# A Complete Evaluation of the TAM3 Model for Cloud Computing Technology Acceptance

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**Abstract.** In this work, we examine the technology acceptance of Cloud computing by using the third iteration of the technology acceptance model, from now on referred to as TAM3. TAM is a well established methodology widely used for the acceptance of technology. Empirical data was analyzed from 138 Cloud developers, IT professionals and managers using factor analysis. The results indicate that user acceptance of Cloud computing can be explained and predicted by variables concerning Perceived Usefulness, Perceived Ease of Use, Subjective Norm, Job Relevance, Image, Output quality, Result Demonstrability, Experience, Computer Self-Efficacy, Perception of external control, Cloud Anxiety, Perceived Enjoyment, Voluntariness, Intention to Use. These results further advance the theory and add to the bases for further research targeted at enhancing our knowledge of technology adoption for Cloud computing. They also provide a first base for companies and governments on how to adopt and successfully integrate Cloud technologies and specifically how users adopt Cloud technologies according to organization size, type and employee job role.

**Keywords:** Cloud computing · Technology adoption · TAM3

## 1 Introduction

Cloud computing is a technology field that has drawn the interest of every company related to it in the last few years. Companies such as Microsoft, Amazon Google and IBM [1] have invested enormous resources and research efforts into implementing and promoting Cloud technologies. Cloud computing has also garnered the attention of Computer Science researchers [2]. Although many models that predict technology acceptance do exist they do not specifically cater to the intricacies and continued evolution of Cloud Computing. The fact that investing in new technologies or migrating to them presents a substantial risk of failure a need for an accurate technology model that can predict the acceptance of Cloud technologies is necessary. The main question that we have to answer is "which factors determine the acceptance of Cloud computing?" To answer that question we are going to use the factors available by the third iteration of the TAM model and evaluate their ability to determine the acceptance of Cloud computing. Before we delve into the analysis of our main question we have to give a background to the technology of Cloud Computing and present the birth and evolution of the TAM model beginning from its first iteration to the third version.


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### 1.1 What Is Cloud Computing?

Some people even today question what Cloud computing is and we see that there is no simple answer. The views on the types are differentiated, both in IaaS, PaaS or SaaS and in the deployment difference between Private, Dedicated or Public Cloud. Also there are a few people who would associate it with Utility Computing and Virtualization. According to Mell and Grance [3] "Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This is possible though its inherit features, which are auto-recovery, self-monitoring, self-management, high scalability auto-reconfiguration, and the possibility of forming SLAs". Judging from this we can conclude that Cloud computing is a larger and more diverse technology than utility computing and virtualization. Adding the substantial cost/value benefits that can be achieved though Cloud computing it can safely be acknowledged as a new vibrant era for computing.

### 1.2 The Technology Acceptance Model 3

Davis [4] developed the Technology Acceptance Model (TAM) as means to determine the factors that influence technology adoption by users. TAM is a widely accepted model for defining user technology acceptance backed by substantial empirical research. The TAM model has included and tested two specific factors: Perceived Usefulness and Perceived Ease of Use. Perceived Usefulness is defined as the potential user's subjective likelihood that the use of a certain system will improve their action and Perceived Ease of Use refers to the effort that the user expects to put in the use of a certain technology. The potential for a user to adopt a technology is also influenced by external variables. TAM explains around 40% [5] of the variance of users behavior in adopting technologies and Google Scholar lists thousands of citations on the original article. TAM2, an extension of the TAM was developed due to the limitations of the TAM in terms of explanatory power. The goal for the TAM2 was to keep the original TAM constructs intact and include additional key determinants of TAM's perceived usefulness and usage intention constructs, and to understand how the effect of these determinants changed with increasing users experience over time with the target system [6]. Because TAM2 only focused on the determinants of TAM's perceived usefulness and usage intention constructs, TAM3 by Venkatesh and Bala [7] added the determinants of TAM's perceived ease of use and usage intention constructs for robustness. Therefore, TAM3 presented a complete nomological network of the determinants that predict user information technology adoption. Following the presentation of the TAM model the research methodology is going to be described, which will include an overview of the survey design, data collection and data analysis. Next the results of the survey are going to be presented which will include a presentation of the survey demographics. Moreover a reliability analysis and the model evaluation of the TAM3 model are going to be presented that show how user are influenced to use Cloud technologies. Finally there is going to be a discussion presenting the limitations of this

work, the theoretical and practical implications, conclusion and the available opportunities for future research.

