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Purchase intention on energy efficient household appliances – a meta-analysis of the studies based on theory of planned behaviour

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Abstract: The purpose of this research is to study the purchase intention (PI) on energy efficient household appliances by making a meta-analytic review of the studies that have applied theory of planned behaviour. Results of 30 studies that met the inclusion criteria have been synthesised in the meta-analysis. A moderator analysis is also made in order to examine the reasons for heterogeneity in the studies. Analysis of publication bias is also made. The findings revealed that all the three variables of TPB have medium to large associations with PI of energy efficient appliances. Attitude was found to have the strongest relationship with r = 0.571, followed by perceived behavioural control with r = 0.465 and subjective norms with r = 0.443. Moderator analysis gave mixed results. This meta-analytic review is the first of its kind in the domain of adoption of energy efficient appliances by households. The study gives valuable insights to policymakers and researchers into the prediction of PI on energy efficient household appliances.

Keywords: theory of planned behaviour; meta-analysis; energy efficient appliances; forest plot; effect sizes; fixed effect; random effect; publication bias; funnel plot, heterogeneity, moderator.

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1 Introduction

Policies that emphasise on energy efficiency have become important in recent decades, as rise in energy consumption is likely to impede the United Nations goal to achieve sustainable development by 2030 (Bhutto et al., 2021). Residential sector has seen strongest growth in electricity consumption and the main cause for it is increased ownership and usage of electrical appliances (Gasper and Antunes, 2011). Appliances have become the main source of household energy consumption and there is a rapid growth in their usage (Li et al., 2019).

Many papers have discussed the growth of energy efficient appliances in various countries. Parikh and Parikh (2016), in their paper mention that India's economic growth has enabled growing middle class to buy household appliances in increasing numbers and by 2030, the upper expenditure classes will be responsible for appliance growth because more purchases will be made per 1,000 persons. Hua and Wang (2019), mention that China is one of the world's largest producers and consumers of household appliances. Appliances and Energy Tracking Report prepared by International Energy Agency (2020), mentions that electricity consumption by household appliances continues to increase and energy use by household appliances in 2018 was 3,000 Twh, which accounted for 15% of global electricity demand. The report further adds that although technological advancements have resulted in manufacturing of energy efficient

appliances, rising ownership of appliances and ever changing consumer preferences is offsetting these savings.

As per capita energy consumption is increasing, many countries have adopted energy efficiency for looming energy problems (Reynolds et al., 2012). Increased energy efficiency enables reduction in energy use. One of the ways to achieve energy efficiency is to use energy efficient appliances. Oikonomou et al. (2009) in their research mention that investment in energy efficient appliances will save more energy rather than energy curtailment. Urban and Ščasný (2012) mention that consumers who use energy efficient appliances can reduce their energy consumption. Residential sector is an important sector that has been marked to contribute to climate targets that have been set internationally and therefore adoption of energy efficiency is required to mitigate the effects of increasing energy demand (Hesselink and Chappin, 2019). As residential sector is an important target for reduction of electricity consumption and adoption of energy efficient appliances would reduce energy consumption, it has become important to understand household behaviour towards energy saving products. It is necessary to undertake research in this area. Many papers have tried to study the PI of energy efficient appliances (Elmusthapha et al., 2018; Ha and Janda 2012; Nguyen et al., 2017; Tan et al., 2017; Waris and Hameed, 2020). All these papers have applied the TPB (Ajzen, 1991), in their attempt to study the PI of energy efficient appliances of households, which is one of the most important psychological theories.

The primary objective of this paper is to make a meta-analytic review of studies that have applied TPB to study the PI of energy efficient appliances of households and to test its predictive power. In this meta-analysis, 30 studies have been synthesised. As the studies were found to be heterogeneous in nature a moderator analysis is made in order to explore the reasons for heterogeneity. For this purpose, the moderators are divided into methodological moderators, situational moderators and cultural moderators. In order to examine whether there is a publication bias in the studies selected, Rosenthal's fail N safe and Egger's regression test is used. Funnel plots also have been depicted for analysing publication bias.

The outline of the remaining part of the paper may be traced as follows. Section 2 provides the theoretical context and Section 3 encapsulates the research methodology. In Section 4, the results are provided and Section 5 discusses the same. Section 6 furnishes policy implications, and Section 7 discusses the limitations of the study and indicates directions for future research.

2 Theoretical development

2.1 Theory of planned behaviour

TPB was proposed by Ajzen (1991) and has been one of the most popular theories to explain individual behaviour in wide range of domains (Wang et al., 2018). Its application is wide in studies related to sustainable behaviours, such as, adoption of electric vehicles (Haustein and Jensen, 2018), energy saving intentions (Abrahamse and Steg, 2011; Liu et al., 2020; Ru et al., 2018), PI of biodegradable drinking straw (Phu et al., 2021), adoption of renewable energy (Jabeen et al., 2019; Korcaj et al., 2015; Zulu et al., 2021).

According to TPB intentions are the most important determinants of behaviour and intentions in turn are determined by attitudes, subjective norms and perceived behavioural control. TPB had its origin in theory of reasoned action (TRA). TRA had two constructs, attitude and subjective norms. Later on, Ajzen added perceived behavioural control to become TPB.

Ajzen (1985) mentioned that that a person with a positive attitude toward an action is more likely to perform that action. As one of the determinants of intentions in TPB, attitude refers to the extent to which a person evaluates behaviour as favourable or unfavourable (Ha and Janda, 2012). For instance a person who has a favourable attitude towards purchasing an energy efficient appliance or towards adoption of renewable energy is most likely to purchase an energy efficient appliance or adopt renewable energy. In studies on green purchase behaviour research proved that attitudes are one of the most relevant predictors of green purchasing decisions (Greaves et al., 2013; Ha and Janda, 2012; Olsen et al., 2010).

Ajzen (1991) said that subjective norms refer to individual's feelings of social pressure from other people or groups or a stress or inspiration from colleagues, family and friends to perform or not to perform a particular behaviour. For instance, a person may be motivated to purchase an energy efficient appliance if his friends, neighbours or relatives have purchased it. Many studies have found subjective norms as an important determinant of green behaviour (Albayrak et al., 2013; Chen and Tung, 2014).

Perceived behavioural control refers to individual's ease or difficulty in performing a specific behaviour (Tan et al., 2017). It is one's perception of ease or difficulty of performing an act. Perceived behavioural control in the context of green purchasing behaviour has been described as, whether an individual can easily consume a product, or it will be difficult to consume (Albayrak et al., 2013).

