Motivation Factor Influencing Behavior Change in Electrical Consumption

Husni Mohd Radzi[1], Chong Pui Yee[1], Nadian Nisa Nik Nazli[2], Shaharina Mokhtar[1], Mohd Zin Mokhtar[1] and Noor Azam Abd Rahman[1]

[1]Universiti Tenaga Nasional, Malaysia, {husni@uniten.edu.my, pychong@uniten.edu.my, shaharina@uniten.edu.my, zin@uniten.edu.my, noorazam@uniten.edu.my}

[2]Universiti Kuala Lumpur, Malaysia, {nadian_nisa13@yahoo.com}

ABSTRACT

This paper discusses consumer awareness and consumer Current electric consumption behavior as possible factors that could increase human motivation in committing to conserving behavior especially on electrical energy. The study also looks at how much motivation factor can create changes in consumer behavior towards the desired outcome. The study tested three hypotheses which are H1: Current Electric Consumption Behavior (CB) has significant influence on Motivation (MV), H2: Awareness (AW) has significant influence on Motivation (MV) and H3: Motivation (MV) has significant effect on Behavior Change (BC). Based on the finding gathered using PLS analysis on 400 respondents indicated that current electrical consumption behavior and consumer awareness have positive effect on person motivation about current electrical issue. Motivation have a negative correlation with resistance to behavior change. This may indicate that the higher the motivation level that a person has the less resistance that consumer feel in changing their behavior towards electric conservation.

Keywords: Motivation, current electric consumption behavior, behavior change, electricity

I INTRODUCTION

Households have a direct connection between their energy efficiency behavior and monthly cost of energy electricity consumption. The consumption behavior varies due to household composition and social standing and this may effect behavior change (European Environment Agency Technical report (2013). Given the lack of research on energy conservation of households in Malaysia, this study attempts to investigate the current situation of household electric consumption behavior in Malaysia. Households have been recognized by researchers as an important target group for electric conservation. In addition, households need to learn on how to save electricity and also need to be exposed on how to use electric efficiently (National Energy Efficiency Action Plan Draft Final Report, 2014). There are research been done which support this idea, showing that changing consumer behavior is normally considered to be an alternative to decrease electric consumption. To that end, it would appear that factors such as social, emotional influences, issue of learning and awareness, coupled with accessibility to technologies know how would be a central factor to formulating effective behavior change of consumer in the residential sector in Malaysia (Azlina, Engku Siti Zaharah Engku Abdullah, Mahirah Kamaludin & Alias Radam, 2016).

In terms of the electricity consumption, as reported by Malaysia Energy Information Hub (MEC) (2014), the use of electricity in Malaysia has increased year by year. The increment of the electricity use attributed mainly from the increasing use of electrical appliances such as washing machines, TV, refrigerators, air-conditioner, refrigerator and many more. The major electricity consuming appliance are refrigerator-freezer followed by air conditioner, washing machine, fan, rice cooker and iron (Saidur et al., 2007). There are several key factors influencing the behavior of household with regards to residential electricity conservation. Among these factors are socio-economic, demographics, housing/dwelling and household attitudes. Increase in electric consumption is influenced by household lifestyle and technology advancement (Norlaila,Khalid Abdul,Alias Radam,& Mad Nasir, 2013). Increasing of world population is ultimately stimulated higher electricity demand. The confrontation of multi energy source issues in relevant to economic, security, environmental and social has put the world energy sustainability at risk. To become a sustainable society, the world must consume less electricity (Low, Abdul Hakim & Choong, 2013).

II LITERATURE REVIEW AND CONCEPTUAL MODEL

Commonly, there are two approaches to promote electric conservation, namely structural energy conservation and non-structural energy conservation approaches. Structural energy conservation refers to the application of technology instruments, tools, or alternative energy resources, most of them require

capital investment. Conversely, non-structural energy conservation is emphasizes on improving or changing of the user's energy use behavior to achieve energy reductions (Low, Abdul Hakim & Choong, 2013). For this particular paper non-structural energy conservation is studied.

Behavioral models are necessary to understand what consumers do, and why they do so. Such models tend to vary widely by theory, concepts and applications (Axsen & Kurani, 2012). Relationships between various factors that influence behavior and consumption practices and the human element are dynamic, and not static. There is evidence that routine consumption is controlled to a large extent by social norms and is profoundly shaped by cultural and economic factors.