## 2 Methodology

### 2.1 Survey Design

The TAM3 model was evaluated by the conduction of a survey. The survey was divided into three sections. In the first section participants were asked to provide demographic and organization data, information about age, gender, educational background, location, job role, years of experience and organization size/type. The second part contained the TAM3 investigation. In order to determine the validity of the TAM3 questionnaire an exploratory factor analysis was conducted. The implementation of the exploratory factor analysis was performed by using the principal component analysis since it is considered a more robust process and less complex conceptually [8]. The size of the sample was 138 participants and it is considered sufficient [9]. The survey was conducted in the English language worldwide as it is the language that is commonly known throughout the world and especially in IT. A seven point Likert scale ranging from "strongly disagree" to "strongly agree" was mainly used. The tool used to analyze the results was SPSS v21.

### 2.2 Data Collection

The survey was conducted through web link sent by email via the Surveymonkey service acknowledging that no personal information will be divulged without the participants authorization. The survey was open for two months from May 1$^{st}$, 2017. Another two month extension was given to reach the necessary number of answers. The email was sent to 500 Cloud developers, IT professionals, managers and other staff responsible for IT decisions from companies and government organizations worldwide. The survey was also posted on the linkedin.com social business network via ad web link for the same amount of time and dates. At the end of August we received a total number of 125 replies, amounting to a response rate of $125 \div 500 = 25\%$. This response rate is consistent with rates in similar surveys in information technology research. In addition, we received thirteen questionnaires via the linkedin.com ad, making it a total sample of $N = 138$.

## 3 Results

### 3.1 Sample Profile

In this section the descriptive and inferential statistics are being presented. Table 1 depicts the demographics of the survey.

**Table 1.** Demographics

| | | N | % |
|---|---|---|---|
| What is your gender? | Female | 30 | 2.7% |
| | Male | 108 | 78.3% |
| Which category below includes your age? | 18–25 | 18 | 13.0% |
| | 26–35 | 72 | 52.2% |
| | 36–45 | 30 | 21.7% |
| | 46–55 | 12 | 8.7% |
| | 56–65 | 6 | 4.3% |
| What is the highest level of education you have completed? | High school | 12 | 8.7% |
| | Master's or equivalent | 48 | 34.8% |
| | PhD | 6 | 4.3% |
| | University-college | 72 | 52.2% |
| Geolocation | Africa | 18 | 13.0% |
| | Asia | 48 | 34.8% |
| | Australia | 6 | 4.3% |
| | Europe | 18 | 13.0% |
| | North America | 48 | 34.8% |

Table 2 depicts the job role of each participant along with the type of organization they work in and the its size according to employee number according to the Eurostat enterprise glossary.

**Table 2.** Job role, organization type and size

| | | N | % |
|---|---|---|---|
| What is your job role? | Cloud developer | 13 | 9.4% |
| | IT professional | 63 | 45.7% |
| | Manager | 62 | 44.9% |
| Organization type | Education | 12 | 8.7% |
| | Financial services | 34 | 24.6% |
| | Health care | 12 | 8.7% |
| | ICT technologies | 26 | 18.8% |
| | Manufacturing | 36 | 26.1% |
| | Media services | 6 | 4.3% |
| | Public sector | 12 | 8.7% |
| Organization size | 1–9 | 12 | 8.6% |
| | 10–49 | 30 | 21.7% |
| | 50–249 | 22 | 15.9% |
| | <250 | 74 | 53.5% |

