Models of Acceptance and Use of Technology Research Trends: Literature Review and Exploratory Bibliometric Study

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Abstract: Acceptance and Use of Technology Models suggest that some constructs predict behavioural intention towards the acceptance and use of technology. For this reason, these models are increasingly used by researchers around the world. At the same time, teachers of information technology and systems teach these models as part of the content of various courses. This study aims to analyse the publications of the last five years on Acceptance and Use of Technology Models. An exploratory bibliometric study was carried out, using the Proquest and Scopus platforms, in the period from 2014 to 2018, to find out which models are most used by researchers. The findings suggest that the number of articles into the top journals has increased, and that there is a wider array of journals publishing articles about this topic. Also, the study revealed that the most cited models were TPB and TAM.

Keywords: Technology Adoption; Use of Technology; Bibliometric; Models of Acceptance; Research Trends.

1 Introduction

Researchers from around the world have developed models for acceptance and use of technology for several years. Understanding the impacts of IT on people and organizations lives and behaviour can serve as an essential foundation for the development of new technologies. At the same time, teachers of information technology

and systems teach these models as part of the content of various courses.

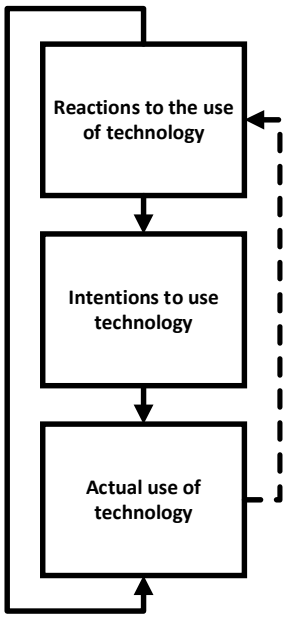
It is not enough to create new technologies, it is necessary to realize if they are useful, easy to use and if are going to be used. Acceptance of the individual and the use of new technologies has been studied over the last decades, and to corroborate these, many models of technology acceptance have been created, such as the Theory of Reasoned Action (TRA) [1], Technology Acceptance Model (TAM) [2]; [3]; [4], Theory of Planned Behaviour (TPB) [5]; [6], Innovation Diffusion Theory (IDT) [7] and, more recently, the Unified Theory of Acceptance and Use of Technology (UTAUT) [8]; [9].

Since the mid-1970s, several researchers have sought to demonstrate the main variables and factors that influence technology uptake and adoption, in a hedonistic context and at the organizational level [10].

Studies on the adoption of information technologies seek to understand, for example, the impacts of the introduction of these technologies in work and leisure environments, the behaviour of people in processes of technological innovation and the reason why the use of a technology is discontinued. Figure 1 presents the basic conceptual framework underlying the models explaining the acceptance of technology according to several authors. The study of the adoption of information technology is critical to realizing the benefits of the technology implanted [11], since technological innovations can significantly affect organizations [12]. This importance can be noted when we see multiples theories that focused on attitudes as determinant of intention to adopt IT [13].

The adoption of any technology by its end users is considered as an essential step that precedes the implementation of that technology [14]. Technologies that facilitate electronic collaboration have become an important component of everyday life, so several studies have examined the adoption of these technologies. Adoption of these technologies is not progressing as fast or as broadly as expected and new systems or new technology acceptances require input at the managerial or organizational level and at the individual level [15].

Fig. 1 Basic Concept Underlying Technology Acceptance Models

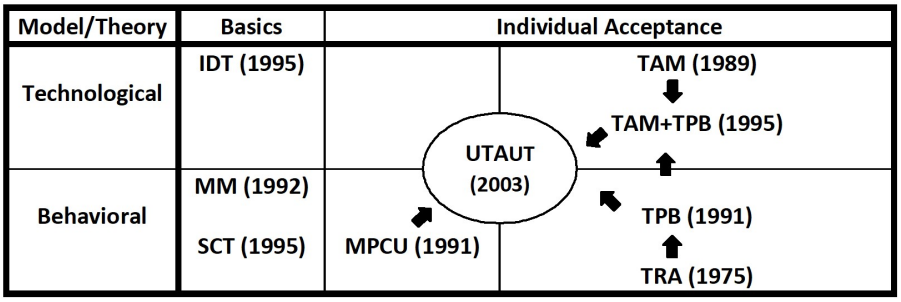


According to Lee and Coughlin (2015), technology is not widely adopted because of insufficient understanding or stereotypes of characteristics, target segment expectations, and needs. There is a substantial difference between what is developed and what is really needed [16].

