

A meta-analytical study of technological acceptance in banking contexts

Technological acceptance in banking contexts

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Abstract

Purpose – The purpose of this paper is to present a systematic framework with a meta-analytical approach to find various types of antecedents, consequences and moderation effects of the technological acceptance model (TAM) in banking contexts.

Design/methodology/approach – The authors conducted a meta-analysis of a total of 142 articles, which generated 636 observations, in an accumulated sample of 45,781 respondents.

Findings – The findings of this meta-analysis demonstrated 18 constructs that were antecedent to the TAM and four constructs that functioned as consequences. Most of these relationships were significant and consistent. The authors also found some methodological, cultural, economic and theoretical moderations effects between TAM constructs and the attitudes/behavioural intentions of banking technological devices.

Research limitations/implications – This meta-analysis reviewed the relationships found worldwide in the literature on TAM constructs in banking contexts. It was possible to identify new avenues for future research. Some specific limitations, such as the non-use of qualitative studies and the clipping of adverse concepts, exist in the secondary data and should be registered.

Practical implications – The work could assist managers in decision-making because the findings resulting from the meta-analysis are more consistent than those from traditional primary surveys.

Originality/value – This research tested the impact of the antecedents, consequences and moderators of the TAM in the banking sector and presented important results via a meta-analytical review. This meta-analysis contributes to the marketing literature by offering a set of empirical generalisations, including relationship coefficients and calculated fail-safe numbers.

Keywords Antecedents, Moderators, Meta-analysis, Banking contexts, Consequences, Technological acceptance model

Paper type Research paper

1. Introduction

The propensity for technological adoption, also known as the technological acceptance model (TAM), comprises a multidimensional construct composed of two main dimensions: perceived usefulness (PU) and perceived ease of use (PEOU) (Davis, 1989). This theory has been widely investigated in innovative business environments because it is associated with the predisposition of an individual to adopt something new (Venkatesh *et al.*, 2008). In the face of investments in digital platforms, which have been intense and aggressive in the banking sector (Laukkanen and Kiviniemi, 2010; Bashir and Madhavaiah, 2015; Chandio *et al.*, 2017), this research topic is relevant in this context.

In this way, some management reports reinforced these perspectives, such as the survey carried out by PwC Consulting among Thai consumers who indicated, in 2016, a 64 per cent increase in bank transactions carried out on digital platforms (Namahoot and Laohavichien, 2018) and also the research conducted by National Federation of Banks in Brazil, which, in 2017, found that more than 50 per cent of banking transactions were carried out on a smartphone or computer (Febraban, 2018). A global survey conducted by The Financial



Service among 787 executives in this field is also noteworthy: 87 per cent of respondents stated that their bank only moderately invests in new digital technologies, while 61 per cent expect it to increase investments soon (Accenture, 2017).

This finding is also confirmed by the academic community in light of research performed in the most diverse countries and contexts. In this way, we highlight the study by Patel and Patel (2018), who investigated the TAM in banking services offered over the internet and its relationship with the perception of security and social influence in India. Meanwhile, the research by Makanyeza and Mutambayashata (2018) analysed the predisposition of consumers towards using plastic money in Zimbabwe. The work of Rodrigues *et al.* (2017), carried out in Portugal, which evaluates the possible influence of web design on the behaviour of mobile bank users, is also relevant.

Although there has been a major expansion of TAM knowledge as a result of the countless works that have been published over recent decades, we found some conflicting results in the literature (Yousafzai, 2012). For example, we can find divergences in the relationship between the TAM and attitudes towards electronic banking applications. Some studies point to positive and significant relationships between both (e.g. Mohammadi, 2015), while others indicate non-significant relationships (e.g. Mashhadima *et al.*, 2007). Another conflicting finding could be concerned with the relationship between the TAM and behavioural intentions. In this case, we found negative and non-significant effects (e.g. Rodrigues *et al.*, 2016) as well as positive and significant effect sizes (e.g. Mohammadi, 2015).

It is possible that the conflicting findings could be explained by methodological elements, such as sample size and type (Hedges and Olkin, 1985; Pan and Zinkhan, 2006), cultural influences (Naem *et al.*, 2013), the economic situation of a country (Zarantonello *et al.*, 2013) and the type of application (mobile or internet banking) used for interaction with the bank.

In this sense, meta-analytical research could make a significant contribution in this context because this method offers the possibility of integrating findings, thus producing a generalizable understanding of the phenomenon (Lipsey and Wilson, 2001). This is because the approach overcomes possible biases associated with research that is carried out and published with several limitations (e.g. size and type of sample, methodological robustness), in turn allowing us to generate accurate estimates of effect size in each analysed relationship (Hedges and Olkin, 1985). Thus, the results of the present study could reflect the state of the art of the TAM in banking and promote more precise decision-making processes involving banking managers in order to minimise potential barriers to the adoption of new technologies.

It is interesting that some meta-analyses of the TAM have already been carried out. For example, Yousafzai *et al.* (2007) conducted two meta-analytical studies on technological acceptance in a general context. Hauk *et al.* (2018) also performed a meta-analysis in which they investigated the chronological relationship between age and the propensity to adopt new technologies. Despite the contributions made by these studies, we cannot precisely evaluate the effects of the antecedents, consequents and moderators of the TAM on the banking sector. This occurs because specific contexts, such as banks, tend to present different constructs and moderators that are investing in other contexts. In this way, the achievements of meta-analyses applied in specific contexts are common among consolidated constructs such as the TAM. For example, we can observe the extended meta-analytical research on the satisfaction construct. In this case, we can refer to Szymanski and Henard's (2001) meta-analysis of consumer satisfaction in general contexts, Brown and Peterson's (1993) meta-analysis of satisfaction in the organisation environment, the consumer satisfaction meta-analysis by Ladeira, Santini, Araujo and Sampaio (2016), Ladeira, Santini, Sampaio, Perin and Araujo (2016) in the hospitality, tourism and consumer banking context, and the meta-analysis conducted by Santini *et al.* (2017) to investigate student satisfaction in the education sector.

It is interesting to note that the banking sector annually increases its investments in innovative policies linked to the development of digital platforms in order to increase benefits and customer satisfaction (Bashir and Madhavaiah, 2015; Chandio *et al.*, 2017). These practices have also led to an increase in the number of users (Laukkanen and Kiviniemi, 2010). At the same time, there is a significant reduction in operating costs and, therefore, greater profitability for banks (Bradley and Stewart, 2003). In recent years, the industry has experienced a very significant technological revolution, generating new forms of operations, as well as reducing geographic constraints and transactional costs (Roy *et al.*, 2017).