Application of TPB in meta-analysis is done to test its predictive power. For instance, McDermott et al. (2015), in their study on dietary patterns, Lin and Roberts (2020), in their study on food safety behavioural intention, Nardi et al. (2019), in their study on food choice, Morren and Grinstein (2016), in their study on environmental behaviour, have tested the predictive power of TPB in their meta-analysis.

Previous studies have proved the validity and utility of TPB and its robustness in moderating the impacts when there is heterogeneity in studies due to difference in sampling methods, data collection methods, methodological designs (Todd et al., 2016). The advantage of application of TPB as a cognitive model is that it takes a holistic approach. In case of research on pro-environmental behaviour, it allows to generalise its findings (Morren and Grinstein, 2016). As this study is on PI of energy efficient appliances, which relates to pro-environmental behaviour, we aim at testing the predictive power of TPB, with respect to PI of energy efficient appliances. We hypothesise that, TPB constructs have a high predictive power in explaining the PI of energy efficient appliances of households.

2.2 Moderator analysis

In meta-analysis, it is common to explore the reasons for heterogeneity in studies by conducting a moderator analysis. Basically, moderator analysis is done to identify those factors that may show significant moderating effects between various associations. In this study, the moderators are broadly classified as, methodological moderators, situational moderators and cultural moderators.

Meta-analytic reviews have considered methodological moderators to find out whether they show significant moderating effects (Hamilton et al., 2020; McDermott et al., 2015; Nardi et al., 2019). Methodological moderators refer to study characteristics such as, the gender composition, the average age of respondents, the sampling method, the method of data collection, the analytical model used and such other study characteristics. In studies on pro-environmental behaviour also methodological moderators have been used. For instance, Morren and Grinstein (2016) in their study consider the type of sample, the sampling method and the data collection method, as moderators. In this study, the methodological moderators are the method of sampling, the method of data collection and the analytical model used in the studies. We hypothesise that, the methodological moderators significantly moderate the relationship between TPB constructs and PI of energy efficient appliances.

The situational moderators refer to specific characteristics of a study. Nardi et al. (2019), in their meta-analytic study on predicting food choice, include origin of food, life cycle or technology of food production, as situational moderators. This study considers focus of study as a situational moderator. That is, whether the study included in the meta-analysis focuses on a particular energy efficient appliance such as a LED or a solar water heater or it focuses on energy efficient appliances in general. We hypothesise that, the focus of study as a situational moderator significantly moderates the relationship between TPB constructs and PI of energy efficient appliances.

The country/cultural moderators refer to certain cultural characteristics of countries and some other characteristics. Cultural characteristics as moderators have also been widely studied in meta-analytic reviews. One of the cultural moderators that have been widely studied is the Hofstede's cultural model (Hofstede and Bond, 1984). His model initially had four dimensions which are individualism, uncertainty avoidance, power distance and masculinity. He later on added two more dimensions, long-term orientation and Indulgence (Hofstede, 2001). Nardi et al. (2019), in their meta-analytic study on predicting food choice, consider all the six dimensions, to find out whether they are significantly moderate the relationship between TPB constructs and intention. Morren and Grinstein (2016) in their meta-analytic study on pro-environmental behaviour consider the dimension of individualism to find out whether it moderates the relationship between TPB constructs and intention to adopt pro-environmental behaviour. In this study, four dimensions of Hofstede are considered. They are individualism, long-term orientation, indulgence and uncertainty avoidance. These four dimensions are more relevant for studies on pro-environmental behaviour, such as PI of energy efficient appliances. We hypothesise that, the Hofstede's four dimensions as country/cultural moderators significantly moderate the relationship between TPB constructs and PI of energy efficient appliances.

Individualism/collectivism dimension is a significant dimension of cultural differences in social behaviour (Triandis, 1990). Societies that rank high on individualism want to behave as an individual, and not as individuals in a group, and countries that rank high on collectivism want to act as members of group and not as an individual (Hofstede, 2001). There have been conflicting findings with regard to the relationship between individualism/collectivism and attitude towards pro-environmental behaviour. Some studies have found that there is a positive and strong relationship between attitudes towards pro-environmental behaviour and collectivism (Bagozzi et al., 2000), whereas some other studies have found that there is a positive and strong relationship between attitude towards environmental behaviour and individualism (Cho et al., 2013; Soyez,

2012). As far as subjective norms and individualism is concerned, studies have found that countries that are collectivist, that is, those who are low on individualism give more weight views in social circles (Ando et al., 2010). In case of perceived behavioural control and individualism research shows that collectivistic cultures feel reliance on others is important (Ando et al., 2010).

Literature on adoption of energy efficiency behaviour by households has shown how households compare their initial investment in purchasing energy efficient equipment with the future savings of energy (Chunekar and Rathi, 2012; Newell and Siikamäki, 2015). Long-term orientation dimension also talks about weighing the future benefits. Long-term orientation dimension of Hofstede (2001) refers to whether an individual considers the future when carrying out behaviours. This dimension has been used in studies on green PI. Carmi and Armon (2014) and Ghazali et al. (2017), in their studies mention that consumers with long-term orientation have stronger inclination towards purchase of energy-saving products. The implementation of pro-environmental behaviour can bring long-term benefits.

Indulgence dimension is the sixth dimension added by Hofstede. Societies ranking high on indulgence are likely to enjoy life more than the societies ranking low on indulgence, who show restraint and respect for social norms (Hofstede, 2001). Indulgence as a dimension has been used in studies on pro-environmental behaviour such as, consumption of renewable energy (Pelau and Pop, 2018). They hypothesise that indulgence has an influence in share of renewable energy in the final consumption.

The dimension of uncertainty avoidance index describes the way in which members of the society deal with uncertainty and risks (Pelau and Pop, 2018). Societies high on uncertainty avoidance are not willing take too many risks. Whereas cultures low on uncertainty avoidance are willing take more risks (Hofstede et al., 2005). Benefits from purchase of energy efficient appliances accrue in future. Consumers always perceive an element of uncertainty in their decision to purchase energy efficient appliances. The reason for this is the factor of irreversibility (Chunekar and Rathi, 2012), meaning, consumers can't sell an energy efficient appliance as easily as they can sell shares of company that they hold.

The last moderator in this category is the location. In this case, entire country itself is considered as a possible moderator, without considering any specific characteristics. The countries included in the analysis have been divided into Asian and non-Asian. Lanzini and Khan (2017), in their meta-analysis of determinants of travel mode choice, consider location as a moderator. There could be so many other characteristics of a country that may have an impact on PI of energy efficient appliances apart from the ones included in the study. We hypothesise that, the location as a moderator significantly moderates the relationship between TPB constructs and PI of energy efficient appliances

3 Methods

3.1 Meta-analysis

This study uses the technique of meta-analysis, in which results from different studies are synthesised to get an estimate of relationship between two or more constructs in the population (Hunter and Schmidt, 2004). It involves the identification of a comparable metric for each study and the weighting of relative effect size according to sample size

(Petttifor et al., 2017). The comparable metric considered in this study is, correlation coefficient (r).

