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Procedia Computer Science 158 (2019) 715–724

Procedia Computer Science

www.elsevier.com/locate/procedia

3rd World Conference on Technology, Innovation and Entrepreneurship (WOCTINE)

# User anxiety as an external variable of technology acceptance model: A meta-analytic study

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**Abstract**

Technology acceptance is an emerging concept which has been researched over the decades. On basis of the prior researches which represented the relationship between the user anxiety and the exogenous variables of technology acceptance model, we conducted meta-analysis to obtain the effect size of the anxiety on perceived usefulness and perceived ease of use. So we used Comprehensive Meta Analysis software program and evaluated 46 articles' correlation scores. Fixed and random effects statistical model were applied to the data. As a result, random effects model was found more relevant to represent the relationship between anxiety and the exogenous variables of technology acceptance model. Findings represented that the average effect size of perceived usefulness and anxiety was small ($\bar{r}$ =-0.139, $p$=0.00), although the effect size of perceived ease of use and anxiety was found medium level ($\bar{r}$ =-0.291, p=0.00) in this study.


Peer-review under responsibility of the scientific committee of the 3rd World Conference on Technology, Innovation and Entrepreneurship

*Keywords:* Technology acceptance model, TAM, perceived usefulness, perceived ease of use,; user anxiety, computer anxiety, meta-analysis

## 1. Introduction

Employees use different systems to carry out their obligations within the organization. These systems are revised or even replaced periodically by new systems due to deficiencies of the current system and advantages offered by the new system. Specifically, accepting technology is important for the employees' adaptation to new technologies and

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1877-0509  Published by Elsevier B.V.
Peer-review under responsibility of the scientific committee of the 3rd World Conference on Technology, Innovation and Entrepreneurship
10.1016/j.procs.2019.09.107

systems. The technology acceptance model defines the adaptation of individuals toward as system or technology [1]. Dimensions of technology acceptance model are usefulness and perceived ease of use and they explain the attitudes and behavioral intention of the users towards employment of any technology or system.

Anxiety is one of the obstacles which hinder to adapt or use a system, technology. Individuals could fell anxiety when they use computers, smart phones or a new systems or technologies. So, present research was designed on the basis of the literature basis of technology acceptance. Evaluating the anxiety as a negative external variable of technology acceptance, we conducted meta-analysis between anxiety and exogenous variables of technology acceptance model (perceived usefulness and perceived ease of use). After assessment of theoretical basis of the concepts, empirical results were reported in this paper.

## 2. Theoretical Framework

### *2.1. Technology acceptance model*

Fred D. Davis [1] put forth technology acceptance model (TAM) explaining the attitudes and behaviors of individuals towards a technological device or system. TAM was developed on the basis of Ajzen ve Fishbein's [2] theory of reasoned action which clarifies the reasons of the behavior of individuals. Furthermore, technology acceptance model illuminates the user's acceptance of any information systems and investigates the determinants of the actual system use. It defines some causal relations which claims that attitude toward using leads to behavioral intention to use and behavioral intention to use leads to actual system use. In addition the dimension of attitude towards using are explained with two exogenous variables, perceived usefulness (PU) and perceived ease of use (PEOU) [3]. Perceived usefulness is defined as the degree to which one believed that using technology would improve the quality of life. Perceived usefulness influences individuals' attitudes and behavioral intention to use of a technology. Perceived ease of use is identified that one believes that using technology does not require any effort. Perceived ease of use also affects individual's attitudes towards the use of technology and their perception of usefulness of a technology [3]

Technology acceptance model was later defined as *"adaptation to information technology innovation"* [4], *"diffusion of innovation"* [5] and *"unified theory of acceptance and use of technology"* [6]. Each model endeavor to explain acceptance or adaptation of individuals toward a technology or system. However, exogenous variables of technology acceptance model are named differently. Perceived usefulness are entitled as "relative advantage" in diffusion of innovation [5] and "performance expectancy" of unified theory of acceptance and use of technology [6] Perceived ease of use are named as "complexity" in diffusion of innovation [5] and "effort expectancy" of unified theory of acceptance and use of technology [6].

### *2.2. Anxiety*

Anxiety is a natural reaction of human body to the stress; in other words, it is a kind of feeling of fear or concern about future. Howard [7] classified the sense of anxiety into three types as trait, state, and concept-specific anxiety. Trait anxiety is a general widespread concern which is experienced by a human throughout his lifetime experience. State anxiety is constructed throughout learning history of individuals and arose in some sensitive occasion. Concept-specific anxiety associates with a particular situation.