Venkatesh et al. (2003) developed a model called Unified Theory of Acceptance and Use of Technology (UTAUT) [8], where they integrate the elements of eight models on the acceptance of technology: Theory of Rational Action (TRA) [1]; Technology Acceptance Model (TAM) [3]; Motivational Model (MM) [17]; Theory of Planned Behavior (TPB) [6]; Combined Model TAM-TPB [18]; Model of PC Utilization (MPCU) [19]; Innovation Diffusion Theory (IDT) [7] and Social Cognitive Theory (SCT) [20].

The UTAUT consists of four determinant constructs of the intention and use of IT and four moderators that were extracted from the eight models previously mentioned (Fig. 2).

Fig. 2. Models that contributed to UTAUT



The option for this model as the basis of this study is justified by its comprehensive and integrative approach, which incorporates a wide variety of variables based on the main theoretical models developed to explain the technology acceptance and use. In particular, Venkatesh et al. (2003) conducted an in-depth analysis of the literature on this topic and proposed a unified model that integrates common contributions to previous theories.

The present study turns attention to the scenario of scientific production on the subject through bibliometrics as instrument of data collection of the research. Bibliometric has been used as a tool to measure scientific production by making a survey of the inventory of scientific activities in the most diverse fields of knowledge. It is a careful search in the publications, and applying a high degree of methodological rigor, it becomes an important tool to analyse the scientific production and quantify the evolution of the knowledge produced by humankind [21], [22].

This study carried out the accounting of the first eighteen years of the 21st century of scientific articles on acceptance and use of technology, with special attention to the years 2014 to 2018. The article is organized with an introduction of the research, followed by the presentation of the conceptual bases of the research (literature review); and the description of methodological procedures. Finally, the results of this bibliometric study and the final considerations of the work are presented and analysed.

2 Literature review

The literature review is a rigorous process that signifies the foundation for conducting any study or research project [14].

Studies of the acceptance of technology have been carried out by different researchers, which have led to countless models that seek to explain the adoption of individual technology. In order to unify these models and generate an even more complete one, covering the main constructs related to IT acceptance, Venkatesh et al. (2003) developed the Unified Theory of Acceptance and Use of Technology - UTAUT, contributing significantly to the studies in the area of Information Systems [23]. Although some theories were not directly related to the area of information technology, they contributed significantly to the construction of the model. The models that originated the UTAUT are described below.

In addition to the UTAUT and the eight models that contributed to it, two more models are analysed, which although not connected to UTAUT, were also used to study the acceptance and use of technology: Technology, Organization and Environment (TOE) framework and the Model of Information Systems Success (MISS).

2.1 Theory of Reasoned Action (TRA)

The Theory of Reasoned Action (TRA) by Fishbein and Ajzen (1975) argues that individual behaviour is determined by the intentions of behaviour, which occur as a function of the attitude of the individual, defined as positive and negative feelings of himself. For this model there is a subjective norm, which involves the individual's perception of what most people think is important for him or her to do in relation to the behaviour in question [4]. The basic constructs of the model are the subjective norms and the behaviour attitude.

2.2 Technology Acceptance Model (TAM)

The TAM (Technology Acceptance Model) model of Davis (1989), aims to evaluate the behaviour of technology use, analyzing the attitudes to use the IS, from perceived utility and ease of use [24]. The model considers as main constructs: subjective norms, perceived ease of use and perceived utility.

A respectable amount of work dealing with Technology Acceptance Model (TAM) clearly indicates a popularity of TAM in the field of technology acceptance in general [25].

Davis (1989) proposed a model that would aid and predict the use of the systems, developing the Technology Acceptance Model (TAM) that explains the degree of interest of IT users to accept and use a new technology. The model suggests that when users are introduced to a new software package, a number of factors influence their decision on how and when it will be used.

