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Cloud Services from a Consumer Perspective

Philip Koehler
Karlsruhe Institute of Technology, Philip.Koehler@kit.edu

Arun Anandasivam
Karlsruhe Institute of Technology, Arun.Anandasivam@kit.edu

MA Dan
Singapore Management University, madan@smu.edu.sg

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Arun.Anandasivam@kit.edu

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Singapore Management University
Madan@smu.edu.sg

ABSTRACT

Although there is an increased attention on Cloud Computing in the academic literature in the recent years, most research work focus on technical aspects of cloud computing. Research on consumers' preferences for cloud services is limited to studies from consulting and industry companies. This paper fills the gap by empirically identifying consumer preferences for cloud service attributes. Using conjoint methods we reveal the relative importance of different attributes of cloud services. The results help both practitioners and academic researchers to better understand the prerequisites of a successful market introduction of cloud services and to design appropriate services. Moreover, the derived information enables a more accurate service differentiation and offers possibilities for second degree price discrimination.

Keywords

cloud computing; consumer preferences; conjoint analysis

INTRODUCTION

Recently cloud computing has attracted more and more attention from both researchers and practitioners. Buyya, Yeo, Venugopal, Broberg and Brandic (2009) name cloud computing a "…massive transformation of the entire computing industry in the 21st century…" and Weiss (2007) states that "cloud computing… is supposedly the next big thing".

Practitioners published a number of newspaper and technical reports within the last two years, outlining the benefits and obstacles of cloud computing. Although IT resources on demand and an increase of datacenter utilization promise flexibility and cost reduction, security and reliability concerns arose and are the major obstacles for the wide adoption of cloud computing. Some even say that cloud computing is nothing more than a marketing buzz word.

Weiss (2007), however, states that "it is a buzzword almost designed to be vague, but cloud computing is more than just a lot of fog". Since the beginning of 2009 there has been a big increase on scientific publications on cloud computing (cf. Armbrust, Fox, Griffith, Joseph, Katz, Konwinski, Lee, Patterson, Rabkin, Stoica and Zaharia, 2009; Buyya et al., 2009; Vaquero, Rodero-Merino, Caceres and Lindner, 2009; Weinhardt, Anandasivam, Blau, and Stoesser, 2009). Unfortunately researchers are still struggling with a clear definition of cloud computing. Vaquero et al. (2009) describes the current situation: "… the overall confusion about the paradigm and its capacities turning the cloud into an excessively general term that includes almost any solution that allows the outsourcing of all kinds of hosting and computing resources." Moreover, most of the research work so far focused on technical issues of cloud computing (cf. Youseff, Butrico and Da Silva, 2008; Vaquero et al., 2009; Briscoe and Marinos, 2009). Marketing issues of cloud computing have been barely studied in literature, especially consumer preferences and pricing strategies which are discussed within industry reports (cf. IDC, 2009; Hosting, 2009) only.

This paper intends to fill this gap by investigating cloud computing from consumers' perspective. Thereby the goal is to identify the consumer preferences for the attributes of cloud services.

A survey was conducted on small and medium enterprises (SMEs) in Singapore. The relative importance of various cloud service attributes was analyzed by using the choice based conjoint analysis. One of the surprising results was that the financial aspect, namely, cost savings from cloud computing, is not among consumers' top considerations when they select cloud providers.

RELATED LITERATURE

Cloud Computing

A clear definition of cloud computing is especially difficult due to the multiple character of it. Vaquero et al. (2009) sees it as a combination of elements of virtualization, utility computing and distributed computing. Briscoe and Marinos (2009) say that cloud computing "… can be seen as a commercial evolution of the academia-oriented grid computing, succeeding where utility computing struggled". Following this idea, cloud computing can be seen as the result of several developments within the information technology. Additional complexity is created as the cloud architecture is diverse. There are several different layers - each having different requirements. This has led to a various amount of definitions. Vaquero et al. (2009) offers a good overview of more than 20 definitions. There are definitions, which focus on the infrastructure layer and some, which try to reduce the characteristics to a common denominator over all layers and identify the total business model of cloud computing. The following definitions show this circumstance:

"A Cloud is a type of parallel and distributed system consisting of a collection of interconnected and virtualized computers that are dynamically provisioned and presented as one or more unified computing resources based on service-level agreements established through negotiation between the service provider and consumers."