On this subject, we highlight a survey published in The Financial Brand about strategic trends in 2018. Five of the ten points published are directly linked to the digital environment in the banking sector: redesigning/improving the digital experience for the consumer; increasing analytical data capacity; automating business and banking processes; increased investment in banking innovation; and focussing on security and authentication.

In this context, the present study has the objective of analysing the antecedents, consequents and moderators of the TAM, with respect to the banking sector, based on meta-analytical research. We intend to advance knowledge about technological acceptance in the following aspects: we will be able to draw definitive conclusions relevant to the theme because the meta-analysis has the capacity to synthesise and generalise the findings of a phenomenon (Dickersin, 2002); we will identify some moderation relationships, including cultural (Minkov and Hofstede, 2012), theoretical (Schierz *et al.*, 2010) and methodological (Hedges and Olkin, 1985; Pan and Zinkhan, 2006) aspects; we will be able to identify avenues for future research because the systematic review carried out can indicate relationships that are still incipient and could be investigated in the future; and we will be able to offer assistance to managers in their decision-making processes because our findings are more consistent than those of traditional primary surveys (Hunter and Schmidt, 2004). Ultimately, the results will enable managers to make more precise decisions to minimise potential barriers to the adoption of new technologies, particularly in the banking context.

2. Technological acceptance model

The propensity for technological adoption has been a subject of study since the 1970s (Schultz and Slevin, 1975). The first studies already identified a strong correlation between the two behaviours of: PU; and PEOU. The seminal work of Davis (1989) proposed a means of measuring the propensity for technological adoption using a multidimensional scale, which comprises these two behaviours. This in turn led to the proliferation of the investigation of this phenomenon in the most diverse countries and contexts. In the banking environment, many studies have been carried out to evaluate the TAM, such as those applied to the evaluation of personal assistance services (Marshall and Heslop, 1988), internet banking (Sukkar and Hasan, 2005) and mobile service platforms (Liébana-Cabanillas *et al.*, 2013).

PU concerns the way in which the consumer sees the technology and how it is used to increase technological performance and the experience of using a particular service (Venkatesh *et al.*, 2008). This application is common in the banking context, with respect to the evaluation of services offered through internet banking, electronic terminals and mobile applications, among others (Kesharwani and Singh Bisht, 2012). PU can be linked to the perception of financial, time and even security savings (Laukkanen and Kiviniemi, 2010).

PEOU is associated with the interaction elements that the technology generates in the user. The user will mentally evaluate the handling of the technology and, consequently, its performance (Venkatesh and Davis, 2000). In this case, evaluation elements are incorporated including the installation process, graphical interface and system quality (Bashir and Madhavaiah, 2015).

2.1 Antecedents and consequences of the TAM

From a systematic review (detailed in the section on methodological design), it was possible to identify 18 antecedents and four consequent constructs of the TAM. In the case, we assumed that four antecedents present a negative (age, discomfort, risk perception and interaction needs) relationship with the TAM. We postulated this because older individuals tend to present more negative attitudes than younger consumers (Hauk *et al.*, 2018). Furthermore, discomfort and risk perception tend to promote uncertainty about the banking system device (Mohammadi, 2015), while interactions are minimised by technological contexts (Mortimer *et al.*, 2015).

The 14 remaining antecedent constructs tend to present a positive relationship with the TAM. This tends to occur because self-efficacy is linked to the ability to perform with electronic devices (Venkatesh and Davis, 2000); compatibility is related to individual values and beliefs about technology (Rogers, 1995); perceived awareness converges with consciousness about the electronic benefits (Al-Somali *et al.*, 2009); involvement will promote a more emotional connection with technological systems (Chang and Kung, 2010); social influence presumes that individuals' positive experience of technological banking devices will inspire others (Wang *et al.*, 2003); innovativeness is directly linked to the acceptance of new technologies and ideas (Rogers, 1995); web design, enjoyment and accessibility perceptions promote positive attitudes towards internet banking devices on the basis of attractiveness (Mouakket, 2009), convenience and flexibility (Kang and Lee, 2012).

In contrast to risk perceptions, credibility tends to promote a positive relationship with the TAM because this construct converges with perceptions of security and safety about the electronic banking technology (Luarn and Lin, 2005). The perception of low cost (Luarn and Lin, 2005) in terms of using the banking system will also promote positive effects with TAM constructs. Finally, system attributes such as perception of quality (Gu *et al.*, 2009), system support (Katsika, 2015) and speed of responses (Pituch and Lee, 2006) will also tend to evoke positive relations with the TAM.

For the consequent constructs, we expected positive relationships across the board. The perception of utility (Venkatesh and Bala, 2008) and the convenience and speed of banking services (Alsajjan and Dennis, 2010) tend to promote positive evaluations and consequently increase positive attitudes, behavioural intentions (Venkatesh and Davis, 2000), perceptions of user performance (Rodrigues *et al.*, 2016) and satisfaction (Tsai *et al.*, 2014). Table I presents each of the identified constructs and their respective concepts.

2.2 Moderation relationships

As previously described, we analysed the moderating relationships between the antecedents and consequences of the TAM. This investigation is important because methodological (Hedges and Olkin, 1985), cultural (Minkov and Hofstede, 2012), economic (Zarantonello *et al.*, 2013) and context statements (Mohammadi, 2015) can play a role in the inconsistencies of TAM-related research findings in the banking context. This conclusion has been reported in other meta-analyses (e.g. Santini *et al.*, 2018; Rosario *et al.*, 2016). In Table II, we present the moderating variables, their description, the form of codification and expected relations.

