Diffusion and Acceptance of Cloud Computing in SMEs: Towards a Valence Model of Relevant Factors

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Abstract

Cloud Computing provides great opportunities especially for companies within the SME segment. This is why Cloud Service Providers (CSPs) are increasing their efforts to make their infrastructure accessible for small companies to help them compensate the lack of their own IT infrastructure. But nevertheless a lot of companies – especially smaller ones – are not yet convinced of the benefits of cloud services. This paper explores factors that influence the diffusion and acceptance of Cloud Computing among SMEs. On the basis of theoretical models and qualitative interviews a valence model of relevant factors was developed. This model provides individual, organizational, technical, and environmental factors influencing the diffusion and acceptance of Cloud Computing among SMEs in a positive or negative way.

1. Introduction

Diffusion is a critical process concerning the success of innovations. Very often it is assumed that new inventions and novel technologies improving a certain situation diffuse themselves only because of the fact, that they bring benefits to their adopters. But according to Rogers, this happens very seldom. In the majority of cases the diffusion of innovations is a rather slow process [1, 2]. Given the fast moving IT environment, this appears to be true for the technological innovation of Cloud Computing within the SME sector as well. The adoption is usually influenced in both directions, accelerating and inhibiting, by many different factors [3]. Depending on the nature of the innovation and its range of use, these factors originate from the personal environment of individuals, from the organization, from the technology or from some other environmental background [1, 15-18].

Recently, the concept of Cloud Computing has generated significant interest in both practitioner and academic communities. There is also already evidence that several different factors affect the diffusion of this innovation [4]. But Cloud Computing is a quite polarizing concept as well. As a survey among German companies has shown, the groups of supporters and opponents are both growing in a comparable way. The group of supporters of Cloud Computing grew from 28 percent to 35 percent, and the group of opponents also grew from 38 to 44 percent from 2011 (sample size n=411) to 2012 (sample size n=436) [3]. The fact that these completely opposed groups are growing nearly at the same rate additionally motivated this research.

The objective of this paper is to find out, which factors influence the diffusion and acceptance of Cloud Computing within organizations. Especially for SMEs, Cloud Computing offers new opportunities due to the accessibility of resources equal to those of large international corporate groups [5]. In addition, SMEs play a major role in the economy. The segment of SMEs is defined by the European Union by several criteria. The most customary one is the size of the company which is limited by 250 employees for SMEs [6]. In 2012 99.7 percent of Austrian companies were SMEs. These companies were responsible for 60 percent of turnover and employment [7]. For these reasons, the focus of this research was placed on the diffusion and acceptance of Cloud Computing in SMEs. The following two research questions (RQ) are assessed by this paper:

RQ1: Which influencing factors are addressed by scientifically proven theory models concerning diffusion and acceptance of technological innovations?

Relevant theory models which deal with the diffusion and acceptance of technological innovations and influencing factors addressed by these models need to be identified to answer this research question.

RQ2: What is the relevance of the influencing factors deduced from the theory models on the attitude of SMEs towards Cloud Computing?

The relevance of the identified factors has to be assessed using a suitable method to answer RQ2.

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The remainder of this paper is arranged as follows. Section 2 provides an overview of the research methodology used to answer RQ1 and RQ2. Influencing factors for the diffusion and acceptance of technological innovations of five different theory models are discussed in section 3. Section 4 deals with the development of the valence model by providing details on the empirical survey and the data analysis. This is followed by a discussion of the identified factors in section 5. Section 6 provides final conclusions together with limitations and remarks on future research.

2. Research Methodology

The research process involved three main steps which are explained in this section.

2.1. Step 1: Selection of theory models

The first step intended to identify theory models which deal with the topic of diffusion and acceptance of technological innovations. Relevant models should cover different perspectives to gain influencing factors from a spectrum as broad as possible. Therefore, theory models incorporating the perspective of the individual as well as the organization, technology and environment were considered.

The models were analyzed and proven factors mentioned within the models were deduced, categorized and clustered according to their scope.

2.2. Step 2: Empirical survey

The approach of the conducted research followed the Grounded Theory which aims at generating theories close to reality with qualitative data evaluation. Although theoretical background had been concerned in advance, work was approached without any preconceived opinion, which is in line with the Grounded Theory [8, 9].