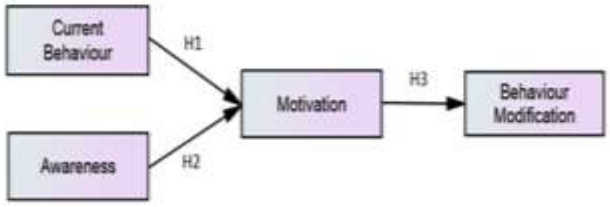

Figure 1. Conceptual Model of Behaviour Change.

Related work suggests that whilst socio-demographic variables like income and household size effect electricity use, psychological variables such as attitudes may be more important in determining changes in that use. Thus important in understanding domestic electricity consumption behaviors, including contextual, socio-demographic and psycho-logical factors (Staddona, Cycil, Gouldenc, Leyguec, Spencec, 2016). Kollmuss and Agyeman (2002), conclude that such behavior represents a complex interplay between multiple factors: demographic factors, external factors (including institutional, economic, and social and cultural factors), and internal factors (including motivation, environmental knowledge, values, attitudes, environmental awareness, environmental involvement, locus of control, and responsibility and priorities). Most models fail to deal with the formation of habits and desires for comfort and convenience.

Based on the above review of literature, this study proposed a model that comprises four variables, these include Current Electrical Consumption Behavior (CB), Awareness (AW), Motivation (MV) and Behavior Change (BC). Variable CB include demographic and household attitude. Variables Awareness (AW) include knowledge responsibilities, priorities, and environmental awareness. Variable Motivation (MV) include values and psychological factors and finally variable Behavior Change (BC) include usage of energy saving appliances (eg. inverter air conditioner, refrigerator etc).

Some behavior change programs reported progress toward goals in reduction in use or demand of electricity. Some used metrics such as units sold or distributed (CFLs, ENERGY STAR™-rated appliances), commitments or following through on commitments to behavioral changes (turning off lights, using power strips, cold laundry, shorter showers, etc.), and still others measured success based on the number of audits completed. Skumatz (2012) Behavioral programs have the potential to deliver significant savings. ACEEE estimates 30%; most of the pilot studies have shown that even small scale efforts routinely deliver 5-15% reductions in energy use. There are legitimate concerns about behavioral programs – and social marketing – efforts. Skumatz (2012).

A. **Research Hypothesis**

In order to empirically test the interrelationships between Current electric consumption behavior, awareness, motivation and behavior change, a conceptual model is developed premised on the reviewed energy saving and behavior consumer literature. In this conceptualized model Current electric consumption behavior, awareness is the predictor influence motivation while motivation is affect behavior change. Figure 1 depicts this conceptualized research model. The hypotheses are developed as per below:

H1: Current electric consumption behavior is positively influence motivation

H2: Awareness is positively influence motivation

H3: Motivation is negatively affect behavior change

III RESEARCH METHODOLOGY

A. **Sample and Data Collection**

The data for this research was collected from household living in Selangor, Kuala Lumpur and Putrajaya, as this housing area used the most energy consumption according to our interview with a representative from Tenaga Nasional Berhad (TNB). The instrument used to collect data a questionnaire survey. The instrument used was adopted from previous literatures and has been tested in our pilot study with a Cronbach Alpha value range from 0.918 to 0.956. (Current Electric Consumption Behavior 0.931; Awareness 0.918; Motivation 0.956; Behavior Change 0.956). Convenient and snow ball sampling method was used to those living in Klang Valley. Survey was administered through hardcopy at selected TNB shop and online

questionnaire from Universiti Tenaga Nasional staff. A total of 400 usable survey respondents have participated in the survey.

IV DATA ANALYSIS DAN RESULTS

The measurement and the structural models were tested using structural equation modelling (SEM). The component based partial least squares using Smart PLS statistical approach was performed in order to evaluate the psychometric properties of measurement scales and to test research hypotheses proposed in this study. SEM enables the simultaneous examination of both the path (structural) and factor analysis (measurement) models in one model. Partial Least Square (PLS) combines a factor analysis with linear regressions, and makes only minimal assumptions, with the goal of variance explanation (R-square). For this study, the sample size is 400 and PLS focuses on prediction of data and is better suited for exploratory models, it is considered to be more adequate for this study. The Smart-PLS Version 3.2 software package was used for the estimations.

