Doctoral Dissertation

An Integrated Model for Assessing Energy-saving Behavior in the Workplace: Empirical Study of NSTDA in Thailand

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September, 2024

Abstract

[**Background**]

Energy conservation is prominently featured among the United Nations' 17 Sustainable Development Goals. The interplay between social and behavioral science and energy usage has begun to play a crucial role in addressing the energy challenge. Employee behavior significantly affects an organization's energy consumption. Numerous intervention strategies have been explored to encourage energy-saving behaviors among employees in the workplace. Nonetheless, only a limited number of studies have examined energy conservation from both social and behavioral viewpoints.

[**Objective**]

The goal of this research is to develop a theoretical model of energy-saving behaviors, grounded in empirical results, with implications for promoting such behaviors in the workplace. To understand the drivers behind energy behaviors in office buildings, the primary research question (PRQ) is: What are the determinants of energy-saving behavior in the workplace? This investigation aims to identify the influential factors of behavior and assess their impact on energy conservation. We examined key behaviors, such as turning off lights when not needed, to encourage energy-saving actions through the lens of social and behavioral sciences. Our approach involved integrating the ability-motivation-opportunity (AMO) model, the norm activation model (NAM), and the theory of planned behavior (TPB) into a cohesive framework. Additionally, external factors like individual comfort and intention were included in the proposed model.

We conducted an online survey targeting employees at the NECTEC building of the National Science and Technology Development Agency, as well as those working in private companies in Thailand. The collected data were analyzed using partial least square structural equation modeling (PLS-SEM) to evaluate the proposed model. By combining these three perspectives, we developed a more comprehensive model of energy-saving behavior, offering practical insights for energy control and management.

[**Results**]

The proposed variables have been shown to predict energy-saving behavior and enhance the AMO model. We employed the NAM to emphasize the implications of energy-saving behavior and the TPB to illustrate the cognitive deliberation process behind effective behaviors.

The empirical results from the PLS-SEM analysis reveal that, in government workplaces, all constructs except behavior motivation are significantly and positively correlated with energy-saving behavior. In contrast, in private company workplaces, ability, motivation, opportunity, intention, and individual comfort all show significant positive correlations with energy-saving behavior.

This integrated framework offers researchers a systematic method for studying the factors that influence energy-saving behavior in the workplace.

Keywords: Energy-saving behavior; Norm activation model; Ability-motivation-opportunity model; Theory of planned behavior; Thailand

DEDICATION

This dissertation is dedicated to my beloved parents.

For their support and encouragement

Acknowledgments

I would like to express my sincere gratitude to my two supervisors, Dr. Youji Kohda and Dr. Chawalit Jeenanunta, who made this work possible for me. Their guidance and advice carried me through all stages of writing this thesis. I am very grateful to my parents and friends for their encouragement, appreciation, support, and keen interest in my academic achievements.

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Chapter 1

Introduction

The transition to sustainable energy is a critical global priority as countries strive to reduce their dependence on fossil fuels and mitigate the impacts of climate change [1]. Different nations face unique challenges and opportunities in this transition, shaped by their specific socioeconomic contexts, technological capabilities, and policy environments [2]. For instance, Thailand and Japan provide contrasting examples of how countries can approach sustainable energy development. With its focus on policy-driven initiatives, Thailand aims to expand its renewable energy capacity to address the rural-urban energy divide and enhance national energy security [3]. In contrast, Japan emphasizes technological innovations and regulatory reforms to improve energy efficiency and increase renewable energy adoption, particularly following the Fukushima disaster [4].

1.1 Background of Thailand Energy Sector

Thailand presents a unique case for studying sustainable energy practices due to its diverse socioeconomic conditions, growing energy demands, and distinct policy environment. Thailand boasts a well-developed energy sector primarily based on oil and natural gas. Conventional thermal sources, such as oil and coal, account for 90% of Thailand's electricity generation. However, oil-fired plants have largely been replaced by natural gas, which supplied 65% of the country's electricity demand in 2018. Coal-fired plants provided an additional 20%, with the remainder coming from hydropower, biogas, and biomass [5]. The electricity load distribution for each sector of Thailand in 2021 is shown in Figure 1.1, which highlights the variation in energy consumption across different sectors.