For reasons of timeliness and changes in the structure of the opinions, it appeared to be reasonable to gather actual information in a qualitative way instead of analyzing quantitative studies which had been conducted in the past. A similar research methodology was applied by Helmreich and Riehle during a research project [10]. In addition, we expected that – due to heterogeneous knowledge of the experts concerning the topic Cloud Computing – it would be conductive to the result, to clarify the definition in advance of the interview which would not have been possible in a quantitative survey.

After having decided on the method of expert interviews, the selection of companies and experts within the companies were the next steps. This was followed by the design of the interview guideline, the survey, data analysis and the presentation of the results. Figure 1 shows the procedure of the research process according to Mayer [11].

The interviewed experts had to be employees of SMEs, who were responsible for the concept, the implementation or control of problem solving or who had privileged access to information about groups of people or decision processes [12].

The objective of the survey was to get an impression of the attitude of companies towards Cloud Computing. The interview guideline was set up to structure the interview and consisted of open questions. It was designed on the basis of prior knowledge about the theory models as described in section three and a broad literature research concerning the definition of Cloud Computing from academic and practitioner perspective.

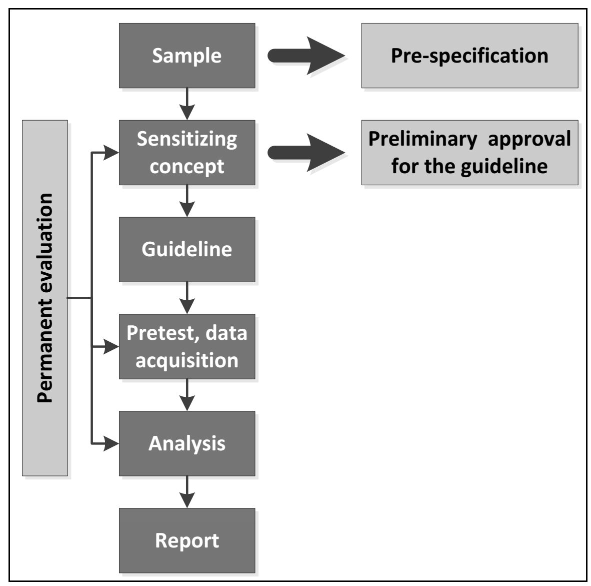

Figure 1: Procedure of the research process [11]

The interviews started with a short introduction clarifying the purpose and the background of the interview. This was followed by questions concerning the expert's field of responsibility and his personal attitude towards Cloud Computing. The guideline also included questions about the actual situation in the company concerning Cloud Computing solutions as well as future projects. The experts were urged to explain their reasons for and against the adoption of Cloud Computing solutions and requirements to increase its use. They were queried on the situation in their markets and industries as well as future trends and their personal attitude towards and experience with

Cloud Computing in the corporate environment. The objective was not the testing of hypothesis deduced, but to develop a relevance model of influencing factors based on empiric research and theoretical background. The research was aimed at inductively drawing a conclusion with comprehensive validity from a couple of interview results [11].

2.3. Step 3: Data evaluation

The third step involved the data analysis of the qualitative data. For this purpose the handwritten minutes of the interviews were transcribed and summarized. Additionally, the notes were checked and amended by the audio recordings that were taken from the interviews. To ensure a systematic, rule guided qualitative data analysis, the revised and completed transcriptions were imported into an analysis software specialized on qualitative data evaluation. Using this software the interview minutes were coded according to the factors identified within the theory models. The analysis resulted in a model containing factors influencing the diffusion and acceptance of Cloud Computing in a positive or negative way ("valence model of relevant factors").