3.2 Inclusion-exclusion criteria

Prior to collecting relevant studies, keywords were used. 'TRA, TP', 'PI' 'adoption intention', 'energy efficient appliances', 'green appliances' 'households', are some of the keywords that were used. These keywords were transformed into Boolean phrases such as, 'TPB' OR 'theory of reasoned action' AND 'adoption of energy efficient appliances', OR 'PI of energy efficient appliances' OR 'green appliances' AND 'households' These Boolean phrases were then entered into various electronic databases such as, JSTOR, EBSCOhost, Google Scholar and ABNInform.

The prime criteria for including a particular study in the analysis, was that the studies should have included at least one construct of the TPB and should have reported the bivariate relationship between the constructs of TPB and PI of energy efficient appliances in the form of correlation (r). Wherever r was not reported β values were used to transform it into r as suggested by Peterson and Brown (2005).

In the process of searching the studies that would meet the inclusion criteria, various matching titles were found, studies that applied TPB, but focused on adoption of renewable energy were excluded, as the focus was not on adoption of energy efficient appliances. Similarly, studies that focused in general on energy saving intentions or electricity saving intentions were also excluded, as they focused on energy or electricity saving intentions in general and not on energy efficient appliances alone. Energy saving intentions could mean so many ways of saving energy and not just by purchasing energy efficient appliances. Studies that focused on energy efficient appliances but did not apply TPB were also excluded. Apart from these studies, studies that applied TPB but did not focus on households but on energy saving intentions at workplace were also excluded.

The underlying rationale for making a meta-analysis of studies that have focused on TPB as applied to PI of energy efficient appliances by households is because of its wide applications. Klockner and Blobaum (2013) noted that about 40% of papers published in in the field of environmental psychology have considered TPB as their theoretical framework. This probably explains why there are more studies that have applied TPB with respect to research on PI of energy efficient appliances. Application of technology acceptance model (TAM) and unified theory of acceptance and use of technology (UTAUT) is found to be more suitable for research on adoption of new technologies such as mobile devices, wireless internet. Moreover, a meta-analysis cannot be conducted if there are not enough studies that would result in a meaningful meta-analysis. For instance, in the process of literature search authors found only one study considered TAM with respect to PI of energy efficient appliances (Hua and Wang, 2019) which has been used along with the three constructs of TPB. As far as TRA and TPB is concerned, TPB is an extension of TRA, which originally had attitudes and subjective norms as constructs. The addition of perceived behavioural control to TRA, accounted for significant amount of variance in intention (Armitage and Conner, 2001). In other words TPB is superior to TRA as a cognitive model.

After all the exclusions, we were left with 30 studies that met all the inclusion criteria. However, 22 studies included perceived behavioural control. All the articles were read in detail by all the authors, separately. Table 1 gives the summary of inclusion and exclusion criteria.

Table 1 Summary of inclusion-exclusion criteria

Inclusion criteria	*Exclusion criteria*
a Studies that included at least one construct of TPB with a focus on PI of energy efficient appliances of households.	a Studies that used TPB constructs but focussed on adoption of renewable energy were excluded as the focus of this study is only on PI of energy efficient appliances.
b These studies should have reported the bivariate relationship between the TPB constructs and the PI. This bivariate relationship should have been in the form of correlation (r). These studies should have reported the sample sizes.	b For the same reason studies that focussed in general on, energy saving intentions and electricity saving intentions were not considered, since energy and electricity saving intentions could mean so many ways of saving and not just saving by using energy efficient appliances.
	c Studies that applied TPB but did not focus on households, but on energy saving intentions at workplace, were excluded, because the focus is on PI of households.

3.3 Basic computation and analysis

Statistical software comprehensive meta-analysis was used for various computations. The first step was to perform effect size analysis. Effect size refers to the strength of relationship between two variables. Borenstein et al. (2009) define effect size as a unit of currency in meta-analysis. The effect size analysis is done by pooling the effect size (r) of all the studies, for all the three constructs of TPB. According to standard procedure of Hedges and Olkin (1985), Fisher's Z score transformation is used, to calculate weighted average correlation and to assign weights to individual effect sizes, which is done based on sample size of the studies. The Z transformation is required, because even if the correlation coefficients pooled from different studies come from non-normal distribution, the Z values are normally distributed (Hedges and Pigott, 2001). The z values are back transformed into correlation coefficients.

An issue that frequently arises in any meta-analytic review is that whether the studies come from same population and whatever variation in the studies is due to sampling error only, or the studies come from different populations and the variation is due to the fact that studies truly differ. The former is known as, fixed effect model and the latter is known as, random effect model. In order to arrive at this decision, Q and I^2 statistics is needs to be examined. If these two statistics are large, it shows that there is heterogeneity and the variation in the studies is due to true differences and therefore random effect model needs to be used (Higgins et al., 2003). A larger Q statistic and I^2 suggested that a random effects model needs to be used. Therefore we applied random effect model.

The results were evaluated based on Cohen's (1988) recommendations, according to which a correlation of r = 0.10 is small effect size, r = 0.30 is medium effect size and r = 0.50 is considered as large effect size. Forest plots also have been depicted. Forest plots are graphical representations that show the relative strength and weakness of study effect sizes for each of the TPB constructs (Lin and Roberts, 2020).

Publication bias analysis is also made to know whether the findings are robust or not. This is done by using fail-safe N, which represents the number of missing studies averaging a Z value of zero that should be added to yield a statistically insignificant overall effect size (Rosenthal, 1984), Egger's regression test is also used to further

understand whether there is a publication bias. Further, publication bias analysis is made by depicting funnel plots,

Table 2 gives the basic details of all the studies included in the analysis.