3. Method design

We identified published and unpublished studies that are relevant to this meta-analysis. At first, the Google Scholar database was searched using the following combinations of words in the fields of "document title" and/or "abstract": "technology acceptance" and "bank"; "ease of use" and "bank"; and "usefulness" and "bank". In a second step, we accessed the following eight databases: Jstor, Emerald, PsycINFO, Taylor & Francis, Elsevier Science

Concepts	
<i>Antecedents</i>	
Self-efficacy	Represents how much users interpret their behaviour, knowledge and ability to handle virtual banking applications (Luarn and Lin, 2005)
Compatibility	Perception of the compliance of a technology with individual values and beliefs (Rogers, 1995)
Perceived awareness	Consciousness about the benefits, advantages and disadvantages of using electronic banking devices (Al-Somali <i>et al.</i> , 2009)
Discomfort	Perception of a lack of control over a new technology (Parasuraman, 2000)
Involvement	Individual perception about the relevance of an object based on its needs, values and interests (Zaichkowsky, 1985)
Age	Age range of the user of electronic banking devices (Hauk <i>et al.</i> , 2018)
Social influences	Perception of how much the opinion of others is important to establish a behaviour (Fishbein and Ajzen, 1975)
Innovativeness	Compared with other people, the innovativeness represents the level to adopt new technologies and ideas (Rogers, 1995)
Web design perceptions	Attractiveness of the digital banking interaction platform (Mouakket, 2009)
Accessibility perceptions	Perceptions of flexibility and convenience linked to the access of system devices (Kang and Lee, 2012)
Credibility perceptions	Perceptions of security, safety and privacy promoted by the electronic banking technology (Luarn and Lin, 2005)
Cost perceptions	Low costs promoted by the use of electronic banking devices (Luarn and Lin, 2005)
Enjoyment perceptions	Perceptions of a pleasurable experience in using electronic banking devices (Bashir and Madhavaiah, 2015)
Risk perceptions	Level of uncertainty about financial, performance, social or privacy loss promoted by banking technology devices (Bashir and Madhavaiah, 2015)
System quality	Perception of the consistency and speed of the electronic banking system (Gu <i>et al.</i> , 2009)
Interaction need	Need to relate to other consumers and employees of a company (Chandio, 2011)
Infrastructure support	Support services offered to the technology user, such as a help desk (Katsika, 2015)
Responses	Perception about the speed and consistency of response to user demand for electronic banking devices (Pituch and Lee, 2006)
<i>Consequences</i>	
Attitude towards use	Level of affective evaluation that the individual has against the use of system devices
Behaviour intentions	Predisposition to use a system (Davis, 1989)
Performance	Perception of the efficiency of electronic banking devices (Rodrigues <i>et al.</i> , 2016)
Satisfaction	Affective and cognitive evaluation related to the performance of the electronic banking device (Oliver, 1980)

Table I.
Antecedents and
consequences
of the TAM

Direct, SCOPUS, Scielo and EBSCO. In this round, the same criteria as previously mentioned were applied to access works that could be relevant to this research.

In a third step, we accessed published research presented at conferences and congresses (e.g. INFORMS, Hawaii International Conference on Systems Sciences, 25th European Conference on Information Systems, Global Marketing Conference, Association for Consumer Research Conference). We also sought out dissertations and theses using ProQuest Dissertations and Theses and Google Scholar. This round had the objective of incorporating unpublished studies, thereby allowing us to discuss the “file drawer problem”, since there is an academic current that reinforces the publication of studies that present significant and strong effects (Rosenthal, 1979).

After the aforementioned steps were completed, 497 papers were identified. Of these, 196 were outside the scope of analysis, given that they involved qualitative research, while 127 studies were not analysed because they did not evaluate constructs related to the TAM.

Table II.
Moderation effects

Variable	Description	Codifications	Expected relations
Sample type	The sample type could be students or non-students. This information was carried in the methodological description of the studies	0 = students 1 = non-students	Student samples tend to have stronger effects because of their homogeneity characteristic (Fern and Moroe, 1996)
Sample size	The sample size had two groups: small or large. This definition was obtained from the median of the sample size obtained in the methodological description of each study	0 = small 1 = large	Small samples tend to have stronger effects on relations because the effect variations are smaller in small samples (Fern and Moroe, 1996)
Number of items on the TAM scale	There is great variability with regard to the methods of measuring the two dimensions of TAM. For example, there are studies that use a large number of items (up to 8) and studies that use a small number of items (2) to measure the TAM. Based on these parameters, the median number of items used in the scales were defined and two groups, small and large, were created	0 = small 1 = large	Smaller scales tend to reduce the measurement capacity (Fern and Moroe, 1996), and therefore scales with more variables should have stronger effects
Country economic level	The index by Zaranonello <i>et al.</i> (2013) is based on the country origins. Three groups were identified: developed, emergent and not developed countries	0 = developed 1 = emergent 2 = not developed	A stronger relationship is expected in research conducted in developed countries. This assumption is based on the perception that developed societies present a more mature community in terms of the abilities concerning online interactions and, consequently, will present greater confidence in this type of transaction and, also, more positive attitudes (Kim and Peterson, 2017)
Culture	We identify two groups of countries using parameters established by Minkov and Hofstede (2012): Eastern and Western	0 = Eastern 1 = Western	We expected stronger relationships in research in Western countries. This assumption is based on increased Western consumer confidence in online transactions (Yamagishi and Yamagishi, 1994)
Innovation level	We coded the level of innovation from the Bloomberg Innovation Index 2018. In this case, the median values of each country of origin of the studies analysed were obtained	0 = low innovation 1 = high innovation	We expected stronger relationships for research conducted in high-innovation countries. This occurs because these nations will tend to demonstrate greater skill and familiarity with platforms (Kim and Peterson, 2017)
Connectivity level	We use the Connected Consumer Index (GFK, 2016). In this case, again, the median of the connectivity indices of each country of the study was obtained	0 = low connectivity 1 = high connectivity	We expect stronger relationships in nations with more connectivity to the internet. This expectation is based on previous arguments that are linked to the greater ability and familiarity of customers with digital platforms (Yamagishi and Yamagishi, 1994)
Device type	Most research concerning the TAM is linked to internet banking and/or mobile banking. Thus, these two groups were taken from the research based on information from the studies	0 = internet banking 1 = mobile banking	A stronger relationship is expected for internet banking users. This is because this type of user makes greater effort before starting to handle the system (installation of security programs, system passwords) and, as a consequence, has more involvement with the platform (Venkatesh and Davis, 2000)

Another 29 were not computed for analysis because they presented insufficient statistics for the conversion of effect sizes, such as ARIMA or econometric equations. Finally, three other papers were not analysed because they were in languages outside the scope of analysis (e.g. Croatian, Chinese). Thus, we analysed 142 surveys that generated a total of 636 observations, in a cumulative sample of 45,781 respondents.

We coded the studies following the procedure of Rust and Cooil (1994). Prior to commencing this activity, the criteria were discussed by the authors of this study and the coding was performed in an individualised way by the two researchers. After the coding was completed, the results were compared and, in this case, a concordance index of 94 per cent of cases was obtained. In cases in which there was no consensus, a third author served as a judge. In this situation, dubious elements were analysed together in group meetings. This procedure was similar to that followed in other meta-analytical studies (e.g. Rosario *et al.*, 2016).