3. Theory models and relevant factors

This section deals with the theory models and the identification of influencing factors for diffusion and acceptance of technological innovations. To investigate diffusion and acceptance of Cloud Computing, well established theories on IT adoption are essential. Various studies on IT adoption are based on Rogers' Diffusion of Innovations theory and Tornatzky and Fleischer's technology-organization-environment framework [13]. Moore and Benbasat's adoption of information technology innovation theory is an extention of the Diffusion of Innovation theory which was also considered for this research. Furthermore Davis' technology acceptance model and the unified theory of acceptance and use of technology by Venkatesh et al. were included. This selection of theoretical models covers a broad spectrum of influencing factors from different areas as well as a broad application of the models in scientific literature. The combination of these five theoretical models should help avoiding gaps criticized in literature (e.g. being too focused on technology [14]). This is why these five models – covering the diffusion and adoption of technological innovations from different perspectives on both the individual and the organizational level – had been considered relevant for this study.

In the following, the theory models are summarized and the identified factors of each model are discussed.

3.1. Diffusion of Innovations Theory

Rogers' Diffusion of Innovations (DoI) theory deals with the diffusion of an idea, practice, or technology that "*is perceived as new by an individual or other unit of adoption*" [1]. Rogers addresses five characteristics that influence the diffusion and acceptance of innovations.

Relative advantage. "Relative advantage is the degree to which an innovation is perceived as being better than the idea it supersedes." [1]

Compatibility. "Compatibility is the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters." [1]

Complexity. "Complexity is the degree to which an innovation is perceived as relatively difficult to understand and use." [1]

Trialability. "Trialability is the degree to which an innovation may be experimented with on a limited basis." [1]

Observability. "Observability is the degree to which the results of an innovation are visible to others." [1]

These five factors were already proven in several diffusion studies and determine the rate of adoption of innovations. They are highly relevant for the purpose of this research and therefore need to be considered.

3.2. Adoption of Information Technology Innovation Theory

In this theory, Moore and Benbasat [15] added two extensions to the Diffusion of Innovations Theory by Rogers [1]. The following factors play an important role in the process of the adoption of innovations too.

Image. "Image is the degree to which use of an innovation is perceived to enhance one's image or status in one's social system." [15]

Voluntariness of use. "Voluntariness of use is the degree to which use of the innovation is perceived as being voluntary or of free will." [15]

According to this theory, not the factors themselves are mandatory, but rather their perception is essential for the adoption of an innovation.

3.3. Technology Acceptance Model

The Technology Acceptance Model (TAM) by Davis [16] describes the causal relations between system design features, perceived usefulness, perceived ease of use, attitude towards using and the actual system use (see Figure 2).

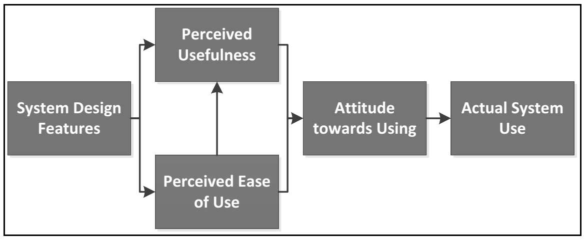

Figure 2: Technology Acceptance Model [16]

In contrast to Rogers, Davis concentrates on the perspective of the individual's perception only. TAM implies that the actual system use is influenced by a chain of factors. The cognitive reactions to the external stimulus (system design features) are two interesting factors which are added to the set of influencing factors.

Perceived Usefulness. Perceived usefulness is "the degree to which an individual believes that using a particular system would enhance his or her job performance." [16]

Perceived Ease of Use. Perceived Ease of Use is "the degree to which an individual believes that using a particular system would be free of physical and mental effort." [16]

3.4. Technology-Organization-Environment Framework

The Technology-Organization-Environment (TOE) Framework by Tornatzky and Fleischer [17] provides further factors suitable for the purpose of this research. The framework indicates that adoption and implementation of technological innovations are influenced from three directions. These contexts influence each other and the decision-making concerning the adoption (see Figure 3). Within the TOE framework, the following factors influence the decision to adopt innovations and therefore were selected for further examination.

Organization size. The size of the organization is a commonly used factor to set boundaries between segments of companies [17]. As stated, this research focused on the SME segment.

Slack resources. Slack resources have a positive influence on the adoption of innovations, but they are neither mandatory nor sufficient [17].

Formal and informal boundary-spanning structures. Tornatzky and Fleischer describe multiple types of relations and roles among members of an organization influencing the diffusion of information [17].