Table 2 Basic details of the studies

Name of the author/study	*Year*	*Sample size*	*Country*
Ali et al.	2019	396	Pakistan
Apipuchayakul and Vassanadumrongdee	2020	288	Thailand
Waris and Ahmed	2020	472	Pakistan
Waris and Hameed	2020	446	Pakistan
Tan et al.	2017	210	Malaysia
Prakash and Gunasekar	2017	150	India
Issock et al.	2018	700	South Africa
Li et al.	2019	305	China
Hua and Wang	2019	280	China
Ji and Chan	2019	2391	China
Dilotsotlhe and Duh	2020	500	South Africa
Ali et al.	2021	1,551	Pakistan
Zhao et al.	2019	477	China
Fatoki	2020	298	South Africa
Ha and Janda	2012	202	South Africa
Abu-Elsamen et al.	2019	663	Jordan
John and Bharthy	2018	110	India
Gangakhedkar and Raman	2021	555	India
Nguyen et al.	2017	682	Vietnam
Wang et al.	2017	253	China
Wang et al.	2019a	269	China
Wang et al.	2019b	972	China
Hameed and Khan	2020	418	Pakistan
Zhang et al.	2020	327	China
Bhutto et al.	2021	673	Pakistan
Moghavemmi et al.	2020	1,075	Malaysia
Chen et al.	2016	655	China
Neves and Oliveira	2021	1,136	Spain
Lin	2015	235	Taiwan
Aslam et al.	2021	291	Pakistan
Zainuddin et al.	2014	392	Malaysia
Waris et al.	2021	373	Pakistan
Khorasanizadeh et al.	2016	221	Malaysia

As can be observed from Table 2, most studies on PI of energy efficient appliances appear from 2017. The earliest study in this analysis is of the year 2012. Most of the

studies have been undertaken in Asian countries; in which China and Pakistan take the lead with 9 and 8 studies, respectively.

Table 3 gives the details of coding of the moderators

Table 3 Coding of the moderators

Moderators		*Description of coding*
1	Methodological moderators	
a	Sampling method used in the study	1, if non-probability sampling, 0, if otherwise
b	Method of collection of data	1, if online, 0, if otherwise
c	Analytical model used in the study	1, if PLS SEM, 0, if otherwise
2	Country/cultural moderators	
a	Individualism	1, if high on individualism, 0, if otherwise (based on median value)
b	Long-term orientation	1, if high on long-term orientation, 0, if otherwise (based on median value)
c	Indulgence	1, if high on indulgence and 0, if otherwise (based on median value)
d	Uncertainty avoidance	1, if high on uncertainty avoidance and 0, if otherwise (based on median value)
e	Location	1, if non-Asian and 0 if Asian
3	Situational moderator	
a	Focus of the study	1, if the focus is particular and 0, if otherwise

4 Results

The results are divided into two parts. The first part relates analysis of association between all the three TPB constructs, which are the independent variables (IV) and PI which is the dependent variable (DV). This analysis is done to find out the degree of association of the IVs, with DV. The second part relates to moderator analysis to examine whether they show significant moderation effects.

4.1 Results of effect size analysis

Table 4 summarises the associations between TPB constructs and PI. Results proved the robustness of TPB constructs in predicting the PI of energy efficient appliances. The findings revealed that all the three variables of TPB have positive and medium to large associations with the dependent variable, PI of energy efficient appliances. Attitude had the strongest relationship ($r = 0.571$, $p < 0.001$), followed perceived behavioural control ($r = 0.465$, $p < 0.001$) and subjective norms (0.443, $p < 0.001$). Q which is large and significant ($p < 0.01$) and the I^2 statistics, which is well above the 75% threshold limit showed that the heterogeneity in the studies is very high (Higgins et al., 2003), prompting us to perform moderator analysis, in order to find out the reasons for heterogeneity in the studies.

Table 4 Results of associations between TPB constructs and purchase intention

Association	*N*	*K*	*R*	*CI*	*Q*	I^2
ATT-INT	15,935	30	0.571	0.481–0.650	1,814.138***	98,401
ATT-SN	14,145	30	0.443	0.376–0.504	674.22***	95,702
ATT-PBC	14,142	22	0.465	0.365–0.555	970.982***	97,685

Notes: INT = intention, ATT = attitude, SN = subjective norms, PBC = perceived behavioural control, n = number of participants, k = number of studies, CI = 95% confidence interval, Q and I^2 = tests of heterogeneity, ***p < 0.001.

The overall effect size (not included in Table 4) considering all the three constructs of TPB is, 0.498 which again shows the large association of TPB construct with PI of energy efficient appliances.

Figures 1, 2, and 3 depict the forest plots. Forest plots are pictorial depiction of effect sizes both of individual studies and also the combined effect size. A forest plot brings all the relevant studies at one place and identifies a common statistic. For instance, the forest plot of attitude-intention relationship shows the correlation between attitude and PI of each of the 30 studies that have been included in the analysis and also the combined effect size, which in this case is 0.571 (shown in Table 4 also). Further, result of each study has two parts. The black square box represents the size of the study, that is, the sample size. Bigger the box, larger is the sample size. The horizontal line on the either side of the black box represents the 95% confidence limits of the study. It measures the precision of the study. Smaller the horizontal line, more precise is the study, that is, more likely that the study will be within the confidence limits. The diamond at the end of the forest plot is the combined effect size.