3.1 Data analysis

To perform the data analysis, we followed the procedure of Hedges and Olkin (1985). In this case, the analysis was performed with the Pearson correlation coefficient. For the studies that did not report the correlation, necessary conversions were made. For example, the results of a student's *t*-test and *f*-tests were converted based on the formulas suggested by Hunter and Schmidt (2004). A similar procedure was used for the statistics reported as standardized beta coefficients. In this case, the recommendations of Peterson and Brown (2005) were followed. These same procedures were commonly used in previous meta-analysis processes (Santini *et al.*, 2017; Kim and Peterson, 2017).

In addition, the level of heterogeneity among the studies was analysed from the *Q* and I^2 tests. The first, called Cochran's *Q*, checks whether the data found in a primary study refute the null hypothesis; that is, whether the null hypothesis is confirmed (when $p > 0.05$), the studies are considered to be homogeneous (Lau *et al.*, 1998). The I^2 statistic is obtained through the *Q* statistic and can range from 0 to 100 per cent. Studies with a 25 per cent index have low heterogeneity, studies with 50 per cent values show moderate heterogeneity and those above 75 per cent have high heterogeneity (Higgins *et al.*, 2003).

The results of this meta-analysis are presented from two perspectives: Hedges-Olkin meta-analysis (HOMA) and hierarchical linear meta-analysis (HiLMA). The HOMA method comprises the steps described above with respect to the conversion of values into correlation levels and their corrections on account of the transformational effect when using the Fisher *z*-transformation. The HiLMA method served to evaluate the moderating effects, since it uses a multivariate format based on regressions (Geyskens *et al.*, 2009).

4. Results

We have observed the predominance of research conducted in India (17 studies), Iran (nine studies) and Malaysia (seven studies). Regarding the platforms investigated, internet banking was most prevalent with 83 publications, followed by mobile applications (41 publications). Table III shows the results linked to the 18 antecedents to the TAM as identified during the systematic review.

Negative relationships were expected from four of the 18 previous constructs (feeling of discomfort, age, risk perceptions and interaction needs). The relationship between discomfort and TAM constructs is not significant. The results are surprising because we expected a negative relation. We assume that the feeling of discomfort was an inhibitor and could make consumers reluctant to adopt new technology (Vatnani and Verma, 2014). We suggest there is a need for more investigations in the future because the systematic review found few studies that test this relationship. In this case, the incongruence of the

Constructs	<i>k</i>	<i>O</i>	<i>N</i>	<i>r</i>	ICI	ICS	<i>z</i>	<i>p</i> -value	<i>Q</i>	<i>I</i> ²	FSN ^a	FSN ^b
<i>PEOU</i>												
Self-efficacy	42	54	13,457	0.42	0.34	0.50	9.30	0.00	2,172.38	97.56	28,802	471
Compatibility	13	15	3,302	0.52	0.38	0.64	6.40	0.00	438.88	96.81	4,480	144
Perceived awareness	7	8	1,357	0.46	0.32	0.58	6.00	0.00	69.78	89.97	782	79
Discomfort	4	4	853	-0.10	-0.40	0.21	-0.63	0.52	65.02	95.38	NC	NC
Involvement	10	14	2,243	0.31	0.21	0.41	5.52	0.00	119.06	89.92	1,066	77
Age	3	3	405	-0.30	-0.66	0.17	-1.26	0.20	24.14	95.85	NC	NC
Social influences	32	37	11,117	0.26	0.16	0.36	5.04	0.00	1,298.28	97.22	9,198	202
Innovativeness	9	9	1,646	0.46	0.33	0.58	6.30	0.00	79.65	89.95	871	77
Web design perceptions	11	12	4,058	0.20	0.03	0.35	2.39	0.01	327.38	96.64	712	57
Accessibility perceptions	12	14	3,303	0.31	0.20	0.41	5.60	0.00	160.14	91.88	1,274	69
Credibility perceptions	53	76	18,626	0.44	0.38	0.49	13.43	0.00	2,563.27	97.11	3,516	682
Cost perceptions	15	16	5,698	0.27	0.07	0.45	2.68	0.00	997.58	98.50	2,776	116
Enjoyment perceptions	14	15	4,008	0.53	0.34	0.68	4.77	0.00	851.40	98.35	5,440	177
Risk perceptions	29	38	8,164	-0.08	-0.16	-0.01	-1.96	0.04	688.06	94.62	574	52
System quality	9	11	3,123	0.48	0.28	0.63	4.38	0.00	464.24	97.84	2,558	113
Interaction needs	3	3	1,371	0.07	-0.12	0.26	0.72	0.47	11.84	83.11	NC	NC
Infrastructure support	7	10	2,179	0.30	0.10	0.48	2.94	0.00	306.10	97.10	698	48
Responses	4	4	1,375	0.24	0.08	0.39	2.94	0.00	28.70	89.54	84	16
<i>PU</i>												
Self-efficacy	38	51	10,703	0.34	0.26	0.41	8.16	0.00	1,347.00	96.29	24,536	355
Compatibility	12	15	2,781	0.57	0.32	0.70	6.13	0.00	575.80	97.57	5,412	165
Perceived awareness	7	10	1,357	0.42	0.28	0.55	5.39	0.00	115.36	92.20	1,063	92
Discomfort	5	6	1,223	-0.11	-0.32	0.10	0.99	0.32	96.57	94.82	NC	NC
Involvement	10	14	2,548	0.39	0.21	0.54	4.02	0.00	434.08	97.00	1,842	96
Age	3	3	405	-0.47	-0.76	-0.01	-2.03	0.04	24.69	95.06	7	3
Social influences	37	43	12,318	0.27	0.16	0.37	4.84	0.00	2,044.28	97.94	2,399	217
Innovativeness	8	8	1,499	0.44	0.30	0.56	5.61	0.00	70.94	90.13	651	68
Web design perceptions	14	18	4,927	0.38	0.22	0.51	4.53	0.00	811.65	97.90	5,221	150
Accessibility perceptions	18	22	5,314	0.44	0.32	0.55	6.54	0.00	731.23	97.12	78,822	177
Credibility perceptions	64	82	21,973	0.41	0.36	0.47	15.35	0.00	1,812.26	95.58	23,167	623
Cost perceptions	17	18	4,856	0.32	0.04	0.56	2.22	0.00	1,332.96	98.95	2,343	123
Enjoyment perceptions	10	10	3,449	0.40	0.13	0.62	2.80	0.00	666.08	98.64	1,639	91
Risk perceptions	34	42	9,563	-0.05	-0.14	0.04	-1.12	0.26	1,030.92	96.02	NC	NC
System quality	12	17	5,233	0.36	0.23	0.47	5.36	0.00	532.35	96.99	3,708	106
Interaction needs	3	3	1,371	0.07	-0.11	0.26	0.81	0.42	10.43	80.82	NC	NC
Infrastructure support	6	9	1,859	0.31	0.18	0.44	4.42	0.00	114.70	93.02	572	43
Responses	4	5	1,375	0.32	0.23	0.41	6.42	0.00	18.90	78.83	248	29

