RISK-BENEFIT-MEDIATED IMPACT OF DETERMINANTS ON THE ADOPTION OF CLOUD FEDERATION

Netsanet Haile, College of Engineering, Technology Management, Economics and Policy, Seoul National University, Seoul, Korea, netsanet@snu.ac.kr
Jörn Altmann, College of Engineering, Technology Management, Economics and Policy, Seoul National University, Seoul, Korea, jorn.altmann@acm.org

Abstract

As an emerging trend for maximizing IT resource utilization, cloud federation raises various technical, economic, and legal issues. In order to understand the future of its adoption among cloud providers, it is important to identify which factors can be driving or inhibiting the process. This study aims at closing this research gap and find out the strength of their inhibiting or facilitating factors. After a thorough review of previous studies, factors suggested by relevant studies as determinants of cloud computing are compiled. Among those determinants, the most relevant factors are selected and, then, used to construct a model of hypothesized relationships of the determinants with the perception of risk and benefits of cloud federation, thus with the intention of joining a cloud federation. Data from a total of 300 cloud service providers, consultants, and IT experts were collected through a survey questionnaire. Questions were asked regarding large firms and small firms. The model is evaluated using structural equation modeling. The findings show that, among the six determinants analyzed by the study, flexibility and competitive pressure showed strong positive impacts. Thus, they are considered the major drivers of cloud federation. Furthermore, interoperability, service quality decline, and legal issues could be linked to be strong inhibitors of cloud federation. However, all these determines are strongly mediated by the perceived risk and perceived benefit of cloud federation. The estimated results for cloud providers showed that large cloud providers are attracted to cloud federation due to the potential of offering flexible services, while small cloud providers are driven by competitive pressure to join a cloud federation.

Keywords: Cloud Computing, Cloud Federation, Structural Equation Modelling, Strategic Alliance, Survey, Adoption, Cloud Provider.

1 INTRODUCTION

Cloud computing has emerged as a paradigm that allows sharing of computing resources and has become a wide-spread trend for increasing IT resource utilization (Breskovic et al. 2013) and the automation of service delivery (Breskovic et al. 2011; Altmann et al. 2011). The computing resources are offered as a service, ranging from infrastructure as a service, platform as a service, to software as a service (Bany Mohammed et al. 2009). Although cloud computing has proved by understanding the economic aspects behind cloud computing (Baek et al. 2014; Haile and Altmann 2013, Rohitratana and Altmann 2012; Altmann et al. 2010), the idea of federating clouds of different providers has emerged just recently.

Cloud federation is a strategic alliance between cloud providers, in which cloud providers have reached a cross-site agreement for cooperating regarding the deployment of service components and the use of capacity from each other to cope with demand variations of clients. Cloud federation allows the use of resources and services hosted by different providers (Altmann and Kashef 2014). A cloud federation business model requires a closer collaboration between cloud suppliers that provide cloud resources as part of the federation. For example, members of a cloud federation may sign a joint federation-level-agreement (FLA) instead of bilaterally signing a multitude of different contracts between the cloud suppliers in the federation (Kim et al. 2014; Kohne et al. 2014). The FLA generally creates a long-term and more reciprocal relationship between its members than it could be expected from a purely free market transaction perspective.

Cloud federation is an enhanced form of cloud computing, which interconnects and allows the use of public cloud resources of different providers (Goiri et al. 2010; Kurze et al. 2011; Celesti 2010). Cloud federation requires interoperability on the technical level as well as business agreements (contract) between providers (Celesti 2010). Interoperability enables a provider to execute the VMs of its customer on the infrastructure of other providers of the federation without the need for adapting the software. The business agreement sets a legal framework for utilizing the resources of the federated clouds. The benefit of cloud federation lies in the improved utilization of the federated clouds and, consequently, in the lower cost for the cloud resource consumer.

Although cloud federation is expected to be the next move of cloud computing, this model is not a popular form of cloud computing yet. It is not clear whether cloud federation will be adopted by many providers in the near future. Therefore, it is meaningful to figure out which factors are the driving and inhibiting factors to the adoption of cloud federation. In addition to this, the impact of these drivers and obstacles to the adoption of cloud federation need to be understood. Even though there are many papers to deal with the adoption of cloud computing from the perspective of end-users and enterprises, there is no work on the adoption of cloud federation yet.

This paper attempts to fill this gap. In detail, the research objective of this study is to find barriers and drivers to the adoption of cloud federation among various influencing factors of cloud computing, and to figure out the amount and direction of impacts of these factors. In particular, we address three research questions within this paper: (1) What are the determinants for the adoption of cloud federation? (2) What are the barriers and drivers for the adoption of cloud federation among the determinants? (3) How much do the driving and inhibiting factors affect the adoption of cloud federation?

For addressing the problem under study, we conducted a comprehensive literature review and a survey. Literature on issues of cloud computing provided the potential factors of acceptance of cloud federation by cloud providers and provided the basis for the risk-benefit-model suggested in this study. The survey has been addressed towards cloud providers, cloud service experts, and IT consultants, as being the experts in the field. It has been conducted to identify the important barriers and drivers of the adoption of cloud federation, as perceived by the experts in the current service market. The survey comprised 300 respondents and has been conducted in Korea.