### 3.2 Reliability Analysis and Model Evaluation

In this sections the reliability analysis and model evaluation are being presented. The relationship between the dependant variable (intention to use) and the independent variables is going to be analyzed. In Table 3 a multiple linear regression model is been presented with dependent variable "the intention to use" and independent variables "the perception of usefulness", "perceived ease of use", "subjective norm", "job relevance", "image", "output quality", "result demonstrability", "experience", "computer self–efficacy", "perception of external control", "cloud anxiety", "perceived enjoyment", "Voluntariness". The model was statistical significant $F(13, 124) = 20.802$, $p = .000$, $R2 = .686$. The model did not have any multicollinearity issues (all VIF less than 10) or a heteroscedasticity. Also, there was not any autocorrelation problem since Durbin Watson = 1.855. The analysis resulted that perceived usefulness (Beta = 0.205, p = 0.044), perceived ease of use (Beta = 0.206, p = 0.036), subjective norm (Beta = 0.427, p = 0.001), job relevance (Beta = −0.272, p = 0.023), image (Beta = −0.565, p = 0.000), experience (Beta = 0.378, p = 0.000), computer self efficacy (Beta = 0.571, p = 0.000), perceived enjoyment (Beta = 0.309, p = 0.007) and voluntariness (Beta = −0.322, p = 0.001) were statistical significant predictors of the intention to use. All predictors had positive effect on intention of use with the exception of the job relevance, image and voluntariness. For one unit improvement either in job relevance or image or voluntariness there was a reduction of −0.272 or −0.565 or −0.322 respectively. In order to find the influence of each factor on the intention to use we use the absolute value of BETA coefficients for the statistical significant factors, perceived usefulness (0.205), perceived ease of use (0.206), subjective norm (0.427), job relevance (0.272), image (0.565), experience (0.378), computer self efficacy (0.571), perceived enjoyment (0.309) and voluntariness (0.322). The sum of these values is 0.205 + 0.206 + 0.427 + 0.272 + 0.565 + 0.378 + 0.571 + 0.309 + 0.322 = 3.255. Now, each value is been divided by 3.881 and we have 6.29%, 6.32%, 13.11%, 8.35%, 17.35%, 11.61%, 17.54%, 9.49%, and 9.89%. Therefore, the approximately contribution of each factor in the intention to use is the following: perceived usefulness (6%), perceived ease of use (6%), subjective norm (13%), job relevance (8%), image (17%), experience (12%), computer self efficacy (18%), perceived enjoyment (10%) and voluntariness (10%).

**Table 3.** Regression analysis for TAM3

| Model | | Unstandardized coefficients | | Standardized coefficients | t | Sig. | Collinearity statistics | |
|---|---|---|---|---|---|---|---|---|
| | | B | Std. error | Beta | | | Tolerance | VIF |
| 1 | (Constant) | −0.974 | 0.447 | | −2.180 | 0.031 | | |
| | Perceived usefulness | 0.234 | 0.115 | 0.205 | 2.037 | 0.044 | 0.246 | 4.072 |
| | Perceived ease of use | 0.264 | 0.124 | 0.206 | 2.120 | 0.036 | 0.265 | 3.780 |

(*continued*)

