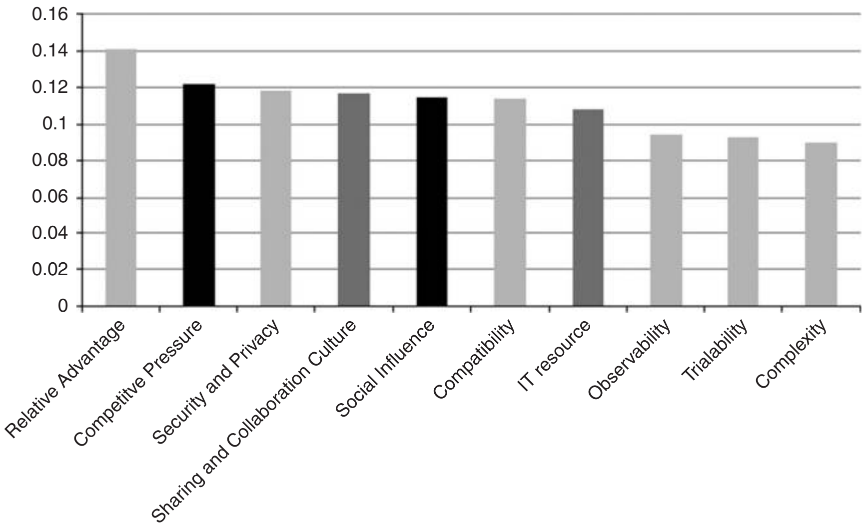

Figure 5.
The ranking of the criteria

(C5: 0.094), complexity (C3: 0.09) and trialability (C4: 0.093), respectively. Among these second five influential factors, four factors (C2, C3, C4 and C5) belong to technology characteristics while one factor (C7) relates to organization characteristics.

6. Discussion

This study considers SaaS adoption from technological, organizational and environmental point of view. The model validation is performed through a group of experts in cloud computing. As expected, we find that all attributes of innovation (relative advantage, compatibility, Complexity, trialability, observability and security and privacy), organization (IT resource and sharing and collaboration culture) and environment (competitive pressure and social influence) are drivers for SaaS adoption. These factors are used to formulate the Fuzzy AHP questionnaire in order to examine the priorities of factors by SaaS adopters. Results show that, SaaS adopters consider relative advantage, competitive pressure, security and privacy, sharing and collaboration culture, social influence, compatibility, IT resource, observability, trialability and complexity, respectively:

(1) *Relative advantage*: the results show that the relative advantage of SaaS technology is an influential factor in moving to SaaS. This is consistent with the study of Wu (2011) that focussed on perceived benefits of SaaS to help the organizations in the adoption of SaaS. Previous studies on IT adoption have also supported the effect of relative advantage (Alam, 2009). While, this observation is on the contrast with the previous study (Lian *et al.*, 2014) implied that the relative advantage of cloud computing technology is unimportant to hospitals. One reason for this inconsistency is that the focussed industry is different. Industries may have different concerns about the adoption of cloud computing technology. Based on ranking results, SaaS adopters mentioned that relative advantage is the first influential factor (the most important factor) in adoption decision. This finding shows that expected relative advantages motivate the organization in adopting SaaS at the first place.

(2) *Competitive pressure*: the result of this study shows that competitive pressure is an influential factor. SaaS adopters claimed that the competitive pressure is the second influential factor after relative advantage in their adoption decision which approves this point that competitive pressure is a trigger for innovation adoption in organizations (Thong and Yap, 1995). This is in line with the study of Low and Chen (2011) about the adoption of cloud computing concluded that firms respond more quickly to cloud computing in the competitive environment.

(3) *Security and privacy*: this study shows that security and privacy is a significant determinant. The result is in line with previous study of SaaS adoption (Wu, 2011). The security and privacy is the third influential factor mentioned by SaaS adopters. It can be concluded that the current adopters of SaaS are satisfied with the existing security and privacy of SaaS solutions. The finding of this study is in line with the previous study (Gupta *et al.*, 2013) in which the security and privacy is the second influential factor in the adoption of cloud computing by SMEs. They realized that SMEs are satisfied with the current security and privacy of cloud computing (Gupta *et al.*, 2013). In addition, this finding approves the claim of SaaS providers that their SaaS solutions are much more reliable than the conventional methods (Subashini and Kavitha, 2011). For instance, Salesforce.com guarantees the security and privacy by applying

a sophisticated technology (Secure Socket Layer (SSL) technology) for the internet security of its SaaS applications in which the data are protected using server authentication and data encryption simultaneously.