This definition by Buyya et al. (2009) focuses on the infrastructure layer. He points out that cloud computing is not just a combination of Grid and Cluster computing as more a next generation of data center (see also Vaquero et al. (2009) for a detailed feature comparison). For him virtual machines and user friendliness established through service level agreements play a crucial role within the transformation to cloud computing. After reviewing several definitions by experts, Vaquero et al. (2009) comes up with the following definition, which is said to be a minimum common denominator:

"Clouds are a large pool of easily usable and accessible virtualized resources (such as hardware, development platforms and/or services). These resources can be dynamically reconfigured to adjust to a variable load (scale), allowing also for an optimum resource utilization. This pool of resources is typically exploited by a pay-per-use model in which guarantees are offered by the Infrastructure Provider by means of customized SLAs."

The definition from Vaquero et al. (2009) does not only focus on the infrastructure layer. The authors consider besides hardware the platform and software services. Therefore, they give an idea of the business model, which is involved with cloud computing. Since the authors believe that the cloud concept is still changing, they do not insist on an ultimate definition and claim their definition as a recent comprehension. Similar to Buyya et al., Vaquero et al. see virtual machines, a dynamic environment and service level agreements as crucial elements of cloud computing.

This paper follows the idea of cloud computing as a business model. Therefore, the definition from Vaquero et al. (2009) is the closest, though there is a different belief concerning the pricing methods. While Vaquero et al. (2009) believe in a fix link of cloud computing to a pay-per-use model, this paper considers a combination of clouds with different pricing methods. Observations in current cloud computing industry show that indeed flat-fee and fixed fee models are very common. As claimed by many researchers (cf. Youseff et al., 2008) the elements of cloud computing are not a technical innovation itself. Sharing computer resources in Grid computing, virtualization and on demand services by Software-as-a-Service (SaaS) has been there before cloud computing. Even, as Weiss (2007) points out, utility computing has been there before. He concludes that the real revolution of clouds is the combination of those different IT aspects into a new business model. Virtualization of datacenter infrastructure helped to increase their utilization by offering storage and computer performance to third parties. On demand software offers possibilities to combine different software solutions into one environment. But combining these software services or development platforms with virtualized infrastructure really offers opportunities for new services and an increase in efficiency by economies of scale.

However, previous research only focused on technical and business implications of cloud computing and left out a consumer perspective (cf. Youseff et al., 2008; Vaquero et al., 2009; Briscoe and Marinos, 2009). Therefore, this paper analyzes the consumer preferences via a conjoint analysis.

Consumer preferences and statistical methodology

Previous research often named technical issues of cloud services or assumed specific consumer preferences. Armbrust et al. (2009) named ten obstacles cloud services have to overcome. Thereby they name problems like availability of service and data lock-in effects. However, they lack of an explanation for the impact on consumer preferences by improving these technical problems. Other researchers like Vouk (2008) assume that consumers choose their cloud computing provider by their preference for reliable services, collaborative support and security issues among other things. However, he does not provide any empirical prove for these assumptions. So far only industry companies have conducted consumer surveys in order to identify preferences for cloud services.