In this model, there are two key variables: Perceived usefulness and Perceived ease of use. The two variables are related to the extent to which the perceived ease of use influences the perceived utility, once the user is already aware of the effort that is needed the system becomes easier, which in turn becomes more useful. In addition, they are directly linked to the Attitude Toward Using, which in turn determines the behavioural intention of use (Behavioural intention) and the actual use of the system.

TAM has been widely used by many researchers because it is considered a valid, robust and user-friendly model [26]; [27]. The TAM model has been used to study the acceptance of various types of technology, such as e-learning [28]; [29]; [23], social media [30], [31], [32], [33] telemedicine [34], software maintenance tools [24], buyer-seller technology [35], mobile applications [36], ERPs [37], virtual worlds [38] and even in higher education [39]; [40].

Despite the recurrent use of this model, several authors investigated their limitations [41].

• The results obtained are based on subjective measures, thus influencing the conclusions and making it impossible to measure the use / acceptance of a real system.

• The variables and relations present in the model do not allow to explain all the associated phenomena due to the complexity of the processes. This is because engaging people involves several factors

that interfere with their perceptions, such as the user's specific technical ability, context and space where the person makes use.

• Behaviour cannot be considered as an end goal, but as a means to an end. Also the intention of use cannot be sufficiently representative of the actual use, since the time period between the intention and the adoption can be affected by a set of uncertainties or other factors that can influence the decision of an individual in the adoption of a technology.

Also, TAM cannot be used as-is because do not take into account the nature of the knowledge shared [42]. Legris, Igham and Collerette (2003) show in their empirical study that the results of TAM have not been clear, particularly due to the lack of significance factors related to human and social processes [43].

To reduce the limitations of TAM Venkatesh and Davis (2000) created the model TAM 2 where it is possible to verify that the determining factors are added, thus extending the explanation for the perceived utility and behavioural intention of use. In this model, new variables appear such as Subjective Norm, Image, Job Relevance, Output Quality, and Result Demonstrability.

Later, Venkatesh and Bala (2008) present the model TAM 3, where they add two determining groups in the perception of the ease of use: Anchor and adjustments (Adjustment). Anchor are considered as general beliefs about computers and their use, which consist of variables such as Computer Self-efficacy, Perceptions of External Control, Computer Anxiety and Computer Playfulness. Regarding the adjustments these are considered as beliefs based on practical experiences, it is composed of "perceived enjoyment" and the goal of usability thus having more information about how easy or difficult it will be to use the system.

2.3 Model of PC Utilization (MPCU)

The Model of Personal Computer Utilization analyses the acceptance and use of technology based on constructs such as: work fit, complexity, long-term consequences, effects on use, social factors, and facilitating conditions. Thompson, Higgins and Howell

(1991) analysed the effects of these constructs on the intention to use PCs.

2.4 Theory of Planned Behaviour (TPB)

Ajzen's Theory of Planned Behaviour (TPB) (1991) expands the TRA with the inclusion of the control construct of perceived behaviour as a determinant of the intention and behaviour of the use of technology. This model has as fundamental constructs: behavioural attitude, subjective norms and perceived behavioural control. The hybrid model, which combines the predictors of TPB with the perceived utility of the TAM model, has as main constructs: behavioural attitude, subjective norms, perceived behavioural control and perceived utility.

2.5 Motivational Model (MM)

The Motivational Model (MM) works with motivational theories to explain the behaviour of individuals, based on the constructs intrinsic and extrinsic motivation. Davis, Bagozzi and Warshaw (1992) used this theory to understand the adoption and use of new technologies.

Some years later Vallerand (1997) proposed a general model of intrinsic and extrinsic motivation, the Hierarchical model. This model serves two objectives: provides a framework to organize the literature on intrinsic and extrinsic motivation, and identify the psychological mechanisms underlying motivational changes [44].