(4) *Sharing and collaboration culture*: the result indicates that sharing and collaboration culture is an influential factor. Adopters mentioned to sharing and collaboration culture in the fourth place after the relative advantage, competitive pressure and security and privacy which shows that adopters use SaaS for facilitating sharing and collaboration in the organization. This finding contradicts with the previous study (Gupta *et al.*, 2013) indicated that SMEs do not use cloud for sharing and collaboration in comparison with conventional methods such as face-to-face meetings, phone calls, etc. However, the observation of this study agrees with the study of (Creeger, 2009) in which customers preferred Google Apps such as Google Calendar and Docs as they can experience a new type of collaboration via Google SaaS.

(5) *Social influence*: the result shows that the social influence of SaaS adoption is an influential factor in the adoption. This finding is in line with previous studies on the adoption of SaaS (Wu, 2011; Benlian *et al.*, 2009) stated that social influence plays a major role in the adoption of SaaS since companies are impacted by others' recommendation. This is the fifth influential factor. being at the fifth place is a clue to this fact that adopters are not blindly following the recommendation of other agents and they consider the relative advantage, competitive pressure, security and privacy as well as the sharing and collaboration culture before considering the social agents.

(6) *Compatibility*: the results show that the compatibility of SaaS technology is an influential factor in its adoption. This finding is in line with the previous study (Johansson and Ruivo, 2013) in which 55 percent of experts confirmed the compatibility of SaaS as an influential factor. However, it is inconsistent with the results of the study of Low and Chen (2011) in which the determinants for the adoption of cloud computing in high-tech industry were explored (Low and Chen, 2011). One possible reason for this inconsistency is that the industries are different as the previous study focussed on high-tech industry while the current study focussed on IT industry. Another reason is that, this study focussed on SaaS service of cloud computing while in the previous study cloud computing services were generally considered. Based on ranking results, SaaS adopters mention that compatibility is the sixth significant factor.

(7) *IT resource*: the results confirm that IT resource in organization is an influential factor for the adoption of SaaS. This observation agrees with the previous study (Xin and Levina, 2008) in which the client-side acceptance of SaaS was explored. They realized that client' IT capabilities and number of users as organizational IT resources are influential in the adoption of SaaS. Based on ranking results IT resource is the seventh influential factor. This finding shows that IT enterprises are more concerned with environmental factors (competitive pressure, social influence) rather than in-house resources of IT in adopting SaaS.

(8) *Observability*: based on hypotheses testing it is found that the observability of the technology is an influential factor for the adoption of SaaS. This observation is in line with previous study that implied cloud computing success cases and

stories may raise the rate of adoption (Lin and Chen, 2012). Based on ranking results, SaaS adopters claim that observability is the eighth influential factor.

(9) *Trialability*: findings show that the trialability of SaaS technology is an influential factor. This is in line with the previous study mentioned that the adopters tempt to try the trial versions of application before actual adoption (Alshamaila *et al.*, 2013). This finding shows that SaaS adopters prefer to use the application individually (informally) without fee in order to decide about registration of enterprise version. For instance, SaaS Google Document is mostly applied informally by individuals (Lin and Chen, 2012). Based on ranking results, SaaS adopters mention that the ninth influential factor in their adoption decision is trialability.

(10) *Complexity*: findings indicate that SaaS complexity is an influential factor in the adoption. This is consistent with the previous study (Alshamaila *et al.*, 2013) implied that the adopters of cloud computing services expected them to be easy-to-use. Based on ranking results, SaaS adopters mention that complexity is the tenth influential factor. This finding shows that SaaS providers are successful to provide easy-to-use applications for users since the adopters mentioned to complexity at the last place in their adoption decision.

7. Conclusion

The organization cannot make a comprehensive decision about the adoption of new technologies without considering the technological, organizational and environmental factors (Tornatzky *et al.*, 1990). Therefore, the goal of this study was to investigate these factors that affect SaaS adoption. Adopting TOE theory, this study showed that all the ten attributes of innovation (relative advantage, compatibility, Complexity, trialability and observability), organization (IT resource, sharing and collaboration culture) and environment (competitive pressure, social influence) are influential in adoption of SaaS. As ranking the decisive factors in the adoption can help organizations to better decision-making, SaaS adopters were targeted to rank the criteria. The results of ranking showed that the three top influential factors for the adopters of SaaS are relative advantage, competitive pressure followed by security and privacy.

7.1 Implications and future directions

This study has provided useful results for SaaS vendors, researchers and customers. SaaS vendors should address mentioned factors to be more successful in delivering their services. For instance, they should clarify the relative advantages of SaaS as the most influential factor in SaaS adoption for organizations based on results of this study. Since the environmental factors are located in the first five influential factors, SaaS vendors should be aware about the influence of competitive pressure and social agents as stimulators of SaaS adoption. For researchers, this study has provided a good literature for future research and applied two well-known IT adoption theories in SaaS context that can be extended to other cloud computing services like PaaS and IaaS. Moreover they can compare their results with this study. It has used a version of fuzzy AHP in which the problems of previous methods of AHP were overcome. Organizations can make strong decisions about adoption of SaaS based on the priority of factors, they can consider ranking of these factors in their decision. For example, sharing and collaboration culture and IT resources as organizational factors should be considered in moving to SaaS.