The results show that, among the six determinants identified by the literature review, two determinants (i.e., flexibility and competitive pressure) showed a strong positive impact. They are considered the drivers of cloud federation. Three determinants (i.e., interoperability, service quality decline, and legal

issues) are identified to be strong inhibitors of cloud federation. However, all these determines are strongly mediated by the perceived risk and perceived benefit of cloud federation as seen by the expert. While large cloud providers are attracted to cloud federation due to the potential of offering flexible services, small cloud providers are driven by competitive pressure to join a cloud federation. Inhibiting determinants are the risk through interoperability for small cloud providers and the risk of a decline in service quality for large cloud providers.

Our contributions are threefold: First, we identified determines for the successful implementation of cloud federation between cloud providers. Second, from a methodological perspective, we integrated the theory of reasoned actions and the theory of cost benefit analysis to construct our structural model. Third, based on the analysis results obtained, we can imply that a significant impact of the determinants on cloud federation adoption for small and large cloud providers exists. Therefore, using these determinants, we can predict whether and under which conditions cloud providers will join a cloud federation.

The remainder of the paper is organized as follows. The next section presents not only the methodology applied and the theoretical frameworks used but also and the determinants that have been identified for the adoption of cloud federation and our model for predicting cloud federation adoption by small and large cloud providers. In section 3, the descriptive data analysis and the model analysis is given. Finally, we conclude our paper with a summary of the results and a brief discussion in section 4.

2 MODEL OF THE ADOPTION OF CLOUD FEDERATION

2.1 Methodology

Identification of the determinants has been based on a literature research. The literature search has been performed using the keywords: cloud computing, cloud federation, strategic alliances, and franchising. After the determinants suggested by relevant studies have been categorized, a cloud federation adoption model has been constructed using the theory of cost-benefit analysis (Drèze and Stern 1987) and the theory of reasoned action (Ajzen and Fishbein 1980).

An online survey questionnaire has been set up, to collect the data for applying them to the proposed model. 5-level Likert scale questions corresponding to each determinant are presented to respondents in the context of small (defined to have 200 and less employees) and large cloud providers (defined to have more than 200 employees). The data collection has been conducted through two rounds. First a pilot survey of 36 global cloud experts has been conducted. After several improvements on the questionnaire a second round of survey has been conducted through a web-based survey system of the Korean panel survey company, 'Do-It-Survey'. 'Do-It-Survey' is an organization specializing in web-based surveys. A sample of 'Do-It-Survey' panel was asked to participate for this survey. As compensation, the respondents are offered a small amount of electronic cash. The company targeted IT manager or IT director. From the whole sample collected (323 Korean IT experts), 23 responses were removed due to lack of experience in cloud computing. Consequently, it leaves a final sample of 300 responses for the empirical analysis. The survey was conducted from January 2015.

The adoption model, which is a structural model, shows the relationship among the determinants of cloud federation and their overall impact on the intention to adopt cloud federation by providers. The evaluation of the fit between the proposed model and the data collected is done using structural equation modelling (SEM) approach (Gefen et al. 2000). Structural equation modelling is an approach used for multivariate analysis to study complex relationships among variables, where some variables can be unobservable. SEM is an appropriate approach for this study, as it involves latent determinants, which are measured through relevant indicators. SEM is also useful to estimate direct and indirect effects among the determinants used to study the adoption of cloud federation.

2.2 Theoretical Framework

The theory of reasoned action (Ajzen and Fishbein 1980; Fishbein and Ajzen 1975) argues that beliefs impact intentions to take action. Managers' attitude towards the acceptance of a certain innovation is based on their perceptions of its benefits, which are shaped by a number of factors inside and outside their organizations. This means that behavioral intentions represent the perceived likelihood that a particular action will be taken. In the model proposed by our study, it is assumed that the behavior of joining a cloud federation is preceded by a high degree of intention.

Prior to this, decision makers evaluate the risks and benefits of the intended action. Such an evaluation involves comparing the cost and benefits of the alternatives present. Businesses and organizations apply the theory of cost-benefit analysis to evaluate the attractiveness of alternatives. The analysis of the expected level of benefits and costs helps predicting whether the benefits of an alternative outweigh its costs. As specified in the theory of cost-benefit analysis (Drèze and Stern 1987), individual decisions with regard to any form of alternatives involves finding out whether the benefits of a specific course of action exceeds the next best alternative. The determinants can include any social determinants or economic determinants (e.g., perception of cost).

The basic assumption of our model is that the intention to join a cloud federation is a cost versus benefit assessment that is guided by the perceptions of cloud providers. In line with this argument, this paper considers perceived risk and perceived benefits to be the mediating constructs of the proposed adoption model. In turn, these perceptions are created by a set of technological determinants, organizational determinants, and environmental determinants, which are related to cloud computing. These determinants are assumed to indirectly affect the providers' intentions of joining a cloud federation through the meditating constructs.

2.3 Determinants of the Adoption of Cloud Federation

Previous studies in cloud computing suggested several determinants of the adoption of cloud federation. Table 1 shows the 6 determinants of adoption of cloud federation, which we identified as the determinants that are important for cloud provider: interoperability, service quality decline, flexibility, legal issues, competitive pressure, and firm size.