Figure 1 Attitude – purchase intention

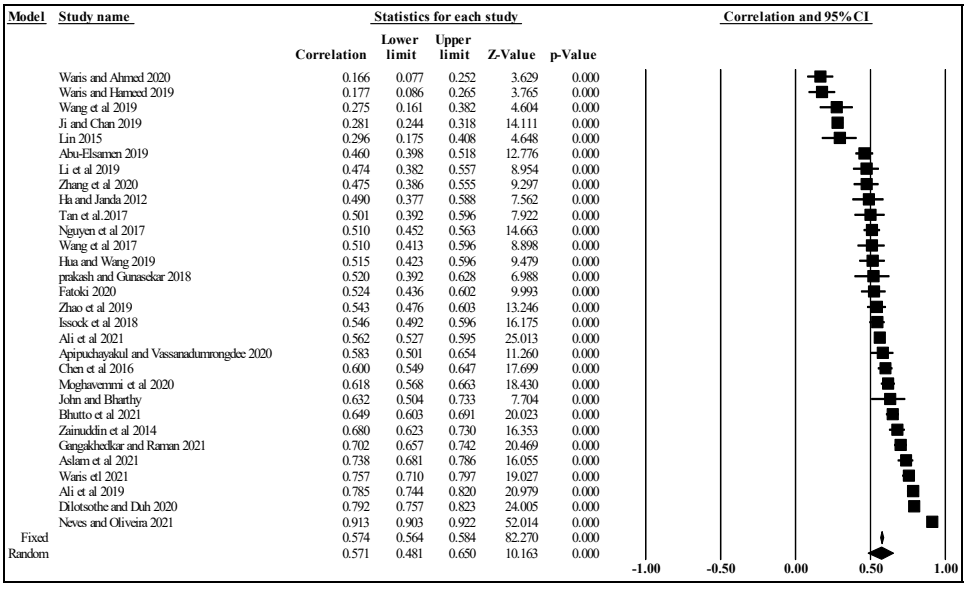


Figure 2 Subjective norms – purchase intention

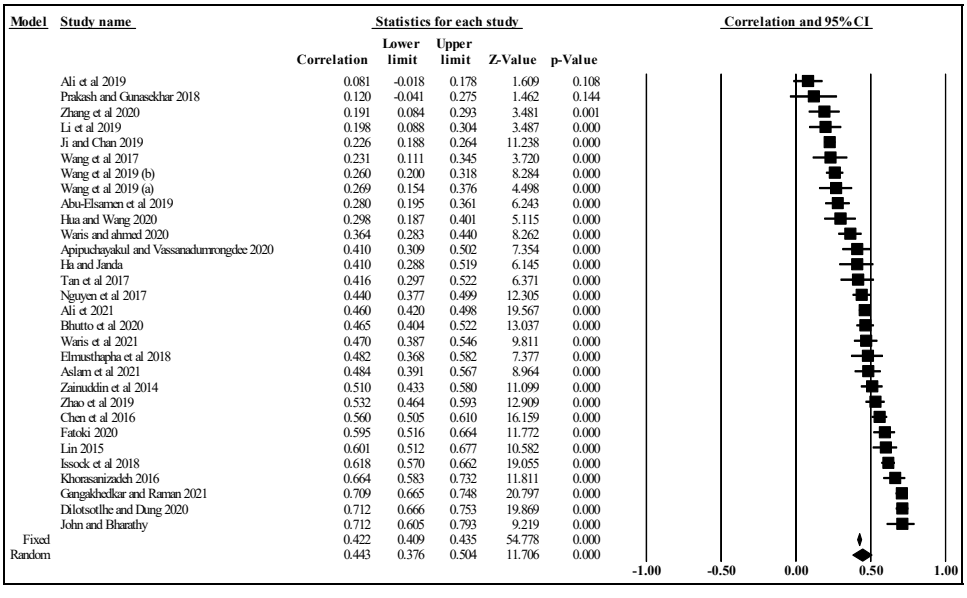
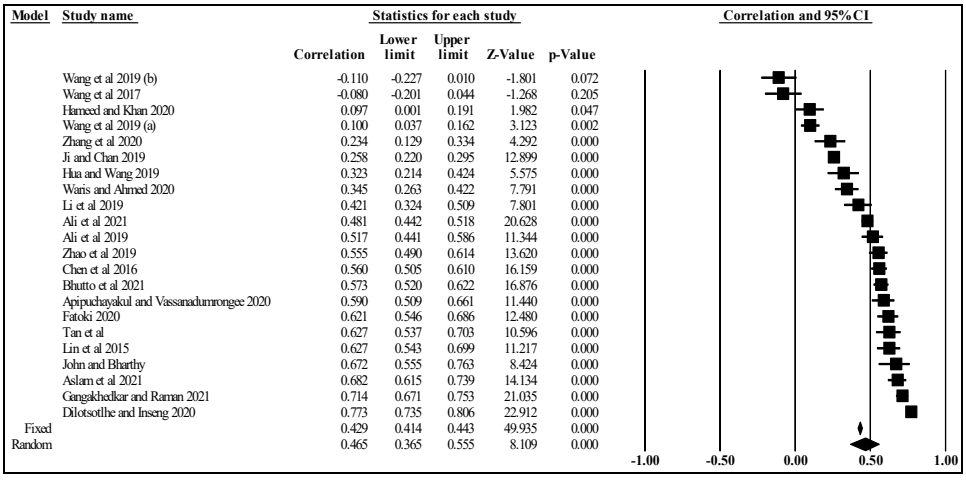


Figure 3 Perceived behavioural control – purchase intention



4.2 Moderator analysis

Tables 5, 6 and 7 show the results of moderator analysis for attitude-intention, subjective norms-intention and perceived behavioural control-intention, respectively. Tables 5, 6 and 7 consist of details of each of the moderators in terms of means of each of the subgroups of the moderators (coding of sub groups is as per the details mentioned in Table 2), Q statistics (degrees of freedom given in the brackets), k, which refers to number of items of each subgroup, p value, R^2 which shows the percentage of variation in PI explained by the moderator, I^2 which shows the dispersion.

Table 5 shows the moderator analysis of attitude-intention relationship. As can be seen from Table 5, none of the methodological moderators, except method of data collection proved to be significant moderator. Even that is marginally significant ($p < 0.1$) and R^2 is also 0% in this case. So the methodological moderators did not explain any variation in effect sizes of attitude-intention relationship. Among the country/cultural moderators, location ($p < 0.05$) with R^2 31%, turned out to be a significant moderator. The rest of the moderators, individualism, long-term orientation, indulgence and uncertainty avoidance, did not show any moderating effect ($p > 0.10$). Focus of study, which is the only situational moderator, proved to be significant moderator ($p < 0.05$) with R^2 27%.

Table 5 Moderator analysis of attitude – intention relationship

Moderator		*Grouping*			*Moderator analysis*			
		Group	*k*	*Mean*	*Q*	*p*	R^2	I^2
a	Methodological							
	MS	1	25	0.568	0.044 (1)	0.879	0%	96,456
		0	5	0.586				98,589
	MD	1	11	0.663	2,321 (1)	0.074#	0%	99,258
		0	19	0.51				94,883
	AM	1	17	0.608	1,193 (1)	0.321	0%	98,944
		0	13	0.519				95,312
b	Country/cultural							
	LOC	1	4	0.742	1,868 (1)	0.022*	31%	99,361
		0	26	0.538				96,518
	INDV	1	21	0.579	0.089 (1)	0.78	0%	98,602
		0	9	0.552				97.8
	LTO	1	21	0.529	1,698 (1)	0.114	18%	96,995
		0	9	0.657				98,926
	INDU	1	13	0.639	2,263 (1)	0.102	20%	98,471
		0	17	0.514				97,332
	UA	1	9	0.547	0.199 (1)	0.682	0%	97,434
		0	21	0.585				98,724
c	Situational							
	FS	1	6	0.704	2,323 (1)	0.037*	27%	98,992
		0	24	0.532				96,989

Notes: MS = sampling method, MD = method of data collection, AM = analytical model, LOC = location, INDV = individualism, LTO = long-term orientation, INDU = indulgence, UA = uncertainty avoidance and FS = focus of study.
***p < 0.01, *p value < 0.05 and #p value < 0.1.

Table 6 shows the moderator analysis for subjective norms-intention relationship. In case of methodological moderators, none of them showed any significant moderating effect ($p > 0.1$), and the R^2 ranged from 0% to 2%. In case of country/cultural moderators, location ($p < 0.01$) with R^2 23%, long-term orientation ($p < 0.05$) with R^2 14%, indulgence ($p < 0.01$) with R^2 28% proved to be significant moderators. Individualism

and uncertainty avoidance did not show any moderating effects. Focus of study also did not show any moderating effect.