Notes: *k*, number of studies; *O*, effect sizes tested; *N*, accumulate sample; *r*, effect size corrected; ICI, lower confidence interval; ICS, upper confidence interval; *Z*, standardized effect size score; *Q*, individual heterogeneity test; *I*², level of heterogeneity; FSN, number of null works or works with contrary results that are necessary to refute the finding; NC, not calculated. ^aRosenthal parameter; ^bOrwin parameter. (*p*-value) Significance level of effect size

Table III.
Direct relationships
(HOMA): antecedents

findings is not sufficient for us to consolidate them because one of the studies analysed presents a positive relation between discomfort and the TAM construct (Jin and Kim, 2013).

Risk perception showed a negative and significant relation only with PEOU ($r = -0.08$, $p < 0.05$). Despite having a low correlation value, the fail-safe number points to a relatively consistent result (FSN_{Rosenthal} = 574; FSN_{Orwin} = 52). In this way, we consolidated the results of research that emphasised the negative effects of the feeling of uncertainty

regarding the protection of consumer privacy, in terms of avoiding financial and identity loss, to the PEOU concerning an electronic banking device (Bashir and Madhavaiah, 2015). However, this relationship was not significant with PU. So, these results indicate that the existence of risk does not mean that technological banking devices are not useful. This follows the findings of Khrewesh's (2011) study.

We also observed that the relationship between age and PU was significant ($r = -47$, $p < 0.05$). In any case, this finding indicates that younger consumers tend to perceive more utility in electronic banking systems (Neves *et al.*, 2013). We could also observe that the relationship between age and PEOU is not significant. These results are interesting because they present a divergent perspective from the meta-analysis conducted by Hauk *et al.* (2018) of the relationship between chronological age and technology acceptance. This could have occurred because the banking contexts tend to have more older adopters of technological devices, according to Hauk *et al.* (2018), than in the case of libraries (Park *et al.*, 2009) or education (Ring *et al.*, 2013).

Finally, interaction needs did not present a significant effect with regard to the dimensions of the TAM. This finding can be useful for future research because only a few studies exist at present and the results are very heterogeneous. For example, Mortimer *et al.* (2015) found no significant effects between interaction needs and the TAM among Australian and Thai mobile banking users, while Ghezelayagh's (2006) thesis reported positive correlations among Iran users.

In the other 14 antecedent positive relationships, we observed very consistent effects. For example, the relationship between the perception of credibility and the TAM showed high levels in the fail-safe number ($r_{\text{PEOU}} = 0.44$; $p < 0.001$; $\text{FSN}_{\text{Rosenthal}} = 3,516$; $\text{FSN}_{\text{Orwin}} = 682$; $r_{\text{PU}} = 0.41$; $p < 0.001$; $\text{FSN}_{\text{Rosenthal}} = 23,167$; $\text{FSN}_{\text{Orwin}} = 623$). These findings are important because, in the literature, we came across some conflicting results about this relationship. While some studies find that credibility is not an important influencer in the decisions of bank users towards adopting online banking (e.g. Pikkarainen *et al.*, 2004), others find opposite results (e.g. Tran and Corner, 2016).

We also find a consistent relationship between self-efficacy and the TAM ($r_{\text{PEOU}} = 0.42$; $p < 0.001$; $r_{\text{PU}} = 0.34$; $p < 0.001$). These results consolidate the assumption that people who have the capacity to interact with electronic devices should not find banking technological devices complex (Mohammadi, 2015). The relationship between social influence and the TAM is also consistent according to the fail-safe number as shown in Table III ($r_{\text{PEOU}} = 0.26$; $p < 0.001$; $r_{\text{PU}} = 0.27$; $p < 0.001$). In this case, the results were consistent with the findings of studies that highlighted social influences as among the strongest influential factors in the adoption of banking technology (Püschel *et al.*, 2010).

In the same way, other constructs also present a consistent relationship with the TAM, e.g. compatibility ($r_{\text{PEOU}} = 0.52$; $p < 0.001$; $r_{\text{PU}} = 0.57$; $p < 0.001$), system quality ($r_{\text{PEOU}} = 0.48$; $p < 0.001$; $r_{\text{PU}} = 0.36$; $p < 0.001$) and cost perception ($r_{\text{PEOU}} = 0.27$; $r_{\text{PU}} = 0.32$). These findings reinforce the assumptions that compatibility plays an important role in the adoption of new technological (Rogers, 1995), as well as system quality; indeed, they represent the first steps in promoting trust in banking technology and consequently the propensity to adopt (Zhou, 2011), along with the cost perception that promotes the technological revolution in the banking sector on the basis of delivering quality banking services at low prices (Roy *et al.*, 2017).

From the fail-safe number index (see Table III), we could detect some moderate and consistent relationships with the TAM: enjoyment; innovativeness; involvement; and infrastructure support. The results related to enjoyment are interesting because few studies have incorporated this construct into the TAM and banking contexts (Bashir and Madhavaiah, 2015). Those that have validate the theoretical claim that enjoyment motivates users to spend more time on new systems and consequently increases the perception of

system value (Venkatesh and Davis, 2000). The positive relationship between innovativeness and the TAM reinforces the fact that consumer characteristics minimise the barriers towards adopting banking technology (Rogers, 1995). In the same way the positive relationship between involvement and the TAM demonstrate that the perceptions of relevance about banking technology devices tend to increase the perception of system efficiency by PU and decrease the mental effort by PEOU (Chang and Kung, 2010). The findings about the positive relationship between infrastructure support and the TAM also demonstrate that this element is important in potentializing the perception of performance of electronic banking devices (Awasthi and Sangle, 2013).

