Users' Trust and Secure Feeling towards Cloud Services

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***Abstract*—The paper describes the study in which end users' trust and feeling of security in regard to cloud services are examined. Trust and security are one of the key issues within cloud where people use a shared pool of computing resources for the storage of their data and thus do not have control over the management of their own data content. An online survey was conducted in three countries (Finland, USA and Japan) with more than 3000 respondents. The twelve cloud trust creators that were identified by cloud software experts in our earlier study were picked, and asked the end users to rank how important those factors are for them when deciding if it is secure to use a service in the cloud. The results show that ease of use has the biggest effect on the secure feeling towards cloud services, followed by the language and the price of the service. Some differences were visible between the countries. These as well as the differences for the results between genders, age groups and expertise levels of the respondents are presented in this paper.**

Keywords-cloud services; end users; security; trust

I. INTRODUCTION

Within the cloud, software, infrastructure and platforms are offered as a service. [1] In cloud services, content (for example, music, email, files), personal information and programs are stored on Internet servers instead of the user's own computer. [2] The cloud services and the content in them are accessible from various devices anytime and anywhere through the Internet.

The cloud environment relies heavily to the notion of trust. People often find it harder to trust on-line services than off-line services. [3] Cloud computing introduces a whole ecosystem of clients, services and infrastructure, where trust boundaries are moved into realms where physical locations and even ownerships are unknown. [4] Establishing, expressing and maintaining trust by technological methods has always been challenging. The traditional question on where are the limits to presenting, simplifying and visualising security without losing trust or creditability, receive a new life within the cloud environment. [5]

Since there are no deterministic means of revealing the factors affecting the human perception of security or trust on cloud environment, security experts and user experience experts who have some familiarity with clouds were first interviewed. Their views on the role of trust in cloud services were then analysed. After that, the results of these 33 interviews [5] were verified by conducting an online survey with end users. Our objective for this study was to investigate what aspects and to what extent contribute and affect to the secure feeling in the cloud.

The rest of this paper is organised as follows. In Section 2, the background literature in relation to cloud services as well as trust is discussed. Section 3 describes the research methodology used in this study. Section 4 presents study results which are then further discussed in Section 5. Section 6 summarizes the study results.

II. BACKGROUND

In this section, a brief background to two main subjects of the study – cloud services and trust – is presented.

A. Cloud Services

Cloud services and cloud computing are today's reality; typical web users use cloud services daily whether they know it or not. [2] The cloud concept is still changing but several early definitions for cloud computing and cloud services exist.

Weiss [6] states that cloud computing is a paradigm where software functionality, hardware computing power, and other computing resources are delivered in the form of service so that they become available widely to consumers. In [7], the following definition is constructed: 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 re-configured to adjust to a variable load (scale), allowing also for an optimum resource utilization. Breiter and Behrendt [8] take the user point of view to cloud services: "The emerging style of cloud computing provides applications, data, and information technology resources as services of a network. The cloud services approach focuses on a positive user experience while shielding the user from the complexity of the underlying technology." In [9], it is continued that services such as free email services, Internet portal services, web hosting services, computing infrastructure services, etc. are all cloud services. NIST [10] defines cloud services from the consumers' perspective as follows: "The capability provided to the consumer to use the provider's applications running on a cloud infrastructure. The applications are accessible from various client devices through a thin client interface such as a web browser (e.g., web-based email). The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems,

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storage, or even individual application capabilities, with the possible exception of limited user-specific application configuration settings."

The main message for the cloud users based on various cloud definitions seems to be that, in the cloud, the end users do not need to worry about the underlying technology and infrastructure details but just rely on the cloud services as a huge storage area of their data, resources and software. This relying is calling for trust.

B. Trust and Secure Feeling

Although a concise and universally accepted definition of trust has remained elusive [11][12], most definitions include an aspect of perceived risk of vulnerability, and also an element of psychological security.

Trust can be said to be a belief, attitude, or expectation concerning the likelihood that the actions or outcomes of another individual, group or organization will be acceptable or will serve the actors interests. [13]

In [14], it is said that trust is letting other persons (natural or artificial, such as firms, nations, etc.) take care of something the trustor cares about, where such 'caring for' involves some exercise of discretionary powers.

Fogg and Tseng [15] define trust as an indicator of a positive belief about the perceived reliability of, dependability of, and user confidence in himself being able to control the technology.

Trust assessment on the cloud environment is complicated by the fact that in the digital world one is faced with the absence of physical cues and the establishment of suitable centralized authorities such as certification authorities is still evolving and not always applicable. [16]

In [17], it is summarised that trust becomes increasingly important as mobile services get more and more involved in the personal life of people and as these services increasingly collect, analyse and store personal data. This is just as well true with not only mobile but all cloud based services.