These determinants can further be grouped into three determinants types: technological determinants, organizational determinants, and environmental determinants. By following this TOE framework (Eroglu 1992), determinants with common characteristics are grouped together. Environmental determinants (external) refer to conditions and developments in the macro-environment (e.g., competitors and government policies). Organizational determinants are factors describing the internal environment such as structural situations of the firm (e.g., firm size and scope). Technological determinants include capabilities of services offered by the firm and enabled by the underlying technology of cloud federation (Eroglu 1992). Many theoretical models of various studies applied this categorization of determinants (Alshamaila et al. 2013; Tehrani, 2013; Low et al. 2011; Chang et al. 2013).

The significant difference of these determinants compared to those of other business alliances, especially, franchising, is one of the technological determinants, namely flexibility. Flexibility allows the adjustment of the cloud service capacity such that the resource utilization reaches close to 100 percent. The adjustments of the cloud service capacity are performed as follows: If excess capacity is available, the capacity is made available to the cloud federation. If there is a shortage of capacity locally, additional capacity is purchased on the cloud federation.

Type	Determinant	Sub-Determinants	Description	Literature Source
Technological Determinants	Interoperability	Compatible Standards	Compatibility with cloud standards increases the risk of a provider to get replaced with another cloud provider by an end-user.	(Neves et al. 2011)
	Service Quality Decline	Security	Security comprises the risk of data loss, phishing, and cyber-attacks.	(Heinle and Strebel 2010; Lee et al. 2013; Kim et al. 2009; Carroll et al. 2011)
		Performance	Performance includes the risk of getting low quality in processing services and high delay in communication services.	(Trigueros-Preciado et al. 2013; Kim et al. 2009)
	Flexibility	Scalability	Scalability comprises the ability of scaling up or scaling down the cloud usage on demand.	(Carroll et al. 2011; Lee et al. 2013; Koehler et al. 2010; Neves et al. 2011)
		Accessibility	Accessibility describes the possibility of accessing the cloud from anywhere and anytime at good quality of service.	(Trigueros-Preciado et al. 2013; Neves et al. 2011)
		Flexibility of Cost	Flexibility of cost is a desirable feature of cloud computing that allows businesses to "pay as and when needed" and comes with an reduction of costs in hardware and software.	(Lee et al. 2013; Koehler et al. 2010; Neves et al. 2011)
Environmental Determinants	Legal Issues	Data Privacy	Data privacy includes legal requirements and binding compliance requirements about privacy, confidentiality, and location of data.	(Heinle and Strebel 2010; Lee et al. 2013; Kim et al. 2009; Carroll et al. 2011)
	Competitive Pressure	Competition in Local and International Markets	Competitive pressure describes the current market situation which makes companies to look for new strategies and markets.	(Tehrani 2013; Altinay 2006)
Organizational Determinants	Firm Size	Number of Employees	The firm size is expressed through the number of employees of the company.	(Heinle and Strebel 2010; Repschlaeger et al. 2013; Koehler et al. 2010)

Table 1. Determinants of joining a cloud federation.

2.4 Model of the Adoption of Cloud Federation

This model is based on the assumption that behavioral intentions represent the perceived likelihood that a particular action will be taken, following the theory of reason actions (Fishbein and Ajzen 1975; Ajzen and Fishbein 1980). As Eroglu (1992) applied it to franchising, we assume that the action of joining a federation of clouds is preceded by a high degree of intention to federate, which, in turn, is preceded by an evaluation stage. In the evaluation stage, the perceived risks versus perceived benefits of this action are assessed by a service provider (Drèze and Stern 1987). More specifically, at the point that the perceived benefits of joining a federation of clouds exceed its perceived risks, providers will have strong intentions to join the cloud federation. The entire model and its components are shown in Figure 1.

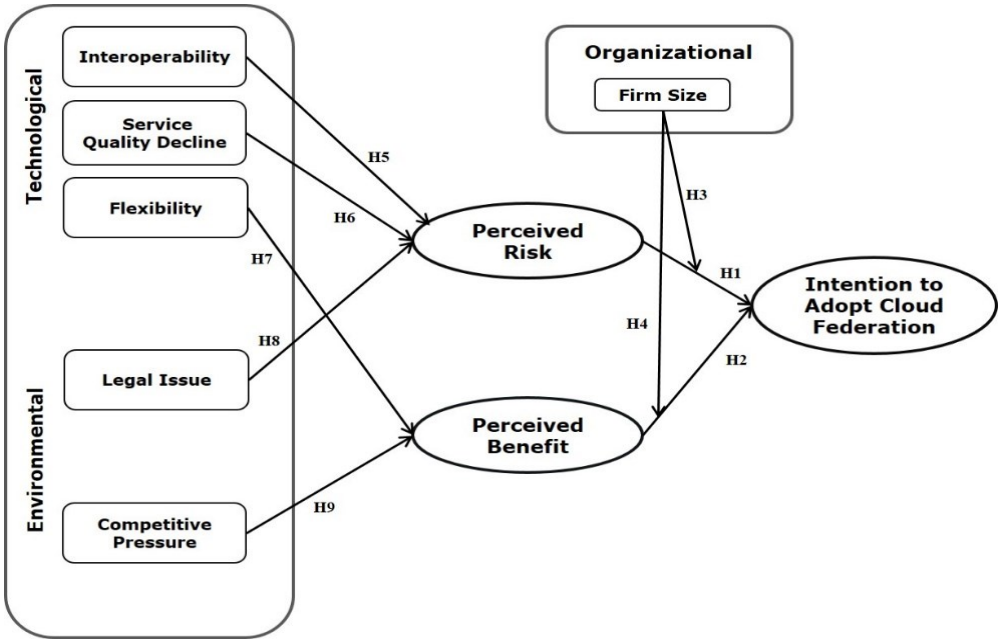

Figure 1. The proposed structural model.