Table 6 Moderator analysis of subjective norms-intention relationship

		Grouping			*Moderator analysis*			
Moderator		*Group*	*K*	*Mean*	*Q*	*P*	R^2	I^2
a	Methodological							
	MS	1	25	0.424	1.29 (1)	0.208	0%	94.95
		0	5	0.528				97,522
	MD	1	13	0.418	0.396 (1)	0.492	2%	96,788
		0	17	0.462				93.36
	AM	1	15	0.434	0.068 (1)	0.79	0%	97,068
		0	15	0.451				97,662
b	Country/cultural							
	LOC	1	3	0.646	19,428 (1)	0.006**	23%	81,879
		0	27	0.416				94,728
	INDV	1	22	0.449	0.17 (1)	0.746	0%	96.48
		0	8	0.424				91,009
	LTO	1	21	0.401	4,232 (1)	0.038*	14%	95,461
		0	9	0.534				93,505
	INDU	1	14	0.534	9,073 (1)	0.001**	28%	94,291
		0	16	0.357				93,793
	UA	1	9	0.394	1,257 (1)	0.356	0%	90,633
		0	21	0.463				96,589
c	Situational							
	Focus of study	1	9	0.497	0.911 (1)	0.292	0%	97,499
		0	21	0.42				94,049

Notes: MS = sampling method, MD = method of data collection, AM = analytical model, LOC = location, INDV = individualism, LTO = long-term orientation, INDU = indulgence, UA = uncertainty avoidance and FS = focus of study.
***p < 0.01, *p value < 0.05 and #p value < 0.1.

Table 7 shows the moderator analysis for perceived behavioural control-intention relationship.

Among the methodological moderators, method of data collection showed marginal significance ($p < 0.1$), and R^2 being 0%. Analytical model turned out to be a significant moderator ($P < 0.05$), with R^2 8%. Among the country/cultural moderators, location ($p < 0.05$) with R2 20%, long-term orientation with R^2 10%, indulgence ($p < 0.01$) with R^2 24%, showed significant moderating effects. Individualism and uncertainty avoidance did not show any moderating effects. Focus of study also did not show significant moderating effect.

Table 7 Moderator analysis of perceived behavioural control-intention relationship

		Grouping			*Moderator analysis*			
Moderator		*Group*	*K*	*Mean*	*Q*	*P*	R^2	I^2
a	Methodological							
	MS	1	19	0.455	0.101 (1)	0.624	0%	97,061
		0	3	0.525				99.33
	MD	1	11	0.55	3,241 (1)	0.071	0%	97,724
		0	11	0.371				97,667
	AM	1	14	0.516	1,715 (1)	0.032*	8%	97,167
		0	8	0.367				97,526
b	Country/cultural							
	LOC	1	2	0.706	6,499 (1)	0.015*	20%	94,042
		0	20	0.435				95,172
	INDV	1	14	0.444	0.385 (1)	0.887	0%	98,191
		0	8	0.5				95,172
	LTO	1	12	0.386	3,334 (1)	0.038*	10%	97,787
		0	10	0.551				96.53
	INDU	1	5	0.655	13,309 (1)	0.003**	24%	87,826
		0	17	0.399				97,547
	UA	1	8	0.504	0.473 (1)	0.539	0%	95,156
		0	14	0.442				98,220
c	Situational							
	Focus of study	1	6	0.462	2,323 (1)	0.96	0%	98,619
		0	16	0.467				97.263

Notes: MS = sampling method, MD = method of data collection, AM = analytical model, LOC = location, INDV = individualism, LTO = long-term orientation, INDU = indulgence, UA = uncertainty avoidance and FS = focus of study.
***p < 0.01, *p value < 0.05 and #p value < 0.1.

4.3 Analysis of publication bias

Another important step in meta-analysis is, to examine whether there is publication bias. Literature of meta-analysis mentions various reasons for the presence of publication bias. Studies with significant results only or published studies only being included or it is likely that some studies that meet our criteria will escape our search and may not be included (Borenstein et al., 2009). Therefore in order find out if there is a publication bias, there are some tests which helps us in detecting the presence or otherwise of publication bias. It is hypothesised that there is no publication bias.

One of the tests is fail-safe N, of Rosenthal (1984), who suggested that we actually compute how many missing studies we would need to retrieve and incorporate in the analysis before the p-value became non-significant. Results show that the fail-safe N for attitude-intention association is, 7,154, which refers to number of missing studies that would bring p value to be significant. It is not likely that we would have missed

7,154 studies and therefore the results presented in this meta-analysis do not show publication bias and are robust. Same is the case with association between subjective norm-intention and perceived behavioural control-intention, for which the fail-safe N is, 2,105 and 3,901, respectively. Therefore the results are robust and do not show any publication bias. We also have used egger's regression test to find out the possibility of publication bias. Table 8 shows the results of egger's regression test

Table 8 Results of Egger's regression test

Association	*t value*	*p value*
Attitude – intention	0.173	0.863
Subjective norms – intention	1,196	0.241
Perceived behavioural control – intention	1,188	0.248

Figure 4 Attitude-purchase intention (see online version for colours)

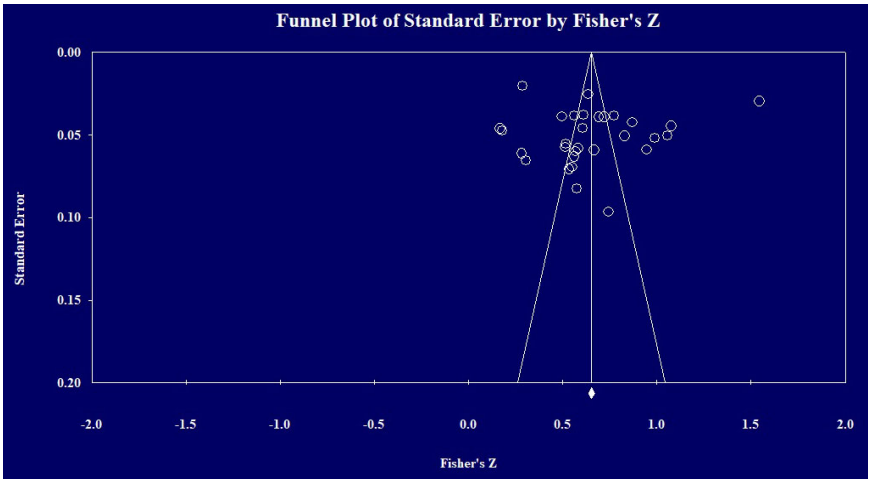


Figure 5 Subjective norms-purchase intention (see online version for colours)