A. **Measure Validation**

Construct Reliability

Reliability which is concerned about issues of stability and consistency in this study refers to the likelihood that construct measurement procedure that has been utilized will yield the same description of a given phenomenon if the measurement is repeated. The current study assessed construct reliability using Cronbach's alpha, Composite reliability (CR) and Average variance extracted (AVE). As indicated in Table 2, the Cronbach's alpha for the research constructs ranged from 0.819 to 0.910 and therefore surpassed the recommended threshold suggested by Byrne (2006). The CR values also ranged from 0.884 to 0.931 while the AVE values ranged from 0.629 to 0.693 again achieving the recommended benchmark of 0.50 (Hair et al., 2014). All in all, the constructs' reliabilities are acceptable and therefore, a good measure of the model.

Construct Validity

Construct validity is interested in the degree of which the construct itself is actually measured (Hair, Anderson, Tatham, & Black, 1998). In this study convergent validity and discriminant validity are used to confirm construct validity. Convergent validity refers to the degree to which a measure of a construct is correlated or related with other measures of the same construct that is theoretically predicted to correlate or relate to (Anderson & Gerbing, 1988). Discriminate validity means that the measurement instrument must be able to discriminate or differentiate the construct being studied from other similar constructs (Hair, Anderson, Tatham, & Black, 1998).

Table 2: Measurement Model

Constructs	*Items*	*Outer Loading*	*Cronbach's Alpha*	*CR*	*AVE*
Awareness	*DK1*	*0.764*	*0.882*	*0.910*	*0.629*
	DK2	*0.841*			
	DK3	*0.835*			
	DK4	*0.821*			
	DK6	*0.727*			
	DK7	*0.763*			
Behaviour Modification	*DC1*	*0.812*	*0.819*	*0.879*	*0.645*
	DC2	*0.836*			
	DC5	*0.749*			
	DC6	*0.814*			
Current Behaviour	*DS12*	*0.830*	*0.825*	*0.884*	*0.657*
	DS13	*0.872*			
	DS14	*0.807*			
	DS8	*0.728*			
Motivation	*DD18*	*0.832*	*0.910*	*0.931*	*0.693*
	DD19	*0.884*			
	DD20	*0.881*			
	DD21	*0.873*			
	DD24	*0.781*			

Convergent Validity

Individual item loadings together with AVE captures the convergent validity of each of the measures for constructs that are modelled reflectively. Table 2 shows all reflective measurement items have high and significant loadings as they surpass the recommended benchmark of 0.7 recommended by Hair et al. (2014) and therefore, indicating their significant contribution to the measured construct. The AVE for all constructs exceeded 0.50 (ranging between 0.629 and 0.693), and thus, supporting the convergent validity of the measurement items.

Discriminant Validity

Three approaches were used to confirm discriminant validity. First, the study checked if the correlations between research constructs were below a unit value (1.0). The maximum correlation value between constructs is 0.747, and therefore, is lower than the value of 0.8 that was recommended by Fraering & Minor, (2006), as evidence of discriminant validity. Second, the study checked if the values of the square roots of the AVE are all greater than the inter-construct correlations. The results presented in Table 2 and Table 3 indicates that all measures have appropriate discriminant validity. Finally, an additional test of discriminant validity assesses each measurement item to ensure that it has a higher loading on its assigned factor than on the other factors (Chin, 1998; Gefen et al. 2000). Again as indicated in Table 2, each measurement item loads higher on the appropriate construct than on any other construct therefore, providing additional support as to the discriminant validity of the measures. All in all, the study provides sufficient evidence that the measurement scales used are reliable and valid.

Table 3: Correlations Between Constructs

Construct	Awareness	Behaviour Modification	Current Behaviour	Motivation
Awareness	0.793			
Behaviour Modification	-0.197	0.803		
Current Behaviour	0.472	-0.217	0.811	
Motivation	0.394	-0.496	0.747	0.832

B. **Hypotheses Testing**

To estimate the structural model paths coefficients and the statistical significance of each path, this study uses Smart PLS 3.2 with bootstrapping as a resampling technique (1000 random samples). In particular, the path coefficients and the R^2 are jointly used to evaluate the model while the error estimates and t-values were used to check the statistical significance (Chin, 1998). Figure 2, Table 2 and Table 3 presents the PLS analysis results. The statistical significance of the path coefficients allows us to see which hypotheses were supported.