In the model proposed, the dependant variable is the intention of cloud service providers to adopt cloud federation. The intention measured here is based on the assessment of perceived risk and perceived benefits of joining a cloud federation. Perceived risk represents the joined impact of determinants that can be considered barriers to the deployment of cloud federation. Perceived benefit represents the joined impact of determinants that can be considered drivers.

The constructs, perceived risk and perceived benefit, are important to the proposed model as they provide the basis for the analysis of the cost and benefits of cloud federation. All determinants of adoption of cloud federation indirectly affect decision makers' assessment of the perceived risk versus perceived benefit trade-off. Both, perceived risk and perceived benefit are based on the premise of a certain level of uncertainty (Ergolu 1992). In the context of cloud providers, financial and performance aspects and their perceived importance for the success of the provider within the federation are considered. Thus, depending on the extent, to which providers perceive the benefits of cloud federation to outweigh its expected risks, favourable intentions will be formulated with respect to joining a federation of clouds.

H1: Perceived risk negatively affects the intention to adopt cloud federation.

H2: Perceived benefit positively affects the intention to adopt cloud federation.

2.4.1 Organizational Determinants

Firm size: Research based on resource scarcity theory explains franchising as being a response to a shortage of the necessary resources (finance, labour, managerial talent) required for companies to expand (Norton, 1998), or to a shortage of knowledge of local markets (Ergolu 1992). As an organizational determinant, firm size impacts the perceived risk component. Since larger systems have more resources to allocate, and a higher capacity to absorb failure, they are expected to take an inverse risk perception such that the larger the system size, the less possible impact of cost and, therefore, the lower the overall perceived risk associated (Altinay 2006). The likely negative correlation between firm size and perceived risk is also supported by the results of a study by (Aydin and Kacker 1990). Consequently, it is proposed that larger systems are likely to assign lower perceived risk to the federation process. Similarly, the impact of perceived benefits can also vary for providers of different sizes. Smaller

providers are likely to perceive cloud federation vital for their sustainability and competitiveness than larger providers.

H3: Small (large) cloud providers are likely to associate higher (lower) risk with joining a cloud federation.

H4: Small (large) cloud providers are likely to associate higher (lower) benefits with joining a cloud federation.

2.4.2 Technological Determinants

Interoperability: Interoperability between various cloud providers' systems is expected to be negatively related to the perceived risk of joining a cloud federation. The more interoperability is achieved between providers, the more interconnection between resources of various cloud providers in spite of their physical distribution becomes possible (Neves et al. 2011). From the perspective of a provider, it means that the provider can be replaced by an end-user through a competitor at any time. It has to be noted, that this perspective is contrary from the perspective of an end-user of cloud computing. For end-users, interoperability such as compatibility of standards (Lee et al. 2013; Repschlaeger et al. 2013) and the availability of commonly used standards (Carroll et al. 2011) contribute to the perception of cloud federation as being beneficial.

H5: Interoperability positively affects the perceived risk of joining a cloud federation.

Quality of service: Cloud federation increases security related concerns (e.g., data loss, phishing, and cyber-attacks) (Trigueros-Preciado et al. 2013; Heinle and Strebel 2010; Lee et al. 2013; Repschlaeger et al. 2013; Kim et al. 2009) and uncertainty about performance (e.g., customer communication can be delayed due to an increasing number of users to be supported) (Trigueros-Preciado et al. 2013; Repschlaeger et al. 2013; Kim et al. 2009).

H6: Quality of service positively affects the perceived risk of joining a cloud federation.

Flexibility: Cloud federation enables providers to acquire additional capacity and resources on demand, improving the availability of services. The ability to scale services to match demand (Trigueros-Preciado et al. 2013; Lee et al. 2013; Repschlaeger et al. 2013, Carroll et al. 2011; Koehler et al. 2010) and to improve accessibility of services (Trigueros-Preciado et al. 2013) contributes to flexible use and can increase the perceived benefits of cloud federation.

H7: Flexibility of services positively affects perceived benefits of joining a cloud federation.

2.4.3 Environmental Determinants

Legal Issues: The legal situation in many countries (e.g., regulations of data privacy and data location restrictions) (Trigueros-Preciado et al. 2013; Heinle and Strebel 2010; Lee et al. 2013; Repschlaeger et al. 2013; Kim et al. 2009; Rafique et al. 2011; Carroll et al. 2011; Alshamaila et al. 2013) let the success of cloud federation being perceived as risky.

H8: Legal issues positively affect the perceived risk of joining a cloud federation.