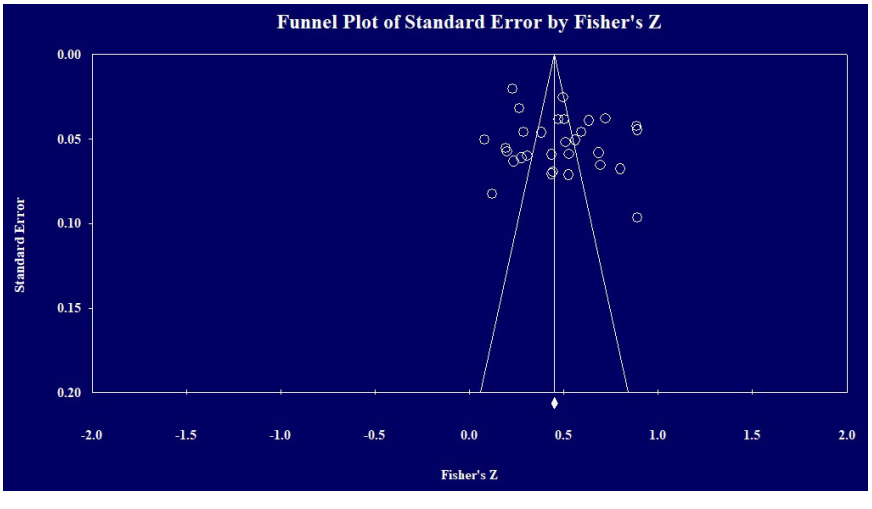
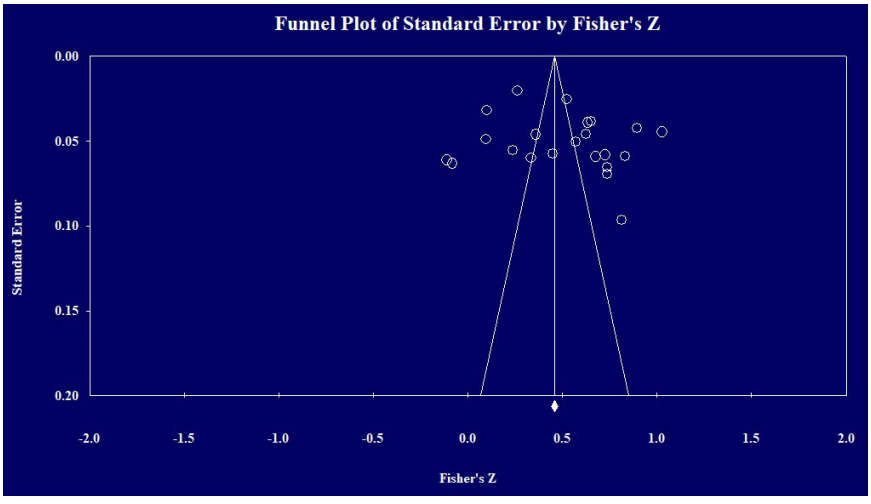


Figure 6 Perceived behavioural control-purchase intention (see online version for colours)



As can be seen from Table 8, the p values for all the three associations are insignificant. Therefore we accept the null hypothesis of no publication bias. Publication bias is also tested through funnel plots. Figures 4, 5 and 6 are the funnel plots for attitude-PI, subjective norms-purchase intention and perceived behavioural control-purchase intention relationships. In case there is a publication bias, the funnel plot will be asymmetric. In all the three cases, the funnel plot is not asymmetric, although in case of ATT-INT there are slightly more studies on the right. This further confirms lack of publication bias.

5 Discussion

Research on adoption of energy efficient appliances by households is growing. In the process of gathering studies for this meta-analysis, we realised that research in this domain has increased from 2017. Probably, the sustainable development goals of UN and the Paris agreement could be the reasons for increasing interest in research on energy efficiency issues such as adoption of energy efficient appliances by households. Researchers have applied various theories to better understand the factors that determine the adoption of energy efficient appliances by households. TPB is one such theory which has been widely used by researchers.

In this meta-analysis, we tested the robustness of TPB in predicting the PI of energy efficient appliances of households. This meta-analysis which is the first of its kind to understand the PI of energy efficient appliances through the lens of TPB, enables us to understand the predictive power of TPB as a model, as applied to PI of energy efficient appliances of households. The results, with medium to large associations between the TPB constructs and PI of energy efficient appliances, proved the robustness of TPB in predicting the PI of energy efficient appliances. Our hypothesis, that, TPB as a model, as applied to PI of energy efficient appliances has a high predictive power, has been proved. The methodological moderators which consist of study characteristics did not show any moderating effect except the marginal moderating effect in case of attitude-intention and

perceived behavioural control relationship. This finding is little different from findings of Morren and Grinstein (2016), who in their meta-analysis, did not find any significant moderating effect for data collection method in the relationship between TPB constructs and pro-environmental intention. They did not find even sample type and sample method to be significant moderators.

Hofstede's dimensions are being widely considered in meta-analysis research, to test whether they significantly moderate the relationship between the independent and the dependent variables. (Morren and Grinstein, 2016; Nardi et al., 2019). We also have taken four dimensions of Hofstede to find out whether they significantly moderate the relationship between TPB constructs and PI of energy efficient appliances. This deepened our understanding of how the country and cultural differences impact the relationship between TPB constructs and PI of energy efficient appliances. Individualism dimension did not moderate any of the associations between TPB constructs and PI of energy efficient appliances. This finding is contrary to the findings of Morren and Grinstein (2016), who found significant moderating effects between attitude and intention to behave pro-environmentally, albeit marginal only, but similar to their finding that individualism is not a significant moderator in case of relationship between subjective norms-intention and perceived behavioural-intention. The long-term orientation and indulgence dimensions moderated the relationship between subjective norms-intention, perceived behavioural control-intention, pointing to the fact that subjective norms and perceived behavioural control are different in driving PI s depending upon whether the country is high or low on long-term orientation and high or low on indulgence. In both cases of subjective norms-purchase intention and perceived behavioural control and PI, the mean effect size is bigger. Therefore, countries high on indulgence seem to be giving priority to subjective norms and go by opinion of those who matter to them. Countries high on indulgence seem to be having greater perceived behavioural control. This could be due to the fact that countries high on indulgence are optimistic (Mackintosh, 2013). Location showed significant moderating effects for all the three associations of TPB, with non-Asian countries showing a higher mean effect size than Asian countries for all the three associations of TPB. This finding is contrary to the findings of Lanzini and Khan (2017), who in their meta-analytic study on determinants of travel mode choice found that location, does not show any moderating effect. As most of the studies were done in Asian countries, we divided the studies into Asian and non-Asian.

