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Bridging the Gap: From Policy to Action - Examining Energy Efficiency Behavior in Delhi's Workforce

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Abstract:
This paper explores the critical role that energy plays in running household appliances, such as hair dryers and refrigerators, and it highlights the urgent issues that result from the misuse and mishandling of energy resources. The study highlights the importance of environmental pollution and the depletion of non-renewable energy sources, while also recognising national efforts to incorporate energy-efficient practices and products into their markets. There is a discernible divide in the general public's adoption of energy-efficient practices and goods in spite of these initiatives**.**
With a focus on Delhi, India's working population, this study attempts to identify the major variables influencing energy-efficient behaviour. A thorough investigation revealed that the adoption of energy-efficient behaviours is highly influenced by individual income levels, the cost of energy-efficient options, and knowledge of energy-efficient practices. On the other hand, it was discovered that government subsidies and social and personal norms had less of an impact on these behaviours. This study not only clarifies the various degrees to which these factors have an impact, but it also opens the door to more focused and successful approaches to encourage energy efficiency in urban populations.

Keywords: Energy efficiency, government policies, awareness, individual income

1. Introduction

Energy serves as the cornerstone for powering a myriad of sectors, including residential dwellings, educational institutions, offices, agriculture, industries, and transportation. Defined in its simplest terms as power derived from the utilization of physical or chemical resources, these resources are categorized into renewable and non-renewable energy sources. The former denotes natural resources capable of self-replenishment, while the latter possesses a finite supply.
Crucial for economic development, the distribution of energy usage is uneven between developed and developing countries. Notably, the average energy consumption per capita in the United States significantly surpasses that of India, Brazil, and China, indicating a pronounced discrepancy (Ritchie & Roser, 2019). On a global scale, per capita energy consumption has consistently risen, with a notable 45% increase between 1970 and 2014. This growth is predominantly driven by escalating consumption in transitioning middle-income countries, exemplified by substantial increases in China, India, and Brazil (Ritchie & Roser, 2019).

The International Energy Agency's report in 2018 revealed a 2.3% growth in worldwide energy consumption, nearly twice the average rate since 2010. This surge is attributed to a robust global economy and heightened demand for various fuels, albeit insufficient to meet the escalating global electricity demand (IEA, April 2019).

India mirrors this global trend, as evidenced by a 5.71% increase in electricity generation and a 7.39% rise in consumption during 2017-2018. The industrial sector accounted for the largest share of electricity consumption, followed by domestic, agricultural, and commercial sectors (Energy Statistics, 2019).

While energy systems have propelled development and growth, they concurrently contribute to environmental degradation and climate change. The depletion of natural resources for energy generation and the resultant emissions and pollution underscore the urgent need for countries to balance energy demand with environmental preservation. Energy efficiency emerges as a pivotal strategy to address these dual challenges.

For densely populated countries like India, where 24.2% of electricity is consumed in households, enhancing energy efficiency becomes paramount for emission reduction. Notably, the implementation of energy-efficient practices in households can swiftly contribute to mitigating emissions and fostering economic and environmental sustainability.

Despite the potential of energy efficiency to reduce emissions, Herring (2006) contends that increased energy-efficient behavior does not guarantee a reduction in greenhouse gas emissions. Nevertheless, it offers financial savings, promotes economic efficiency, and facilitates the transition toward a fossil-free energy future.

The concept of energy efficiency, defined as using less energy to perform the same task and eliminating energy waste, yields multifaceted benefits such as reduced greenhouse gas emissions, diminished energy import demands, and lowered costs on both household and economy-wide levels (Piccirilli Dorsey, Inc., n.d.).

Achieving energy efficiency involves various strategies, including the replacement of outdated appliances with newer, energy-efficient alternatives and the incorporation of innovative technologies. The potential for efficiency improvements spans across buildings, transportation, industry, and energy generation.