Building trust in the cloud is not a straightforward task and there are a lot of issues to be solved before a user can truly feel safe towards services in the cloud.

III. RESEARCH METHOD

As the target of the study was to examine the feelings of cloud service end users, and as the cloud is a worldwide concept, a broad and representative sample of end users in several countries was needed. Hence, a quantitative research approach was chosen. A web-based survey was used to conduct the quantitative study. According to [18] quantitative data enable standardized and objective comparisons and the measurement of quantitative research permits overall descriptions of situations or phenomenon in a systematic and comparable way. There are several advantages of web-based surveys. As stated in [19], in a web-based survey the speed of recruitment is very fast and travel cost and time are eliminated. [19] This was important as an international study with respondents in several different countries was meant to be conducted.

A web-based survey was seen as an appropriate way to go deeper from the interview results gotten earlier. [5] It must be noted that the survey consisted of several other dimensions beside the trust and security issues; e.g., our results of today's usage of cloud services based on the survey are already published in [2].

A. Data Sources and Collection

The survey design process adopted from [19] and [20] was followed. When designing the sampling for the survey the sampling design process adopted from [20] was used.

The survey was decided to be conducted in three different countries: Finland, Japan and USA. Decision of choosing these three countries was due to the fact that each of them had acted as a pacesetter in many ICT fields, e.g., in mobile technology and services usage. As these countries have been in the forefront of technology use and acceptance in the consumer sector, they present fruitful contexts for analyzing consumers' use of and perceptions towards new technologies such as cloud services. Furthermore, all of these three countries are so dissimilar with each other concerning the location and the cultural background that it was thought to be interesting to find out possible differences when comparing the results of these countries.

The original survey was made in English; the Finnish and Japanese versions were translated by experts. The questionnaires for each of the three countries were identical except for the background question about the annual income of the respondents where the currency was localised for each country. Each of the three language versions was then created to be an individual online survey by one market research company in each of the countries who also took care of finding the respondents matching the pre-defined criteria from their customer registers and closing the polls after the desired sample size was acquired.

The sample size was decided to be approximately one thousand respondents from each country. This size is typical for surveys that are nationwide, regardless of the size of the country. Thus, the overall sample size was ca 3000 responses. The survey was generated and data gathered with Digium Enterprise data collection service. A total of 3187 responses, all of them acceptable, was received between the time period of 10 June and 21 June 2010. There were 1005 respondents from Finland, 1089 from USA and 1093 from Japan.

The criterion for selecting the survey respondents was to get a representative sample from each country based on the demographics of the countries. The gender, age and self evaluated cloud service expertise distribution of respondents from different countries can be seen in Table 1. Furthermore, the demographic information of the gender and age of the population for each country is shown in brackets (for more information see [21][22][23]).

B. Data Analysis Method

The quantitative analysis of the survey was made using SPSS Statistics 17.0 computer software. At the first stage of the analysis frequency distributions and other descriptive statistics were obtained. Also several cross tabulations, t-tests and analysis of variances (ANOVA) were made to compare the samples.

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TABLE I. GENDER, AGE AND EXPERTISE DISTRIBUTION OF THE RESPONDENTS

	Finland	USA	Japan
n	1005	1089	1093
Gender	%	%	%
Male	50,3 (48,6)	47,7 (49,1)	50,4 (49,8)
Female	49,7 (51,4)	52,3 (50,9)	49,6 (50,2)
Age	%	%	%
15-24	11,2 (14,8)	13,3 (17,7)	13,7 (15,7)
25-34	19,6 (15,3)	16,5 (18,0)	17,7 (16,7)
35-44	15,8 (15,0)	19,9 (20,4)	21,1 (18,1)
45-54	20,6 (16,9)	19,2 (17,0)	16,7 (15,6)
55-64	20,4 (17,6)	15,5 (11,0)	21,0 (18,9)
Over 65	12,3 (20,4)	15,5 (15,8)	9,8 (15,0)
Expertise	%	%	%
Novice user	60,7	70,6	83,0
Intermediate user	32,3	25,3	15,9
Advanced user	7,0	4,1	1,1

IV. SECURE FEELING IN THE CLOUD

Our research question regarding trust and secure feeling in the cloud was about the factors that could contribute and affect to the user's secure feeling in the cloud. The question was phrased in the following way:

How important are the following factors when deciding if it is secure to use a specific cloud service (for example, webmail or music library)?