The remaining antecedent constructs also present moderate correlations with the TAM. This confirms that the perceived awareness or consciousness of the benefits of banking technologies is important to predisposition towards adoption (Al-Somali *et al.*, 2009); the attractiveness of digital banking platforms linked to web design increase the perception of PEOU and PU (Mouakket, 2009); the flexibility and convenience of electronic banking devices that promote accessibility perceptions remove online banking adoption barriers (Kang and Lee, 2012); and the speediness of responses to user demand is necessary if users are to adopt banking technologies devices (Pituch and Lee, 2006).

After the evaluation of the antecedent constructs, we proceeded to the analysis of the consequent constructs. The results are presented in Table IV. The four constructs identified in the systematic review indicated positive and significant relationships with the dimensions of the TAM.

Based on the findings, it can be observed that the most tested relationships (attitude and intention) present highly consistent effects in TAM constructs. Thus, this result address some of the conflicting reports in the literature and reinforce the validity of classical theoretical claims that highlight attitude as a critical success element in the acceptance of new technology (Davis, 1989). In this way, TAM constructs will increase the attitude and behaviour intentions through the perception of utility and convenience (Venkatesh and Bala, 2008) and easy handling and reduction in transfer costs (Wessels and Drennan, 2010; Kesharwani and Singh Bisht, 2012).

Finally, we also identified moderate relationships between performance and satisfaction. This result is interesting because few studies have investigated these consequents of the TAM (Tsai *et al.*, 2014). The findings suggest that, when electronic banking devices are perceived as useful and easy to use, user satisfaction (Tsai *et al.*, 2014) and perception of performance increase (Rodrigues *et al.*, 2016).

4.1 Moderation effect tests

In order to analyse possible moderation effects, analysis using the HiLMA method was carried out. The analysis followed the criteria established by Lipsey and Wilson (2001)

Constructs	<i>k</i>	<i>O</i>	<i>N</i>	<i>r</i>	ICI	ICS	<i>z</i>	<i>p</i> -value	<i>Q</i>	<i>I</i> ²	FSN ^a	FSN ^b
<i>PEOU</i>												
Attitude towards use	60	73	19,258	0.44	0.38	0.50	12.84	0.00	2,030.42	96.55	34,375	545
Behaviour intentions	103	122	33,276	0.42	0.37	0.47	15.27	0.00	3,976.20	96.95	34,856	888
Performance	5	5	1,371	0.52	0.09	0.78	2.34	0.02	302.38	98.68	437	41
Satisfaction	5	5	1,997	0.50	0.28	0.67	4.13	0.00	119.42	96.65	871	65
<i>PU</i>												
Attitude towards use	59	70	18,168	0.59	0.53	0.65	14.92	0.00	2,571.99	97.56	32,576	749
Behaviour intentions	119	140	39,993	0.50	0.46	0.54	22.33	0.00	3,702.88	96.30	120,511	1,341
Performance	8	8	3,388	0.57	0.35	0.73	4.55	0.00	460.15	98.47	2,196	68
Satisfaction	5	6	1,997	0.54	0.31	0.71	4.20	0.00	206.45	97.57	1,158	70

Table IV.
Direct relationships
(HOMA): consequents

and Geyskens *et al.* (2009). It should be noted that the analysis was performed based on the relationships between the TAM and attitude and between the TAM and behavioural intention, given that the statistics Q and I^2 were quite significant and that there were enough observations (> 100) to carry out the analysis. Table V presents the results.

Regarding the analysis of possible methodological moderators (type, sample size and number of scale items), two significant moderating relationships were observed: the moderating effect of sample size on the relationship between PEOU and use intention; and the moderating effect of the scale size on the relationship between PU and attitude. In the first case, it can be seen that small samples produce stronger correlations ($M_{small} = 0.51$; $M_{large} = 0.42$; $p < 0.05$). This finding confirms the assumption of Fern and Moroe (1996). In the second case, it was found that the relationship was stronger in studies that used a scale with more items of measurement ($M_{small} = 0.34$, $M_{large} = 0.59$; $p < 0.05$). This result confirms the assumption about the loss of effect when testing the reduction of items from an original scale (Fern and Moroe, 1996).

Regarding cultural and economic moderations, there were significant relationships between PEOU and attitude. In this sense, we observed a stronger relationship in developed economies ($M_{developed} = 0.71$; $M_{no_developed} = 0.45$; $p < 0.05$). We also noted a stronger relationship between PEOU and attitude in Western countries ($M_{western} = 0.52$; $M_{eastern} = 0.38$; $p < 0.05$). The results confirm previous assumptions that consumers in developed countries and Western cultures tend to have more confidence in using online banking platforms (Teo *et al.*, 2012; Kim and Peterson, 2017).

In the case of theoretical moderating, we did not detect the innovation moderating effect. However, at the level of internet connectivity, it was found that, for consumers in countries with greater internet access, there was a stronger relationship between PEOU and attitude ($M_{less_connectivity} = 0.49$; $M_{more_connectivity} = 0.66$; $p < 0.05$). Thus, it can be argued that longer internet connection times lead to a greater familiarity with electronic systems (Yamagishi and Yamagishi, 1994). We also detected a significant moderation effect of device type on the relationship between TAM constructs and attitude. In these instances, the relationship was stronger when the interviewees were users of internet banking (PEOU: $M_{internet} = 0.57$; $M_{mobile} = 0.41$; $p < 0.05$; PU: $M_{internet} = 0.45$; $M_{mobile} = 0.30$; $p < 0.05$). This finding reinforces the assumption that internet users have more experience of handling online banking systems, given the need for prior system installation (Lee and Im, 2015).

