*SOCIETY. INTEGRATION. EDUCATION*
*Proceedings of the International Scientific Conference. Volume V, May 24th -25th, 2019. 525-549*

# TOWARDS EXTENDING THE ORIGINAL TECHNOLOGY ACCEPTANCE MODEL (TAM) FOR A BETTER UNDERSTANDING OF EDUCATIONAL TECHNOLOGY ADOPTION

**Vilma Sukackė**
Kaunas University of Technology, Lithuania

***Abstract.*** *Technology acceptance model (TAM) is arguably the most widely used intention theory that explains the individual's acceptance of a certain technology. Since Davis introduced TAM in 1986, it has been applied and validated in a variety of disciplines, including educational sciences. However, scholars note that depending on a specific context, the original TAM needs to be extended, which has been done by introducing external variables and other theories. Despite the existent TAM2 and TAM3, numerous scholars still opt for the original TAM, extending it with the variables and theories that are relevant to the specific context of their study. The aim of the present paper is to provide an overview of validated TAM extensions, which might later help to further the understanding of educational technology acceptance, which is a prerequisite of its adoption. Since interdisciplinarity in various contexts is becoming more and more common, the overview presents TAM extensions that come from a number of different disciplines. The overview is based on 108 papers that were retrieved from the Web of Science (Clarivate Analytics) by searching for the keywords 'extended Technology Acceptance Model', 'extended TAM', and 'TAM extension'.*
***Keywords:*** *Technology acceptance model, TAM, extended TAM, technological innovations in education.*

## Introduction

Technologies are omnipresent and are constantly being developed or upgraded to improve different walks of life. Despite their innovativeness, some Information and Communication Technologies (ICTs) have a very short span of popularity and soon become obsolete. In other words, they are not accepted by the users in a way that they would adopt them, or continue using them in the future. Over the last five decades, such processes have increasingly attracted the attention of numerous scholars. There have been various attempts to propose a model that would explain users' acceptance and sustained use of a particular ICT. One of the most widely used intention theories is Technology Acceptance Model devised by Davis in 1986 (Lai, 2017; Bhatiasevi & Naglis, 2016). The purpose of the model is to explain a user's acceptance of computer technology.


*http://dx.doi.org/10.17770/sie2019vol5.3798*

According to Newell (2014), changes in technology as well as socio-economics, politics, human potential, and paradigms also influence the way the society learns. The living conditions of the current society are greatly influenced by the Industry 4.0, which is presently shifting into Industry 5.0 (Schwab, 2016). Therefore, it becomes evident that educators need to create educational environments which would prepare learners for operating in dynamic contexts that are powered by technological innovation (Janiūnaitė, 2004). It is only natural that such educational environments are inseparable from technology. However, technology itself as well as the process of its adoption often becomes an innovation to the different stakeholders that might be involved in the teaching and learning processes. In Diffusion of Innovation Theory, Rogers (1962) explains that in terms of implementing innovation, innovation adopters can be classified into innovators, early adopters, early majority, late majority, and laggards (Rogers, 2010). It can be claimed that TAM is closely related to the very first stages of innovation adoption. More precisely, it can be stated that acceptance is one of the prerequisites of innovation adoption and sustained use of, for instance, educational technology.

It is important to note that the first version of TAM was not infallible, thus there have been several different editions introduced in 1989 (TAM, by Davis, Bogozzi, & Warshaw), 2000 (TAM2, Venkatesh, & Davis), 2003 (UTAUT, Venkatesh, Morris, Davis, & Davis), and 2008 (TAM3, Venkatesh, & Bala). The aforementioned versions of TAM were validated and tested longitudinally in different contexts (e.g. education, business, medicine, etc.) and by focusing on different technology users (e.g. educators, learners, customers, etc.). Nevertheless, there are scholars who believe that the list of important variables might be inexhaustible depending on the specific research area and context. Due to its relative simplicity, TAM as a model on its own has received considerable criticism (Teo, Dolek, & Bozelais, 2018; Rigopoulou, Chaniotakis, & Kehiagias, 2017; Bhatiasevi & Naglis; 2016; Muthitcharoen, Palvia, & Grover, 2011). As ICTs permeate and indubitably influence other existent scientific fields and research is becoming more and more interdisciplinary, the original TAM becomes too limited, thus scholars combine it with additional variables, models, and theories.

There exist numerous overviews of TAM as well as its comparison to other intention theories. However, the novelty of the present paper lies in providing an overview of the extensions to the original TAM that were validated in different contexts by scientists who represent a variety of disciplines. The overview is carried out by analyzing research papers from various disciplines that were published in the span of 1997 to 2018 and are available on the Web of Science (Clarivate Analytics). The results that are described in the present paper can serve

as a basis for developing an extended TAM for a better understanding of educational technology adoption.

**The aim and scope.** The present paper aims to provide a concise overview of the means to extend the original TAM, which might later help to further the understanding of educational technology acceptance, it being a prerequisite of its adoption. The aim is achieved by analyzing empirical research papers. To meet the abovementioned end, several objectives were formulated. They are the following: (i) to reveal what variables are introduced to extend the original TAM, and (ii) to indicate what other intention theories and models are used to extend the original TAM.

## Methods

The current overview is based on a total of 108 scientific papers that were published between 1997 and 2018. The papers were retrieved in November 2018 from Web of Science (Clarivate Analytics) by searching for the following keywords: 'extended Technology Acceptance Model', 'extended TAM', and 'TAM extension'. The platform was chosen because it is highly valued in various scientific communities and gives access to "world-class research literature linked to a rigorously selected core of journals" (clarivate.com). The search results of the aforementioned keywords returned 120 scientific papers. However, twelve of them were excluded from the present overview as they were literature reviews or theoretical papers with no empirical data to support and validate the proposed model extensions. Later, the collected papers were categorized according to the date of publication, scientific field, TAM extension, and results.

## The structure of the paper

The following section briefly introduces the different editions of TAM and explains what key variables are present in each version. After that, the results of the analysis are presented. The analysis section is followed by conclusions.

## Historical Development of Technology Acceptance Model (TAM)

Technology Acceptance Model (TAM) was first proposed by Davis (1986) in his PhD thesis. Davis mostly based TAM on Theory of Reasoned Action (TRA) (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975) as well as previous research and models that originate in intention theories and, for instance, marketing literature with the aim to

> *improve our understanding of user acceptance processes, providing new theoretical insights into the successful design and implementation of information systems. . . TAM should provide the theoretical basis for a practical "user acceptance testing"*

> *methodology that would enable system designers and implementors to evaluate proposed new systems prior to their implementation. (1985, 7).*

Figure 1 depicts the original TAM. As one can see, Davis (1986) suggested testing the relationship between the variables related to (i) design features as well as (ii) cognitive, and (iii) affective response in order to predict the behavioural response. As Davis (1986) explains, the first set of variables refer to *alternative systems* (p. 24). The second set of variables contain *perceived usefulness* and *perceived ease of use*. Both of them are conceptualized by using Ajzen and Fishbein's (1977) definitions. The former is said to refer to "the degree to which an individual believes that using a particular system would enhance his or her job performance," whereas the latter is explained as "the degree to which an individual believes that using a particular system would be free of physical and mental effort" (Ajzen & Fishbein, 1977, as cited in Davis, 1986, 26).

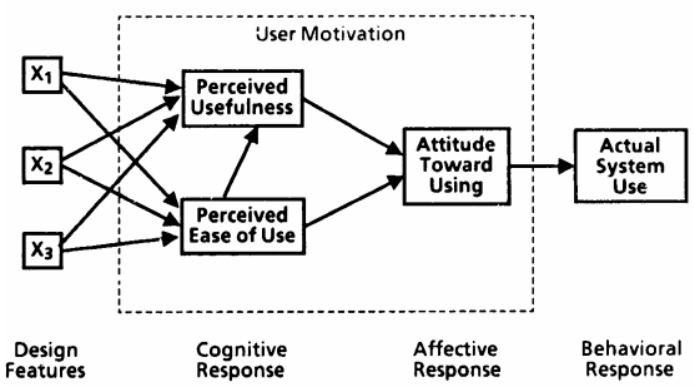


*Figure 1* ***The original Technology Acceptance Model*** *(Davis, 1986, 24)*

In a paper published in 1989 and co-authored by Davis, Bogozzi, and Warshaw, TAM is slightly modified. Firstly, instead of *unspecified design features*, it includes *external variables*. Secondly, it introduces *behavioural intention to use*, which is directly influenced by *perceived usefulness* and *attitude toward using*. However, these are not the final changes that were made to the original TAM model.