6 Implications

This meta-analytic review has wide implications for policy makers, marketers of energy efficient appliances and researchers. The first insight that we get from this analysis is that, the TPB constructs have high predictive power with respect to PI of energy efficient appliances of residents, with attitudes showing a large association with PI. Policy makers need to publicise the benefits of having energy efficient appliances so as to further enhance the positive attitude of the households. As the meta-analysis has proved that, attitude is the strongest determinant of PI, policy makers in the energy and environment domains, need to devise strategies to take advantage of this positive attitude. One way is, to phase out energy inefficient appliances through legislations, apart from publicising the benefits of energy efficient appliances. The marketers of energy efficient appliances need to work along with government in for this purpose. Informational campaigns through

various media would further help strengthen the positive attitude of people towards energy efficient appliances.

The positive and medium association of perceived behavioural control with PI shows that if people feel that they can easily adopt energy efficient appliances they will finally buy it. The marketers of energy efficient appliances and the policy makers need to make the energy efficient appliances easily available and affordable by bringing down the prices, since past research has shown that one of the reasons for reluctance of consumers to buy energy efficient appliances is price (Young et al., 2010). Among all the three constructs of TPB subjective norms showed the least association with PI. But the association is still medium. This finding also has significant implications for policy makers, as it brings to light the fact that neighbours, friends and important others who have already purchased energy efficient appliances can act as influencers. Policy makers and marketers need to project the importance of energy efficient appliances through these important others, so that the households who have not yet adopted the energy efficient appliances, adopt it.

The moderator analysis too has significant implications. The results of methodological moderators show that, they do not significantly impact the effect sizes. This finding is of significance for the researchers and indicates that, researchers have the flexibility to adopt different types of sampling methods, methods of data collection and analytical models. The only significant moderating effect in this category was that of analytical model, in case of perceived behavioural control and PI relationship,

Focus of study as a situational moderator, which significantly moderated the relationship between attitude and intention, gives insights to researchers, policy makers and marketers. A consumer's attitude towards PI of energy efficient appliances in general cannot be same as in case of PI of a particular energy efficient appliance such as, an air conditioner or a refrigerator. As the extant literature (Ali et al., 2019) mentions that, influencing factors may differ with the product, researchers should focus on PI of consumers towards specific energy efficient appliances. Policy makers and marketers need to have different policies and marketing strategies respectively depending upon the product.

All the four Hofstede's dimensions, individualism, long-term orientation, indulgence and uncertainty avoidance did not show any moderating effect for attitude-intention relationship. This finding is of great importance to policy makers. The similarity of attitudes towards PI, whether countries are high or low on individualism, long-term orientation, indulgence and uncertainty avoidance, makes it easy for policy makers in various countries to implement uniform policies to stimulate PI, through positive attitude that consumers have. The moderating effects of indulgence on subjective norms-intention and perceived behavioural control-intention has important insights for policy makers and marketers of energy efficient appliances. They should consider these two aspects of TPB, to stimulate the PI energy efficient appliances in countries which are high on indulgence. As the countries low on long-term orientation showed a bigger relational strength, in case of subjective norms-intention, the policy makers should strive to strengthen PI of consumers through word of mouth of those who have already purchased energy efficient appliances, because these cultures seem to give importance to the opinion of important others. Same is the case with perceived behavioural control-intention relationship. The policy makers and marketers of energy efficient appliances should attune their strategies by strengthening the behavioural control of consumers in these countries. This again can be done by making the energy efficient appliances easily available at reasonable prices.

The fact the uncertainty avoidance did not show moderating effects for any of the associations of TPB is again a significant insight for the policy makers and marketers of energy efficient appliances, as this shows that households no longer consider purchasing energy efficient appliances as risky.

Another important insight for the policy makers relates to the moderating effects of location in case of the all the three TPB associations. This brings to light to them the fact that attitudes, subjective norms and perceived behavioural control could be influenced by country characteristics other than those mentioned in Hofstede's dimensions. These factors could be GDP, human development index (HDI). The policy makers need to consider this complexity while devising the policies related to energy efficient appliances. As the analysis has shown that in case of location as a moderator, the mean effect size of Asian countries is less than that of non-Asian countries. Policy makers in Asian countries need to give further policy push to enhance the adoption of energy efficient appliances. For instance, existing literature mentions that energy efficient appliances have still not gained market share in the whole of Chinese market (Hua and Wang, 2019). In case of Pakistan also research has shown that Pakistanis have low propensity to purchase energy efficient appliances (Ali et al., 2019). That also probably explains as to why there are more number of research papers in the domain of adoption of energy efficient appliances in Asian countries, as this meta-analytic review has shown.

7 Conclusions, limitations and future research directions

This meta-analysis which focused on finding out robustness of TPB, in predicting PI of energy efficient appliances of households, is first of its kind. By including 30 studies that met the inclusion criteria we conducted the meta-analysis and the results proved the robustness of TPB in predicting the PI of energy efficient appliances. A high Q statistics and a high I2 meant that there is significant heterogeneity, so we adopted random effect model and conducted moderator analysis to find out the reasons for heterogeneity. The moderators were broadly divided into three. They are methodological, cultural, and situational moderators. Except marginal significance of method of data collection in case of attitude-intention and perceived behavioural control-intention relationship, the methodological moderators it did not prove to be significant. Among the cultural moderators, none of them proved significant in case of attitude-intention relationship. Long-term orientation and indulgence proved to be significant only in case of subjective norms and intention, perceived behavioural control and PI. Location showed significant moderating effect for all the three associations of TPB.

This study suffers from some limitations. When compared to other studies in the domain of energy efficiency such as adoption of renewable energy, the studies on adoption energy efficient appliances are still very less. There is also a need to examine the robustness of association between PI and actual purchase behaviour. In future, as more studies consider actual behaviour also, meta-analytic review testing the robustness of association between intention and actual behaviour can be conducted. This analysis considers only three original constructs of TPB. Researchers have considered other factors along with TPB constructs such as, environmental concern, environmental knowledge, knowledge of eco labels along with TPB to study the PI of energy efficient appliances and have called it extended TPB. We did not consider these factors, again because of the reason that there were less number of studies focusing on these factors. As

more research evolves on PI of energy efficient appliances with more number of determinants along with TPB constructs, future research can consider these factors and can conduct another meta-analysis.

There is also a further scope to use other moderators apart from the ones considered in these studies. The fact that, location as a moderator proved to be significant shows that there could be other country characteristics, beyond the Hofstede's dimensions, that need to be considered. HDI, GDP of countries can be considered as moderators in future meta-analysis of studies focusing on PI of energy efficient appliances.

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