Communication process. Informal networks within the company play an important role concerning the generation and dissemination of information [17].

Technological availability. The availability of technologies often depends on characteristics of the industry [17].

Technological characteristics. Complexity and risk of innovations influence the probability to adoption [17].

Industry characteristics and market structure. The readiness for innovation is often determined by market influences and product driven need or pressure to innovate [17].

Competitors. Surveys show that a higher number of competitors encourage the adoption of innovations [17].

Government regulation. Regulations by the government often drive or even force companies to research for technological alternatives. On the one side, regulations may call for application of certain technologies. On the other side, regulations may cause companies to refrain from innovations in certain areas [17].

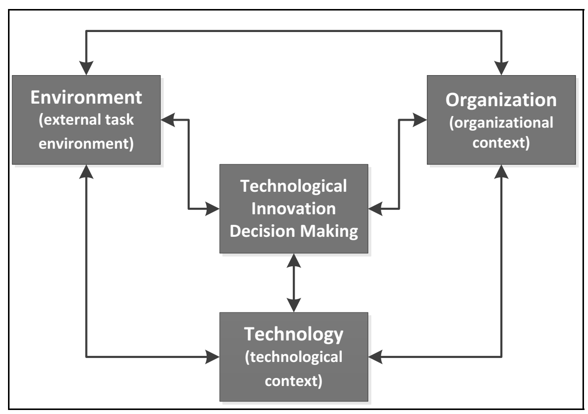

Figure 3: TOE Framework [17]

In addition to the factors itself, Tornatzky and Fleischer's classification scheme consisting of the technological, organizational and environmental context will also be used as basis for clustering the factors.

3.5. Unified Theory of Acceptance and Use of Technology

The fifth theory considered for the identification of influencing factors is the Unified Theory of Acceptance and Use of Technology by Venkatesh et al. [18]. According to this theory, there exist four factors with direct influence on acceptance and behavior of users (see Figure 4). The first three factors affect the behavioral intention, which again affects use behavior. The fourth factor, facilitating conditions, has direct influence on use behavior.

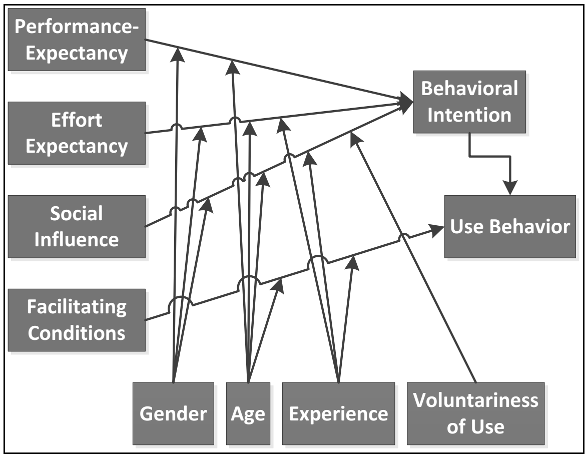

Figure 4: UTAUT [18]

Performance expectancy. “Performance expectancy is defined as the degree to which an individual believes that using the system will help him or her to attain gains in job performance.” [18]

Effort Expectancy. “Effort expectancy is defined as the degree of ease associated with the use of the system.” [18]

Social Influence. “Social influence is defined as the degree to which an Individual perceives that important others believe he or she should use the new system.” [18]

Facilitating Conditions. “Facilitating conditions are defined as the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system.” [18]

3.6. Categorization of the factors

In the course of the analysis twenty-two influencing factors were identified which were considered as relevant concerning diffusion and acceptance of technological innovations like Cloud Computing. In the next step these factors were clustered on the basis of their particular context. For this purpose four categories of factors were defined: individual, organizational, technological and environmental factors. These categories were derived from the perspectives of the particular theory models. The mapping is provided in Table 1.