On the other hand, in technology acceptance literature, different kinds of anxieties have been defined in recent years, such as technology anxiety, computer anxiety, online shopping anxiety, mobile anxiety etc. Strong and negative emotions may be shown in some situations that occur when interacting with technology, so this means technology anxiety is experienced [8]. According to Leso and Peck [9], computer anxiety can be defined as feeling anxious when using a computer. Factors such as age, gender, ethnicity, previous computer experience, self-efficacy, learning styles lead to computer anxiety. Similar to computer anxiety, mobile anxiety is a concern with mobile technology and its applications. *"With the popularity of smartphones, the smartphone screen is enlarged as lots of users consider the inconvenience of use with small mobile phone screen; larger screens as a computer could display more contents at a time"* [10]. Buying products or services via internet (online shopping) gives a number of advantages to the customers [11]. Nevertheless, customers have various anxieties and problems towards electronic shopping and this kind of

anxiety called as online-shopping anxiety. The most common reason of online-shopping anxiety is security issue related to theft of credit card information [12].

The sense of anxiety emerging from using computer based systems is related negatively to attitude and behavior toward using a technological devices or systems [13,14]. In addition, a meta-analytic research of technology acceptance indicated that anxiety was evaluated as an external variable of unified theory of acceptance and use of technology [15]. One of the studies conducted on elderly users showing anxiety toward a technology was examined in a health care service system in China and its implications were that technology anxiety effects negatively perceived ease of use and perceived usefulness [16]. Another study, which was done in a digital library context, indicated that users computer anxiety and their perception of ease of use the system are negatively related [17]. So we suggested the following hypotheses:

Hypothesis 1: Anxiety is negatively associated with perceived usefulness.
Hypothesis 2: Anxiety is negatively associated with perceived ease of use.

## 3. Method

### *3.1. Literature search*

In order to obtain the sufficient and adequate data within the scope of technology acceptance and anxiety of individuals toward a system, present researchers conducted a literature search in April 2019. Search terms were determined on the basis of technology acceptance literature. Authors limited the search to peer review journal and English language articles. In the SCOPUS databases within the title, abstracts and keywords, we searched the terms of exogenous variables of technology acceptance model [perceived usefulness (relative advantage, performance expectancy), perceived ease of use (complexity, effort expectancy)] with anxiety and attained 842 articles. Afterwards, quotation marks were used to search whole concepts and two searches within "title, abstracts and keywords" of the articles carried out as the following:

- In the first search row "perceived usefulness" OR "relative advantage" OR "performance expectancy" OR "perceived ease of use" OR "complexity" OR "effort expectancy" were written using quotation marks and "OR" conjunction.
- In the second row "anxiety" was typed and these two groups (rows) of keywords using the "AND" conjunction were searched.

The search results revealed that 81 articles met the criteria that we defined before. Then we scanned the articles whether they had quantitative results (i.e. correlation, mean, standard deviation, t-test) and obtained 46 articles which were established for coding. Detailed information of the articles included meta analysis in this study were given in Table 3 in Appendix A. 27 of 46 articles had correlation scores between perceived usefulness and anxiety and 31 of them had the correlation scores between perceived ease of use and anxiety.

### *3.2. Meta-analysis Procedures*

Theoretical characteristics (conceptualization and measurement instruments of perceived usefulness, perceived ease of use and anxiety), demographic characteristics (gender, occupation, countries of the sample) and methodological characteristics (correlation scores, means, standard deviations, Cronbach's alpha values of the scales) of the relevant 46 papers were coded. Correlation scores between PU and anxiety were separated from the correlation scores of PEOU and anxiety and meta-analyses were done the two different data one by one. We followed the meta-analytic procedures of Cooper and Hedges [18] and Lipsey and Wilson [19]. Correlation coefficients and sample size were used to determine the effect size. *"Ficher's Z-transformed correlations were weighed with sample size, and then weighed coefficients were summed and divided by sum of weights"* [20]. So true population correlation was obtained and effect sizes were computed by using Comprehensive Meta-analysis software program.

*3.2.1. Tests for outlier and publication bias*

On the basis of Geyskens et al. [21] recommendations of outliers, we evaluated the forest as well as funnel plots. Fisher's Z scores of perceived usefulness and anxiety relation was illustrated in Fig.1.(a) and perceived ease of use and anxiety was illustrated in Fig.1.(b). Both plots indicated an outlier study included meta-analysis, as seen in the right side of the funnel on each diagram illustrated in Fig.1.(a) and Fig.2.(b).