Competitive pressure: The need to compete with other providers in the market increases the perception of benefits of cloud federation (Tehrani 2013; Low et al. 2011; Chang et al. 2013). Altinay argues that domestic saturation and competitive pressures will result in greater perceived benefits associated with internationalization of companies in the context of franchising (Altinay 2006). In the light of these arguments, it is expected that higher domestic saturation and competitive pressures will result in greater perceived benefits associated with joining a cloud federation.

H9: Competitive pressure positively affects the perceived benefits of joining a cloud federation.

3 ANALYSIS OF THE STRUCTURAL MODEL

3.1 Profile of Respondents

The profile of the respondents can briefly be described with two statistics about their expertise: (1) role of respondents in the cloud service market; (2) length of experience of respondents in the cloud service market.

Role of respondents in the cloud service market: The respondents were asked to indicate their role in relation to the cloud service market. Therefore, their profile shows that 145 of the respondents were managers, 28 were consultants, 92 of the participants were researchers, and 58 experts of cloud computing. Regarding their current workplace, respondents indicated to be working for a cloud provider (30), for IT companies collaborating with and employing cloud providers (282), and for a research institute dealing with cloud services (11).

Length of experience of respondents in the cloud service market: The respondents indicated their experience in relation to cloud services in terms of the length of their involvement in the market at different capacities. The length of their experience ranged from less than 1 year to more than 10 years. The proportion of the responses was: 4 years and more (42), 3 to 4 years (36), 2 to 3 years (72), 1 to 2 years (67), and less than 1 year (83). Therefore, more than 50% of the participants of the study had 2 years and more than 2 years of experience in cloud computing and in the cloud service market.

3.2 Model Analysis

This section presents the hypotheses testing process and the analysis results using AMOS solutions. The analysis results show the estimates of coefficients of the relationships between the determinants and constructs as hypothesized in H1 to H9. As the values of the coefficients indicate the strength of the relationships and the type of impact, they determine whether the hypotheses are to be accepted or rejected. The model yields an explanatory power of R^2=0.41 in case of the intention to adopt cloud federation by small cloud providers, and R^2=0.40 for the case of large providers. The model showed an overall good fit (Hu and Bentler 1999) for the two data sets used. The data set for small cloud providers yielded fit values of *p-value=0.001*, *CMIN/DF=1.9*, *GFI=0.98*, *CFI=0.99*, and *RMSEA=0.056*. The data set for large cloud providers yielded fit values of *p-value=0.001*, *CMIN/DF=2.3*, *GFI=0.98*, *CFI=0.93*, and *RMSEA=0.066*. All values indicate a good fit of the model.

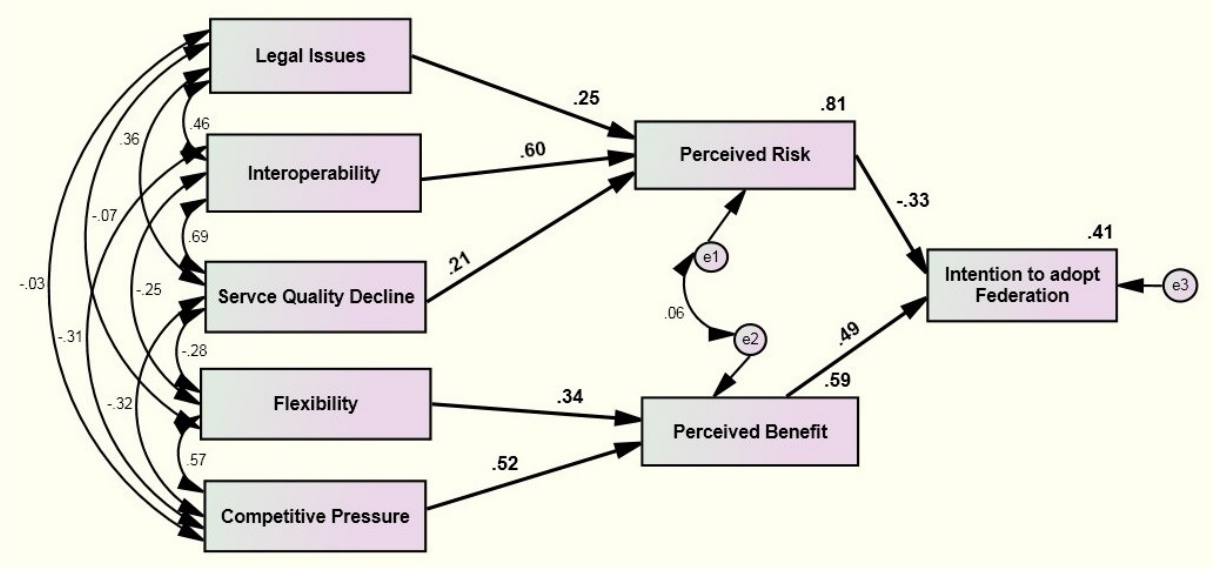

Figure 2. Estimation of the structural model for small cloud providers.

	Determinants and Constructs						
Construct	Competitive Pressure	Flexibility	Service Quality Decline	Interoperability	Legal Issues	Perceived Risk	Perceived Benefit
Perceived Risk			0.21	0.60	0.25		
Perceived Benefit	0.52	0.34					
Intention to Adopt Federation	0.25	0.17	-0.07	-0.20	-0.08	-0.33	0.49

Table 2. Estimation of direct and indirect effects of constructs for small cloud providers.