A 7 step Likert scale, where 1=Not important at all, and 7=Extremely important, was used. Also a Not applicable option was given. The cloud trust affect factors found in our earlier interview [5] were used as a basis for the options which the respondents was asked to value. These 12 affect factors were:

- Own experiences
- Friends' recommendation
- Brand reputation, image and name
- Background and home country of the company
- A critical mass of users
- Search engine results
- User license agreements
- Price
- Ease of use
- Visual image of the service web page
- Transparency
- Language

A. Overall Results

According to the survey, the factors having an effect on the overall users' experience about the secure usage of cloud services are ranked in the order of importance in Table 2.

When looking at the average results of the whole respondent group the most significant factor in trust creation is stated to be the ease of use. It received the mean value of 5,91, Two out of every five (40,1 %) of the respondents had valued this factor as Extremely important (value 7 in the Likert scale).

The ease of use was closely followed by the language issues. The respondents feel that when deciding if it is secure to use a specific cloud service the fact that the service uses their own language is important by an average of 5,86. As many as 43,1% of the respondents had given the highest importance value for this factor.

Maybe the most surprising factor is the price, which was ranked as the third in the most important factor list ranked by the average values, with the mean of 5,72, and 37,1% of the respondents given the highest possible importance value to this factor.

When taking a look at the last factors on that list it is noted, also quite surprisingly, that the recommendation from one's friends receives the lowest markings out of these suggested factors.

B. Results divided by countries

These twelve affect factors divided by countries are presented in Figure 1. The ease of use as well as understandable user license agreements are appreciated the most in Finland. The language issues are considered extremely important, especially in USA. For the American respondents it is also significantly more important that the company is located in their home country than for the Finnish or Japanese respondents. Finnish respondents value their own and their friends' experiences more than other two countries; actually, in Japan, the recommendation from one's friends receives the lowest markings out of all the questions and all the countries. The Japanese respondents, on the other hand, have more faith in the search engine results than the other two countries, and do not care as much about the appearance of the web page as the others.

TABLE II. THE FACTORS OF SECURE FEELING WITHIN CLOUD SERVICES

How important are the following factors when deciding if it is secure to use a specific cloud service:	***Mean***	***Median***	***Std. Deviation***
The service is easy to use.	5,91	6,00	1,365
The service uses my own language.	5,86	6,00	1,521
The price is low.	5,72	6,00	1,528
The user license agreements are understandable.	5,54	6,00	1,522
The appearance of the service web page is nice and professional.	5,32	6,00	1,475
The company offering the service has a good brand reputation, image and name.	4,84	5,00	1,621
I have previous good experiences about the service.	4,70	5,00	1,650
The company offering the service is located in my home country.	4,60	5,00	1,829
Many of the people I know use the service.	4,49	5,00	1,708
I am able to look through the source code of the service.	4,37	4,00	1,915
The service is one of the first hits within the search engine results.	4,19	4,00	1,755
My friends recommend the service.	4,08	4,00	1,804

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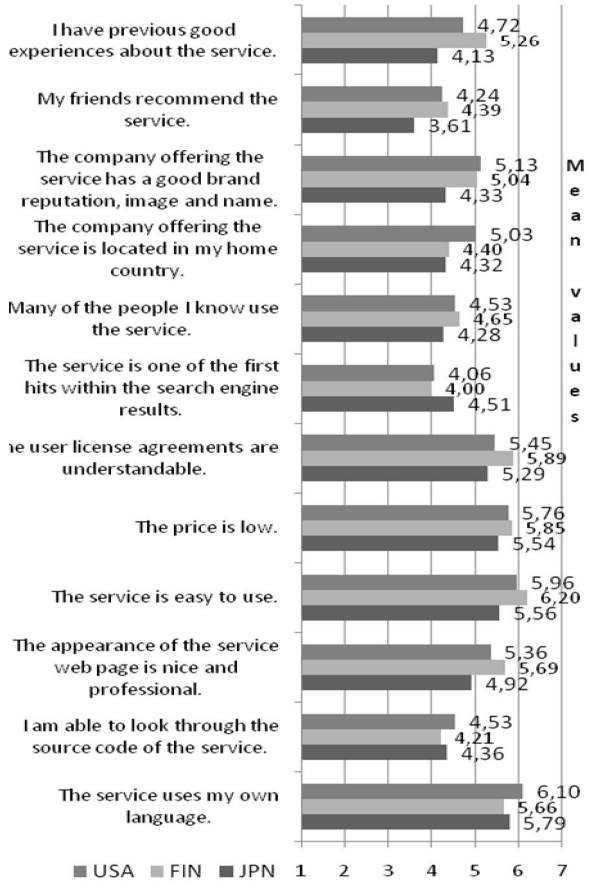


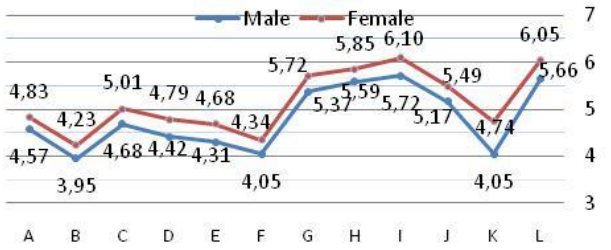
Figure 1. The factors of secure feeling within cloud services divided by countries.