While technological advancements are crucial for energy efficiency, the role of human behavior in utilizing these technologies cannot be overstated. Research indicates that a significant portion of potential energy savings from high-efficiency technologies is lost due to social, cultural, and economic factors. Therefore, addressing these factors becomes integral to fostering energy efficiency within the economy (Piccirilli Dorsey, Inc., n.d.).

Successful energy policies hinge on effective implementation, adoption, and utilization by the populace. The literature underscores the importance of considering behavioral sciences in policy formulation to ensure policies resonate with the intended audience. Past research emphasizes the need for economists to delve into behavioral sciences before implementing policies to bridge the gap between policy intent and public action (Hahn & Metcalf, 2016; Allcott & Mullainathan, 2010; Abrardi, 2019).

Acknowledging the cost-effective nature of energy conservation to meet escalating energy demand, the Government of India enacted the Energy Conservation Act in 2001. The establishment of the Bureau of Energy Efficiency in March 2002 was a pivotal step, providing an institutionalized and strengthened delivery mechanism for energy efficiency services and fostering coordination among various entities (Bureau of Energy Efficiency, India, 2020).

Despite India's array of energy schemes and policies, there appears to be a gap between policy formulation and public action. This gap is not exclusive to government policies but extends to general energy efficiency attitudes among the populace. Consequently, comprehending energy efficiency practices and behaviors among people becomes imperative for achieving comprehensive reductions in gas emissions and minimizing reliance on non-renewable energy sources.

This research endeavors to identify the factors influencing energy efficiency behavior among the working population in Delhi, India.

2. Literature Review

This section delves into several studies related to energy efficiency behavior conducted by researchers in the past. A substantial body of literature exists on motivational factors and barriers influencing energy efficiency behavior. For an in-depth exploration of such studies, Ding et al.'s work in 2018 provides valuable insights.

Yue et al. (2013) explored the factors impacting the energy-saving behavior of households in Jiangsu province, China, categorizing them into four key aspects: energy-saving awareness, behavioral ability, demographic factors, and situational factors. The conceptual framework they developed serves as a foundational reference for understanding energy efficiency behavior (Yue et al., 2013).

This paper aims to investigate selected factors and their influence on the energy efficiency behavior of the working population in Delhi, India, particularly focusing on situational factors, awareness, government policies, income, social and personal norms, and price.

2.1 Awareness

Numerous studies have explored the relationship between environmental awareness/knowledge and resultant energy efficiency behavior. Pothitou et al. (2016) found significant correlations between knowledge about energy saving and actions taken to reduce energy use, emphasizing the role of positive environmental values and greater knowledge in fostering energy-saving activities in households. Bartiaux (2008) challenged the paradigm of consumers' rationality, suggesting that environmental information may not directly translate into energy-saving practices.

Molina et al. (2013) studied the influence of environmental knowledge on pro-environmental behavior among university students from different countries, highlighting cultural and contextual factors affecting behavior. Gadenne et al. (2011) identified a strong association between environmental attitudes and energy-saving behaviors. This section presents conflicting findings, with some studies demonstrating a positive relationship between environmental knowledge and energy-saving behavior.

2.2 Government Policies

The connection between government policies, such as subsidies and incentives, and energy-saving behavior has been a focal point for researchers. Steg et al. (2006) proposed that incentives targeting efficiency behavior are perceived as more effective than disincentives targeting curtailment behavior. However, Gadenne et al. (2011) found no significant influence of government policies or subsidies on energy-saving behaviors.

Poortinga et al. (2003) revealed that the acceptability of specific energy-saving measures depends on the characteristics of those measures, with consumers preferring home-related measures over transport-related

ones. Maki et al. (2016) concluded that financial incentives have a positive effect on pro-environmental behavior.

This paper seeks to explore the impact of government policies, particularly subsidies, on the energy efficiency behavior of respondents.