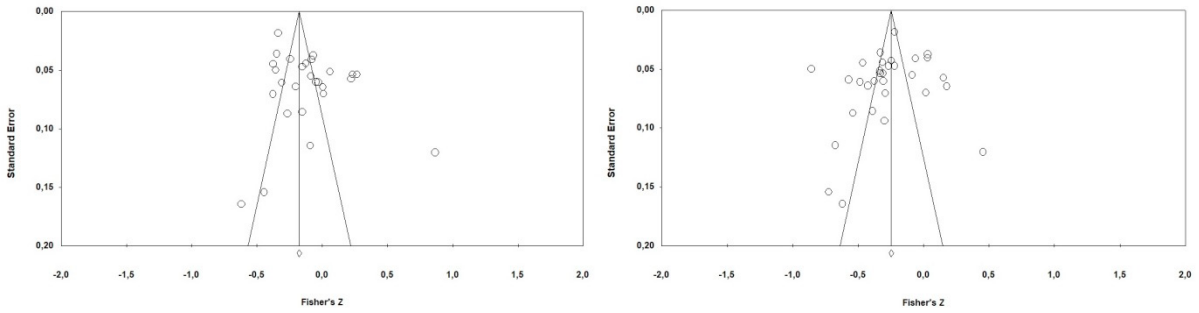


Fig. 1. (a) Funnel Plot of Perceived Usefulness and Anxiety; (b) Funnel plot of Perceived Ease of use and Anxiety.

The outlier study was removed the data and then the effect size scores were evaluated as seen in Table 1 representing the fixed as well as random effect models effect size estimation. Both effect size scores of fixed and random effect models increased after the outlier study eliminated the sample of meta-analysis, so this study was removed.

Table 1. Evaluation of the outlier study removing

| **Effect size (r̄)** | **PU and Anxiey (r̄)** | **PEOU and Anxiety (r̄)** |
|---|---|---|
| Fixed effect model (before outlier study removing) | -0.173 | -0.241 |
| Fixed effect model (after outlier study removing) | -0.179 | -0.245 |
| Random effect model (before the outlier study removing) | -0.109 | -0.272 |
| Random effect model (after the outlier study removing) | -0,139 | -0.291 |

Publication bias is evaluated whether researchers tend to not report non-significant results or overstate the effect size in meta-analysis [22]. In order to control publication bias, funnel plot and Begg and Mazumdar rank correlation results could be evaluated [23]. All studies included in meta-analysis are expected to allocate around the line of zero-point on funnel plot, but Kendal S statistics' scores of Begg and Mazumdar rank correlation enables researcher to interpret significance of results. If Kendal's S statistics rejects the null hypothesis (Keχndal Tau's coefficient is non-significant), the results can interpret no publication bias in the meta-analytic study [19].

In present study, Tau's coefficient were non-significant for PU and anxiety ($p=0.63>0.05$) and also non-significantfor PEOU and anxiety ($p=0.07>0.05$). Following the results represented in Table 2, we could conclude there was no publication bias of our study.

*3.2.2. Q statistics: Effect size variability across studies*

The meta-analysis procedure generates the primary effect results for corrected and uncorrected correlation scores. The uncorrected correlation coefficients are estimated using sample-size weighted correlation scores; on the contrary, the corrected correlations are estimated using sample-size weighted Fischer's Z-transformation correlation scores. In order to stabilize variance, Ficher's Z transformation is used and it enables variance of Z to remain constant for all values of the population of the correlation coefficient [19]. On the basis of corrected Fisher's Z-transformation with 95% confidence internals, the corrected standard deviation could be estimated.

Some procedures of the meta-analysis recommends fixed and random effects model. True effect size is estimated on the basis of the samples of each study. Fixed effect model assumes that the effect size for each study has the same

effect to estimate the true effect size. Furthermore, all other factors which influence the effect size are the same for each study included to meta-analysis. So the true effect size entitled as "fixed effect" will be the same for each study in the meta-analysis [24]. However, a number of factors, such as measurement instruments using to measure the relevant concepts and ages, occupations or genders of the sample influence the effect size of each study included to meta-analysis. Therefore, random effect model assumes that true effect sizes are normally distributed [25] In order to make decision to which model should be used, Q statistics are evaluated. *"The Q statistics measure whether data suggest that the effect sizes of different studies estimate the same population effect size"* [19]. If Q statistic is non-significant, fixed effect model is relevant; otherwise, significant results represent random effect model is appropriate for the studies included to meta-analysis.