The SEM estimations (Figure 2, Figure 3, Table 2 and Table 3) using AMOS confirm the hypothesis that the intention of cloud providers to adopt cloud federation is affected negatively by perceived risk (H1). The result for this hypothesis holds true for both, small cloud providers (β=*-0.33, p>0.001*) and large cloud providers (β=*-0.25, p>0.001*). Similarly, the positive impact of perceived benefits on the intention to federate (H2) is found to be significant (β=*0.49, p>0.001*) in the case of small providers and (β=*0.55, p>0.001*) for large providers. This leads to the acceptance of the hypotheses H1 and H2.

Considering the results, it can be seen that the hypotheses H3 and H4, which assume a variation of the impacts of perceived risk and perceived benefits on the intention to adopt cloud federation due to size of firms, can be confirmed. While the results show that small cloud providers associate stronger risk to cloud federation than large cloud providers (support of H3), they also show that small cloud providers have a smaller (though large) benefit from cloud federation than large providers (H4 is not supported).

According to the analysis of hypothesis H5, interoperability is likely to significantly contribute to perceived risk of joining a cloud federation for both, smaller (β=*0.60, p>0.001*) and larger (β=*0.25, p>0.001*) cloud providers. Although the perceived risk of interoperability among cloud providers is strong for all sizes of providers, small providers are more likely to consider interoperability risky. Based on this result, hypothesis H5 is confirmed.

Hypothesis H6 theorized that cloud providers consider a decline in the quality of service as a source of risk for cloud federation. This impact is found to be significant for small providers (β=*0.21, p>0.005*) and for large providers (β=*0.36, p>0.001*). Therefore, cloud providers are likely to perceive the threats of cloud federation on quality of service. As a consequent, hypothesis 6 can be accepted.

The positive role of flexibility on the intention to adopt cloud federation is addressed by hypothesis H7. The assumption that cloud federation enables providers to scale their services and provide them with more capabilities to adapt to their target markets strongly contributes to the perceived benefits of cloud federation. The estimated coefficients show (β=*0.34, p>0.001*) for small firms and (β=*0.45, p>0.001*) for larger firms. Small providers can benefit from joining cloud federations by obtaining more resources in cases of more demand. On the other hand, larger cloud providers can also be able to address wider markets. Based on this result, hypothesis H7 is accepted.

The positive impact of legal issues on perceived risk of cloud federation is considered in hypothesis H8. The results show a significant positive impact (β=*0.25, p>0.001*) for small providers and (β=*0.29, p>0.001*) for large providers, confirming hypothesis H8. Though it is found to be important for both, small providers seem to associate more legal concerns to cloud federation than large providers. This can be caused by the limited resources of small providers. As inhibiting legal factors arise, small providers are more likely to refrain from engaging in federations.

In hypotheses H9, the study assumes a positive relationship between competitive pressure and the perception of benefits of joining a cloud federation. This means, cloud providers expect to improve their competitiveness in their target markets by joining a federation. The impact of competitive pressure on perceived benefits of cloud federation is significant for both, small providers (β=*0.52, p>0.001*) and large providers (β=*0.44, p>0.001*). Therefore, hypothesis 9 is accepted.

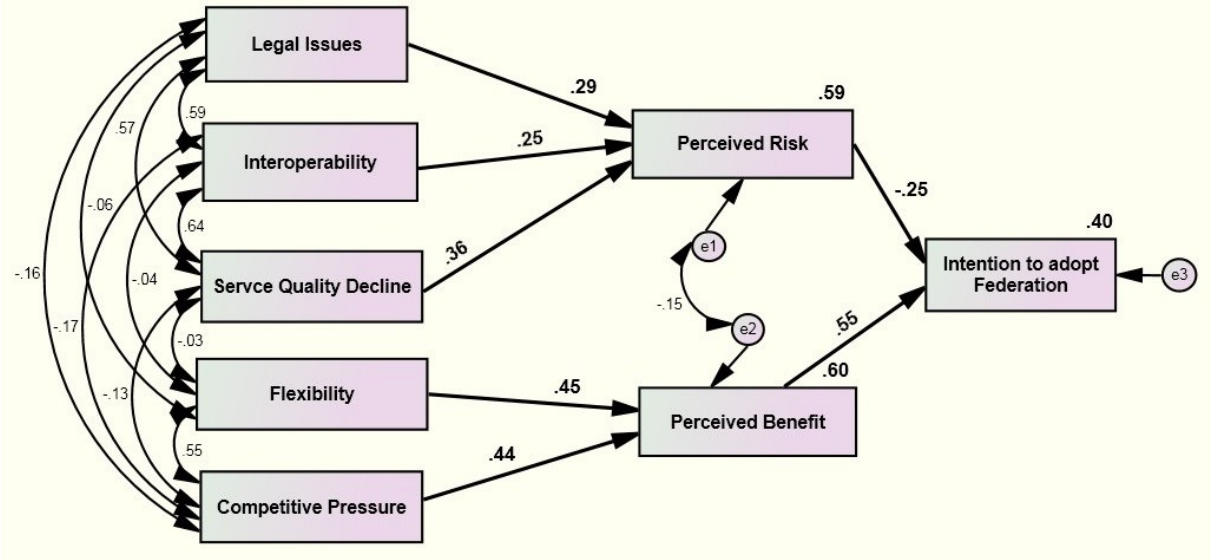

Figure 3. Estimation of the structural model for large cloud providers.