As of May 2018, the Electricity Generating Authority of Thailand (EGAT) accounted for 37% of the country's electricity demand, with independent power producers supplying 35%, small power producers 19%, and electricity imports covering 9% [6]. In 2015, Thailand's Power Development Plan (TPDP) for 2015–2036 outlined new strategies, targets, and policies for the next 20 years [7]. This plan included energy-saving programs and energy-efficiency promotions aimed at reducing total electricity demand by 25% over this period. From 2015 to 2036, the plan aims to increase the use of alternative energy by 25%.

According to the TPDP, the plan includes the construction of nine clean coal-fired power plants (totaling 7,390 MWe), 20 additional gas-fired power plants (17,728 MWe), and renewable-energy plants (14,206 MW), including hydropower, much of which will be imported from Myanmar or Laos. To implement these policies for the next 20 years, they forecasted the total electricity load demand for 2026.

The Electricity Generating Authority of Thailand (EGAT) operates a diverse power-generation infrastructure, consisting of three thermal power plants, six combined cycle power plants, 24 hydropower plants, eight renewable energy plants, and four diesel power plants. The majority of EGAT's electricity production comes from gas-fired generation, which accounts for 67%, while coal-fired power plants contribute 20%. The distribution of this electricity is primarily handled by the Metropolitan Electricity Authority (MEA), which serves the Bangkok region, and the Provincial Electricity Authority (PEA), which supplies the rest of Thailand [6].

Figure 1.2 illustrates the yearly load comparison for 2019, 2020, and 2021. The load pattern in 2020 was significantly lower compared to the other two years due to lockdowns during the COVID-19 pandemic [8]. However, there was a slight increase in load patterns in 2021. The COVID-19 pandemic has caused a global health crisis and economic disruption, which has directly impacted the power grid.

1.2 Rationale for Choosing Thailand

Thailand's focus on policy-driven initiatives, particularly through the Alternative Energy Development Plan 2018 (AEDP 2018), aims to increase the share of renewable energy in its national energy mix. This approach is designed to address both the rural-urban energy divide and the broader objective of enhancing energy security across the nation. The country's strategy to augment renewable energy capacity, especially in the solar and biomass sectors, provides a valuable opportunity to analyze the effectiveness of policy instruments in a developing context [9].

The choice of Thailand as a primary example in this thesis is driven by several factors. First, Thailand's rapidly developing economy and its significant reliance on imported fossil fuels highlight the urgent need for a sustainable energy transition. Second, the diverse geographic and socioeconomic landscape of Thailand poses unique challenges in energy distribution