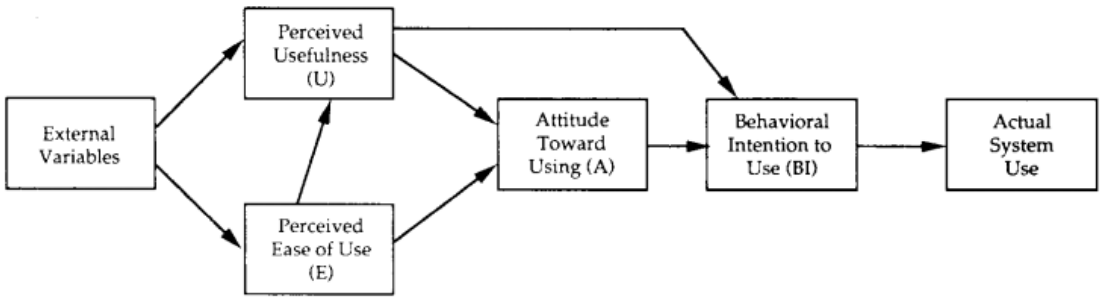


*Figure 2* ***The improved Technology Acceptance Model***
*(Davis, Bogozzi, & Warshaw, 1989, 985)*

The final version of the original TAM was presented by Venkatesh and Davis in 1986. In the model, the factor of *attitude toward using* was removed. Venkatesh (2000, 343) explains that the latter was done because the link between *attitude* and other variables was deemed to be too weak. It should also be noted that the finalized model that can be seen in Figure 3 below precisely indicates the *external variables*, which are the following: *system characteristics*, *training*, *user involvement in design*, and *the nature of the implementation process* (Venkatesh & Davis, 1996, 453).

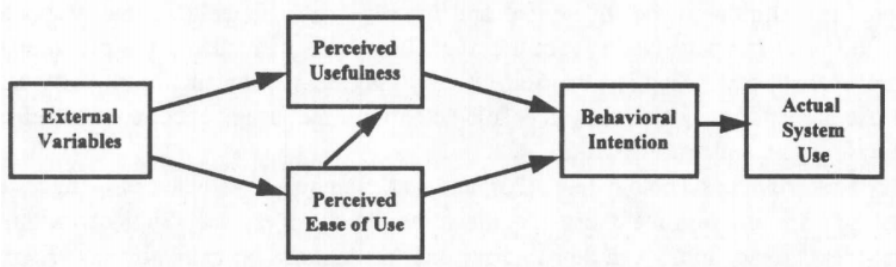


*Figure 3* ***The finalized Technology Acceptance Model*** *(Venkatesh & Davis, 1986, p. 453)*
*Source: Venkatesh, V., & Davis, F.D. (1996). A model of the antecedents of perceived ease of use: Development and test. Decision Sciences, 27(3), 451-481.*

In 2000, Venkatesh and Davis proposed an entirely new version of TAM, namely TAM2. As can be seen in Figure 4, TAM2 includes the finalized version of TAM. However, instead of the aforementioned *external variables* present in the finalized original TAM, TAM2 opts for such constructs as *subjective norm, image, job relevance, output quality,* and *result demonstrability; voluntariness* and *experience* are added as the moderating drivers (Venkatesh & Davis, 2000, 188). In other words, to explain the usage of a particular piece of technology, TAM2 takes into account the influence of the social and cognitive instrumental processes (ibid.). As Venkatesh and Davis (2000, 187) note, the constructs come from TRA (Fishbein & Ajzen, 1975) and Theory of Planned Behavior (TPB) (Ajzen, 1991). Moreover, they are defined along the same lines as in TRA and TPB. Due to the limiting format of the paper, the reader is kindly encouraged to explore the definitions that are provided in the original papers by Fishbein and Ajzen (1975), Ajzen (1991) or Venkatesh, Morris, Davis, and Davis (2003).

Several years later, in 2003, Venkatesh, Morris, Davis, and Davis presented the scientific community with one more edition of Technology Acceptance Model. It is called the Unified Theory of Acceptance and Use of Technology (UTAUT). The main aim of proposing such a framework was to combine the existent models into one that can explain an individual's intention to use and the actual usage of information technologies (Venkatesh et al., 2003, 467). As is evident from Figure 5, the two central concepts of TAM, namely, *perceived usefulness* and *ease of use* are removed, and so are *system characteristics,*

*training*, *user involvement in design*, *the nature of the implementation process*, *subjective norm*, *image*, *job relevance*, *output quality*, and *result demonstrability*. The new introduced variables are *performance* and *effort expectancy*, *social influence*, and *facilitating conditions*; two new moderating drivers are added, namely, *gender* and *age*.

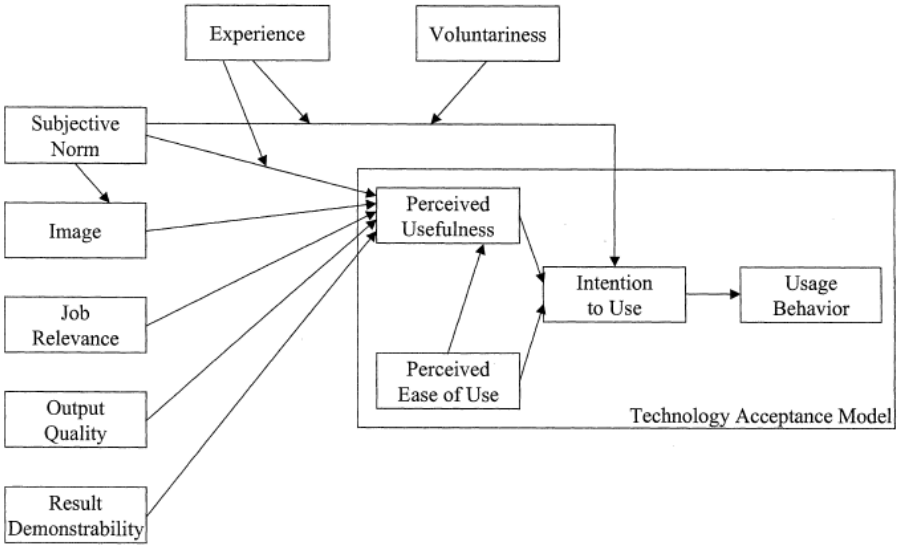


*Figure 4* ***Technology Acceptance Model 2 (TAM2)*** *(Venkatesh & Davis, 2000, 188)*

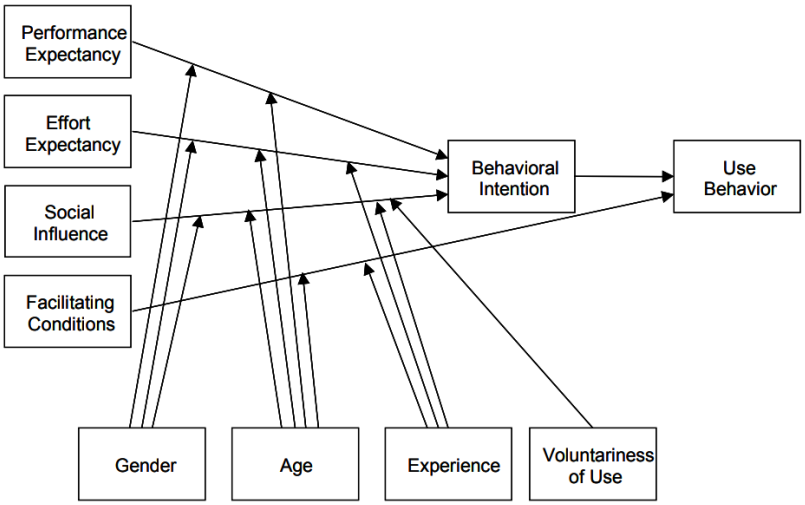


*Figure 5* ***The scheme of the Unified Theory of Acceptance and Use of Technology (UTAUT)*** *(Venkatesh, Morris, Davis, & Davis, 2003, 447)*

The most recent update of TAM2 ir referred to as TAM3. It is comprised of the earlier explained TAM2 and the model of the Determinants of perceived ease of use that was developed by Venkatesh in 2000. The six determinants are the following: *computer self-efficacy*, *perception of external control*, *computer anxiety*, *computer playfulness*, *perceived enjoyment*, and *objective usability* (Venkatesh, 2000, 279). Venkatesh and Bala (2008, 280) note that the thick lines

in Figure 6 signify the new proposed relationships that are present in TAM3. In other words, "experience. . .[moderates] the relationships between (i) *perceived ease of use* and *perceived usefulness*; (ii) *computer anxiety* and *perceived ease of use*; and (iii) *perceived ease of use* and *behavioral intention*" (Benkatesh & Bala, 2008, 281).