	Determinants and Constructs						
Construct	Competitive Pressure	Flexibility	Service Quality Decline	Interoperability	Legal Issues	Perceived Risk	Perceived Benefit
Perceived Risk			0.36	0.25	0.29		
Perceived Benefit	0.44	0.45					
Intention to Adopt Federation	0.24	0.25	-0.09	-0.06	-0.07	-0.25	0.55

Table 3. Estimation of direct and indirect effects of constructs for large cloud providers.

Considering these analysis results, small providers are more likely to be driven by competitive pressure to join a cloud federation, while the risk of interoperability is an important factor for them. An explanation is that small providers depend on differentiating their services, as it is important for their future growth. Larger providers are likely to be attracted to cloud federation due to the potential of offering flexible services. Furthermore, they are likely to be concerned about the decline of their service quality, which is justified due to the principle agent problem.

4 CONCLUSION

The objective of this study is to infer the conditions for establishing a cloud federation among cloud providers successfully. In order to achieve this objective, we identified the major determinants of the adoption of cloud federation by investigating the findings of previous studies. Using these determinants mediated by the perception of risk and the perception of benefit and applying a combined theoretical framework based on the theory of cost benefit analysis and the theory of reasoned action, we constructed a structural model of the intention of small and large cloud providers to adopt a cloud federation.

Using data obtained through a survey among cloud computing experts, our structural model showed the strength of the relationships between the determinants. The results also showed that the proposed model can explain 41% and 40% of the variance of intentions to adopt cloud federation for small providers and large cloud providers, respectively. Specifically, 81% of perceived risks and 59% of perceived benefits

of joining a cloud federation by small providers are explained by our model. For large firms, 59% and 60% of the perceived risks and the perceived benefits can be explained.

The perceived benefits of flexibility and competitive pressure showed strong impact on the perceived benefits of cloud federation, thus increasing the intention to adopt cloud federation. On the other hand, interoperability and the concern of declining quality of service showed the strongest impact on the perceived risk of cloud federation, consequently decreasing the intention to join a cloud federation.

References

Ajzen, I. and Fishbein, M. (1980). Understanding Attitudes and Predicting Social Behavior. Prentice-Hall, Englewood Cliffs, NJ.

Altinay, L. (2006). Selecting partners in an international franchise organization. International Journal of Hospitality Management, 25 (1), 108-128.

Altmann, J., Courcoubetis, C., and Risch, M. (2010). A marketplace and its market mechanism for trading commoditized computing resources. Annals of Telecommunications, 65 (11-12), 653-667.

Altmann, J., Hovestadt, M., and Kao, O. (2011) Business support service platform for providers in open cloud computing markets. INC, IEEE 7th International Conference on Networked Computing.

Altmann, J. and Kashef, M. M. (2014). Cost model based service placement in federated hybrid clouds. Future Generation Computer Systems, 41, 79-90.

Alshamaila, Y., S. Papagiannidis, and F. Li. (2013). Cloud computing adoption by SMEs in the north east of England: A multi-perspective framework. Journal of Enterprise Information Management, 26 (3), 250-275.

Aydin, N. and Kacker, M. (1990). International outlook of U.S.-based franchisers. International Marketing Review, 7 (2), 43-53.

Bany Mohammed, A., Altmann, J., Hwang, J. (2009). Cloud computing value chains: understanding business and value creation in the cloud. EMDS 2008, Workshop on Economic Models for Distributed Systems, in Economic Models and Algorithms for Distributed Systems, Birkhäuser.

Baek, S., Kim, K., Altmann, J. (2014). Role of platform providers in service networks: the case of Salesforce.com AppExchange. CBI 2014, 16th IEEE Conference on Business Informatics.

Bharadwaj, S.S. and Lal, P. (2012). Exploring the impact of Cloud Computing adoption on organizational flexibility: a client perspective. In Intl. Conf. on Cloud Comp. Tech. Appl. Managt.

Breskovic, I., Brandic, I., and Altmann, J. (2013). Maximizing liquidity in cloud markets through standardization of computational resources. Intl. Symp. on Service-Oriented Syst. Engineering.

Breskovic, I., Maurer, M., Emeakaroha, V. C., Brandic, I., and Altmann, J. (2011). Towards autonomic market management in cloud computing infrastructures. CLOSER2011, Intl. Conference of Cloud Computing and Service Science.

Carroll, M., Van der Merwe, A., and Kotze, P. (2011). Secure cloud computing: Benefits, risks and controls. In: Information Security South Africa (ISSA), IEEE.

Celesti, A., Tusa, F., Villari, M., and Puliafito, A. (2010). How to enhance cloud architectures to enable cross-federation. In Proceedings of Cloud Computing (CLOUD), 2010 IEEE 3rd International Conference, IEEE, 337-345.