Hosting (2009) conducted a study with a focus on small and medium enterprises. The study has therefore comparable requirements to the survey of this paper. The survey asked the respondents to name the three most important factors, which drive them to invest in cloud computing. 34% of the respondents ranked cost savings as the number one factor for investing. High availability (17%), performance (12%) and consumption based pricing (12%) are seen as important drivers as well. It is no surprise to the researcher of Hosting, because those factors have prompted companies to outsource their IT services for years. The ability of cloud computing to share network resources and scale across them offers substantial cost savings. Being asked which obstacles cloud computing has to overcome, 64% of the respondents named security concerns. But also support (58%) and lock-in effects (40%) are important consumer concerns which should be taken into account when modeling cloud services. The study also reveals that the reputation of the provider is an important factor for consumers' choice, as still 27% of respondents named it.

The IDC (2009) study comes up with similar issues. Most of their respondents (83%) rate competitive pricing as the most important attribute. The researchers of IDC explain the high ranking of service level agreements (81%) by respondents' fear of performance and availability outtakes. The requirement of understanding the business and industry of the consumer (68%) is not cloud specific, as it is important in any other IT related field. The requirement rated on number four with 67%, allowing cloud offerings to migrate back onto consumer premises if needed, is related to the fear of lock- in situations.

Understanding consumer preferences are most important for the success of cloud computing. Vouk (2008) mentions: "The most important cloud entity, and the principal quality driver and constraining influence is, of course, the user." Alam and Perry (2002) outline further that especially for services in contrast to tangible products consumer orientation is more important. They explain that consumers are more involved in delivery and purchase of services and this creates therefore a longer commitment and intimate relationship with consumers. However, previous industry studies only estimated the utility of cloud services by measuring individually the preference for each service attribute. This compositional approach lacks an evaluation of the service as a whole. Therefore the consumer tradeoff between different service offers can hardly be estimated. Furthermore the compositional approach only allows a limited comparison of attributes' importance. Therefore, decompositional approaches, such as the conjoint analysis, promise a better analysis of consumer preferences.

Green, Krieger and Wind (2001) stresses the fact that conjoint analysis have become the most used marketing research method for analyzing consumers' tradeoffs, by identifying consumers' part worth utilities for attribute levels. The popularity can be explained by the central contribution of conjoint analysis: provide an answer why consumer choose the products or services they choose. This is why the conjoint analysis has been assessed as the most suitable research method for identifying preferences for cloud services.

SURVEY PARTICIPANTS

Demographic Statistics

A web-based survey was used to collect empirical data. The survey focused on small and medium enterprises (SME) in Singapore. Following a definition of the European Commission[1] it includes all small companies with fewer than 50 employees and all medium enterprises with 51 up to 250 employees. The survey was conducted in a four-week period in November 2009. Potential respondents were contacted with an invitation letter which was sent via email. Per link they were forwarded to the online questionnaire. The processing time of the survey was kept short to about 15 minutes to fill out, in order to prevent consumers from dropping out, as pointed out by Seehan (2001). A total of 144 SMEs participated in the survey and 60 completed data sets.

The sample of 60 respondents fulfills the screening requirements, as 67% of the participating respondents are working in a small company with less than 50 employees in total, 27% are working in a medium sized company with 51 up to 250 employees, and 6% are working in bigger companies. Furthermore, a wide range of different industry sectors have been included, assuring that there is no industry bias within the study.

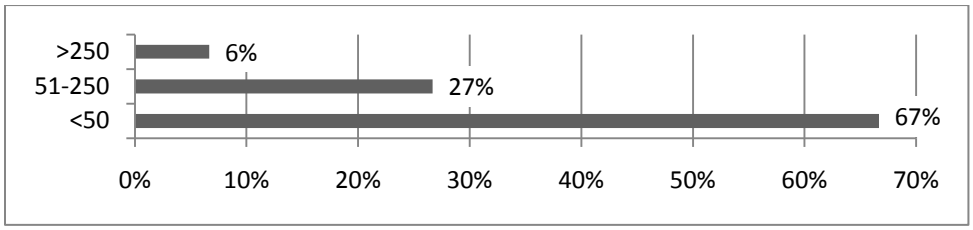

Figure 1: Companies' Employees

About 24% of the respondents are working on a chief executive level. Still the most respondents (57%) consider themselves as employees. The remaining proportion of 19% includes other position - mainly on a medium management level.