	PU (attitude)		PEOU (attitude)		PU (intention)		PEOU (intention)	
	β	z	β	z	β	z	β	z
<i>Methodological moderations</i>								
Sample type	-0.14	-1.7 ^{ns}	-0.12	-1.5 ^{ns}	0.10	1.19 ^{ns}	-0.03	-0.48 ^{ns}
Sample size	0.09	1.4 ^{ns}	0.06	-1.0 ^{ns}	0.11	1.88 ^{ns}	0.14	2.87*
Scale size	-0.09	-0.35 ^{ns}	-0.26	-2.5*	-0.22	2.43*	0.02	0.71 ^{ns}
<i>Cultural and economics moderations</i>								
Economic level	0.06	0.68 ^{ns}	0.25	2.5*	0.05	0.13 ^{ns}	0.18	0.25 ^{ns}
Cultural orientations	0.09	1.3 ^{ns}	0.14	2.1*	0.06	0.75 ^{ns}	0.12	1.87 ^{ns}
<i>Theoretical moderations</i>								
Innovation level	0.16	1.9 ^{ns}	-0.09	-1.3 ^{ns}	-0.01	-0.11 ^{ns}	-0.01	-0.07 ^{ns}
Connectivity level	-0.17	-1.8 ^{ns}	-0.22	-2.4*	0.01	0.15 ^{ns}	-0.02	-0.52 ^{ns}
Device type	0.16	2.0*	0.15	2.0*	0.03	0.60 ^{ns}	0.02	0.41 ^{ns}

Notes: ns, not significant. * $p < 0.05$

Table V.
Moderation effect
results (HiLMA)

4.2 Discussion

The results show that self-efficacy was positive with TAM dimensions. This is interesting because some studies have attempted to link self-efficacy only with the PEOU dimension (e.g. Gu *et al.*, 2009; Al-Somali *et al.*, 2009). This study confirms significant and similar relationships for both dimensions of the TAM. It is also important to note that some researchers have found weak relationships between these two constructs (e.g. Mouakket, 2009) while this research finds very strong and consistent effect sizes. In this way, the current meta-analysis consolidated this relationship and opened up new directions for alternative investigations into these constructs (e.g. analysing possible moderations and mediation effects).

The compatibility construct was more related to the PEOU dimension. As a result, we can suggest that the beliefs about individual technological values converge with the elements of interaction associated with technological devices (Rogers, 1995). Another interesting result concerns the significant relationship between perceived awareness and the TAM constructs. This is because early studies concerning this behaviour emphasised that a lack of awareness of the benefits provided by technology was one of the main reasons for non-adoption (e.g. Sathye, 1999). Nowadays, an increase in the recognition of benefits is accompanied by an increase in the use of electronic banking devices (Al-Somali *et al.*, 2009). However, this result should be viewed with caution because few studies have investigated this relationship, as well as perceived awareness as a critical factor in consumers' adoption of electronic banking devices (Mohammadi, 2015). Thus, we suggest more robust research, e.g. in the form of longitudinal and cross-cultural studies, to consolidate this finding.

We could not find a significant relationship between discomfort and the TAM. However, it is important to consider this result carefully because few studies on this relationship have been conducted and the degree of heterogeneity concerning this finding is strong. This heterogeneity could be the result of applying different methodological designs (e.g. type and sample size, country) in previous studies (Hunter and Schmidt, 2004). For example, while Purnomo and Lee (2013) found a positive and significant relationship between discomfort and the TAM among a sample of students in Indonesia, Kansal (2016) and Vatnani and Verma (2014) found a negative relation with a professional sample in India. In this case, we could not test possible moderation effects because the number of studies is insufficient (Lipsey and Wilson, 2001). Thus, it is important to carry out more investigations into this relationship to establish a more homogeneous result.

We also observed similar effects of involvement and TAM constructs. This result suggested that, if the design of electronic banking devices involved users, this could be a key element in their willingness to adopt new technologies as observed on websites where high involvement led to higher purchase intentions (Jiang *et al.*, 2010).

The age of users does not present any significant relationships with PEOU. Again, we found only a few studies that tested the relationship with these two constructs and the findings are mixed. While Giovanis *et al.* (2012) found moderate and negative effects of age in terms of PEOU among Greek consumers, Teo *et al.* (2012) found a neutral effect among Malaysian students. Thus, it is possible that, in the future, with a larger number of studies, researchers may find significant effects for this construct, since the meta-analysis of Hauk *et al.* (2018) proven the existence of negative relationships with respect to chronological age in the adoption of new technologies in a general context.

The findings of the present meta-analysis consolidate the relationship between social influences and TAM constructs (PU and PEOU). This result is interesting because, as Kesharwani and Singh Bisht (2012) pointed out, previous studies of this relationship reported conflicting findings, while Vankatesh and Davis (2000) found that social influence only impacts technological acceptance among users with previous experience of the respective system. Others researchers (e.g. Püschel *et al.*, 2010) have found that social

influence is an important and influential factor in the adoption of technology, independent of the experience.

Similar effects were found in the relationships between innovativeness and TAM constructs. This result was interesting because it refers to a key behaviour in helping to understand the e-banking phenomenon (Lassar *et al.*, 2005) and few studies have been performed in the banking context. Another positive relationship was observed between web design perceptions and TAM constructs. We suggest that positive platform interfaces tend to evoke feelings of security, involve a low level of complexity and, consequently, motivate the propensity towards technological acceptance (Kesharwani and Singh Bisht, 2012). This perception is congruent with one of the strategic trends in 2018, as detected by The Financial Brand survey, which suggests that significant investment is needed in the redesign of electronic banking platforms in order to improve the consumer digital experience.

We also observed an important positive relationship between accessibility and the TAM. This result reinforced the claims of system theory, which regards this construct as one of the most important in encouraging consumers to use online services and the internet (Ody, 2000). Thus, this result corroborates the assumptions that technological banking devices evoke perceptions linked to the 24-hour availability of system access, provided that the self-management of financial transactions by users is viable (Nor *et al.*, 2010).

In the same vein, we saw a positive relationship between perceived credibility and TAM constructs. This finding reinforces the assumption that the perception of security and privacy is one of the most important antecedents when adopting new technologies (Deng *et al.*, 2010). In this way, we are able to claim that this theme is one of the most important topics on strategic agendas concerning electronic banking devices (The Financial Brand, 2018).

Cost perception presented a positive and significant relationship with the TAM. This relation is important because, most often, it is the focus of investigation in IS studies (Luarn and Lin, 2005). This finding also reinforces the claims made by social cognitive theory (Bandura, 1986) and highlights how this construct is a significant barrier to users in terms of adopting technological banking devices. Thus, managers must always think strategically in order to reduce possible cost barriers.

We also detected a positive relationship between enjoyment perceptions and the TAM. This is interesting on two levels. First, the relationship is stronger for PEOU dimensions. This suggests that the pleasure evoked by the electronic device will be linked to a better perception of system performance. Second, few studies have investigated this area and, therefore, we present a fairly consolidated path between these two behaviours.