Our study has some limitations that can direct future researches. First, we investigated the adoption of SaaS on the organization level analysis while the individual (user) level was not considered. In order to remedy this limitation, Future research should consider individual dimension by considering individual level analysis of SaaS adoption such as user trust. Second, this study only investigated SaaS adopter's opinions in ranking the criteria. Future research can categorize the priorities based on adopters and non-adopters. Finally, this study considered IT enterprises while different industries may have different concerns about the adoption of new technologies, future researches should consider different industries to enhance the completeness of this study.

References

Alam, S.S. (2009), "Adoption of internet in Malaysian SMEs", *Journal of Small Business and Enterprise Development*, Vol. 16 No. 2, pp. 240-255.

Alshamaila, Y., Papagiannidis, S. and LI, F. (2013), "Cloud computing adoption by SMEs in the north east of England: a multi-perspective framework", *Journal of Enterprise Information Management*, Vol. 26 No. 3, pp. 250-275.

Beecham, S., Hall, T., Britton, C., Cottee, M. and Rainer, A. (2005), "Using an expert panel to validate a requirements process improvement model", *Journal of Systems and Software*, Vol. 76 No. 2, pp. 275-351.

Benlian, A., Hess, T. and Buxmann, P. (2009), "Drivers of SaaS-adoption – an empirical study of different application types", *Business & Information Systems Engineering*, Vol. 1 No. 5, pp. 357-369.

Buckley, J.J. (1985), "Fuzzy hierarchical analysis", *Fuzzy Sets and Systems*, Vol. 17 No. 3, pp. 233-247.

Chang, D.-Y. (1996), "Applications of the extent analysis method on fuzzy AHP", *European Journal of Operational Research*, Vol. 95 No. 3, pp. 649-655.

Chao, R.-J. and Chen, Y.-H. (2009), "Evaluation of the criteria and effectiveness of distance e-learning with consistent fuzzy preference relations", *Expert Systems with Applications*, Vol. 36 No. 7, pp. 10657-10662.

Chong, S. (2004), "Electronic commerce adoption by small and medium enterprises in Australia: an empirical study of influencing factors", available at: http://is2.lse.ac.uk/asp/aspecis/20040033.pdf (accessed February 15, 2013).

Chunye, G., Jie, L., Qiang, Z., Haitao, C. and Zhenghu, G. (2010), "The characteristics of cloud computing. Parallel processing workshops (ICPPW)", *39th International Conference, September 13-16*, pp. 275-279.

Creeger, M. (2009), "CTO roundtable: cloud computing", *Commun. ACM*, Vol. 52 No. 5, pp. 50-56.

Dyba, T. (2000), "An instrument for measuring the key factors of success in software process improvement", *Empirical Software Engineering*, Vol. 5 No. 4, pp. 357-390.

Gupta, P., Seetharaman, A. and Raj, J.R. (2013), "The usage and adoption of cloud computing by small and medium businesses", *International Journal of Information Management*, Vol. 33 No. 5, pp. 861-874.

Henry, A. (2008), *Understanding Strategic Management*, Oxford University Press.

Herrera-Viedma, E., Herrera, F., Chiclana, F. and Luque, M. (2004), "Some issues on consistency of fuzzy preference relations", *European Journal of Operational Research*, Vol. 154 No. 1, pp. 98-109.

Jadeja, Y. and Modi, K. (2012), "Cloud computing – concepts, architecture and challenges", *International Conference on Computing, Electronics and Electrical Technologies (ICCEET)*.

Jeol, Y. (2008), *SaaS Model Economics 101: Competitive Advantage in Software-as-a-Service*, available at: http://chaotic-flow.com/; http://chaotic-flow.com/saas-model-economics-101-competitive-advantage-in-software-a-a-service/ (accessed April 1 2014).

Johansson, B. and Ruivo, P. (2013), "Exploring factors for adopting ERP as SaaS", *Procedia Technology*, Vol. 9 No. 1, pp. 94-99.

Lee, S., Kim, W., Kim, Y.M. and Oh, K.J. (2012), "Using AHP to determine intangible priority factors for technology transfer adoption", *Expert Systems with Applications*, Vol. 39 No. 7, pp. 6388-6395.

Lee, S.-G., Chae, S.H. and Cho, K.M. (2013), "Drivers and inhibitors of SaaS adoption in Korea", *International Journal of Information Management*, Vol. 33 No. 3, pp. 429-440.

Lian, J.-W., Yen, D.C. and Wang, Y.-T. (2014), "An exploratory study to understand the critical factors affecting the decision to adopt cloud computing in Taiwan hospital", *International Journal of Information Management*, Vol. 34 No. 1, pp. 28-36.