Usage and Expectations of Cloud Services

Besides demographic considerations, respondents were asked about their current usage behavior of cloud services. Moreover, respondents were asked about their consideration and expectation of Software as a Service (SaaS) in more details. The research shows that most of the respondents have already gained experience with external service providers, as 30% are hosting their own web services by another provider, which could be considered as Platform as a Service. In contrast, only 8% are using external infrastructure service provider to store or process their data.

Considering the use of SaaS, respondents were first asked whether they would consider SaaS solutions if they need new applications. Respondents could give out multiple choices. The answers are summarized in Figure 2.

[1] European Commission. "SME Definition". 6th May 2003. *European Commission Website*. 19th Nov 2009 http://ec.europa.eu/enterprise/enterprise_policy/sme_definition/index_en.htm

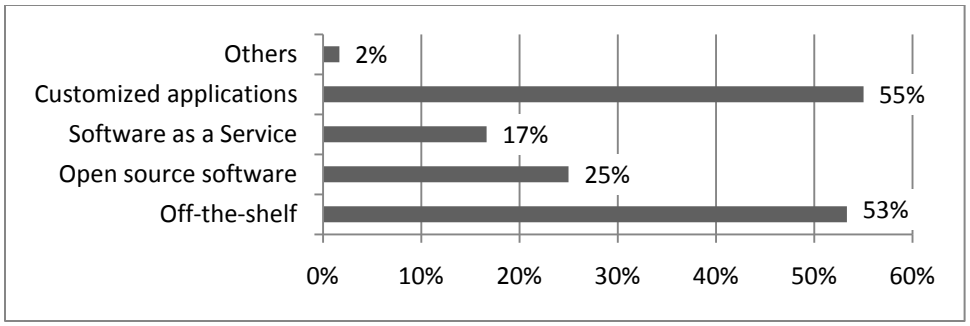

Figure 2: Consumer Application Considerations

As Figure 2 shows, 17% respondents will consider SaaS as a solution to their application needs. The fact that enterprises are more and more aware of cloud services and their benefits, as the IDC (2009) studies revealed, seems to have no influence on their practical choice making. When considering standardized applications, potential consumers still strongly prefer packaged "off the shelf" software (53%), such as Microsoft's Office. Moreover, the preference to customized applications (55%) can be explained by companies' specific needs, since these off-the-shelf software solutions are believed to have the advantage of being tailored and adjusted to each company's individual business environment.

However, 32% are intending to use or increase their use of SaaS in the future. Figure 3 shows that most of these 32% of consumers are planning to invest in SaaS within the next 12 months.