The risk perception was not significant with respect to PU. However, the relationship was significant and negative with PEOU. Thus, we suppose that the perception of uncertainty concerning financial transactions, performance and social or privacy loss promoted by banking technology devices (Bashir and Madhavaiah, 2015) tended to prompt the perception about the inadequate performance of electronic devices. On the other hand, the non-confirmation with PU could be linked to the view put forward by the psychoanalyst Jonathan Davidoff (1983) that, even though the consumer may be experiencing a pleasant and comfortable situation, s/he may, at the same time, may have feelings of fear.

The perception of system quality was noted and a strong relationship was detected with TAM constructs. Thus, it is important to think about the consistency of the banking system in order to promote technological acceptance (Gu *et al.*, 2009). These results are important since limited research has been carried out in the banking context; indeed, this meta-analysis consolidates this finding. Thus, other researchers could investigate possible moderators and mediators, rather than this direct relation.

The results also indicate that the need for interaction with other consumers or employees of the company was not a significant antecedent of the TAM. This further reinforces the importance of banks to make massive investments in the technological area in terms of electronic machines.

The last two antecedent constructs of the TAM, infrastructure support and responses, presented positive relationships. This highlights the importance of services offered to the technology user (e.g. the help desk) and the importance of consistency in the response to this demand, since these are elements that will increase the predisposition towards the acceptance of technological banking devices. This finding could point to other managerial priorities in electronic banking contexts that will be relevant in the near future (The Financial Brand did not highlight such strategic priorities for 2018).

Based on the consequent constructs analysis, we detected significant relationships across the board. PU presents higher effect sizes than PEOU, with respect to attitude and behavioural intention constructs. This finding reinforced the results of Yousafzai *et al.* (2007), who carried out a TAM meta-analysis in a general context. We also saw higher effects sizes for PU with respect to the performance and satisfaction constructs. Thus, these findings converge with PU concepts, thereby highlighting how consumers perceive the overall performance of and experience with electronic banking devices (Venkatesh *et al.*, 2008). This consolidates these relationships in the banking context since, at present, it is possible to find conflicting results, while no previous meta-analysis in banking contexts has been presented.

On the other hand, we could only detect one full moderation. The results show that internet banking promotes stronger relationships between TAM constructs and attitudes towards electronic banking devices. This suggests that systems that evoke more involvement and more experience tend to engage users and consequently promote better attitudes towards the system (Lee and Im, 2015).

Based on these results and on the confirmation of the relationships between antecedents, consequents and moderators of TAM constructs, we present Figure 1, which shows the main results of this meta-analysis.

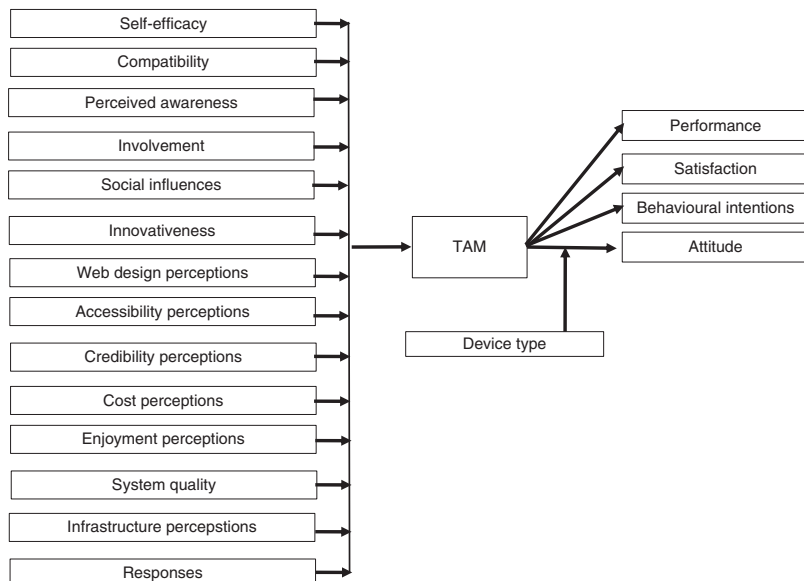


Figure 1.
Meta-analysis results

5. Conclusions

This research project involved a meta-analysis to evaluate the relationship between antecedents, consequents and moderators of the TAM. Thus, a systematic review was carried out that analysed 142 studies in a cumulative sample of 45,781 respondents. The results of this systematic review identified 18 antecedent constructs, four consequent constructs and nine moderating variables.

Among the main findings, we highlight a number of moderate and consistent positive relationships, such as the antecedents of compatibility, self-efficacy, social influence, system quality and cost perception. It is also worth noting that the consequent constructs of attitude and intention to use electronic banking systems presented the most consistent relationships within all the constructs investigated, on account of the high fail-safe number.

The moderating effects also led to interesting insights. The methodological moderators showed a partial variability regarding the size of the sample and scale. Partial moderations were also observed in cultural and economic elements in the relationship between PEOU and attitude.

This study identified possible relationships that need further investigation in the banking context, such as perceived awareness, discomfort, age, innovation, need for interaction and response time. Age, according to Hauk *et al.* (2018), is correlated with PU as moderated by the type of technology. This leads to the conclusion that the more innovative the technology adopted by companies in the financial sector is, the more that employees' age should be taken into account. This is related to another finding, which did not identify innovation as a moderator. This result should be explored, since one important assumption in the innovation literature (Rogers, 2004) is that the greater the innovation, the greater its benefit (Kaushik and Rahman, 2015). In addition, another factor, as highlighted by Wang *et al.* (2003), is that the past experiences of users with one type of technology can inspire them to use others. Thus, we can infer that innovation in the banking sector should be analysed more carefully, because technology that is considered as new or a break from the current model enjoys very fast diffusion time and is not considered innovative in the long term.

To better understand this phenomenon, we suggest that future research should explore those relationships that deserve more attention, especially the effect of innovativeness. Theories such as the theory of reasoned action (Fishbein and Ajzen, 1975), social cognitive theory (Bandura, 1986), the theory of planned behaviour (Ajzen, 1991) and innovation diffusion theory (Rogers, 2004) might be a good start.

Finally, we highlight some limitations of our work, such as the exclusion of qualitative studies and the clipping of adverse concepts that occur in the secondary data. These limitations can be overcome with the application of a research method other than meta-analysis. Despite its limitations, the utility of the meta-analytical approach, given its contribution to the field of knowledge and ability to provide more definitive conclusions on the subject, is clear. Therefore, we propose that this study should be understood as contributing to the research area in question, in terms of validating relevant theory and highlighting the relationship between the state of the art in the banking context and behaviour (Hunter and Schmidt, 2004).

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