Chang, B.Y., Hai, P. H., Seo, D. W., Lee, J. H., and Yoon, S. H. (2013). The determinant of adoption in cloud computing in Vietnam. In Proc. of Intl. Conf. Computing, Managt and Telecomm. IEEE.

Dillon, T., Wu, C., and Chang, E. (2010). Cloud computing: issues and challenges. In Proceedings of Advanced Information Networking and Applications (AINA), 24th International Conference. IEEE.

Doherty, A. M. (2009). Market and partner selection processes in international retail franchising. Journal of Business Research, 62 (5), 528-534.

Drèze, J. and Stern, N. (1987). The Theory of Cost-Benefit Analysis. 2 (4), 909-990. North-Holland.

Eroglu, S. (1992). The internationalization process of franchise systems: a conceptual model. International Marketing Review 9 (5), 19-30.

Fishbein, M. and Ajzen, I. (1975). Belief, Attitude, Intention and Behavior: An Introduction to Theory and Research.
Gefen, D., Straub, D. W., and Boudreau, M. C., (2000). Structural equation modeling and regression: guidelines for research practice. Communications of the Associat. for Information Systems, 4 (1), 7.
Goiri, I., Guitart, J., and Torres, J. (2010). Characterizing cloud federation for enhancing providers' profit. In Proceedings of Cloud Computing (CLOUD), 3rd Intl. Conference. IEEE, 123-130.
Haile, N. and Altmann, J. (2013). Estimating the value obtained from using a software service platform. In: Altmann, Vanmechelen, Rana (Eds.), GECON 2013, LNCS 8193, Springer. 244-255.
Heinle, C. and Strebel, J. (2010). IaaS adoption determinants in enterprises, in Economics of Grids, Clouds, Systems, and Services. Springer. 93-104.
Hu, L. T. and Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. Structural Equation Modelling: A Multidisciplinary Journal, 6 (1), 1-55.
Hwang, J. and J. Park. (2007). Decision factors of enterprises for adopting grid computing, In Grid Economics and Business Models. Springer. 16-28.
Kim, K., Kang, S., and Altmann, J. (2014). Cloud Goliath versus a federation of cloud Davids. In Economics of Grids, Clouds, Systems, and Services. Springer International Publishing. 55-66.
Kim, W. (2009). Cloud computing: today and tomorrow. Journal of Object Technology, 8 (1), 65-72.
Kim, W., Kim, S. D., Lee, E., and Lee, S. (2009). Adoption issues for cloud computing. In Proceedings of the 7th Intl. Conference on Advances in Mobile Computing and Multimedia. ACM.
Koehler, P., Anandasivam, A., and Dan, M. A. (2010). Cloud services from a consumer perspective. In Proceedings of AMCIS 2010. 329.
Kohne, A., Spohr, M., Nagel, L., and Spinczyk, O. (2014). FederatedCloudSim: a SLA-aware federated cloud simulation framework. In Proc. of 2nd Intl. Workshop on CrossCloud Systems. 3.
Kurze, T., Klems, M., Bermbach, D., Lenk, A., Tai, S., and Kunze, M. (2011). Cloud federation. In Proceedings of 2nd Intl. Conference on Cloud Computing Grids, and Virtualization 2011. 32-38.
Lee, S.G., Chae, S. H., and Cho, K. M. (2013). Drivers and inhibitors of SaaS adoption in Korea. International Journal of Information Management, 33 (3), 429-440.
Low, C., Chen, Y., and Wu, M. (2011). Understanding the determinants of cloud computing adoption. Industrial Management and Data Systems, 111 (7), 1006-1023.
Minkler, A. 1990. An empirical analysis of a firm's decision to franchise. Economic Letters, 34, 77-82.
Neves, F.T., Marta, F. C., Correia, A. M. R., and Castro Neto, M. (2011). The adoption of cloud computing by SMEs: identifying and coping with external factors. TechRepublic. 11th Conferencia da Associacao Portuguesa de Sistemas de Informacao (CAPSI).
Nkhoma, M. Z. and Dang, D. P.: Contributing Factors of Cloud Computing Adoption: a Technology-Organisation-Environment Framework Approach.
Norton, S. 1998. Franchising, brand name capital, and the entrepreneurial capacity problem. Strategic Management Journal 9, 105-114.
Rafique, K., Tareen, A. W., Saeed, M., Wu, J., and Qureshi, S. S. (2011). Cloud computing economics opportunities and challenges. In Proceedings of 4th Intl. Conference on Broadband Network and Multimedia Technology (IC-BNMT), IEEE.
Repschlaeger, J., Erek, K., and Zarnekow, R. (2013). Cloud computing adoption: an empirical study of customer preferences among start-up companies. Electronic Markets, 23 (2), 115-148.
Rohitratana, J. and Altmann, J. (2012). Impact of pricing schemes on a market for software-as-a-service and perpetual software. Future Generation Computer Systems, 28 (8), 1328-1339.
Tehrani, S. R. (2013). Factors Influencing the Adoption of Cloud Computing by Small and Medium-Sized Enterprises (SMEs). Thesis and Dissertations, Ryerson University.
Trigueros-Preciado, S. S., Pérez-González, D., and Solana-González, P. (2013). Cloud computing in industrial SMEs: identification of the barriers to its adoption and effects of its application. Electronic Markets, 23 (2), 1-10.