2.6 Combined Model TAM-TPB

Taylor and Todd (1995) created a new model combining TAM and TPB. The Technology Acceptance Model and two variations of the Theory of Planned Behaviour were compared to assess which model best helps to understand usage of information technology. Decom-

posing the belief structures in the TPB provided a moderate increase in the explanation of behavioural intention [18].

2.7 Social Cognitive Theory (SCT)

Starting from Social Cognitive Theory [45], Compeau and Higgins (1995) used it based on constructs such as expectations of performance and personal results, self-efficacy, affection and anxiety, to study the use of computers, however the nature of the model allows the acceptance and use of information technologies in general to be analysed.

2.8 Innovation Diffusion Theory (IDT)

As for the Innovation Diffusion Theory, Moore and Benbasat (1996) have adapted the characteristics of innovation presented by Rogers (1995) and refined the constructs so that they could be used in studies of individual acceptance of technology. The main constructs of this theory are relative advantage, ease of use, image, trialability, compatibility, results demonstrability and voluntariness.

IDT suggests that IT acceptance (termed adoption within this perspective) patterns within a network of users is shaped by a process of communication and social influence, whereby later adopters are informed of the availability and utility of a new IT by earlier adopters within their social network [7].

IDT also suggests that communication channels may have differential effects across the user population in that the more innovative early adopters are likely to be more motivated by mass media while the less innovative late adopters rely more on interpersonal channels [46].

Subsequent IDT research has examined a variety of mass- media channels (e.g., news media, experts) and interpersonal channels (e.g., colleagues, family members) that serve as the conduits of information and influence and studied the impacts of these channels on perceived IT attributes [47]. In fact, according to Momani and Jamous (2017), the TAM constructs derive from IDT, given that the

variable "perceived utility" has its representation as "relative advantage" and the variable "perceived ease of use" is also present in the IDT [48].

2.9 Unified Theory of Acceptance and Use of Technology (UTAUT)

The UTAUT consists of four constructs that are determinant of the intention and use of IT and four moderators that were extracted from the eight models previously mentioned. The determinants are: Performance Expectation - degree in which the individual believes that using the system will have performance gains at work; Effort Expectation - where the individual relates the degree of facility associated with the use of the system; The Social Influence - degree of perception of the individual in relation to the others as to their belief in the need for new technology to be used or not; And the Facilitating Conditions - degree by which the individual believes that there is an organizational and technical infrastructure to support the use of the system [49]; [8].

From the empirical review of the eight models Venkatesh et al. (2003) extracted 31 linguistic statements that represented the most salient factors in the measurement of Technology Acceptance, next they consolidated 28 of the 31 statements into independent constructs [50].

The moderator constructs of TI's intention to use are gender, age, experience of the individual, and voluntariness to use - degree to which the use of technology is voluntary, free, and non-mandatory [8]; [49]. This model has been used to study the acceptance of various types of technology, such as web 2.0 technologies [51].

Some years later Venkatesh et al. (2012) published the UTAUT2, with the insertion of three constructs, in addition to UTAUT: "Hedonic Motivation", "Price Value" and "Habit" [9]. The "Hedonic Motivation" construct is perceived pleasure, that is, fun or pleasure that the use of a technology can provides, it plays an important role in the acceptance and use of mobile technology.

The "Habit" construct is defined as the extent to which people tend to perform behaviors automatically due to learning.

The authors also added the "Price Value / Price Relevance" construct to the model because an important difference between organizational use and consumer use is that consumers often bear the monetary cost of using the technology, while employees do not.

Venkatesh, Thong and Xu (2012) point out that costs and prices can have a significant impact on consumers' use of the technology.

The contributors to the UTAUT have suggested that the core determinants (performance expectancy, effort expectancy, social influence and facilitating conditions) in this model can be used to explain actual usage of information technologies [52].

However, some authors have criticized this model. Bagozzi (2007) for example, wrote that UTAUT is a well-meaning and thoughtful presentation, but that it presents a model with 41 independent variables for predicting intentions and at least 8 independent variables for predicting behaviour, and that it contributed to the study of technology adoption reaching a stage of chaos [53].