Table 2. Heterogeneity, overall meta-analytic results and publication bias

| | PU and Anxiey | *p(sig.)* | PEOU and Anxiety | *p(sig.)* |
|---|---|---|---|---|
| Sample size | 11345 | | 12746 | |
| Number of effect sizes | 26 | | 30 | |
| **Effect Size ($\bar{r}$)** | | | | |
| Fixed effect model | -0.179 | 0.00 | -0.245 | 0.00 |
| Random effect model* | -0,139 | 0.00 | -0.291 | 0.00 |
| **Heterogeneity** | | | | |
| Q statistics ($X/df^2$) | 397.460/25 | 0.00 | 527.789/29 | 0.00 |
| **Publication Bias** | | | | |
| Tau S Statistics (tau coef.) | -0.06858 | 0.63 | -0.17849 | 0.07 |
| **95% CIs** | | | | |
| Lower | -0.215 | | -0.360 | |
| Upper | -0.062 | | -0.218 | |

In present study, we conducted a meta-analysis to obtain the effect size of PU and anxiety first. Table 2 represented a significant result of Q statistics ($X^2$=397.460/$df$=25), so the random effect model is appropriate and the random effect size could be reported in this study. In addition, the effect size of PU and anxiety are negative and significant ($\bar{r}$ =-0.139, $p$=0.00). The effect size results differentiated from -0,215 to -0.062 at the 95% confidence interval, and the interval was not include the zero point. In terms of Cohen's (1988) effect size classification, the effect size of PU and anxiety was small in this study. So hypothesis 1 was supported.

Afterwards, meta-analysis was done to acquire the effect size of PEOU and anxiety. As seen in Table 2, Q statistic was significant ($X^2$=527.789/$df$=29), and we used random effect model to interpret effect size of relevant constructs. Average effect size of PEOU and anxiety was medium level ($\bar{r}$ =-0.291, $p$=0.00), according to Cohens's (1998) effect size classification. The effect size results are between -0.360 and -0.218 at 95% confidence interval, in addition to not including zero point. As a result, hypothesis 2 of this study was supported.

## 4. Conclusion

The technology acceptance model defines the adaptation of individuals toward as system or technology; on the contrary, anxiety is an obstacle to hampered to adapt or use a system or technology. As soon as individuals use computers, smart phones or a new systems or technologies, many of them suffer from the anxiety. So anxiety could be examined as a negative antecedent of technology acceptance model. On the basis of the empirical findings of prior researches, we evaluated the relationship between anxiety and the dimensions of technology acceptance model, especially exogenous variables (perceived usefulness and perceived ease of use).

Empirical data from relevant 46 articles (correlations, means, standard deviations) were used in meta-analysis. Correlation scores between perceived usefulness and anxiety were separated from the correlation scores of perceived ease of use and anxiety, and the meta-analyses were done to the two different data one by one. Publication bias was

controlled with funnel plot and Kendal Tau's coefficient, so no publication bias was found. Afterwards, Q statistics was examined in order to make decision to relevant model for the effect size estimation. Each analysis of perceived usefulness and anxiety as well as perceived ease of use and anxiety showed that random effects model were appropriate to interpret the both effect sizes. Results were indicated that the effect size of perceived usefulness and anxiety was small, but perceived ease of use and anxiety was medium level. So it could be interpreted that any type of anxiety may lead to perceive that any technology or system is not easy to use even if it was designed user friendly.

A meta-analytic research of technology acceptance indicated that anxiety was evaluated as an external variable of unified theory of acceptance and use of technology in 10 out of 22 studies [15]. However, this study was not reported any effect size estimation between the variables of technology acceptance model and anxiety. So present study have took Diwivedi et al.'s [15] study a step further and confirmed anxiety as a negative antecedent of technology acceptance model .

Present research has some limitation, such as searching only the SCOPUS databases and scarce relevant studies, evaluating only two variables of technology acceptance model with anxiety and not analyzing moderator analyses. Further research could be designed to overcome those limitations. So, other databases could be included to the study and then the number of papers will be increases. Furthermore, other variables of technology acceptance model (attitude, intention and behavior towards using) may be evaluated and moderator analysis might be conducted so that the variability of the effect sizes could be explained.