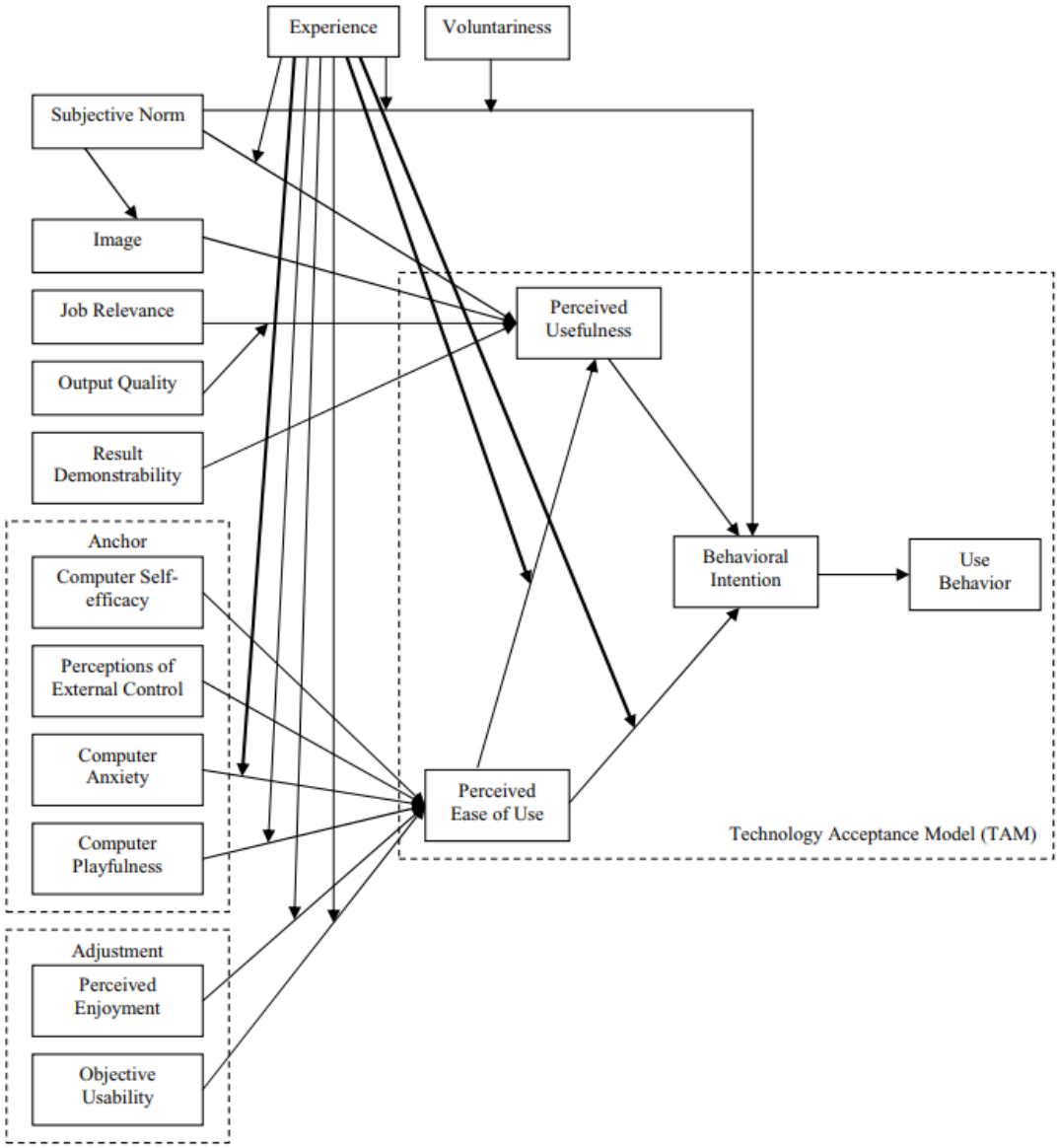


*Figure 6* ***Technology Acceptance Model 3 (TAM3)*** *(Venkatesh & Bala, 2008, 280)*

Table 1 provides a concise view of the variables that are present in all of the discussed editions of Technology Acceptance Model and are said to influence an individual's intention to use an ICT and its actual usage. The constructs that overlap and those that are unique to each proposed model are marked in different colours.

*Table 1* ***The variables present in all of the editions of TAM. The overlapping variables are marked in different colours*** *(produced by the author of the paper)*

| ***Edition*** | ***Variables*** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **TAM (1986)** | Perceived usefulness | Perceived ease of use | Attitude toward using | Design features | | | | |
| **TAM (1989)** | Perceived usefulness | Perceived ease of use | Attitude toward using | External variables | | | | |
| **TAM (1996)** | Perceived usefulness | Perceived ease of use | External variables | | | | | |
| | | | System characteristics | Training | User involvement in design | The nature of the implementation process | | |
| **TAM2 (2000)** | Perceived usefulness | Perceived ease of use | Voluntariness | Subjective norm | Image | Job relevance | Output quality | Result demonstrability |
| **TAM3 (2008)** | Perceived usefulness | Perceived ease of use | Voluntariness | Subjective norm | Image | Job relevance | Output quality | Result demonstrability |
| | Experience | Computer self-efficacy | Perceptions of external control | Computer anxiety | Computer playfulness | Perceived enjoyment | Objective usability | |
| **UTAUT (2003)** | Performance expectancy | Effort expectancy | Social influence | Facilitating conditions | Gender | Age | Experience | Voluntariness of use |

## Results

As can be seen from Figure 7, the largest share of the papers come from 2017, 2013, 2018, 2009, and 2015. This is an interesting result that indicates the potential limitations of the updated versions of TAM, namely TAM2, TAM3, and UTAUT or any other existent intention theories that might be used in measuring technology acceptance. Since the saturation of the publications during each year is not of prime importance in the present overview, it will not be discussed in further detail. However, one can extrapolate that the steady increase in extended TAM papers signals a call for reconsidering the original TAM as well its previous upgrades.

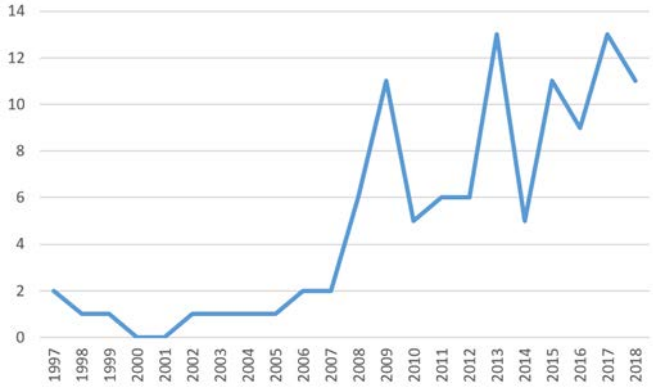


*Figure 7* ***The date and number of publications of the retrieved TAM papers***

The collected papers come from a variety of fields (see Table 2). The three top areas in which extended TAM was applied are education, IT, and business. It should be noted that in many cases, the three areas could be seen as overlapping.

For instance, there exists research that is conducted on the acceptance of a tool meant for training (future) employees of a business entity. However, it was decided to ascribe the collected papers to the field categories according to the focus of the journal in which they were published.

*Table 2* ***The distribution of the papers representing different scientific fields***

| Field | Number of papers |
|---|---|
| Education | 34 |
| IT | 27 |
| Business | 17 |
| Medicine | 8 |
| Marketing | 6 |
| Management | 5 |
| Telecommunication | 4 |
| Automation | 2 |
| Sustainability | 1 |
| Tourism | 1 |
| Library studies | 1 |
| Engineering | 1 |
| Agriculture | 1 |

After a careful inspection of TAM extensions that were indicated in the collected papers, the author of the present paper noticed several unanticipated tendencies. Firstly, even though the finalized version of TAM (1996) excluded the construct of attitude that was present in the previous versions of the model, a large share of the collected papers reintroduced it. Moreover, different aspects and levels of attitude were indicated, for instance, *attitude (toward use / toward service / strength)* (Altanopoulou & Tselios, 2017; Lee et al., 2017; Alnajjar, 2017; Teo, 2016; Govender & Rootman le Grange, 2015; Chin & Lin, 2015; Lin et al., 2015; Kitchen et al., 2015; Rawashdeh, 2015; Shim & Oh, 2015; Cegarra-Navaroo et al., 2013; Rackers et al., 2013; Bere & Rambe, 2013; Chang et al., 2012; Lee et al., 2012; Ghazizadeh et al., 2012; Lee et al., 2012; Egea et al., 2011; Sternad et al., 2011; Alenezi et al., 2010; Liu et al., 2009; Al-Harby et al., 2009; Kim et al., 2009; Qi et al., 2009; Alshare et al., 2009; Shin, 2008; Ha et al., 2007; Di Bendetto et al, 2003; Chen et al., 2002; Jackson et al., 1997). It can be suggested that attitude can be related to the constructs of perception / consciousness / awareness, which were found in the papers of Dutta et al., 2018; Naspetti et al., 2017; Govender et al., 2015; Nasir & Yurder, 2015; Bao et al., 2013, Salajan et al., 2011; Egea et al., 2011; Liu et al., 2009; Al-Khateeb, 2007; Gefen & Keil, 1997; and Jackson et al., 1997.