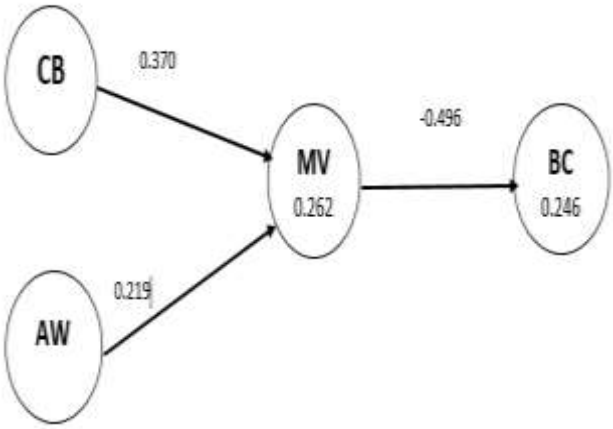

Figure 1. Measurement and Structural Model Results.

As indicated in Table 4 and Figure 2, R^2 for "Motivation" and "Behavior Change" are 0.262 and 0.246 respectively. This implies that these dependent variables (i.e., ""Motivation" and "Behavior Change") explain at least about 26.2% and 24.6% of the model respectively. The t-statistics for "Current electric consumption behavior → motivation", "awareness → motivation" and "motivation → behavior change" provided in Table 4 are 7.068, 4.280 and 12.134 respectively. All in all, these measures are considered statistically significant and therefore, confirming that all the posited relationship paths presented in Figure 2 and Table 4 are positive (H1, H2) supported and negative (H3) supported.

Table 4: Results of Structural Equation Model Analysis.

Proposed Hypotheses	Hypothesis	T-Statistic	Path Coefficients	R^2	Result
Current Behaviour → Motivation	H1	7.068	0.370	0.262	Supported
Awareness → Motivation	H2	4.280	0.219		Supported
Motivation → Behaviour Modification	H3	12.134	-0.496	0.246	Supported

In particular, Hypothesis (H1) posited a positive direct relationship between "Current electric consumption behavior" and "Motivation". The results shown in Figure 2 and Table 4 support the hypothesis with a strong and significant relationship (0.370). This result supports the belief that increased levels of Current electric consumption behavior enhance the motivation of consumer in energy saving.

Hypothesis 2 (H2) predicts that increased levels of awareness enhances the motivation of consumer. The results shown in Figure 2 and Table 4 again support this hypothesized relationship with a robust and significant relationship (0.219). This finding provides support for a positive relationship between awareness and motivation in the energy saving context.

Hypothesis 3 (H3) posited a negative relationship between motivation and behavior changes. The results in Figure 2 and Table 4 show a strong and negatively significant relationship (-0.496) and therefore, support the theorized relationship. This finding highlights the increased motivation of consumer and reduce the behavior change in energy saving.

V DISCUSSION AND CONCLUSION

Demographic data conclude that the majority of the study sample are adult female (31-40 years old) that work in the private sectors (187, 46.7%) with a monthly income around RM 2000 – RM 4000 (169, 42.2%). Most of the sample having a degree qualification (224, 56%) and were the bill payer themselves (290, 72%). Most sample are gathered from the state of Selangor (196, 49%) living in a double storey houses (100, 25%) that they owned (202, 50%) and living with their family (342, 85.5%) of more than five person per house hold (108, 27%). The average amount of electricity bills that the sample end up paying monthly is around RM 101 to RM 150.

The PLS analysis, CB and AW explained 0.262 (26%) of Motivation (MV). While Motivation (MV) explained 0.246 (24%) of BC. It means there are 74-76% of underlying factors that are still need to be understood on motivation and behavior change factors. The Current electric consumption behavior

in the analysis showed a positive significant relationship with Motivation with 0.370 ($p<0.05$, significant) same as Awareness with Motivation with 0.219 ($p<0.05$, significant). This positive relationship explained that the more Awareness and application of Current electric consumption behavior, the more a person will have the motivation to change their behavior into conserving electricity. Motivation and Behavior Change indicated negative relationship of -0.496 ($p<0.05$, significant) which mean the lower the motivation the higher the resistance of the sample to practice electrical conservation behavior. Thus, more study need to be done to find out what are the factors that can motivate person to continuously practice conservation of electricity.