2.3 Income

The role of income in energy efficiency behavior has been discussed in previous studies, recognizing it as a crucial factor determining access to and usage of energy. Druckman and Jackson (2008) found that household energy use and associated carbon emissions are strongly related to income levels. Sardianou (2007) identified socio-economic variables, including income, as determinants of energy conservation preferences.

Watson (2012) highlighted financial barriers related to purchasing energy-saving products. Sun and Jiang (2013) concluded that income has a negative impact on energy consumption behavior, emphasizing its influence on different population segments. This paper aims to examine how income levels impact respondents' energy efficiency behavior.

2.4 Social and Personal Norms

Personal and social norms play a pivotal role in influencing individuals' energy efficiency behavior. Nordlund and Garvill (2003) demonstrated that personal norms mediate the effects of values and specific problem awareness on willingness to cooperate in environmental conservation. Goldblatt et al. (2005) explored the impact of expert knowledge on household energy consumption, revealing that personal norms influenced behavior, especially concerning mobility.

Drawing inspiration from these studies, this paper aims to investigate how personal and social norms influence energy efficiency behavior.

2.5 Price

Consumer behavior is inherently influenced by the cost-benefit analysis of products. Reddy and Painuly (2004) identified economic and financial barriers as significant factors hindering the adoption of renewable energy technologies. Belaid and Garcia (2016) found that more expensive energy-intensive behaviors are less favored by households.

This paper aligns with the trajectory set by these studies and seeks to understand the influence of the cost of energy-efficient products on respondents' energy efficiency behavior.

2.6 Hypotheses

Building on the factors explored in this paper, several hypotheses are proposed:

H1. Awareness about energy efficiency practices does not impact actual energy efficiency.

H2. Government policies and subsidies do not affect energy efficiency behavior.

H3. Energy efficiency behaviour is independent of the working population's annual income level.

H4. A person’s energy efficiency behaviour is independent of personal and social norms.

H5. The price of energy-efficient goods does not influence energy efficiency behaviour.

2.7 Assumptions

This research is based on the following assumptions:

Awareness in this paper refers to awareness of energy-saving practices, assessing whether knowledge translates into actions.
The term "Price" implies that if there is no purchase behaviour regarding energy-efficient products, the respondent is not behaving in an energy-efficient manner.
Government policies refer to subsidies provided by the government to increase energy efficiency behaviour, and their impact is assessed in this paper.
By investigating these factors and hypotheses, this paper aims to contribute to the understanding of energy efficiency behaviour among the working population in Delhi, India.

Methodology

3.1 Research Problem: The primary objective of this study was to investigate the potential impact of independent variables, including awareness, government policy, income, social and personal norms, and price (cost), on the dependent variable—energy efficiency behavior exhibited by respondents.
3.2 Survey Design: To address this objective, data collection utilized a specifically tailored questionnaire, administered online. Employing purposive sampling, the questionnaire link was distributed to 80 individuals. However, the final dataset was derived from 70 completed and submitted responses.
3.3 Questionnaire Design: The questionnaire encompassed diverse categorical and five-point Likert statements. Categorical responses were structured as Yes/Sometimes/No to gauge energy efficiency behavior and awareness. The Likert statements employed a 5-point scale, ranging from Strongly Disagree to Strongly Agree, to measure other independent variables such as government policy, income, social and personal norms, and price.
3.4 Sample: The target demographic for this study comprises the working population in Delhi, India. The investigation seeks to ascertain the influence of the identified independent variables on the energy efficiency behavior within this specific group.
3.5 Data Analysis Tools: The subsequent analysis of responses, essential for hypothesis testing, was conducted using Microsoft Excel 2016. Two data analysis tools—ANOVA and Linear Regression—were employed for evaluating each hypothesis. The examination involved assessing the impact of each independent variable on the dependent variable, namely, energy efficiency behavior.

4.2 Hypotheses testing

Testing for H1.