**Table 3.** (*continued*)

| Model | | Unstandardized coefficients | | Standardized coefficients | t | Sig. | Collinearity statistics | |
|---|---|---|---|---|---|---|---|---|
| | | B | Std. error | Beta | | | Tolerance | VIF |
| | Subjective norm | 0.488 | 0.148 | 0.427 | 3.296 | 0.001 | 0.149 | 6.714 |
| | Job relevance | −0.322 | 0.140 | −0.272 | −2.308 | 0.023 | 0.180 | 5.563 |
| | Image | −0.572 | 0.143 | −0.565 | −4.010 | 0.000 | 0.126 | 7.958 |
| | Experience | 0.460 | 0.089 | 0.378 | 5.164 | 0.000 | 0.467 | 2.143 |
| | Computer self-efficacy | 0.780 | 0.157 | 0.571 | 4.966 | 0.000 | 0.189 | 5.300 |
| | Perceived enjoyment | 0.369 | 0.134 | 0.309 | 2.765 | 0.007 | 0.200 | 4.991 |
| | Voluntariness | −0.392 | 0.115 | −0.322 | −3.424 | 0.001 | 0.283 | 3.536 |

a. Dependent variable: Intention to use

# 4 Discussion

## 4.1 Limitations

The fact that this is a worldwide survey with participation from all continents presents some limits to the final results. Trying to extrapolate a global view of technology acceptance behavior is challenging. The areas that are keener to respond are the ones with a more advanced technological background like Europe and America. Moreover different regional laws, social influences and economic regulations were not taken into account and would be even more difficult to extract useful results in such an attempt. Regional analysis would have to be restricted in the occasion of a survey that would include any of the factors above.

## 4.2 Implications

From this research we can extrapolate both theoretical and practical results. Cloud computing is continually gaining momentum in its adoption in all areas of technology use. Companies use cloud technologies for some years now but there still leys a need for an effective implementation that will result to the maximum gains that they can provide. The theoretical contribution is to provide additional insight as to how Cloud technology is adopted by users thought the analysis of one of the most influential technology acceptance models. The practical implications begin with giving additional knowledge, after the analysis done on the UTAUT2 [10] model, to managers and IT professionals as to how to approach and implement Cloud technologies in their workplace. Furthermore it will give them a better understanding to the challenges that the adoption of cloud technologies entail. Moreover this work has given an extensive analysis of Cloud computing usage and the conditions under which the users adopt Cloud technologies. In addition this investigation has provided and analysis as to how

user experience influences Cloud technology acceptance. The TAM3 model has been validated as an accurate tool to describe the technology acceptance of Cloud computing although not all factors are significant enough to the intention to use and adjustments have to be made. The use of this model is only the second step after the analysis done on the UTAUT2 model in giving a more comprehensive answer to which factors determine Cloud adoption. The analysis of the UTAUT2 and TAM3 models will help in the creation of a definitive model for Cloud technology adoption.

### 4.3 Conclusion

These survey results combined with the UTAUT2 survey results have given us useful data as to how to move forward to the creation of a comprehensive technology acceptance model that will be specific to the adoption of Cloud. Our initial research question "Which factors determine the acceptance of Cloud computing?" can be answered as follows: Intention to use Cloud computing is primarily influenced by the factor of Computer Self Efficacy. Computer self-efficacy is the belief in one's ability to successfully perform a technologically sophisticated new task. It would seem that users in the last few years have become more accustomed to cloud technology use and feel confident to use it effectively. The Image factor was the second most influential factor in the TAM3 model. In the age of social media Image has taken a significant role as to how users think the adoption of a technology will reflect on them. Furthermore the factors of perceived usefulness, perceived ease of use, subjective norm, job relevance, experience, perceived enjoyment and voluntariness played a positive role in the Intention to Use Cloud technologies. Output quality, perception of external control, cloud anxiety and result demonstrability had a negative impact on the adoption of Cloud technologies and can be excluded.

### 4.4 Future Research

This research paper represents the final results of a broad survey for the TAM3 model. This paper is a continuation of the research for a complete technology acceptance model which started with a research paper on the UTAUT2 model [11]. The valuable conclusions and data drawn from the surveys done on the TAM3 and UTAUT2 models in being compiled into a model that will appropriately explain the technology adoption of cloud computing doing away with unnecessary factors used in the above models Further research will include a survey on the new model so as to validate it as a comprehensive technology acceptance model for Cloud Computing and answering the final research question.

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