Staddona et al., (2016) have studied how information dissemination, feedback and rewards are important in influencing conservation behavior, they also discussed how individual psychology and physical capacity can be both the motivation and the barrier in achieving the objective. They also suggest to look at all opportunity that is available such as social, cultural and environmental that can be used together to overcome this problem. They also suggest nine point of intervention that can be adopted such as education, persuasion, incentivisation, environmental restructuring, modelling and enablement by increasing mean and reducing barrier. However there are three intervention alternatives that was never been done which are coercion, training and restriction.

The European Environment Agency Technical report (2013) suggest a more lenient measures. Energy efficiency/conservation initiatives use several different types of interventions:

1) Communication and engagement: information and promotion, training, personal advice and one-to-one engagement, demonstrations, benchmarking, commitment, goal-setting, labelling, prompts, modelling, feedback;
2) Economic incentives and disincentives: subsidies, levies, surcharges, taxes, bonuses, tax differentiations, tax refunds, financial instruments such as interest free loans, rewards and penalties;
3) Regulatory: general laws and rules, specific exemptions, covenants and agreements;

Empirical evidence from psychology and behavioral economics shows that consumer choices and actions often deviate systematically from neoclassical economic assumptions of rationality, and there are certain fundamental and persistent biases in human decision-making that regularly produce behavior that these assumptions cannot account for Pollitt MG and ShaorshadzeI (2013). Some examples of energy conservation behavior but not limited to, switching off the unnecessary lightings, thermostat control, turn off the monitor screen whenever not in use, turn the computer into hibernate mode or sleep mode when leaving the computer for a short period, use stairs instead of lift as possible as could, as well as maximum use of the natural lighting. All of these energy conservation actions can reduce energy usage dramatically (Low, Abdul Hakim & Choong, 2013).

Human behavior is an essential ingredient in energy conservation efforts. In support of that, the best way to cope with the rising energy demand is not to supply more but is to save. "Energy conservation is an inescapable responsibility for humanity". Dumas (1976) once asserts that the excess consumption of energy always arises from wasteful of the user's behavior. Hansen (2002) also quotes that over half of the energy used by user is wasted. "People is the main factor in achieving energy efficiency" (Loosen & Moosdijk, 2001). The significance of this approach has been reported by many researchers (Low, Abdul Hakim & Choong, 2013).

Bream (1986) indicates that approximately 10 percent of savings in energy cost can be achieved if the users are more energy conserving. Loosen and Moosdijk, (2001) also reveals that about 5- 10 percent of energy savings can be achieved by improving energy user's behavior. A similar result has been evidenced in a study conducted by Ouyang, Gao, Yan, Hokao, & Ge, (2009) of which 10 percent of electricity reduction achieved easily by improving user's behavior. Therefore, cumulative amount of energy cost saving can be reached through energy conservation behavioral changes.

VI RECOMMENDATION

Based on the findings from this study, there are other factors that were not being investigated which could contribute to motivation factor to conserve electricity consumption behavior. Researchers would like to suggest that the rate of electricity usage be reviewed. The formulation of electricity rate should be higher as the amount of electricity usage increases and in contrast, the rate of electivity usage be lower for lower usage. It is hope that with this differential rate, consumers will be more cautious on their electricity usage and will therefore make effort to reduce usage of electricity.

ACKNOWLEDGMENT

This study is funded under BOLD2025, Institute of Informatics and Computing in Energy (IICE).

REFERENCES

A. Kollmus, J. Agyeman (2002). Mind the gap: why do people act environmentally and what are the barriers to pro-environmental behavior? *Environ. Educ. Res*., 8, 239–260.

A.A. Azlina, Engku Siti Zaharah Engku Abdullah, Mahirah Kamaludin & Alias Radam (2015). ENERGY Conservation of Residential Sector in Malaysia (Penjimatan Tenaga Bagi Sektor Kediaman Di Malaysia) *Journal of Business and Social Development 3(2)*, 51-62

A. Kollmus, J. Agyeman. (2002) Mind the gap: why do people act environmentally and what are the barriers to pro-environmental behavior? *Environ. Educ. Res*., 8, 239–260.