*Table 3* ***TAM2 and TAM3 variables found in the collected papers***

| **Shared TAM2 and TAM3 variables** | | **Purely TAM3 variables** | |
|---|---|---|---|
| **Variable** | **Sources** | **Variable** | **Sources** |
| *job relevance* | Bhatiasevi and Krairit, 2013; Son et al., 2012; Zhang et al., 2008 | *(perceived) playfulness* | Dumpit and Fernandez, 2017; Shim and Oh, 2015 |
| *output quality* | Bhatiasevi and Krairit, 2013; Shan et al., 2008 | *(perceived) enjoyment / joy / arousal / satisfaction* | Nagy, 2018; Alalwana et al., 2018; Chang and Chen, 2018; Balouchi et al., 2017; Abdullah et al., 2016; Barhoumi, 2016; Chin and Lin, 2016; Lowry et al., 2013; Lee at al., 2012 |
| *result demonstrability* | Bhatiasevi and Krairit, 2013; Son et al., 2012 | *Corporate / social image* | Chang and Chen, 2018; Guardia er al., 2011; Stern et al., 2008 |
| | | *(perceived) (technology / computer / online/system / service) self-efficacy* | Dutta et al., 2018; Huang, 2016; Barhoumi, 2016; Bhatiasevi and Naglis, 2016; Abdullah et al., 2016; Govender and Rootman le Grange, 2015; Al-Azawei and Lundqvist, 2015; Tarhini et al., 2014; Al-Mushasha, 2013; Bao et al., 2013; Tarhini et al., 2013; Sternad et al., 2011; Ahmad et al., 2010; Alenezi et al., 2010; Irani et al., 2009; Lau and Woods, 2009; Cho et al., 2009; Hernandez et al., 2009; Al-Harby et al., 2009; Shih and Huang, 2009; Tseng and Hsia, 2008; Lee, 2006 |
| | | *(technology / computer) anxiety* | Oh et al., 2016; Abdullah et al., 2016; Calisir et al., 2014; Sternad et al., 2011; Al-Ammary, 2010; Alenezi et al., 2010; Shih et al., 2009; Shan et al., 2008 |

Secondly, as was mentioned in the previous sections, the papers for the analysis were retrieved by looking for the following keywords: 'extended Technology Acceptance Model', 'extended TAM', and 'TAM extension'. TAM2 and TAM3 were purposefully not included as the aim of the present paper is to reveal the means to extend the original TAM so they can be used to build a model that would help to better comprehend the adoption of educational technology. However, after having determined the additional variables, it was evident that a number of papers included variables from TAM2 and TAM3 (see Table 3) as well as UTAUT without acknowledging that they are actually conducting research by already using the existent extended TAMs.

The following UTAUT variables were also found:

- *social norms / social influence / social context* (Chang & Chen, 2018; Patel & Patel, 2018; Altanopoulou & Tselios, 2017; Lwoga & Lwoga, 2017; Rigopoulou et al., 2017; Tarhini et al., 2014; Tan et al., 2014; Tarhini et al., 2013; Son et al., 2012; Sternad et al., 2011; Irani et al., 2009), and
- *facilitating conditions* (Altanopoulou & Tselios, 2017; Alnajjar, 2017; Kabir et al., 2017; Tarhini et al., 2013; Asua et al., 2012; Zhang et al., 2008).

Finally, such moderating TAM2, TAM3, and UTAUT drivers as

- *age* (Werber et al., 2018; Gupta & Jain, 2015; Tarhini et al., 2014; Ahmad et al., 2010; Cho et al., 2009; Ha et al., 2007),

- *gender* (Dutta et al., 2018; Lwoga & Lwoga, 2017; Gupta & Jain, 2015; Al-Azawei & Lundqvist, 2015; Tarhini et al., 2014; Tan et al., 2014; Bao et al., 2013; Ahmad et al., 2010; Cho et al., 2009; Al-Harby et al., 2009; Saed & Abdinnour-Helm, 2008; Gefen & Straub, 1997), and
- *(previous / computer/tool / Internet / online flow / service) experience* and *usage* (Teo et al., 2017; Abdullah et al., 2016; Tarhini et al., 2014; Shin et al., 2013; Cha, 2013; Rackers et al., 2013; Sternad et al., 2011; al-Ammary, 2010; Alenezi et al., 2010; Lau & Woods, 2009; Hernandez et al., 2009; Qi et al., 2009; Saeed & Abdinnour-Helm, 2008; Ha et al., 2007; Dishaw & Strong, 1999; Jackson et al., 1997) were also discovered.

Having acknowledged the abovementioned, the remaining of the section will present the different categories of variables that do not belong to TAM2, TAM3 or UTAUT as well as theories and frameworks that were used to extend the original TAM.

## Perceived characteristics

As can be seen in Table 1, in the first three TAM frameworks (incl. the first editions of the original TAM), there are two key perceived characteristics, namely *perceived usefulness* and *perceived ease of use*. The review of the collected papers reveals that depending on the field and context of the research, scholars introduced additional perceived characteristics to extend the original TAM.

*Table 4* ***A classification of the perceived characteristics***

| Affordances | Trust-related | Technology-related | Quality-related | Accessibility-related |
|---|---|---|---|---|
| Resources (Irani et al., 2009) | Trust (Werber et al., 2018) | Attractiveness (Chiang and Chen, 2018) | Quality of expert system (Alshare et al., 2009) | Financial cost (Tan et al., 2014) |
| Internet content (Al-Khateeb, 2007) | Risk (Balouchi et al., 2017; Karavasilis et al., 2016; Zeba and Ganguli, 2016; Nasir and Yurder, 2015; Karjaluoto et al., 2014; Tan et al., 2014; Rackers et al., 2013; Egea et al., 2011; Shin, 2008) | Service level (Liu and Ma, 2004) | Content quality (Calisir et al., 2014) | Reachability (Karjaluoto et al., 2014) |
| Convenience (Bhatiasevi and Naglis, 2016; Bere and Rambe, 2013; Chang et al., 2012) | Security (Patel and Patel, 2018) | Complexity (Ramkumar and Jemani, 2015) | Substitutability (Cha, 2013) | |
| Compatibility (Rigopoulou et al., 2017) | Web privacy (Rawashdeh, 2015) | Processing speed (Kitchen et al., 2015) | Quality of teaching (Salajan et al., 2011) | |
| Network externality (Lee, 2006) / network effects (Kitchen et al., 2015) | (Source) credibility (Balouchi et al., 2017; Lin et al., 2015; Lin et al., 2013) | Developer responsiveness (Gefen and Keil, 1998) | | |
| Behavioural control (Karavasilis et al., 2016; Lin et al., 2015; Cha, 2013; Lin et al., 2013) | Reliability (Alshare et al., 2009) | | | |

The provided classification of the perceived characteristics can be subdivided into five categories (see Table 4), namely, (i) affordances, (ii) trust-related, (iii) technology-related, (iv) quality-related, and (v) accessibility-related features.

## User / consumer characteristics

It can be noted that different editions of TAM include variables that are related to the individual. However, the review of the collected papers reveals that the original TAM lacks more variables that are related to personal characteristics. Scholars from diverse research areas extended TAM with such features as (i) user / consumer learning and cognitive factors as well as (ii) personality-related elements, (iii) values and beliefs, (iv) habitual behaviour, and additional elements related to (v) demographics.

*Table 5* ***A classification of user / consumer characteristics***

| Learning-related and cognitive | Personality-related | Values and beliefs | Habitual behaviour | Demographics |
|---|---|---|---|---|
| Learning styles (Al-azawei et al., 2016; Al-Azawei and Lundqvist, 2015) | Extraversion (Altanopoulou and Tselios, 2017) | Social values (Rigopolou et al., 2017) | Habit (Asua et al., 2013) | Region (Gupta and Jain, 2015) |
| Learning performance (Nagy, 2018) | Agreeableness (Altanopoulou and Tselios, 2017) | Materialistic values (Rigopolou et al., 2017) | User preferences (Kowalewski et al., 2013) | Education / educational level / educational background (Tarhini et al., 2014; Al-Ammary, 2010; Cho et al., 2009; Al-Khateeb, 2007) |
| (ICT/computer) Knowledge (Lwoga and Lwoga, 2017; Melas et al., 2011; AL-Khateeb, 2011) | Personal innovativeness (Lwoga and Lwoga, 2017; Karavasilis et al., 2016; Kitchen et al., 2015; Karjaluoto et al., 2014; Tan et al., 2014) | Internal locus of control (Tseng and Hsia, 2008) | Ritualistic orientation (Cha, 2013) | Income / income level (Zhang, 2013; Al-Ammary, 2010; Al-Khateeb, 2007) |
| Autonomy (Fethali and Okada, 2018) | Risk tolerance (Stern et al., 2008) | Expectations (Fryad and Paper, 2015; Tarhini et al., 2015) | Instrument orientation (Cha, 2013) | |
| Motivation (Lowry et al., 2013; Guardia et al., 2011; Al-Ammari et al., 2011) | Neuroticism (Altanopoulou and Tselios, 2017) | Health concerns (Werber et al., 2018) | Viewing orientation (Cha, 2013) | |
| Intrinsic involvement (Jackson et al., 1997) | Impulsiveness (Stern et al., 2008) | | | |
| Concentration (Lee and Chen, 2010) | Conscientiousness (Altanopoulou and Tselios, 2017) | | | |
| Emotion (Lee et al., 2012; Ha et al., 2007) / valence (Lee et al., 2012) | | | | |
| Curiosity (Lowry et al., 2013) | | | | |
| Openness to experience (Altanopoulou and Tselios, 2017) | | | | |

As was previously mentioned, the largest share of the collected papers report on conducting research in educational contexts. This can explain the extensive list of purely learning-related characteristics as well as other features (see Table 5)

that can be considered important for the learning process – be it formal, non-formal or informal.

## System characteristics

As one of the external variables in the finalized version of TAM, there is the construct of *system characteristics*. However, the characteristics are not specified. In the analysed papers, numerous system characteristics are introduced. They can be categorized along the lines of (i) the basic system features, (ii) quality aspects, (iii) source of challenges, (iv) accessibility, and (v) available support. It should be noted that these categories can also be ascribed to the *facilitating conditions* in UTAUT, which refer to "the degree to which an individual believes that an organizational or technological infrastructure exists to support use of the system" (Venkatesh et al., 2003, 453).