Table 1: Cluster of influencing factors

Individual	Organizational	Technological	Environmental
perceived usefulness [16]	organization size [17]	technological availability [17]	industry characteristics and market structure [17]
perceived ease of use[16]	facilitating conditions [18]	technological characteristics [17]	government regulation [17]
	compatibility [1]		competitors [17]
	trialability [1]		social influence [18]
	observability [1]		
	relative advantage [1]		
	communication processes [17]		
	image [15]		
	slack resources [17]		
	complexity [1]		
	effort expectancy [18]		
	voluntariness of use [15]		
	formal and in-formal bounda-ry-spanning structures [17]		
	performance expectancy [18]		

4. Development of the valence model

This section deals with the details of the empirical survey leading to the valence model. It provides an overview of the involved companies with their experts and describes results of the survey and the data analysis. Further detail is given on the factors identified and the resulting valence model of relevant factors is discussed.

4.1. Selection of companies and experts

During the research nine expert interviews were conducted. The selection of companies intended to cover a range of different industries within the SME segment. Table 2 provides an overview of the interviewed companies. It shows the experts’ fields of responsibility. To cover perspectives from different areas of responsibility within the companies, the selected experts were from the IT department, organizational development, information management and top-management. The duration of the interviews ranged from 45 to 90 minutes.

Table 2: Company overview

Industry	Number of employees	Area of responsibility	Duration (min.)
Retail	180	IT	90
Sales	130	IT	45
Engineering	120	IT/Org.	60
Builder's merchant	100	Org.	45
Commerce	50	IT	75
Power train engineering	220	IM	75
Electrical engineering	80	IT/Org.	60
IT Services	10	IT	60
IT Services	36	Top-Mgmt.	60
IT…Information Technology, Org…Organizational Development, IM…Information Management, Top-Mgmt…Top-Management			

The head offices of all companies are located in Upper Austria. Their business operating areas vary from local to global. During our requests for appointments we experienced a great willingness to participate in the survey. There were only two companies which refused to take part, mainly because of a conflicting schedule.

4.2. Conduction of the survey

The interviews took place on the companies' premises. The guideline was used as a rough frame for the talks. In addition to the handwritten minutes the interviews were digitally recorded for reasons of completeness and consistency. All nine interviews took place in April 2013.

4.3. Data analysis and additional factors

The objective of the qualitative content analysis was to generate a model concerning the relevance of the influencing factors identified in the theory models as described previously. Frequency analysis is considered an adequate method for qualitative data analysis [19]. It provides the potential to quantify qualitative results and thereby allows establishing a ranking which leads to the valence model of relevant factors. In the course of this research we did not intend to show the frequency of the mentions only but also the orientation (positive or negative) of their influence on acceptance and diffusion of Cloud Computing. Therefore, the valence analysis was chosen as method for analysis. With this method, a bipolar evaluation of the factors was possible [19]. Multiple mentions of one factor per interview were possible.

The data analysis was carried out by using the software atlas.ti, a tool specifically designed for qualitative data analysis [20]. The tool supported this process and helped to elaborate the model. As the interview minutes had already been transcribed using a word-processing software, these nine files could be imported into atlas.ti creating a so-called hermeneutic unit. Additionally, each factor was applied by codes representing the parameter values "positive", "negative" and "neutral". Then, each text passage within the interview minutes bearing upon a factor was coded by the corresponding code of the factor. This was done by marking the respective text passage and assigning the corresponding code of the factor by drag and drop.

After having finished this iterative process, the text passages that were not yet marked by factors from the theories, were subject for deeper investigation. This led to additional factors which had not been explicitly addressed within the five theory models. Due to their evident relevance the following factors were added to the set of factors provided before.

Perceived security and safety. This factor is defined here as the degree to which the significantly involved actors and constituents of the concept of a technological innovation succeeded to convey the perception of security and safety.

Costs. Costs are defined as funds necessary for implementation and operation of the new solution compared with the previous one. The strategy "buy first, build second" for example leads to increased cost efficiency [21].

Trust. The factor trust represents the ability of the significantly involved actors to convey the perception of reliability and trustfulness. The role of trust is especially important in the context of a public cloud scenario [22].

Regulatory framework. This factor is defined as the degree to which the solution to be implemented is influenced and affected by legal regulations.

Energy efficiency. This last factor to be added is defined as the degree to which the new solution leads to advantages concerning the efficient use of energy [23–25]. These factors were also included in the analysis.