2.10 Technology, Organization and Environment (TOE)

The Technology, Organization and Environment (TOE) framework was developed in 1990 [54]. It identifies three aspects of an enterprise's context that influence the process by which it adopts and implements a technological innovation: technological context, organizational context, and environmental context.

The TOE framework as originally presented, and later adapted in IT adoption studies, provides a useful analytical framework that can be used for studying the adoption and assimilation of different types of IT innovation [55], and so has become a useful approach for examining factors affecting the adoption of IT in organizations [56].

2.11 Model of Information Systems Success (MISS)

The Model of Information Systems Success [57] was developed due to the finding of the critical role of IS quality in the success of business and information system function. IS quality occupies a very prominent place in IS success models. DeLone and McLean (1992)

have identified IS success as a multifaceted construct consisting of quality measures (system quality and information quality), attitudinal outcomes (use and satisfaction), and performance-related outcomes (individual and organizational impacts).

An ‘‘updated” IS success model was proposed in 2003 by DeLone and McLean, which includes IS service quality. As IT impacts not only immediate users, but also work groups, organizations, industries, consumers, and society, DeLone and McLean (2003) replaced the individual impact and organizational impact constructs of their original IS success model with the ‘‘net benefits” construct in their ‘‘updated” model.

Most empirical studies related to IS success models have dealt with individual impact rather than organizational impact [58]. Later Petter et al. (2008) analysed the relationships between the six constructs of the DeLone and McLean model (2003) by reviewing 180 articles related to IS success published in the period of 1992–2007. At the individual level of analysis, the authors found some sup- port for several of the 15 pairwise associations [59].

3 Methodology

The objective of this study was to understand which Acceptance and Use of Technology Models are most used (that is, the most cited) by researchers at the beginning of the 21st century.

In addition to the UTAUT and the eight models that contributed to it, two more models are analysed, which although not connected to UTAUT, were also used to study the acceptance and use of technology: Technology, Organization and Environment (TOE) framework, and the Model of Information Systems Success (MISS).

To reach the objective, we used bibliometrics. The first time the term bibliometrics was used was by Pritchard (1969) and in this study we used the methodology of Dias (2019). The Proquest and Scopus platforms were used, and all articles of the 21st century were counted, in which the designations of the models were present. Care was taken to write the names of the models in quotation marks, to ensure that articles would not be found with just a few of the words that make up the name of each model.

First, all articles published between 2001 and 2018, in which the model was referred anywhere were counted. More than 22,000 articles were found. Then we also count all the articles in which the model was referred, in the article title, in the abstract or in the keywords, meaning that this model had been used in the research referred in that article. Finally, the same articles were counted, but only for the years 2014 to 2018.

4 Results and Discussion

The study revealed that most of the Acceptance and Use of Technology research had been published in the last five years under review. Almost as many articles from 2014 to 2018 and from 2001 to 2013, which means that scientific production on Acceptance and Use of Technology has been increasing in recent years.

Although it was expected that the UTAUT model was the most used, given that it is the most recent one, the data showed that the most mentioned model in any part of the articles was the TPB, while the most mentioned in title, abstract and keywords was the TAM (see Table 1 and Table 2).

When searching the Proquest platform for references to models in any part of the articles, it was found that in the period 2001 to 2018 the most mentioned was the TPB with 26.5%, followed by the TAM with 24.4%, the TRA with 17.6% and the SCT with 17.3% and only then UTAUT with 4.2%. The same five models appear in leadership when analysing only the years 2014 to 2018: first TPB with 28.5%, followed by TAM with 23.5%, TRA with 16.6%, SCT with 15.3% and only then UTAUT with 6.1%.