*Table 6* ***A classification of system characteristics***

| System features | Quality aspects | Source of challenges | Accessibility | Available support |
|---|---|---|---|---|
| System characteristics (Lwoga and Lwoga, 2017; Saed and Abdinnour-Helm, 2008) | System quality (Lee et al., 2017; Govander and Rootman le Grange, 2015; Shim and Oh, 2015) | Innovativeness of IT (Zhang et al., 2008) | Accessibility (Zhang, 2013) | Technical support (Govender and Rootman le Grange, 2015; Ramkumar and Jenamani, 2015; Son et al., 2012) |
| Features (Chin and Lin, 2016) | Technical quality (Lau and Woods, 2009) | Technology turbulence (Autry et al., 2010) | Visibility (Bhatiasevi and Krairit, 2013) | System support (Cho et al., 2009) |
| User-centric characteristics (Lwoga and Lwoga, 2017) | Content richness (Barhoumi, 2016) | Technological breadth (Autry et al., 2010) | Trialability (Bhatiasevi and Krairit, 2013) | User manuals functionality (Sternad et al., 2011) |
| System integration (Saeed and Abdinnour-Helm, 2008) | Content quality (Lau and Woods, 2009; Lee, 2006) | Technological complexity (Son et al., 2012) | Free access (Barhoumi, 2016) | Software maintainability (Bhatiasevi and Krairit, 2013) |
| Platform service (Chang and Chen, 2018) | Pedagogical quality (Lau and Woods, 2009) | Service complexity (Oh et al., 2016) | Affordability (Zhang, 2013) | Actionable feedback (Liu et al., 2009) |
| Information system usefulness (Saed and Abdinnour-Helm, 2008) | Information architecture (Barhoumi, 2016) | ICT feature demands (Melas et al., 2011) | (Internet) Cost (Alnajjar, 2017; Al-Khateeb, 2007) | |
| Tool functionality (Dishaw and Strong, 1999) | Information integrity (Egea et al., 2011) | Waiting line (Oh et al., 2016) | Internet availability (Al-Khateeb, 2007) | |
| Software functionality (Abdullah et al., 2016; Bhatiasev and Naglis, 2016; Bhatiasevi and Krairit, 2013) | Publisher's quality (Barhoumi, 2016) | | | |

It can be claimed that the original TAM overlooked a number of important system characteristics. From the elements listed in Table 6, it is evident that for

an ICT to be accepted and used, it is important for it to be truly functional, have all-round quality and accessibility, and if potential challenges might occur, the support element might be essential.

## Interaction with technology

In the collected papers, two types of interactions with technology can be noticed. They can be divided into (i) the general interaction and (ii) relationship with technology.

*Table 7* ***A classification of interaction with technology related elements***

| *Category* | *Variables* | | | | | |
|---|---|---|---|---|---|---|
| **Interaction** | Learner-learner (Nagy, 2018) | Learner-teacher (Nagy, 2018) | Interactivity (Alkali and Abu Mansor, 2017) | Interaction (Nagy, 2018) | Collaboration index (Naspetti et al., 2017) | Communication (Rackers et al., 2013; Sternad et al., 2011) |
| | (Focused) Immersion (Shin et al., 2013; Lowry et al., 2013; Saade and Bahli, 2005) | Situational involvement (Jackson and Leitch, 1997) | Telepresence (Lee and Chen, 2010) | Presence (Shin et al., 2013 | Temporal dissociation (Lowry et al., 2013; Saade and Bahli, 2005) | Time distortion (Lee and Chen, 2010) |
| **Relationship with technology** | (Emotional) attachment (Teo et al., 2018; Teo, 2016) | Citizen engagement (Cegarra-Navarro et al., 2013) | Technology subscription (Gupta and Jain, 2015) | Control (Lowry et al., 2013) | | |

As the elements in Table 7 suggest, when conducting TAM research, it might also be of use to take into account the different existing relationships not only in terms of how much interactivity an ICT allows, but the directions of the interaction as well. The latter is an important aspect especially when one considers ITC use in educational contexts.

## Other external variables

It is natural that people incorporate technology into their daily (esp. professional) lives not only voluntarily. There are numerous external forces that influence individuals to embrace a certain ICT. The column on the left-hand side of Table 8 indicates the variables that stand for the stimuli for change as was discovered in the collected papers. As was already mentioned, support (see the middle column of Table 8) is another important aspect when getting accommodated to using technologies. Finally, one of the key variables of the original TAM, *perceived usefulness*, might be influenced by variables that are related to benefits of using a particular technology (see the right-hand side colum of Table 8).

It should be noted that the elements present in Table 8 might be also seen as the more specific instances of nature of implementation (column 'stimuli for change') in the original TAM or facilitating conditions (column 'support source') in UTAUT.

*Table 8* ***A classification of other external variables***

| Stimuli for change | Support source | Benefits |
|---|---|---|
| External isomorphic pressures (Liu et al., 2008) | Government support (Al-Subari et al., 2018) | Technology benefits (Di Benedetto et al., 2003) |
| Social pressure (Cho et al., 2009) | Top management (Ramkumar and Jenamani, 2015; Son et al., 2012; Shih and Huang, 2009) | Economical benefits (Di Benedetto et al., 2003) |
| Peer influence (Salajan et al., 2011) | University support (Al-Mushasha, 2013) | |
| Argument for change (Jackson and Leitch, 1997) | | |
| Firm-generated information (Lee et al., 2017) | | |
| Policies (Barhoumi, 2016) | | |
| Rules (Barhoumi, 2016) | | |

## Miscellaneous variables

After ascribing all the variables into categories that were presented in Tables 3-8, some elements could only be labelled as miscellaneous. They are the following: *flow*, *task characteristics*, *course attributes*, *business process fit*, *task technology fit*, *quality of work life*, *user-generated information*, *confirmation*, and *individual differences*. Since these variables do not belong purely to perceived characteristics, user / consumer / system characteristics or interaction characteristics, they were not placed into the tables. However, this is not to say that such elements are not at all related to the variables that are present in Tables 3-8.

## Moderating effects

The original TAM does not include any moderating variables. They were introduced in TAM2, TAM3, and UTAUT. As can be seen from Figures 4-6, the moderating drivers are *voluntariness*, *experience*, *gender*, and *age*. All of them except for voluntariness were found after inspecting the collected papers. In addition to them, scholars also introduced such moderators as *specialty*, *education*, *environmental concern*, and *time consciousness*.

## Combination with other theories and frameworks

The variables that were used to extend the original TAM come from a variety of other theories, research frameworks, or literature from a specific discipline. As can be seen from Table 9, the majority of such additions come from marketing literature that explains consumption-related behavior.

*Table 9* ***Examples of theories and frameworks used to extend the original TAM***

| Title | Source examples | Comments |
|---|---|---|
| TAM2 | Karavasilis et al., 2016; Bhatiasevi and Krairit, 2013 | See section *Historical Development of Technology Acceptance Model (TAM)* |
| UTAUT | Altanopoulou and Tselios, 2017; Kabir et al., 2017 | See section *Historical Development of Technology Acceptance Model (TAM)* |
| Innovation Diffusion Theory (IDT) | Rigopoulou et al., 2017; Karavasilis et al., 2016; Bhatiasevi and Krairit, 2013; Zhang, 2013; Chen et al., 2002 | Deals with the following features of innovations: relative advantage, compatibility, complexity, trialability, and observability. |
| Dhammism | Teo et al., 2018 | Adds a Buddhist condition of attachment to explain person-to-object attachment. |
| Self-determination theory (SDT) | Fathali and Okada, 2018 | SDT deals with different types of motivation. |
| Theory of Planned Behavior (TPB) | Rigopoulou et al., 2017; Lin et al., 2015; Lin et al., 2013; Cha, 2013 | Helps to predict individual's behavior. |
| Expectation-Confirmation Theory (ECT) | Shin et al., 2013 | Claims that if an individual is satisfied about previous use of technology, s/he will continue to use it. |
| Expectation Disconfirmation Theory (EDT) | Cho et al., 2009 | Helps to explain the individual's choice (not) to use technology after having used it and weighed all pros and cons. |
| Consumption Theory | Zhang, 2013 | Deals with how individuals make decisions of consumption. |
| Consumer motivation theory | Shim and Oh, 2015 | Helps to explain why consumers are motivated to consume. |
| Value Consumption Theory | Rigopoulou et al., 2017 | Deals with five consumption values (functional, conditional, social, emotional, and epistemic) which influence consumers' choice. |
| Social Exchange Theory (SET) | Gefen and Keil, 2008 | Claims that when a person has to make a decision, s/he makes a cost-benefit analysis and chooses the most beneficial route. |
| Preferential decision knowledge | Muthitcharoen et al., 2011 | Helps to understand how an individual develops different choices; can be divided into Attitude-Based Preference and Attribute-Based Preference. |
| Task-technology fit model (TTF) | Barhoumi, 2016; Dishaw and Strong, 1999 | Refers to a piece of technology being able to meet the requirements set by a specific task. |
| Trust theory | Shim and Oh, 2015 | Helps to describe a relationship between different business agents. |
| Variables from mobile technology and sales force automation (SFA) literature | Karjaluoto et al., 2014 | Refer to improving the work of sales force through equipping it technology. |
| Big five personality characteristics | Altanopoulou and Tselios, 2017 | Refers to the following personality traits: extraversion, agreeableness, conscientiousness, neuroticism, and openness to experience. |
| Software characteristics | Bhatiasevi and Krairit, 2013 | Refer to software functionality, software reliability, and software maintainability. |
| Cognitive absorption (CA) | Lowry et al., 2013; Saade and Bahli, 2005 | Refers to involvement with an ICT, includes temporal dissociation, focused immersion, and heightened enjoyment. |
| TPACK | Teo et al., 2017 | Refers to the instructor's technological pedagogical content knowledge. |
| Health Belief Model (HBM) | Wahyuni and Nurbojatmiko, 2017 | Based on the assumption that when an individual feels that there are risks to his/her health, s/he will take precautions. |

## Conclusion

It can be claimed that Technology Acceptance Model (TAM) is a versatile means to conduct research and explain an individual's behaviour that is related to technology acceptance (e.g. in educational contexts) and its further usage. The present paper analysed 108 papers that come from over ten different scientific areas, which helped to reveal what variables, models, and theories can be combined with the original TAM. The results indicate that the original TAM on its own is not entirely sufficient, thus scholars have mostly extended it with diverse context-specific variables.