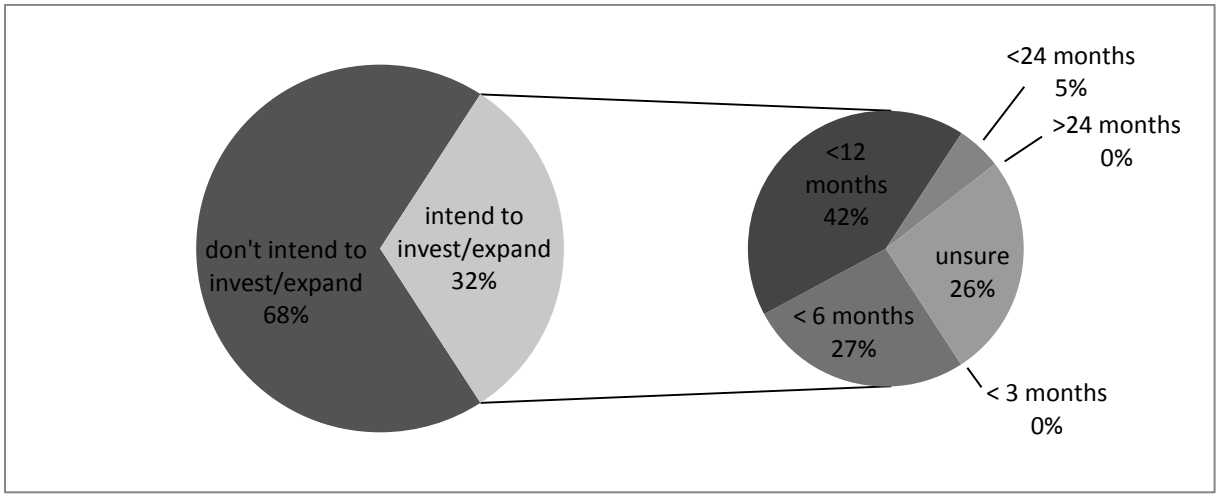

Figure 3: Intended Time until Use of SaaS

When being asked what kind of applications to use within the cloud, respondents gave out different answers compared to previous studies. Besides services, such as web hosting, CRM, HR and office, which have already been considered as predestinated for cloud computing, the respondents also ranked accounting and billing services high for future use. This contradicts previous results of the NTT study (2009) which predicted that critical data will never be transferred into the cloud.

Answers to the question why respondents consider SaaS solutions seem not conventional as well (see Figure 4). Most previous studies named financial aspects, such as the cost reduction and payment smooth, as top benefits of cloud services. However, this survey shows financial factors, i.e., less initial costs and less on-going costs, only ranked the 5th and 6th importance in consumers' consideration. Instead, respondents seem to appreciate more the flexibility of SaaS, especially the possibility of accessing applications from anywhere and anytime, as well as the ability of scaling the application usage on demand. These factors are considered as functional benefits of cloud services. They are surprisingly higher ranked than those financial benefits.

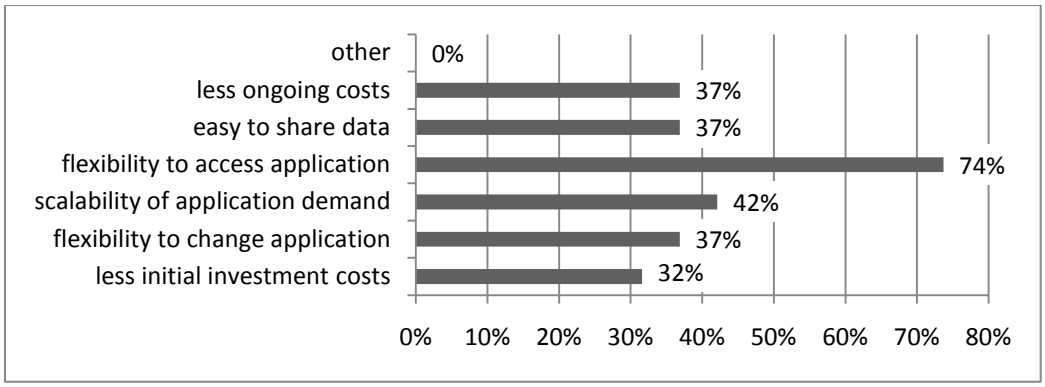

Figure 4: Reasons to Consider SaaS

CONSUMER PREFERENCES FOR CLOUD SERVICE ATTRIBUTES

In order to estimate the preferences of the total sample, a choice based conjoint analysis, which was first introduced by Louviere and Woodworth (1983), was included in the survey. The first step of the analysis was the selection of suitable attributes and attribute levels for describing cloud services best. Following Weiber and Mühlhaus (2009), a document review has been done and a list of 18 attributes with 49 attributes' levels in total was created. This list was then reduced by validating it through expert interviews[2], resulting in the following final selection of attributes:

Provider Reputation	The reputation of the service providers refers to the attitude, beliefs and trust consumers have about the provider. Reputation can be either low or high.
Required Skills	Services can be either easy or complex to use. Therefore, for some services training is required whereas for other no training is required for the consumer to use it.
Migration Process	Cloud services work with data. They either use standard data formats, which are used by other service providers as well, or they use provider specific data formats.
Pricing Tariff	Services can be priced by different tariffs. Within a pay-as-you-use tariff, consumers only pay for what they actually use. With a flat rate tariff, consumers pay a fixed amount e.g. a month and can use the service as often as they want. If the service provider offers a one-time-purchase, the consumer only pays an initial price at the first time of use and can use it unlimited afterwards.
Cost compared to intern solution	The costs of cloud services can be compared to a traditional solution within the company. In this survey, cloud services can have equal costs compared to an intern solution, but also may have 15% less or 25% less costs.
Consumer Support	Providers can offer consumer support in different ways, if their consumers need help. Standard electronic support includes Frequently Asked Questions and online documentation. Within individual electronic support, such as e-mail, live-chat or a forum, consumers get answers tailored to their specific needs. Phone and personal visits belong to the group of individual personal support, where consumers get personal and direct contact to a provider's employee.

Table 1: Conjoint Attributes

[2] Expert interviews include one on one interviews with marketing and IT experts from a major telecommunication company

This selection has some similarities to previous studies. Five of the above listed attributes are named as top benefits or obstacles for cloud computing by Hosting (2009). Security and reliability was not included in the list for the following reasons. First of all, although security and reliability in general remain important issues for consumers, a lack of security or reliability are considered as a knock-out criterion in this research scenario. In this case, these attributes should not be included in the conjoint analysis, as Weiber and Mühlhaus (2009) point out. Second, it is assumed that from a consumer's perspective it is impossible to differentiate cloud services based on security and reliability.

For the creation of efficient choice sets, an implementation of Kuhfeld (2009) by the statistic application SAS was used. Street (2005) approved the efficiency of these SAS algorithms compared to alternative approaches. In total, 13 choice sets have been included in the survey, and each consists of three stimuli alternatives and one non-choice option. In order to ensure the external validity, the 13th choice set has been used as a holdout set. The number of choice sets and alternatives was set in order to balance between the required information and the respondents' exhaustion, as proposed by Gensler (2006a).

To estimate the part worth utilities, an implementation of Kuhfeld (2009) was adopted. This implementation includes a part-worth model for all attributes, except cost reduction. For cost reduction a vector model was assumed. The choice decision behavior was predicted using a multinomial logit choice model (MNL). Afterwards, the part worth utilities were estimated with a maximum likelihood approach (ML) and finally were standardized to relative importance.

The null hypothesis that "there are no strictly preferred attributes and all part worth utilities equal zero" is rejected based on a significance level of α=0.01 and a likelihood ratio of 161.34. In other words, the research finds that potential consumers of cloud services do have a strong preference with regards to the different service attributes. Figure 5 shows the relative importance of all attributes' levels (out of the total sample).