## Appendix A.

Table 3. Relevant studies included in the sample of this research

| Study | Sample size | Country of study | Type of anxiety | Sample characteristics |
|---|---|---|---|---|
| Article1 [26] | 279 | China | Technology anxiety | Potential MCDMS service participants |
| Article 2 [27] | 500 | Turkey | Technology anxiety | Customers |
| Article 3 [28] | 40 | USA | Computer anxiety | Undergraduate students |
| Article 4 [29] | 2904 | Turkey | Computer anxiety | Pre-service teachers |
| Article 5 [30] | 134 | Australia | UGIS-specific anxiety | Australian universities |
| Article 6 [31] | 612 | India | Online shopping anxiety | Respondents from 12 different cities |
| Article 7 [32] | 350 | USA | Computer Anxiety - Fear | Students of various business majors |
| Article 8 [33] | 350 | USA | Computer anxiety - Confidence | Students of various business majors |
| Article 9 [34] | 380 | Taiwan | Mobile anxiety | Participants from Taipei (212) and Kaohsiung (168) |
| Article 10 [35] | 306 | Indonesia | Computer anxiety | Individuals who had taken at least one e-learning course |
| Article 11 [36] | 204 | China | Technology anxiety | |
| Article 12 [37] | 278 | Turkey | Online shopping anxiety | Actual online shoppers |
| Article 13 [38] | 139 | An Asian Country | Computer anxiety | Senior citizens |
| Article 14 [39] | 79 | Brazil | | Brazilian operations managers |
| Article 15 [40] | 449 | Unknown | Technology anxiety | The PSA user and the nonuser |
| Article 16 [41] | 189 | Unknown | Anxiety | |
| Article 17 [42] | 116 | USA | computer anxiety | Users of electronic spreadsheets |
| Article 18 [43] | 290 | Korea | Computer anxiety | Online users older than 50 years of age |
| Article 19 [44] | 355 | USA | Computer anxiety | Two different age groups: young adults and senior citizens |
| Article 20 [45] | 211 | USA | Computer anxiety | Two different age groups: young adults and senior citizens |
| Article 21 [46] | 332 | Iran | Technology anxiety | employees from Iranian sports organizations |
| Article 22 [47] | 273 | Greece | Anxiety | study participants |

| | | | | |
|---|---|---|---|---|
| Article 23 [48] | 242 | UK | Computer anxiety | undergraduate student |
| Article 24 [49] | 546 | Turkey | Anxiety | blue-collar workers |
| Article 25 [50] | 510 | Turkey | Anxiety | Turkish EFL learner |
| Article 26 [51] | 770 | Saudi Arabia | Anxiety | Users of cloud computing |
| Article 27 [52] | 72 | Canada | Computer anxiety | Estonian college student |
| Article 28 [53] | 408 | Saudi Arabia | Computer anxiety | students |
| Article 29 [54] | 246 | USA | Computer anxiety | Employees |
| Article 30 [55] | 128 | Turkey | Mobile anxiety | Physicians |
| Article 31 [56] | 714 | Azerbaijan | Computer anxiety | Users of e-learning in Khazar University and the Baku State University |
| Article 32 [57] | 282 | Belgium | Anxiety | Flemish licensed or qualified caregivers |
| Article 33 [58] | 71 | USA | Computer anxiety | Students |
| Article 34 [59] | 600 | Spain | Anxiety | Individuals over 16 years old |
| Article 35 [60] | | Unknown | | |
| Article 36 [61] | 578 | Finlandiya | Computer anxiety | Older consumers (aged 60-79) |
| Article 37 [62] | | | | |
| Article 38 [63] | 450 | Finland | Computer anxiety | Users from 68 top companies from Finland |
| Article 39 [64] | 402 | Taiwan | Computer anxiety | Junior high school teachers |
| Article 40 [65] | 206 | Taiwan | Computer anxiety | |
| Article 41 [66] | 287 | Greece | Computer anxiety | Employees |
| Article 42 [67] | 207 | Taiwan | Statistics anxiety | Online MBA students |
| Article 43 [68] | 228 | Taiwan | Computer anxiety | The departments of nursing of five universities |
| Article 44 [69] | 45 | Holland | Computer anxiety | Chinese participants in an executive MBA program |
| Article 45 [70] | 114 | Canada | Anxiety | Students |
| Article 46 [71] | 147 | UK | Computer anxiety | Undergraduates |

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