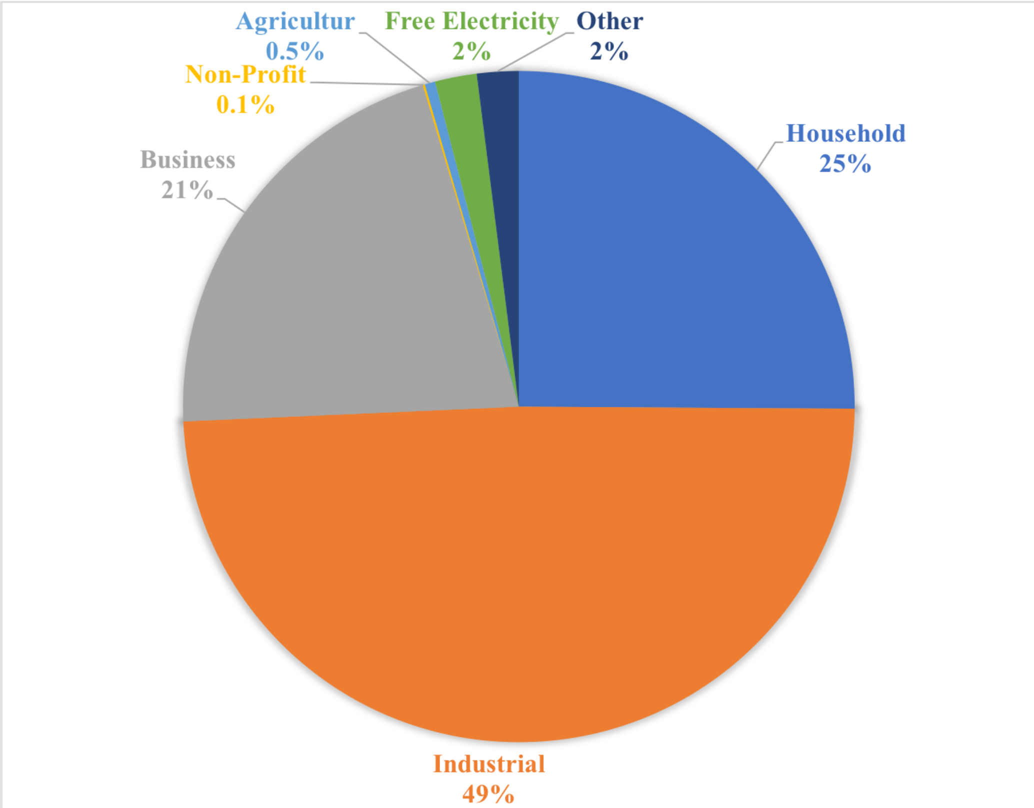

Figure 1.1: Electricity Load for each sector of Thailand in 2021

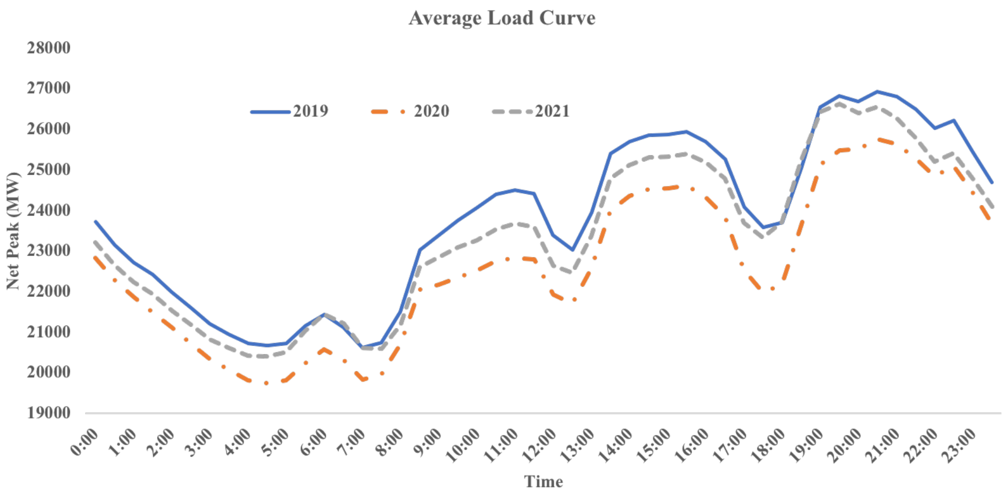

Figure 1.2: Yearly Load Demand Comparison 2019, 2020, and 2021

and access, making it a compelling case for studying the impacts of targeted policy interventions. Finally, Thailand's experience offers important lessons for other developing countries in the region that face similar challenges in balancing economic development with environmental sustainability [10].

This thesis builds upon the foundational work using the Motivation-Opportunity-Ability (MOA) framework as applied to American office settings [11]. However, it introduces a novel perspective by employing the Ability-Motivation-Opportunity (AMO) framework to specifically analyze energy-saving behaviors in Thai office environments. The emphasis on 'ability' as the initial determinant in the AMO framework reflects the unique socio-cultural and technological context of Thailand, distinguishing this research from previous studies. Additionally, the introduction of a unique Case 3 model provides new insights into the applicability of these frameworks across diverse settings, contributing a significant extension to the existing literature.