Table 1

Regression Statistics	
Multiple R	0.307498924
R Square	0.094555588
Adjusted R Square	0.081240229
Standard Error	1.348587342
Observations	70

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	12.91494253	12.9149	7.101242108	0.00961252
Residual	68	123.6707718	1.81869		
Total	69	136.5857143			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	10.09605911	1.244956313	8.10957	1.38583E-11	7.61178747	12.58033076	7.61178747	12.58033076
IDV	0.609195402	0.228606965	2.66482	**0.00961252**	0.153017307	1.065373498	0.153017307	1.065373498

Hypothesis H1: Awareness about energy efficiency practices and its Impact on Actual Energy Efficiency Behavior

To assess the relationship between awareness about energy efficiency practices and actual energy efficiency behavior, a statistical linear regression model was employed at a 95% confidence level. The results are presented in Table 1.

The statistical analysis revealed that the P-value, determined to be 0.0096, is less than the predetermined alpha value of 0.05. As a result, the null hypothesis (H1) is rejected. This finding provides compelling evidence that awareness about energy efficiency practices does, indeed, have a significant impact on actual energy efficiency behavior. Therefore, the data supports the conclusion that an individual's awareness of energy-efficient practices influences their behavior towards energy efficiency positively.

Testing for H2.

Table 2

Regression Statistics	
Multiple R	0.202324959
R Square	0.040935389
Adjusted R Square	0.026831498
Standard Error	1.38794455
Observations	70

ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	5.591189326	5.591189326	2.902418054	0.093013133
Residual	68	130.994525	1.926390073		
Total	69	136.5857143			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 90.0%*	*Upper 90.0%*
Intercept	14.62190016	0.744332604	19.64430965	9.70371E-30	13.13660757	16.10719275	13.38067174	15.86312858
IDV	-0.158776167	0.093197729	-1.703648454	**0.093013133**	-0.344749341	0.027197006	-0.314190118	-0.003362217

Table 2: Results of Linear Regression Analysis

Hypothesis H2: Government Policies and Subsidies Impacting Energy Efficiency Behavior

To examine the influence of government policies and subsidies on energy efficiency behavior, a statistical linear regression model was implemented. The analysis was conducted at a 90% confidence level, with an alpha value of 0.1. The results are summarized in Table 2.

The statistical testing, carried out at a 90% confidence level, yielded a P-value of 0.0930, which is less than the alpha value of 0.1. As a consequence, the null hypothesis (H2) is rejected. This indicates that government policies, specifically in the form of subsidies, do have a discernible impact on energy efficiency behavior. Interestingly, it's noted that when a 95% confidence level is applied, the hypothesis is accepted.

In conclusion, the findings suggest that government interventions, such as subsidies, play a role in influencing energy efficiency behavior among individuals. The nuances of this influence may be subject to variations in the confidence level used for analysis.

Hypothesis H3: Impact of Annual Income Level on Energy Efficiency Behavior

To assess whether the energy efficiency behavior is influenced by the annual income level of the working population, an ANOVA: single factor model was employed. The analysis was conducted at a confidence level of 95%. The results are presented in Table 3.

Table 3

SUMMARY				
Groups	*Count*	*Sum*	*Average*	*Variance*
DV	70	937	13.38571429	1.979503106
Your Annual Income	70	155	2.214285714	1.736024845

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	4368.028571	1	4368.028571	2351.22902	**1.46757E-88**	3.90973
Within Groups	256.3714286	138	1.857763975			
Total	4624.4	139				

The ANOVA analysis indicates a statistically significant difference between groups, with an extremely small P-value of 1.468^-88, which is well below the alpha value of 0.05. Consequently, the null hypothesis (H3) is rejected.

This implies that there is a significant dependency between energy efficiency behavior and the annual income level among the working population. In other words, individuals' energy efficiency practices are influenced by their annual income.

In summary, the findings suggest a strong association between annual income and energy efficiency behavior, highlighting the impact of financial factors on individuals' energy-saving practices.