4.4. Density of factors

Based on the result of the analysis eight factors were eliminated because they had not been mentioned in a positive or negative sense during the interviews. These factors include *industry characteristics and market structure, slack resources, communication processes, competitors, government regulation, social influence, formal and informal boundary-spanning structures* and *organization size*. Fourteen of originally twenty-two factors deduced from the theory models remain, completed by five additional factors which were identified during the data analysis. What is noticeable is that (i) none of the factors derived from the theoretical models and classified as environmental factors played a noteworthy role for the interviewed experts; and (ii) all but one of the eliminated factors originated from the TOE framework by Tornatzky and Fleischer.

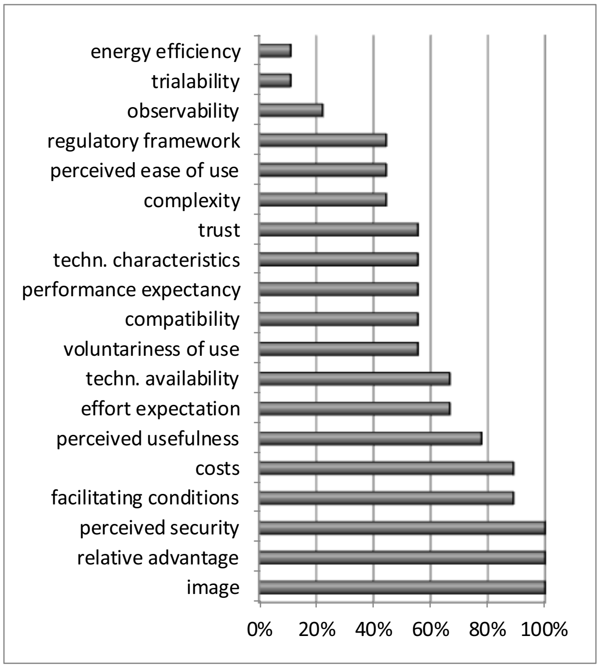

Figure 5: Density of factors

The density of the factors describes the relative share of companies that have mentioned the factor during the interview in a positive or negative way. Their relative values are shown in Figure 5. The factors are listed from top to bottom in ascending order. For example, the factor "relative advantage" was mentioned in all nine interviews thus having a density of 100%.

4.5. Valence model of relevant factors

The valence analysis conducted reveals the distribution of positive and negative mentions of each factor (see Figure 6). As shown in the figure, the factor "relative advantage", for example, was mentioned 12 times in a positive and 9 times in a negative sense.

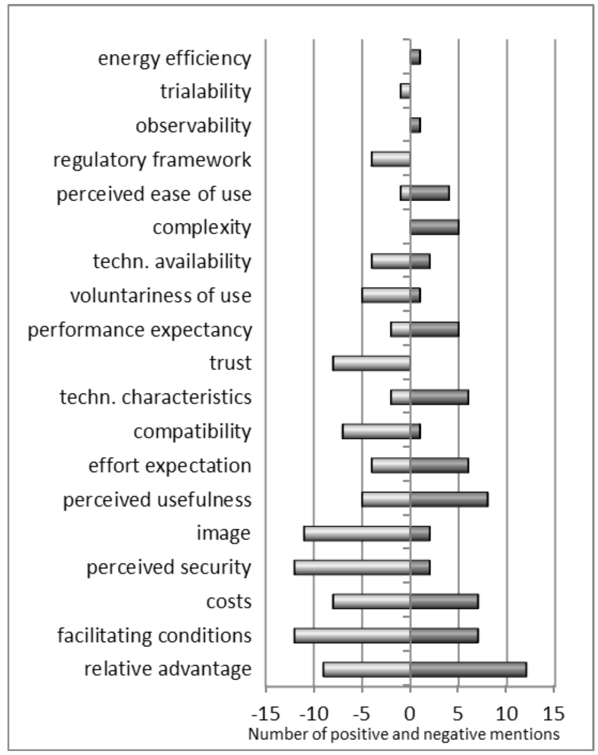

Figure 6: Results of the valence analysis

The adjustment of the set of influence factors through nine qualitative interviews led to the creation of a model showing the relevance and weighting of influencing factors. The model, as illustrated in Figure 7, provides information concerning the direction of influence (positive or negative) on the identified drivers for diffusion and acceptance of cloud computing. The numbers in brackets denote the valence of the factors. The first number shows the positive value and the second number the negative mentions. For example, "costs (7/8)" means that this factor was mentioned seven times in a positive context and eight times in a negative context.