C. *Results divided by genders, age groups and expertise levels of the respondents*

As can be seen in Figure 2, the main difference between the genders was that the female respondents had given higher values to all the factors than the males.

No similar dependencies could be seen when comparing the results between the age groups, presented in Table 3. However, there were significant differences in some of the factors, especially between the youngest and oldest age groups. When looking at the most evident (more than half a unit difference between the averages) differences between the age groups it can be noticed that the youngsters and the elderly people have different attitudes towards a few of the factors. The young people (below 35 years) respect their own and their friends experiences more than the old ones (over 65 years) while the opposite is true with the home country and language of the service. The results between the different self-evaluated expertise groups are shown in Figure 3.

For the novice users, their own and their friends' experiences, appearance of the service web page, or company's reputation were not as important as for the more advanced users when deciding if it secure to use a specific



A = I have previous good experiences about the service.
B = My friends recommend the service.
C = The company offering the service has a good brand reputation, image and name.
D = The company offering the service is located in my home country.
E = Many of the people I know use the service.
F = The service is one of the first hits within the search engine results.
G = The user license agreements are understandable.
H = The price is low.
I = The service is easy to use.
J = The appearance of the service web page is nice and professional.
K = I am able to look through the source code of the service.
L = The service uses my own language.

Figure 2. The factors of secure feeling within cloud services divided by genders.

cloud service. On the other hand, the language of the service or the location of the service provider did receive lower average values from the advanced users than from the novice or intermediate users. These results imply that users prefer to begin their trust creation process by gaining experiences from local service providers who offer services in users' mother tongue. Only when enough experience has been collected can the users have confidence to their capabilities to judge the security of a service based on their prior experiences and knowledge.

The results divided between the age groups and the expertise are strikingly similar. This of course is partly due to the fact that there is a correlation between those to variables; a bigger percentage of the older people judged themselves to be novice users than of the younger people.

V. DISCUSSION

People are already in the cloud even if they might not know it. They use cloud services such as webmail or social networking sites without thinking of the underlying technology. Majority of cloud end users still evaluate themselves as novice users. [2] In this environment people are drawn into services that they trust and feel secure towards.

Our objective for this study was to investigate what aspects and to what extent contribute and affect to the secure feeling in the cloud.

The fact that ease of use got the highest average value as a factor affecting to end user's trust and secure feeling towards services in the cloud is by no means an unexpected result. Already, Fogg and Tseng [15] noted that one of the elements included in user trust experience is that the

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TABLE III. FEELING OF SECURITY FACTORS WITHIN CLOUD SERVICES DIVIDED BY AGE GROUPS

How important are the following factors when deciding if it is secure to use a specific cloud service:						
Age:	***15-24***	***25-34***	***35-44***	***45-54***	***55-64***	***65+***
I have previous good experiences about the service.	5,04	4,91	4,65	4,69	4,47	4,36
My friends recommend the service.	4,51	4,51	4,13	3,91	3,70	3,67
The company offering the service has a good brand reputation, image and name.	5,00	4,80	4,75	4,90	4,82	4,84
The company offering the service is located in my home country.	4,17	4,27	4,53	4,71	4,89	5,14
Many of the people I know use the service.	4,78	4,72	4,43	4,37	4,41	4,18
The service is one of the first hits within the search engine results.	4,50	4,26	4,04	4,06	4,24	4,08
The user license agreements are understandable.	5,35	5,43	5,42	5,63	5,72	5,70
The price is low.	5,76	5,67	5,68	5,75	5,77	5,67
The service is easy to use.	5,84	5,83	5,82	6,00	6,00	5,95
The appearance of the service web page is nice and professional.	5,36	5,35	5,25	5,41	5,26	5,34
I am able to look through the source code of the service.	4,26	4,18	4,27	4,51	4,49	4,60
The service uses my own language.	5,60	5,50	5,88	5,98	6,08	6,09

users can trust themselves of being able to control the technology. Also, Kaasinen [17] states that the users have to have a clear conception of the functionality of the service even if they do not need to know all the details. In [24], convenience of use was identified as one of two key success factors of mobile Internet services.