Interestingly enough, numerous scientists enhance the original TAM by combining it with TAM2, TAM3, and UTAUT constructs. In addition to that, a number of other variables are added as well. They can be broadly classified along the lines of the features that are related to (i) perceived characteristics, (ii) user / consumer characteristics, (iii) system characteristics, (iv) interaction with technology, and (v) external features.

The analysis of the collected papers also reveals that scholars tend to combine TAM not only with its extensions (i.e. TAM2, TAM3, and UTAUT), but with other theories and frameworks as well. In the collected papers, the original TAM is mostly combined with other intention and behavior theories that mostly come from marketing literature.

The results presented in this paper have both theoretical and practical importance. As the paper reports on the variables coming from diverse scientific fields to extend TAM, the results might be useful in constructing a new, more advanced intention theory that would more accurately explain a person's acceptance and usage of, for example, educational ICTs. It is recommended that future endeavours extend the original TAM to build a model for a better understanding of educational technology adoption. In practice, the results presented in the paper might be helpful not only in constructing a research framework for an interdisciplinary context, but also when developing or improving a certain piece of educational technology, thus making it more sustainable.

### References

Abdullah, F., Ward, R., & Ahmed, E. (2016). Investigating the influence of the most commonly used external variables of TAM on students' Perceived Ease of Use (PEOU) and Perceived Usefulness (PU) of e-portfolios. *Computers in Human Behavior, 63,* 75-90.

Ahmad, T.B.T., Madarsha, K.B., Zainuddin, A.M.H., Ismail, N.A.H., & Nordin, M.S. (2010). Faculty's acceptance of computer based technology: Cross-validation of an extended model. *Australasian Journal of Educational Technology, 26*(2).

Ajzen, I. (1991). *The Theory of Planned Behavior. Organization Behavior and Human Decision Processes*. Academic Press, Inc. 179-211.

Ajzen, I.M., & Fishbein, M. (1980). *Understanding Attitudes and Predicting Social Behavior*. Prentice-Hall, Englewood Cliffs, NJ.

Alalwan, A.A., Baabdullah, A.M., Rana, N.P., Tamilmani, K., & Dwivedi, Y.K. (2018). Examining adoption of mobile internet in Saudi Arabia: Extending TAM with perceived enjoyment, innovativeness and trust. *Technology in Society, 55*, 100-110.

Al-Ammary, J. (2010, March). Factors affecting the acceptance and use of computers and the internet by elderly people in the Kingdom of Bahrain. In *International Conference on Information Management and Evaluation* (p. 9). Academic Conferences International Limited.

Al-Azawei, A., & Lundqvist, K. (2015). Learner Differences in Perceived Satisfaction of an Online Learning: An Extension to the Technology Acceptance Model in an Arabic Sample. *Electronic Journal of e-Learning, 13*(5), 408-426.

Al-Azawei, A., Parslow, P., & Lundqvist, K. (2017). Investigating the effect of learning styles in a blended e-learning system: An extension of the technology acceptance model (TAM). *Australasian Journal of Educational Technology, 33*(2).

Alenezi, A.R., & Karim, A. (2010). An empirical investigation into the role of enjoyment, computer anxiety, computer self-efficacy and internet experience in influencing the students' intention to use e-learning: A case study from Saudi Arabian governmental universities. *Turkish Online Journal of Educational Technology-TOJET, 9*(4), 22-34.

Al-Harby, F., Qahwaji, R., & Kamala, M. (2009, September). The effects of gender differences in the acceptance of biometrics authentication systems within online transaction. In *CyberWorlds, 2009. CW'09. International Conference on* (203-210). IEEE.

Alkali, A.U., & Abu Mansor, N.N. (2017). Interactivity and Trust as Antecedents of E-Training Use Intention in Nigeria: A Structural Equation Modelling Approach. *Behavioral Sciences, 7*(3), 47.

Al-Khateeb, F.B. (2007, May). Predicting internet usage in two emerging economies using an extended technology acceptance model (TAM). In *Collaborative Technologies and Systems, 2007. CTS 2007. International Symposium on* (143-149). IEEE.

Al-Mushasha, N.F.A. (2013, May). Determinants of e-learning acceptance in higher education environment based on extended technology acceptance model. In *e-Learning "Best Practices in Management, Design and Development of e-Courses: Standards of Excellence and Creativity", 2013 Fourth International Conference on* (261-266). IEEE.

Alnajjar, G. (2017). Facilitating conditions and cost in determining M-Commerce acceptance in Jordan: Initial findings. In *Leadership, Innovation and Entrepreneurship as Driving Forces of the Global Economy* (345-351). Springer, Cham.

Alshare, K.A., Freeze, R., & Kwun, O. (2009). Student intention to use expert systems: An exploratory study. *Journal of Computer Information Systems, 49*(4), 105-113.

Altanopoulou, P., & Tselios, N. (2017). Assessing acceptance toward wiki technology in the context of Higher Education. *The International Review of Research in Open and Distributed Learning, 18*(6).

Asua, J., Orruño, E., Reviriego, E., & Gagnon, M.P. (2012). Healthcare professional acceptance of telemonitoring for chronic care patients in primary care. *BMC medical informatics and decision making, 12*(1), 139.

Autry, C.W., Grawe, S.J., Daugherty, P.J., & Richey, R.G. (2010). The effects of technological turbulence and breadth on supply chain technology acceptance and adoption. *Journal of Operations Management, 28*(6), 522-536.

Balouchi, M., Aziz, Y.A., Hasangholipour, T., Khanlari, A., Abd Rahman, A., & Raja-Yusof, R.N. (2017). Explaining and predicting online tourists' behavioural intention in accepting consumer generated contents. *Journal of Hospitality and Tourism Technology, 8*(2), 168-189.

Bao, Y., Xiong, T., Hu, Z., & Kibelloh, M. (2013). Exploring gender differences on general and specific computer self-efficacy in mobile learning adoption. *Journal of Educational Computing Research, 49*(1), 111-132.

Barhoumi, C. (2016). User acceptance of the e-information service as information resource: A new extension of the technology acceptance model. *New Library World, 117*(9/10), 626-643.

Barnett, T., Kellermanns, F.W., Pearson, A.W., & Pearson, R.A. (2006). Measuring information system usage: Replication and extensions. *Journal of Computer Information Systems, 47*(2), 76-85.

Belanche, D., Casaló, L.V., & Flavián, C. (2012). Integrating trust and personal values into the Technology Acceptance Model: The case of e-government services adoption. *Cuadernos de Economía y Dirección de la Empresa, 15*(4), 192-204.

Bere, A., & Rambe, P. (2013, June). Extending technology acceptance model in mobile learning adoption: South African University of Technology students' perspectives'. In *International Conference on e-Learning* (52-61). Academic Conferences International Limited.

Bhatiasevi, V., & Krairit, D. (2013). Acceptance of open source software amongst Thai users: an integrated model approach. *Information Development, 29*(4), 349-366.

Bhatiasevi, V., & Naglis, M. (2016). Investigating the structural relationship for the determinants of cloud computing adoption in education. *Education and Information Technologies, 21*(5), 1197-1223.

Calisir, F., Altin Gumussoy, C., Bayraktaroglu, A.E., & Karaali, D. (2014). Predicting the intention to use a web-based learning system: Perceived content quality, anxiety, perceived system quality, image, and the technology acceptance model. *Human Factors and Ergonomics in Manufacturing & Service Industries, 24*(5), 515-531.

Cegarra-Navarro, J.G., Eldridge, S., Martinez-Caro, E., Teresa, M., & Polo, S. (2014). The value of extended framework of TAM in the electronic government services. *Electronic Journal of Knowledge Management, 12*(1), 14-24.

Cha, J. (2013). Predictors of television and online video platform use: A coexistence model of old and new video platforms. *Telematics and Informatics, 30*(4), 296-310.

Chang, C.C., & Chen, P.Y. (2018). Analysis of critical factors for social games based on extended technology acceptance model: a DEMATEL approach. *Behaviour & Information Technology*, 1-12.

Chang, C.C., Yan, C.F., & Tseng, J.S. (2012). Perceived convenience in an extended technology acceptance model: Mobile technology and English learning for college students. *Australasian Journal of Educational Technology, 28*(5).