Table 1. Articles published in the 21st century on Acceptance and Use of Technology Models (Data collected from Proquest on November 2019)

Model	Authors	Published Papers 2001-2018		Published Papers 2014-2018	
		Anywhere	Title, Abstract or Keywords	Anywhere	Title, Abstract or Keywords
TRA	Fishbein and Ajzen 1975	3999	400	1848	157
TAM	Davis 1989	5563	**1750**	2613	**1001**
MPCU	Thompson, Higgins and Howell 1991	12	0	6	0
TPB	Ajzen 1991	**6034**	1057	**3172**	558
MM	Davis, Bagozzi and Warshaw 1992	607	43	278	22
TAM-TPB	Taylor and Todd 1995	149	4	90	2
SCT	Compeau and Higgins 1995	3944	405	1706	204
IDT	Moore and Benbasat 1996	846	154	418	73
UTAUT	Venkatesh, Morris, Davis and Davis 2003	958	238	684	163
TOE	Tornatzky and Fleischer 1990	83	24	59	15
MISS	DeLone and McLean 1992	566	8	253	2

Analysing in Scopus the references to the models in any part of the articles, it was found that the four most cited models were the same, although in a different order. It was verified that in the period 2001 to 2018 the most mentioned was the TPB with 34.3%, followed by the SCT with 29.1%, the TAM with 16.9% and the TRA with 8.0%. The UTAUT appears only in seventh place, with 2.4% after MM and MISS. The same four models appear in leadership when analysing only the years 2014 to 2018: first TPB with 36.9%, followed by SCT with 25.8%, TAM with 17.9%, and TRA with 6.7%. UTAUT appears in sixth place, with 3.9% after MM with 4.7%.

Analysing references to the models in the titles, abstract and keywords of the articles, it was verified that in the period 2001 to 2018 the most mentioned was the TAM with 42.9%, followed by the TPB with 25.9%, the SCT with 9.9%, the TRA with 9.8% and only then the UTAUT with 5.8%. The same five models appear in the lead when analysing only the years 2014 to 2018: the first TAM

with 45.6%, followed by the TPB with 25.4%, the SCT with 9.3%, the UTAUT with 7.4% and only after the TRA with 7.1%.

In recent years, references to UTAUT have increased, but also to TAM, which still seems to be the model on which more studies are based, whereas models such as MM, Combined TAM-TPB and MPCU are very rarely mentioned in the articles analysed.

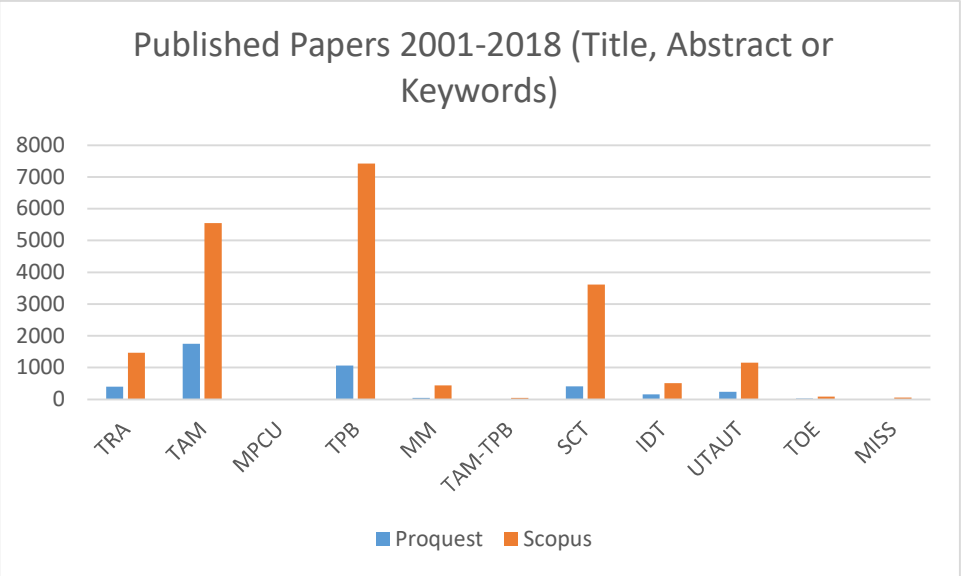
The findings suggest the number of Acceptance and Use of Technology articles into the top journals has increased, and that there is a wider array of journals publishing articles.