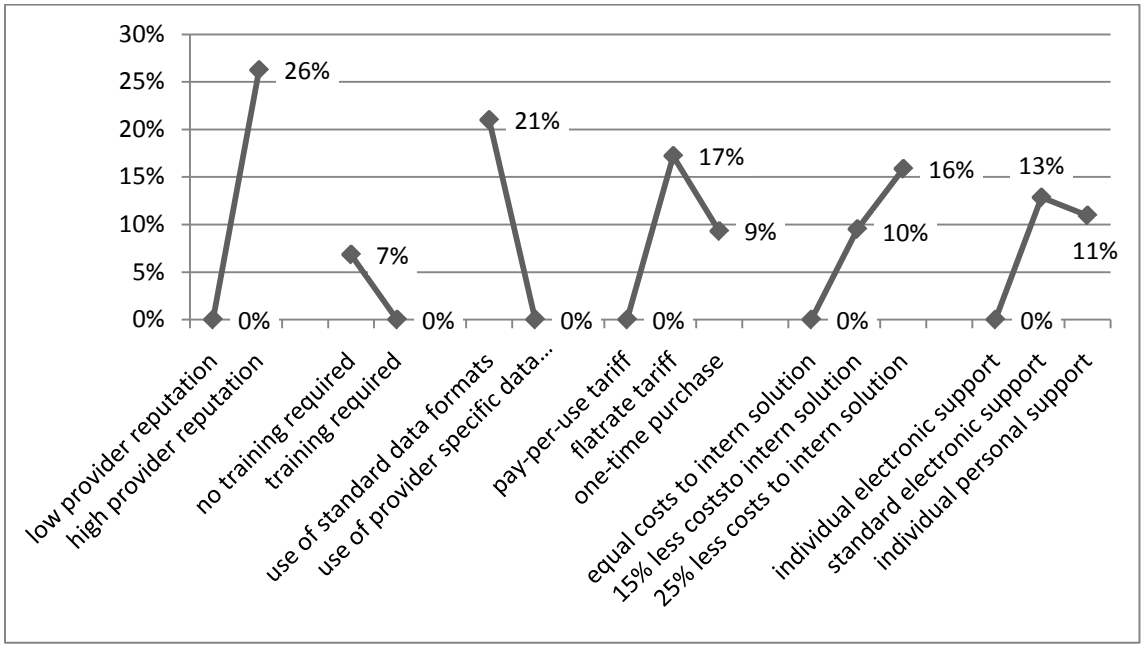

Figure 5: Sample Preferences

Unlike previous studies, which only considered the absolute importance of various attributes, the conjoint approach in this study allows a more in-depth comparison of the relative importance of cloud attributes. Even if two attributes, such as cost reduction and provider reputation, both are considered "very important", they still may have quite different relative importance to each other when a consumer has to opt for one of them.

Suppose an ideal computing service gives a consumer the maximum utility (100%). Such a cloud service should be offered by a provider with high reputation (26% relative importance, which is the highest one), uses standard data formats (21%), and requires no additional training. From an economic point of view, respondents prefer a flat rate pricing model (17%) and as much cost reduction as possible (16%). Corresponding IT supports are offered preferably by standard electronic sources (13%), such as frequently asked questions and documentation. The results provide an idea how consumers' utility reacts to differing some service attributes. For instance, if a provider decides to offer IT services under a one-time purchase model

instead of a flat rate pricing tariff, potential consumers will evaluate this change with a 8% utility reduction, because the flat rate tariff accounts 17% of the total utility while one-time purchase pricing only 9%.

Provider reputation was considered the attribute with the highest relative importance. Following the same logic above, it can be concluded that the cloud service offered by a new market entrant with no reputation, all else equal, will be evaluated with 26% less utility compared to the service from a well-established provider. Hence, the new entrant has to offer other additional incentives, such as higher cost reductions, in order to compete against the existing well-established cloud companies. The finding that provider reputation is the most appreciated attribute by consumers offers important insights. It suggests that established IT companies can benefit from their "historical" good reputation. It is expected to see not only Google, Microsoft or HP are taking over market leadership positions in the cloud industry, but also telecommunications companies, such as AT&T, SingTel or Deutsche Telekom, have high potential to enter the cloud computing field successfully. The fact that reputation is ranked high can possibly be explained by its side effects. Reputation is often correlated with trust. As mentioned earlier, security issues are hard to differentiate. Therefore, trust in the providers' security arrangements is of importance.

The use of standard data formats was ranked the second most important attribute with 21% relative importance. It indicates that consumers are afraid of being locked in by one specific service provider a lot. This result is consistent with the IDC (2009) study which highlighted the increased importance and consumer understanding of provider lock-in situations. Therefore, it is suggested that in general cases providers should offer their services with standard data formats, as otherwise consumers will react with high loss of utility. For those providers who are considering using their specific data formats should evaluate carefully whether the additional benefits from consumer lock-in outbalance the decrease of consumer utility and possible loss of market share.