Chin, J., & Lin, S.C. (2015). Investigating users' perspectives in building energy management system with an extension of technology acceptance model: A case study in indonesian manufacturing companies. *Procedia Computer Science, 72*, 31-39.

Chin, J., & Lin, S.C. (2016). A behavioral model of managerial perspectives regarding technology acceptance in building energy management systems. *Sustainability, 8*(7), 641.

Cho, V., Cheng, T.C.E., & Hung, H. (2009). Continued usage of technology versus situational factors: An empirical analysis. *Journal of Engineering and Technology Management, 26*(4), 264-284.

Davis, F. (1986). *A technology acceptance model for empirically testing new-end-user information systems: Theory and results*. Massachusetts, United States: Sloan School of Management, Massachusetts Institute of Technology.

Davis, F.D., Bagozzi, R.P., & Warshaw, P.R. (1989). User acceptance of computer technology: a comparison of two theoretical models. *Management science, 35*(8), 982-1003.

Di Benedetto, C.A., Calantone, R.J., & Zhang, C. (2003). International technology transfer: Model and exploratory study in the People's Republic of China. *International Marketing Review, 20*(4), 446-462.

Dishaw, M.T., & Strong, D.M. (1999). Extending the technology acceptance model with task–technology fit constructs. *Information & management, 36*(1), 9-21.

Dumpit, D.Z., & Fernandez, C.J. (2017). Analysis of the use of social media in Higher Education Institutions (HEIs) using the Technology Acceptance Model. International *Journal of Educational Technology in Higher Education, 14*(1), 5.

Dutta, B., Peng, M.H., & Sun, S.L. (2018). Modeling the adoption of personal health record (PHR) among individual: the effect of health-care technology self-efficacy and gender concern. *Libyan Journal of Medicine, 13*(1).

Egea, J.M.O., & González, M.V.R. (2011). Explaining physicians' acceptance of EHCR systems: An extension of TAM with trust and risk factors. *Computers in Human Behavior, 27*(1), 319-332.

Fathali, S., & Okada, T. (2018). Technology acceptance model in technology-enhanced OCLL contexts: A self-determination theory approach. *Australasian Journal of Educational Technology, 34*(4).

Fayad, R., & Paper, D. (2015). The technology acceptance model e-commerce extension: a conceptual framework. *Procedia Economics and Finance, 26*, 1000-1006.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention, and behaviour: An introduction to theory and research.* Reading, Mass; Don Mills, Ontario: Addison-Weley Pub. Co.

Gefen, D., & Keil, M. (1998). The impact of developer responsiveness on perceptions of usefulness and ease of use: an extension of the technology acceptance model. *ACM SIGMIS Database: the DATABASE for Advances in Information Systems, 29*(2), 35-49.

Gefen, D., & Straub, D.W. (1997). Gender differences in the perception and use of e-mail: An extension to the technology acceptance model. *MIS quarterly*, 389-400.

Ghazizadeh, M., Lee, J.D., & Boyle, L.N. (2012). Extending the Technology Acceptance Model to assess automation. *Cognition, Technology & Work, 14*(1), 39-49.

Gillenson, M.L., & Sherrell, D.L. (2002). Enticing online consumers: an extended technology acceptance perspective. *Information & management, 39*(8), 705-719.

Govender, I., & Rootman-le Grange, I. (2015, October). Evaluating the Early Adoption of Moodle at a Higher Education Institution. In *European Conference on e-Learning* (p. 230). Academic Conferences International Limited.

Gupta, R., & Jain, K. (2015). Adoption behavior of rural India for mobile telephony: A multigroup study. *Telecommunications Policy, 39*(8), 691-704.

Ha, I., Yoon, Y., & Choi, M. (2007). Determinants of adoption of mobile games under mobile broadband wireless access environment. *Information & Management, 44*(3), 276-286.

Hernandez, B., Jimenez, J., & José Martín, M. (2009). Adoption vs acceptance of e-commerce: two different decisions. *European Journal of Marketing, 43*(9/10), 1232-1245.

Huang, L.K. (2017). A cultural model of online banking adoption: Long-term orientation perspective. *Journal of Organizational and End User Computing (JOEUC), 29*(1), 1-22.

Irani, Z., Dwivedi, Y.K., & Williams, M.D. (2009). Understanding consumer adoption of broadband: an extension of the technology acceptance model. *Journal of the Operational Research Society, 60*(10), 1322-1334.

Jackson, C.M., Chow, S., & Leitch, R.A. (1997). Toward an understanding of the behavioral intention to use an information system. *Decision sciences, 28*(2), 357-389.

Janiūnaitė, B. (2004). *Edukacinės novacijos ir jų diegimas*. Kaunas: Technologija.

Kabir, M.A., Saidin, S.Z., & Ahmi, A. (2017, October). An extension of technology acceptance model to determine factors that influence the intention to use electronic collection system in Nigerian federal hospitals. In *AIP Conference Proceedings* (Vol. 1891, No. 1, p. 020072). AIP Publishing.

Karavasilis, I., Vrana, V.G., & Zafiropoulos, K. (2016). An Extended Model of E-Government Adoption by Civil Servants in Greece. *International Journal of Electronic Government Research (IJEGR), 12*(1), 1-23.

Karjaluoto, H., Töllinen, A., Pirttiniemi, J., & Jayawardhena, C. (2014). Intention to use mobile customer relationship management systems. *Industrial Management & Data Systems, 114*(6), 966-978.

Kim, Y.J., Chun, J.U., & Song, J. (2009). Investigating the role of attitude in technology acceptance from an attitude strength perspective. *International Journal of Information Management, 29*(1), 67-77.

Kitchen, P.J., Martin, R., & Che-Ha, N. (2015). Long term evolution mobile services and intention to adopt: a Malaysian perspective. *Journal of Strategic Marketing, 23*(7), 643-654.

Kowalewski, S., Arning, K., Minwegen, A., Ziefle, M., & Ascheid, G. (2013). Extending the engineering trade-off analysis by integrating user preferences in conjoint analysis. *Expert Systems with Applications, 40*(8), 2947-2955.

Lai, P.C. (2017). The literature review of technology adoption models and theories for the novelty technology. *JISTEM-Journal of Information Systems and Technology Management, 14*(1), 21-38.

Lau, S.H., & Woods, P.C. (2009). Understanding learner acceptance of learning objects: The roles of learning object characteristics and individual differences. *British journal of educational technology, 40*(6), 1059-1075.

Lee, E.Y., Lee, S.B., & Jeon, Y.J.J. (2017). Factors influencing the behavioral intention to use food delivery apps. *Social Behavior and Personality: an international journal, 45*(9), 1461-1473.

Lee, S.M., & Chen, L. (2010). The impact of flow on online consumer behavior. *Journal of Computer Information Systems, 50*(4), 1-10.

Lee, W., Xiong, L., & Hu, C. (2012). The effect of Facebook users' arousal and valence on intention to go to the festival: Applying an extension of the technology acceptance model. *International Journal of Hospitality Management, 31*(3), 819-827.

Lee, Y.C. (2006). An empirical investigation into factors influencing the adoption of an e-learning system. *Online information review, 30*(5), 517-541.

Lin, F.T., Wu, H.Y., & Nga, T.T.N. (2013, September). Adoption of Internet banking: An empirical study in Vietnam. In *E-Business Engineering (ICEBE), 2013 IEEE 10th International Conference on* (pp. 282-287). IEEE.

Lin, F.T., Wu, H.Y., & Tran, T.N.N. (2015). Internet banking adoption in a developing country: an empirical study in Vietnam. *Information Systems and e-Business Management, 13*(2), 267-287.

Liu, D., Lu, W., & Niu, Y. (2018). Extended Technology-Acceptance Model to Make Smart Construction Systems Successful. *Journal of Construction Engineering and Management, 144*(6), 04018035.

Liu, L., & Ma, Q. (2005). The impact of service level on the acceptance of application service oriented medical records. *Information & Management, 42*(8), 1121-1135.

Liu, Y.C., Lin, C., Huang, Y., & Liu, CW. (2009). Extending the Technology Acceptance Model in a Context of Integrating Technology into a University Classroom. *Creating Global Economies through Innovation and Knowledge Management: Theory & Practice*, 550-563.

Lowry, P.B., Gaskin, J., Twyman, N., Hammer, B., & Roberts, T. (2012). *Taking 'fun and games' seriously: Proposing the hedonic-motivation system adoption model (HMSAM).*

Lwoga, E.T., & Lwoga, N.B. (2017). User Acceptance of Mobile Payment: The Effects of User-Centric Security, System Characteristics and Gender. *The Electronic Journal of Information Systems in Developing Countries, 81*(1), 1-24.

Matemba, E.D., & Li, G. (2018). Consumers' willingness to adopt and use WeChat wallet: An empirical study in South Africa. *Technology in Society, 53*, 55-68.

Melas, C.D., Zampetakis, L.A., Dimopoulou, A., & Moustakis, V. (2011). Modeling the acceptance of clinical information systems among hospital medical staff: an extended TAM model. *Journal of biomedical informatics, 44*(4), 553-564.

Muthitcharoen, A., Palvia, P.C., & Grover, V. (2011). Building a model of technology preference: The case of channel choices. *Decision Sciences, 42*(1), 205-237.