Testing for H4.

H4. A person's energy efficiency behavior is independent of personal and social norms.

The testing for this hypothesis was done by applying a linear regression model at a confidence level of 90%. Following were the findings,

Hypothesis H4: Independence of Energy Efficiency Behavior from Personal and Social Norms

To investigate whether an individual's energy efficiency behavior is independent of their personal and social norms, a linear regression model was employed at a confidence level of 90%. The results are summarized in Table 4.

Regression Statistics	
Multiple R	0.227003478
R Square	0.051530579
Adjusted R Square	0.037582499
Standard Error	1.160597253
Observations	70

ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	4.976381626	4.976381626	3.694456872	0.058784456
Residual	68	91.59504695	1.346985984		
Total	69	96.57142857			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 90.0%*	*Upper 90.0%*
Intercept	12.49312832	0.862376035	14.48686862	1.81037E-22	10.77228373	14.2139729	11.05505395	13.93120269
Norms	-0.108858348	0.0566352	-1.922096998	**0.058784456**	-0.22187213	0.004155434	-0.203301638	-0.014415058

Table 4: Results of Linear Regression Analysis

The linear regression analysis yielded a P-value of 0.0587, slightly exceeding the alpha value of 0.1. Thus, at the 90% confidence level, the hypothesis (H4) is rejected, indicating that energy efficiency behavior is not considered independent of an individual's social and personal norms.

Interestingly, it's worth noting that at a higher confidence level of 95%, the hypothesis was accepted, suggesting that there might be some ambiguity in the relationship between energy efficiency behavior and personal and social norms.

In conclusion, the results imply that there may be a nuanced relationship between energy efficiency behavior and personal/social norms, with the outcome being influenced by the chosen confidence level for analysis. Further exploration and research may provide additional insights into the intricate dynamics of this relationship.

Testing for H5.

Hypothesis H5: Influence of Price on Energy Efficiency Behavior

To assess whether the price of energy-efficient goods influences energy efficiency behavior, an ANOVA: single-factor model was implemented at a 95% confidence level. The findings are summarized in Table 5.

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
DV	70	937	13.38571429	1.97950311
price	70	157	2.242857143	1.46190476

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	4345.714286	1	4345.714286	2525.54446	**1.37252E-90**	3.90973
Within Groups	237.4571429	138	1.720703934			
Total	4583.171429	139				

Table 5: Results of ANOVA Analysis

The ANOVA analysis indicated a statistically significant difference between groups (F (1,138) = 2525.5) with a remarkably small P-value (p = 1.373^-90). At a 95% confidence level where the alpha value is 0.05, the result surpasses the significance threshold. Consequently, the hypothesis (H5) is rejected, suggesting that the prices of energy-efficient goods do indeed influence energy efficiency behavior.

The outcomes imply that individuals consider the cost of energy-efficient products as a significant factor in shaping their energy efficiency behavior. This aligns with the findings of Reddy & Painuly (2004) and underscores the impact of economic considerations on sustainable consumer choices.

In summary, the rejection of H5 indicates a noteworthy association between the pricing of energy-efficient goods and the exhibited energy efficiency behavior among respondents. Future research could delve deeper into the specific economic considerations that play a role in this relationship.

5. Findings and Conclusion

The results from the previous section, relating to the hypotheses testing, have been discussed in this section. It has been noted that all the hypothesis (H1-H5) were rejected. Following points help explain the impact of each hypothesis test result on this paper.

1.H1. Hypothesizes that awareness about practices that improve energy efficiency does not impact the actual energy efficiency behavior. The hypothesis being rejected would imply that there is a relationship between actual EEB and awareness about EEB practices. This underscores the need for targeted awareness campaigns to foster sustainable practices among the working population.
The findings of this paper are in line with findings of Pothitou et. al. (2016) and Gadenne et. al. (2011) that awareness (knowledge) about energy efficiency behavior plays a key role in reducing energy consumption.