In contrast to all previous industry studies, this conducted survey shows that when consumers decide on cloud services, financial aspects play a role with less importance level as people have expected. The different research approach of using relative rather than absolute importance of the attribute could be an explanation for the lower rank of financial aspects. Companies may take the cloud solution into consideration because of their financial benefits. However, when they are choosing a specific cloud provider, other service attributes play a more crucial role in the decision process. Surprisingly, the pricing method (with 16% relative importance) is as important as the cost reduction (17%). This suggests the importance of adopting a smart pricing strategy (for providers).

Considering the quality criteria proposed by Gensler (2006b), the estimated part worth utilities have plausible directions. The internal validity was already shown as significant as a likelihood ratio before. The correct prediction of consumer choice, the so-called hit rate, is 58%. This is more than twice as high as the chance with random selection. As the hit rate is calculated out of the hold out set, part worth utilities show a reasonable external validity. The no-choice option has been selected 17% of all choice decisions and shows no sign that consumers have avoided difficult choice decisions, as mentioned by Haaijer, Kamakura and Wedel (2001). However, a slight increase in non-choice selection can be observed during the answering process which is possibly explained by exhausting effects.

Similar to other information goods, cloud services could be "versioned". Service providers can vary their service attributes and quality in a relatively easy and inexpensive way, namely, changing attribute characteristics and offering several versions. According to the results of the conjoint analysis, each version will create a different utility based on the part worth utilities of each attribute the version consists of. As mentioned by Varian (2003), versioning is one possibility of second degree price discrimination. This approach seems to suit well the results, as individual consumer preferences cannot be observed directly and consumers should select for their own, which version suits best their willingness to pay. Therefore, pricing discrimination based on self selection should work quite well within the cloud industry.

CONCLUSION

Cloud computing is still in its infant stage. Though, it has been attracting more attentions from practitioners and researchers, previous academic literature focused on its technical details only (cf. Vaquero et al., 2009; or Youseff et al., 2008). The consideration of consumers has barely been included until now. Therefore, this paper intended to explore consumer preferences for service attributes and showed possibilities of second degree pricing discrimination in cloud computing field.

Respondents' preferences for cloud service attributes were estimated using choice based conjoint analysis. This approach allows looking at the relative importance, rather than the absolute importance, of various attributes, and hence provides a better understanding of customer choice. The results show that on average reputation of the cloud service provider and the use of standard data formats are more important than those financial aspects such as cost reduction or pricing tariff choice.

Further analyses have been conducted; however, they are not included here in order to keep the paper short. They include a Hierarchal Bayes approach based on Rossi, Allenby and McCulloch (2005) to estimate individual part worth utilities. A cluster analysis revealed three specific consumer segments with different preferences, which allow further possibilities for second degree price discrimination as mentioned by Varian, Farrell and Shapiro (2004). Furthermore, a regression analysis of tariff preference shows significant correlation with insurance and flexibility effects, which are best described by Lambrecht and Skiera (2006).

Practitioners can gain useful insights from this study. They could understand the cloud computing from a consumer's perspective and get ideas what consumers are looking for in cloud services. Moreover, they could learn how consumer preferences influence service designs and pricing strategies. Whether service providers use pricing only for increasing their revenue or controlling congestion, they should always take consumer preferences into account.

There are several fields for promising future research. First of all, this study showed consumer heterogeneity and possibilities of the second degree price discrimination. However, it does not provide any insight on how these different preferences result in different willingness to pay. Future research may therefore estimate individual willingness to pay. Breidert (2006) provides an overview of possible approaches. The results would also allow a further cost benefit analysis of introducing versioning into cloud computing

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