Nagy, J.T. (2018). Evaluation of online video usage and learning satisfaction: An extension of the technology acceptance model. *The International Review of Research in Open and Distributed Learning, 19*(1).

Nasir, S., & Yurder, Y. (2015). Consumers' and physicians' perceptions about high tech wearable health products. *Procedia-Social and Behavioral Sciences, 195*, 1261-1267.

Naspetti, S., Mandolesi, S., Buysse, J., Latvala, T., Nicholas, P., Padel, S., ... & Zanoli, R. (2017). Determinants of the acceptance of sustainable production strategies among dairy farmers: Development and testing of a modified technology acceptance model. *Sustainability, 9*(10), 1805.

Nasser AL-Subari, Saleh & Mohamed Zabri, Shafie & Ahmad, Kamilah. (2018). Factors Influencing Online Banking Adoption: The Case of Academicians in Malaysian Technical University Network (MTUN). *Advanced Science Letters*. 24. 3193-3197. DOI: 10.1166/asl.2018.11342.

Oh, H., Jeong, M., Lee, S., & Warnick, R. (2016). Attitudinal and situational determinants of self-service technology use. *Journal of Hospitality & Tourism Research, 40*(2), 236-265.

Patel, K.J., & Patel, H.J. (2018). Adoption of internet banking services in Gujarat: An extension of TAM with perceived security and social influence. *International Journal of Bank Marketing, 36*(1), 147-169.

Qi, J., Li, L., Li, Y., & Shu, H. (2009). An extension of technology acceptance model: Analysis of the adoption of mobile data services in China. *Systems Research and Behavioral Science: The Official Journal of the International Federation for Systems Research, 26*(3), 391-407.

Räckers, M., Hofmann, S., & Becker, J. (2013, September). The influence of social context and targeted communication on e-government service adoption. In *International Conference on Electronic Government* (pp. 298-309). Springer, Berlin, Heidelberg.

Ramkumar, M., & Jenamani, M. (2015). Organizational Buyers' Acceptance of Electronic Procurement Services—An Empirical Investigation in Indian Firms. *Service Science, 7*(4), 272-293.

Rawashdeh, A. (2015). Factors affecting adoption of internet banking in Jordan: Chartered accountant's perspective. *International Journal of Bank Marketing, 33*(4), 510-529.

Rejón-Guardia, F., Sánchez-Fernández, J., & Muñoz-Leiva, F. (2011). *Motivational Factors that influence the Acceptance of Microblogging Social Networks: The µBAM Model* (No. 06/11). Faculty of Economics and Business (University of Granada).

Rigopoulou, I.D., Chaniotakis, I.E., & Kehagias, J.D. (2017). An extended technology acceptance model for predicting smartphone adoption among young consumers in Greece. *International Journal of Mobile Communications, 15*(4), 372-387.

Rogers, E.M. (2010). *Diffusion of innovations*. New York: Free Press.

Saadé, R., & Bahli, B. (2005). The impact of cognitive absorption on perceived usefulness and perceived ease of use in on-line learning: an extension of the technology acceptance model. *Information & management, 42*(2), 317-327.

Saeed, K.A., & Abdinnour-Helm, S. (2008). Examining the effects of information system characteristics and perceived usefulness on post adoption usage of information systems. *Information & Management, 45*(6), 376-386.

Salajan, F., & Welch, A., & Peterson, Cl., & Ray, N.C. (2011). Faculty Perceptions of Teaching Quality and Peer Influence in the Utilization of Learning Technologies: An Extension of the Technology Acceptance Model. *World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education 2011*, 2500-2509.

Shan, S., Shen, H., & Lu, X. (2008). Evaluating business intelligence acceptance with the technology acceptance model. *38th International Conference on Computers and Industrial Engineering 2008, 3*, 2756-2767.

Shih, Y.Y., & Huang, S.S. (2009). The actual usage of ERP systems: An extended technology acceptance perspective. *Journal of Research and Practice in Information Technology, 41*(3), 263.

Shin, D.H. (2008). Understanding purchasing behaviors in a virtual economy: Consumer behavior involving virtual currency in Web 2.0 communities. *Interacting with computers, 20*(4-5), 433-446.

Shin, D.H., Biocca, F., & Choo, H. (2013). Exploring the user experience of three-dimensional virtual learning environments. *Behaviour & Information Technology, 32*(2), 203-214.

Son, H., Park, Y., Kim, C., & Chou, J.S. (2012). Toward an understanding of construction professionals' acceptance of mobile computing devices in South Korea: An extension of the technology acceptance model. *Automation in construction, 28*, 82-90.

Stern, B.B., Royne, M.B., Stafford, T.F., & Bienstock, C.C. (2008). Consumer acceptance of online auctions: An extension and revision of the TAM. *Psychology & Marketing, 25*(7), 619-636.

Sternad, S., Gradisar, M., & Bobek, S. (2011). The influence of external factors on routine ERP usage. *Industrial Management & Data Systems, 111*(9), 1511-1530.

Schwab, K. (2016). *The fourth industrial revolution*. New York: Crown Business.

Tamboli, M.A., & Biswas, P.K. (2015, October). Mobile Learning Applications' Acceptance Model (MLAAM). In *Computing and Communication (IEMCON), 2015 International Conference and Workshop on* (pp. 1-6). IEEE.

Tan, G.W. H., Ooi, K.B., Chong, S.C., & Hew, T.S. (2014). NFC mobile credit card: the next frontier of mobile payment? Telematics and Informatics, 31(2), 292-307.

Tarhini, A., Hone, K., & Liu, X. (2013). User acceptance towards web-based learning systems: Investigating the role of social, organizational and individual factors in European higher education. *Procedia Computer Science, 17*, 189-197.

Tarhini, A., Hone, K., & Liu, X. (2014). Measuring the moderating effect of gender and age on e-learning acceptance in England: A structural equation modeling approach for an extended technology acceptance model. *Journal of Educational Computing Research, 51*(2), 163-184.

Tarhini, A., Hone, K., & Liu, X. (2014). The effects of individual differences on e-learning users' behaviour in developing countries: A structural equation model. *Computers in Human Behavior, 41*, 153-163.

Teo, T. (2016). Modelling Facebook usage among university students in Thailand: the role of emotional attachment in an extended technology acceptance model. *Interactive Learning Environments, 24*(4), 745-757.

Teo, T., Doleck, T., & Bazelais, P. (2018). The role of attachment in Facebook usage: a study of Canadian college students. *Interactive Learning Environments, 26*(2), 256-272.

Teo, T., Milutinović, V., Zhou, M., & Banković, D. (2017). Traditional vs. innovative uses of computers among mathematics pre-service teachers in Serbia. *Interactive Learning Environments, 25*(7), 811-827.

Tseng, A.H., & Hsia, J.W. (2008, September). The impact of internal locus of control on perceived usefulness and perceived ease of use in e-learning: An extension of the technology acceptance model. In *Cyberworlds, 2008 International Conference on* (815-819). IEEE.

Venkatesh, V. (2000). Determinants of perceived ease of use: Integrating control, intrinsic motivation, and emotion into the technology acceptance model. *Information systems research, 11*(4), 342-365.

Venkatesh, V., & Bala, H. (2008). Technology acceptance model 3 and a research agenda on interventions. *Decision sciences, 39*(2), 273-315.

Venkatesh, V., & Davis, F.D. (1986). A model of the antecedents of perceived ease of use: Development and test. *Decision Sciences, 27*(3), 451-481.

Venkatesh, V., & Davis, F.D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management science, 46*(2), 186-204.

Venkatesh, V., Morris, M.G., Davis, G.B., & Davis, F.D. (2003). User acceptance of information technology: Toward a unified view. *MIS quarterly*, 425-478.

Wahyuni, R. (2017, August). Explaining acceptance of e-health services: An extension of TAM and health belief model approach. In *Cyber and IT Service Management (CITSM), 2017 5th International Conference on* (1-7). IEEE.

Web of Science. Accessed through https://clarivate.com/products/web-of-science/

Werber, B., Baggia, A., & Žnidaršič, A. (2018). Factors Affecting the Intentions to Use RFID Subcutaneous Microchip Implants for Healthcare Purposes. *Organizacija, 51*(2), 121-133.

YeolShim, G. (2015). An Empirical Study on Factors Affecting Customer Adoption of Virtual Store in Extended Technology Acceptance Model: Focusing on the role of Trust and Playfulness. *International Conference on Business and Economics (ICBE 2015)*, 381-382.

Zeba, F., & Ganguli, S. (2016). Word-Of-Mouth, Trust, and Perceived Risk in Online Shopping: An Extension of the Technology Acceptance Model. *International Journal of Information Systems in the Service Sector (IJISSS), 8*(4), 17-32.

Zhang, N., Guo, X., & Chen, G. (2008, September). An Extended IT Adoption Model and Two Empirical Studies in Chinese Cultural Contexts. In *Advanced Management of Information for Globalized Enterprises, 2008. AMIGE 2008. IEEE Symposium on* (pp. 1-5). IEEE.

Zhang, X. (2013). Income disparity and digital divide: The Internet Consumption Model and cross-country empirical research. *Telecommunications Policy, 37*(6-7), 515-529.