It is interesting, though, that ease of use showed to be of different importance level with different respondent groups. This factor has significantly more importance for the Finns than to the Japanese respondents. Some of this may be explained by the fact that this factor was more important for the advanced users of cloud services than for the novice users, and in Finland a considerably larger percentage of respondents evaluated themselves to be advanced cloud service users than in Japan.

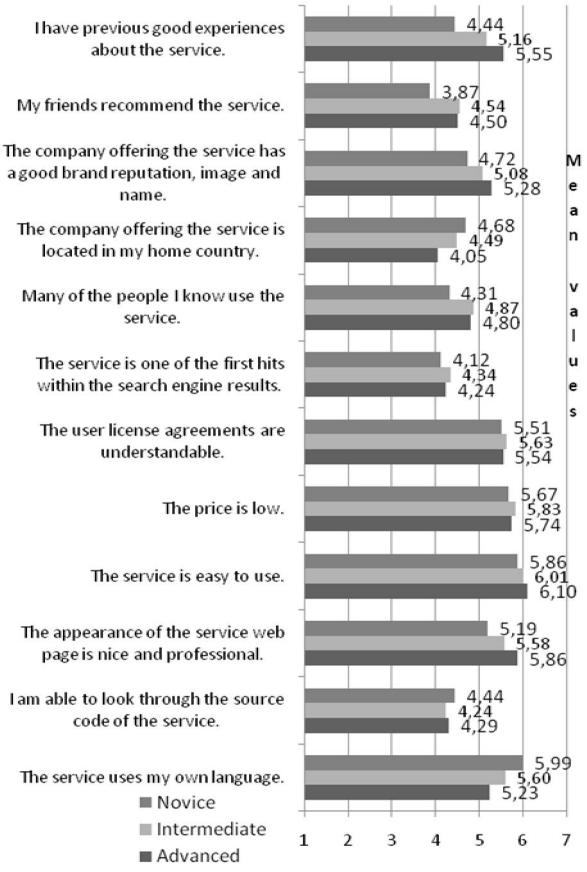

Figure 3. The factors of secure feeling divided by end users' self-evaluated experience within cloud services.

The ease of use was closely followed by the language of the service. Especially the American respondents felt strongly that when deciding if it is secure to use a specific cloud service it is important that the service uses their own language. This is quite obvious as English language has such a strong ground in ICT sector. The end users have grown used to using English in the internet environment.

It was somewhat surprising that the low price was ranked to be the third important factor in this context. Conventionally, low price is thought not to increase trust. It might be that the fact that many of the largely popular cloud services (e.g., Facebook, Gmail and Youtube) are free has affected the general atmosphere and consumers are willing to lay trust on the free or low priced services more than before cloud era. However, low price has also earlier been noted to act as one of the key success factors of a specific internet solution. [25]

Limitations of the study mainly rise from the fact that our study was conducted as an online survey, which excludes the group of people not active in the Internet. Nevertheless, as the target of the survey was to study the end users' attitude towards online services it was only natural to choose the online method for conducting the survey.

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VI. CONCLUSION AND FUTURE WORK

Our study examined end users' trust and secure feeling in regard to cloud services. An online survey was conducted in three countries (Finland, USA and Japan) with more than 3000 respondents. The twelve factors that create trust in the cloud, which were identified by cloud software experts in our earlier study, were taken and asked the end users to rank how important those factors are for them when deciding if it is secure to use a specific cloud service.

The results show that in general the ease of use has the biggest effect on the feeling of security towards cloud services, followed by the language and the price of the service.

Some differences were visible between the countries. The ease of use as well as understandable user license agreements are appreciated the most in Finland. The language issues are considered extremely important especially in USA. For the American respondents it is also significantly more important that the company is located in their home country than for the Finnish or Japanese respondents. The Japanese respondents, on the other hand, have more faith in the search engine results than the other two countries, and do not care as much about the appearance of the web page as the others.

The main difference between the genders was that the female respondents had given higher values to all the factors than the males. The differences between the age groups and expertise were significant between the youngest and oldest respondents as well as the self-evaluated novice and advanced cloud service users. The young as well as the advanced users respect their own and their friends' experiences more than the oldest age group and the novice users, while the opposite is true with the home country and language of the service.

These results will be taken a deeper look at our future research where we will be studying end users' perceptions towards cloud services and their security using an online focus group research method.

ACKNOWLEDGMENT

This study was carried out in Cloud Software Program launched by Finnish Strategic Centre for Science, Technology and Innovation TIVIT Plc and conducted together with F-Secure. We thank both of these parties for their support.

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