Lin, A. and Chen, N.-C. (2012), "Cloud computing as an innovation: percepetion, attitude, and adoption", *International Journal of Information Management*, Vol. 32 No. 6, pp. 533-540.

Linthicum, D.S. (2009), *Cloud Computing and SOA Convergence in Your Enterprise: A Step-by-Step Guide*, Pearson Education.

Low, C. and Chen, Y. (2011), "Understanding the determinants of cloud computing adoption", *Industrial Management and Data Systems*, Vol. 111 No. 7, pp. 1006-1023.

Marian, M. and Hamburg, I. (2012), "Guidelines for increasing the adoption of cloud computing within SMEs", *The Third International Conference on Cloud Computing, GRIDs, and Virtualization*, pp. 7-10.

Misra, S.C. and Mondal, A. (2011), "Identification of a company's suitability for the adoption of cloud computing and modelling its corresponding return on investment", *Mathematical and Computer Modelling*, Vol. 53 Nos 3/4, pp. 504-521.

Paksoy, T., Pehlivan, N.Y. and Kahraman, C. (2012), "Organizational strategy development in distribution channel management using fuzzy AHP and hierarchical fuzzy TOPSIS", *Expert Systems with Applications*, Vol. 39 No. 3, pp. 2822-2841.

Price, K. (2011), *Cloud Computing Issues and Impacts*, Ernst & Young organization.

Ramanathan, R. (2001), "A note on the use of the analytic hierarchy process for environmental impact assessment", *Journal of Environmental Management*, Vol. 63 No. 1, pp. 27-35.

Rezaei, J. and Ortt, R. (2013), "Multi-criteria supplier segmentation using a fuzzy preference relations based AHP", *European Journal of Operational Research*, Vol. 225 No. 1, pp. 75-84.

Rhoads, K. (1997), "Introduction to influence" , available at: www.workingpsychology.com/, www.workingpsychology.com/definit.html (accessed April 20, 2014).

Rogers, E.M. (1995), *Diffusion of Innovations*, The Free Press, New York, NY.

Saaty, T.L. (1979), "Applications of analytical hierarchies", *Mathematics and Computers in Simulation*, Vol. 21 No. 1, pp. 1-20.

Soliman, K.S. and Janz, B.D. (2004), "An exploratory study to identify the critical factors affecting the decision to establish internet-based interorganizational information systems", *Information & Management*, Vol. 41 No. 6, pp. 697-706.

Stine, K., Kissel, R.C., Barker, W., Fahlsing, J. and Gulick, J. (2008), *Guide for Mapping Types of Information and Information Systems to Security Categories*, US Department of Commerce.

Subashini, S. and Kavitha, V. (2011), "A survey on security issues in service delivery models of cloud computing", *Journal of Network and Computer Applications*, Vol. 34 No. 1, pp. 1-11.

Sultan, N.A. (2011), "Reaching for the 'cloud': how SMEs can manage", *International Journal of Information Management*, Vol. 31 No. 3, pp. 272-278.

Thong, J.Y.L. and Yap, C.S. (1995), "CEO characteristics, organizational characteristics and information technology adoption in small businesses", *Omega*, Vol. 23 No. 4, pp. 429-442.

Tornatzky, L.G., Fleischer, M. and Chakrabarti, A.K. (1990), *The Processes of Technological Innovation*, Lexington Books.

Van Laarhoven, P.J.M. and Pedrycz, W. (1983), "A fuzzy extension of Saaty's priority theory", *Fuzzy Sets and Systems*, Vol. 11 Nos 1/3, pp. 199-227.

Vives, X. (2005), *Innovation and Competitive Pressure*, Department of Economics, UC Berkeley, available at: http://escholarship.org/uc/item/1s1059v

Wang, T.-C. and Chen, Y.-H. (2008), "Applying fuzzy linguistic preference relations to the improvement of consistency of fuzzy AHP", *Information Sciences*, Vol. 178 No. 19, pp. 3755-3765.

Wang, Y.-M., Luo, Y. and Hua, Z. (2008), "On the extent analysis method for fuzzy AHP and its applications", *European Journal of Operational Research*, Vol. 186 No. 2, pp. 735-747.

Wu, W.-W. (2011), "Developing an explorative model for SaaS adoption", *Expert Systems with Applications*, Vol. 38 No. 12, pp. 15057-15064.

Xin, M. and Levina, N. (2008), "Software-as-a-service model: elaborating client-side adoption factors", *Proceedings of the 29th International Conference on Information Systems*, *Paris*, available at: http://ssrn.com/abstract=1319488 or http://dx.doi.org/10.2139/ssrn.1319488

Zadeh, L.A. (1965), "Fuzzy sets", *Information and Control*, Vol. 8 No. 3, pp. 338-353.