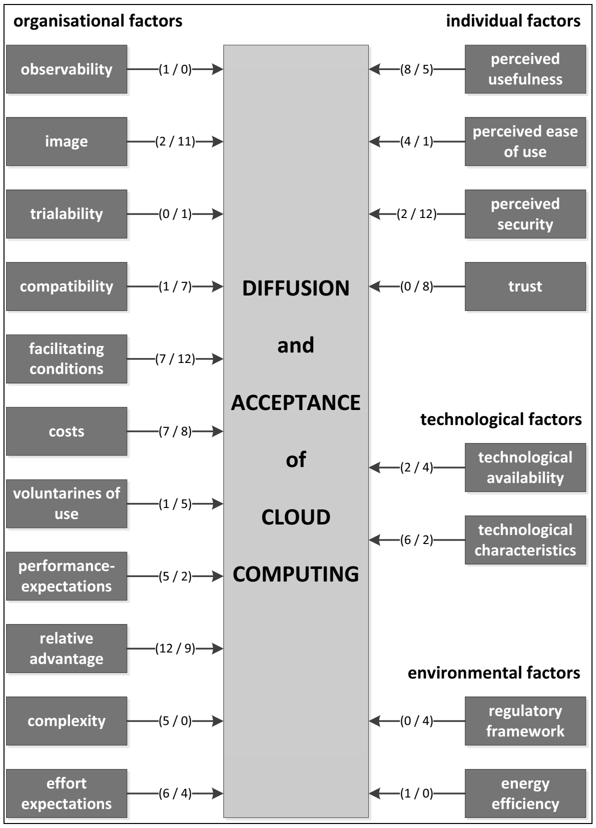

Figure 7: Valence model of relevant factors

5. Discussion

The analysis of the expert interviews revealed a total of 70 statements describing positive influence on acceptance and diffusion and 95 statements describing a negative influence. The statements of the relevant factors that lead to the valence model are discussed in the following.

Image. For all of the interviewed companies the organizational factor *image* is a relevant factor. Only one positive statement was made stating that Cloud Computing solutions help to improved security and conformance to standards which leads to a positive image of the company. All other statements expressed the opposite. Further negative comments were made concerning the seriousness of Cloud Service Providers (CSPs) and nebulosity about the geographical location of stored and processed data. Thus, the factor *image* influences acceptance and diffusion of Cloud Computing mostly in a negative way.

Relative advantage. Positive statements in the context of this organizational factor include load relieving of the network infrastructure, enhancement of service availability, removal of hardware maintenance and partly of operation of the own infrastructure, flexibility, simple administration, collaboration opportunities, potential savings, and increased automation. The negative ones included that there are too few users involved, limited facilities on CSP-side, or hardly any staff savings in order to create enough advantage for the organization.

Perceived security and safety. This individual factor was mentioned in a positive way in the context of uncritical data and improvement of data security by higher standards at the CSPs. Negative statements were concerns about security, privacy management, data transfer to third parties, and too little contractual agreements concerning data security.

Facilitating conditions. This organizational factor affects the availability of technical and organizational requirements. Internet bandwidth was mentioned both positively and negatively. Reliability of the infrastructure providers and missing redundancy of connections were negative statements in this context. Four companies mentioned that some of their essential software does not support the cloud infrastructure.

Costs. The survey furthermore revealed that Cloud Computing does not automatically lead to cost savings. Especially within the SMEs sector this is due to non-achievement of economies of scale. The interviewed experts had high capital expenditures and high costs for customization on the negative side and possible cost reduction through outsourcing on the positive side.

Perceived usefulness. This individual factor was mentioned predominantly in a positive way. Statements included ubiquitous access, resources for core business, automation, load removal of the internet connection, and replacement of high-end workstations, and increased security and safety. The latter was mentioned critically too. Some interviewees could not identify sufficient benefits of the adoption of cloud solutions.