Table 2. Articles published in the 21st century on Acceptance and Use of Technology Models (Data collected from Scopus on November 2019)

Model	Authors	Published Papers 2001-2018		Published Papers 2014-2018	
		Anywhere	Title, Abstract or Keywords	Anywhere	Title, Abstract or Keywords
TRA	Fishbein and Ajzen 1975	11968	1462	5057	568
TAM	Davis 1989	25116	**5550**	13578	2727
MPCU	Thompson, Higgins and Howell 1991	9	9	5	5
TPB	Ajzen 1991	**51142**	7422	**28046**	**3777**
MM	Davis, Bagozzi and Warshaw 1992	7345	432	3553	181
TAM-TPB	Taylor and Todd 1995	121	42	99	22
SCT	Compeau and Higgins 1995	43395	3608	19593	1698
IDT	Moore and Benbasat 1996	1197	507	565	203
UTAUT	Venkatesh, Morris, Davis and Davis 2003	3604	1149	2979	767
TOE	Tornatzky and Fleischer 1990	130	87	110	68
MISS	DeLone and McLean 1992	4882	52	2383	20

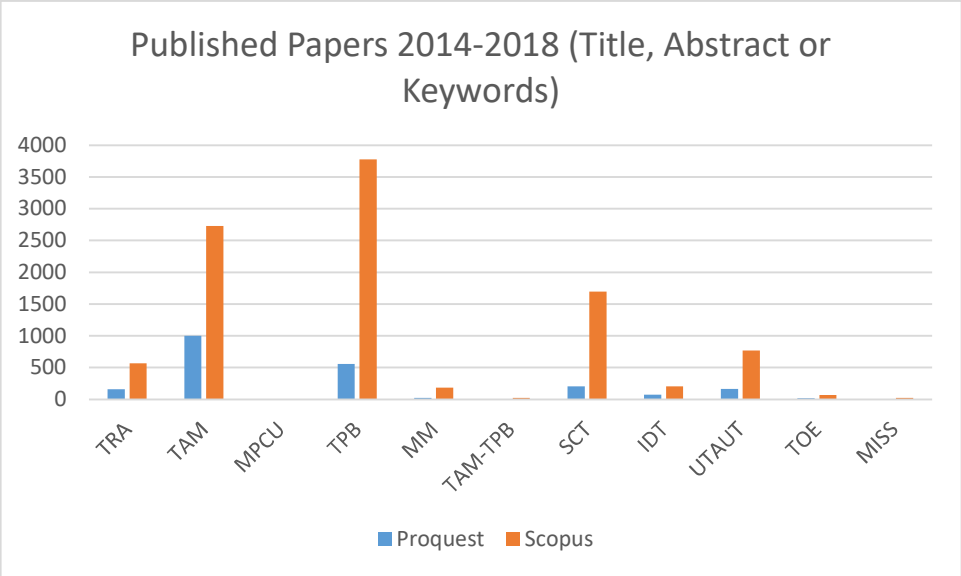
As can be seen, the results obtained on the Proquest platform are similar to those obtained on the Scopus platform (see Table 1 and Table 2).

Fig. 3 Published Papers 2001-2018



Although the Scopus platform indexes more journals than the Proquest platform, it is curious to note that on the Proquest platform there are more articles on the MPCU and MM models (see Fig. 3 and Fig. 4).

Fig. 4 Published Papers 2014-2018



5 Conclusions

It has been found that the TAM model is still the most popular among researchers engaged in Acceptance and Use of Technology. Other models such as TPB and SCT are more commonly used than the latest UTAUT. One explanation may be that investigators consider TAM to be easier to apply than UTAUT. However, the use of UTAUT has also been increasing in recent years.

The paper besides a review of the literature on the main models, includes implications for the development of an effective use of technology research and reviews the literature that has been published in the period of 2001-2018 in top journals.

The study provides both academics and practitioners with an updated review of Acceptance and Use of Technology literature along with a sense of how Acceptance and Use of Technology research is evolving. This review provides academics and practitioners a macro overview of the topics and placement of articles that compose the Acceptance and Use of Technology research literature.

The main limitations of this study are that only two databases of scientific literature (Proquest and Scopus) were used, and some articles may be repeated in the count, because the same article may be based on more than one model.

As future studies, we intend to analyse in which types of technologies were applied the different models, also verifying if there are more suitable models to study the acceptance of certain technology.

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