Anderson, J. C. & Gerbing, D. W. (1988). "Structural Equation Modeling in Practice: A Review and Recommended Two-Step Approach," *Psychological Bulletin*, *103*(3), 411-423

Bream, C. F. (1986). Energy management in buildings – techniques and priorities. In A. F. C. Sherratt (Ed.), Energy management in buildings. London: Hutchinson.

Chin, W.W. (1998). Issues and opinion on structural equation modelling, *MIS Quarterly*, *22*(1), 7–16.

Dumas, L. J. (1976). The conservation response: strategies for the design and operation of energy-using systems Lexington, Mass: Lexington Books

European Environment Agency Technical Report (2013). Achieving energy efficiency through behaviour change: what does it take? No 5/2013, ISSN 1725-2237Luxembourg: Publications Office of the European Union, 2013, ISBN 978-92-9213-384-9, ISSN 1725-2237, doi:10.2800/49941

Fraering, M & Minor, M.S. (2006). Sense of community: An exploratory study of US consumers offinancial services, *International Journal of Bank Marketing*, *24*(5), 284-306.

Gefen, D., Straub, D. W & Boudreau, M. C. (2000). Structural equation modelling and regression guideline for research practice. *Communications of the Association for Information Systems*, *4*(7), 1–70.

Hansen, S. J. (2002). Manual for Intelligent Energy Services. Lilburn,Ga.: Fairmont Press.

Hair, J.F., Anderson, R.E., Tatham, R.L & Black, W.C. (1998). *Multivariate data analysis*. Upper Saddle River (NJ): Prentice-Hall.

Hair, J. F., Hult, G. T. M., Ringle, C., & Sarstedt, M. (2014). A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM). Sage Publications, Inc.

Jonn Axsen and Kenneth S. Kurani. (2012). Social influence, consumer behavior and low-carbon energy transition. *Annual Review of Environment and Resources*., 37, 311-340.

Kahneman D. (2003). A psychological perspective on economics. *Am Econ Rev*., 93, 162.

Kahneman D. (2003). Maps of bounded rationality psychology for behavioral economics. *Am Econ Rev*., 93, 1449–75.

Lisa A. Skumatz (2012). Measuring the Impacts of Behavior Change Programs: Filling in the Blanks, Economic Research Associates, Inc. ACEEE Summer Study on Energy Efficiency in Buildings

Loozen, A and Moosdijk, C.V.D. (2001). A Consumer Advise on Energy Efficient Use and Purchase of Household Appliances and Lighting. In: Bertoldi, P., Ricci, A. and Almeida, A.D. *Energy Efficiency in Household Appliances and Lighting*, 468-474.

Low Sheau Ting, Abdul Hakim Bin Mohammed & Choong Weng Wai (2011). Promoting Energy Conservation Behaviour: A Plausible Solution to Energy Sustainability Threats. *2011 International Conference on Social Science and Humanity IPEDR vol.5 (2011) IACSIT Press, Singapore*

Ouyang, J., Gao, L. L., Yan, Y., Hokao, K., & Ge, J. (2009). Effects of improved consumer behavior on energy conservation in the urban residential sector of Hangzhou, China. *Journal of Asian Architechure and Building Engineering*, 8(1), 243-249.

Pollitt MG, ShaorshadzeI (2013). The role of behavioural economics in energy and climate policy. In: Fouquet R, editor. Handbook on Energy and Climate Change. EdwardElgar.

Malaysia Energy Commision. (2014). *National Energy Balance*. Putrajaya.

Norlaila Abdullah Chik, Khalid Abdul Rahim, Alias Radam, Mad Nasir Shamsudin (2013). Co2 Emissions Induced By Households Lifestyle In Malaysia. . *International Journal of Business and Society*, 14(3), 344 - 357

Sam C. Staddona, Chandrika Cycil b, Murray Gouldenc, Caroline Leyguec, Alexa Spencec. (2016). Intervening to change behaviour and save energy in the workplace: A systematic review of available evidence, *Energy Research & Social Science*, 17, 30–51

Saidur, R., Masjuki, H. H., Jamaluddin, M. Y., Ahmed, S. (2007). Energy and Associated Greenhouse Gas Emissions from Household Appliances in Malaysia. *Energy policy*, 35, 1648-1657.