Effort expectation. Concerning this factor the experts expect a reduction of effort in maintenance and operation of the infrastructure as a positive influence. On the other hand, they see high efforts caused by the implementation.

Technological availability. Companies mentioned the availability of required infrastructure in a positive way; limited capabilities concerning the implementation of specific requirements were seen negatively.

Voluntariness of use. Interviewees reported that in most scenarios the decision to implement a Cloud Computing solution is closely linked to a certain provider. Moving from one provider to another is at least problematic, interoperability between different providers even impossible in most cases. This so-called “lock-in effect” is seen very critically by the interviewed experts.

Compatibility. Concerning this factor experts experienced conflicts regarding their company's philosophy which occasionally is contradictory to key characteristics of Cloud Computing.

Performance expectancy. The statements on this factor were mostly positive. Cloud Computing leads to a broader service offering and measured services. Degradation of access time was mentioned as problematic.

Technological characteristics. The use of Cloud Computing solutions leads to a simplification of administration as well as to an increase of usability.

Trust. This is a key factor for most experts. For them trust is the basis for a successful partnership between the CSP and Cloud Computing adopters. Often smaller, local providers are perceived more trustworthy than the global big players.

Complexity. According to the interviewed experts Cloud Computing is not a very complex technology to implement. Simple usability and administration as well as a high degree of automation contribute to that.

Perceived ease of use. Characteristics like rapid elasticity and the high degree of automation contribute to a positive attitude towards this factor. Especially companies which are not notably IT-oriented often show resistance to change. This lack of readiness and willingness to change hinders the adoption of innovative solutions like Cloud Computing.

Regulatory framework. Due to varying regulations in different legal frameworks the storage location is an important factor to the interviewed experts. Datacenters located in Austria are preferred in general; a location within Europe is seen as mandatory.

Observability. Monitoring and measuring of the impact of the implementation of Cloud Computing by defined key performance indicators helps to confirm the effects of Cloud Computing adoption. However, only one company had already defined appropriate indicators.

Trialability. Trialability of Cloud Computing solutions drives familiarity, which helps to increase acceptance.

Energy efficiency. Only one company considered the factor energy efficiency as relevant. All other companies appraised the ecological impact of their energy consumption as negligible.

Although some of the factors were mentioned only by few experts, the factors were – due to the limited number of interviewees – nonetheless considered as relevant and therefore mentioned in the discussion.

The conducted interviews also revealed that the definition of the term Cloud Computing is still far from being clear, even for IT experts. Therefore, the understanding of the concept differs among them. It was noticeable that most companies see Cloud Computing as a synonym for "public cloud" solutions. As interviews showed, the deployment model "private cloud" is not yet diffused. For this reason it is inevitable for a discussion about that topic to start with an initial clarification to have a consistent understanding.

6. Conclusion

This paper combines the theoretical approach from scientifically recognized literature with a practical evaluation of influences on the diffusion and acceptance of Cloud Computing among SMEs. The analyzed theory models cover four main areas of influence on acceptance and diffusion of technological innovations: The individual, the organization, the technology and the environment. Factors from these established theory models dealing with acceptance and diffusion of innovations served as a vital basis for the data analysis process. The conducted expert interviews with nine SMEs revealed that decisions concerning adoption of cloud solutions are driven by 19 different factors from all four areas. It turned out that certain factors of the five selected theory models are appropriate for Cloud Computing, but also need to be enriched by additional factors.

As a result a valence model was created which sheds light on the differing relevance of influencing factors in both positive and negative directions. Thereby it provides a broad overview of essential areas and perspectives which have to be considered from the viewpoint of an SME.

Due to the limited size of the sample in the conducted qualitative research, the results have not yet been empirically proven. However, we believe that the findings of this research provide interesting results and enough relevance to indicate important factors for the diffusion and adoption of Cloud Computing. A quantitative survey to a significant extent will be subject for future research. This survey could also include an analysis of causal relations between business figures (e.g. financial background, cost and revenue structure) and the adoption of Cloud Computing as well.

7. Acknowledgement

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