2.H2. Hypothesized that subsidies in the form of government policies does not affect energy efficiency behavior. The hypothesis was rejected at a low level of confidence but accepted at higher level of confidence thus implying that government policies may affect the energy efficiency behavior. It may also be inferred that government policies alone might not affect behavior.
The introduction of more subsidized policies could affect the energy efficiency behavior of people to some extent. In this aspect our findings are in line with findings of the researchers cited in the literature review above differ from that of Gadenne et. al (2011).
However, a possible explanation for this could be the development of the countries the research was conducted in. India is still a developing country whereas Australia is a developed country.

3.H3. This hypothesis puts forth the idea that energy efficiency behavior is independent of annual income levels. The hypothesis was rejected on the basis of ANOVA test conducted. Concluding that EEB is dependent on an individual's annual income level. It seems logical because the ability to purchase an item depends on how much money does a person make.
Although there have been no universally accepted conclusions on this since studies on this relationship have not been able to give conclusive evidence that income alone can affect energy efficiency behavior but most of them have found income and finances to be an important factor with regard to purchase of energy saving products..

4.H4. Tested if energy efficiency behavior is independent of personal and social norms. The hypothesis was rejected at a 90% level of confidence. Our results are in line with that found by Nordlund& Garvill (2003). Concluding that EEB is dependent on individuals social and personal norms.
This shows that people use their norms and beliefs while practicing EEB as well as while purchasing energy efficient appliances.
However, this conclusion may not be concrete since **H4** was accepted at a higher level of confidence.

5.H5. Evaluated the influence of price of energy efficient products on energy efficiency behavior. As per the result of test it was found that the hypotheses put forth was rejected at a high level of confidence. Inferring that price of energy efficient products greatly influences the EEB of individuals.
The results of this hypothesis are greatly in line with the findings of Reddy& Painuly (2004) who conducted their research in Mumbai, India.

Conclusion and Implications:
The comprehensive exploration of factors influencing energy efficiency behavior (EEB) among the working population in Delhi, India, has yielded compelling findings that challenge traditional assumptions

and illuminate the intricate dynamics of sustainable practices. The rejection of all hypotheses underscores the multifaceted nature of EEB and prompts a deeper understanding of the complex interplay between awareness, government policies, income levels, personal and social norms, and pricing of energy-efficient goods.

Implications for Practice:

These findings hold crucial implications for policymakers, businesses, and organizations aiming to promote sustainable energy practices:

1. **Tailored Awareness Campaigns:** Designing targeted awareness campaigns addressing specific knowledge gaps and cultural nuances can be instrumental in fostering a culture of energy efficiency among the diverse working population.
2. **Policy Interventions:** Policymakers should carefully design and implement subsidies, considering their nuanced impact on EEB. Understanding the varying confidence levels emphasizes the need for adaptive policies that account for diverse perspectives and socioeconomic contexts.
3. **Inclusive Economic Strategies:** Recognizing the influence of income levels on EEB necessitates inclusive economic strategies. Subsidy programs and incentives should be designed to benefit individuals across different income brackets, ensuring widespread adoption.
4. **Normative Interventions:** Developing interventions that leverage personal and social norms can enhance the effectiveness of energy-saving initiatives. Understanding the complex interplay between norms and behavior is essential for designing interventions that resonate with diverse cultural values.
5. **Affordability of Energy-Efficient Products:** Addressing pricing barriers for energy-efficient goods is crucial for widespread adoption. Policymakers and industry stakeholders should explore mechanisms to make energy-efficient products more affordable and accessible, potentially through subsidies or innovative financing models.

In conclusion, the study's findings not only contribute to academic discourse but also provide actionable insights for practitioners. Effectively promoting energy efficiency behavior requires a holistic understanding of the intricate factors at play, guiding the development of targeted and context-specific interventions for a sustainable energy future.

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