1.3 Comparative Context: The Case of Japan

While Thailand is used as a primary example to understand policy-driven approaches to sustainable energy, Japan illustrates a different pathway characterized by its advanced technological infrastructure and response to energy challenges, particularly after the Fukushima disaster [4]. Japan's focus on integrating technological innovations, such as smart grids and the Feed-in Tariff (FiT) system, has resulted in significant growth in solar energy capacity and improvements in energy efficiency. By examining both Thailand and Japan, this thesis seeks to provide a broader understanding of how different nations can navigate the complex transition to renewable energy under varying conditions [2].

1.4 Energy-saving Behavior and Workers

Government entities in Thailand, classified as small businesses/commercial enterprises, account for 22% of the country's national electricity consumption [12]. According to the Provincial Electricity Authority (PEA), load demand in the business sector significantly dropped to 12% in April 2020 compared to 2019, but saw a 4% increase by April 2021. This slight increase in the load factor in April 2021 has raised awareness about the importance of saving electrical energy. Unlike households, where electricity bills are directly paid by residents, there is more potential for energy waste in the business sector [11]. Given the increase in load demand in the business sector in 2021, policymakers, grid operators, and regulators must develop energy-saving plans for the workplace to ensure long-term energy efficiency.

There are two main approaches to reducing energy consumption in small businesses/commercial buildings. The first approach focuses on technical solutions to enhance building energy efficiency, such as implementing hybrid ventilation systems and upgrading building management systems. However, technical solutions often face challenges such as loss of building information [13] and high uncertainty in energy-saving outcomes [14].

The second approach emphasizes the impact of human behavior on energy-saving and building performance. Studies have shown that about 56% of energy consumption during non-working hours is due to workers leaving lights and devices on [15]. Workers who actively engage in energy-saving practices can reduce their consumption by up to 50% during working hours. Behavioral studies have achieved energy-savings of 5% to 30% by motivating changes in worker behavior [16]. In office settings where workers are not responsible for electricity costs, group dynamics, and normative beliefs play a significant role in reducing energy consumption.

Promoting energy-saving behavior among workers is particularly challenging compared to encouraging such behavior at home, due to the lack of financial incentives for workers and the voluntary nature of pro-environmental actions in public places. Additionally, workers often lack access to energy-control features in buildings and may not receive organizational support for energy-saving behaviors [17]. The increasing use of automated building-control systems and open-plan workspaces further limits workers' control over environmental factors such as windows, thermostats, and lighting [15].

To address these challenges, researchers have examined workers' energy-saving behavior from various social-psychological perspectives. The theory of planned behavior (TPB) and normative activation theory (NAM) are widely used frameworks in studies on pro-environmental behavior. TPB has been extensively used to study environmentally friendly practices [18], green purchasing[19], and energy-saving[20]., and has received considerable support despite some limitations. To address these limitations, researchers have integrated additional variables into the TPB framework [18].

An adapted ability-motivation-opportunity (AMO) model has been proposed to identify the influential factors of energy-saving behavior [21]. By integrating the AMO model with decision-making and human behavior theories, researchers aim to better understand the complexity of human behavior. Model integration allows for compensation of the limitations of individual theories by incorporating empirical findings and various social-psychological perspectives. This new integrated framework provides a more comprehensive understanding of energy-conservation behavior in the workplace.

To examine this proposed framework and its associated hypotheses, we conducted structural equation modeling (SEM). This integrated approach combines the AMO model with NAM and TPB, offering a systematic method to study the factors influencing energy-saving behavior in workplaces.

1.5 Research Gap and Study Purpose

Carbon emissions from energy consumption have become a significant contributor to overall emissions, drawing global attention. Thailand faces challenges with inadequate energy supply, leading to energy insecurity. To address this, the Thai government has mandated all government agencies, including public schools, to reduce their energy usage. The country's energy efficiency plan for 2018 aims to decrease electricity consumption in the building sector by 10% by the year 2030. [22]. Currently, there are increasing numbers of energy-saving research in residential building [23, 24, 25] and promoting energy-saving behavior to students in the universities [26, 27]. However, it is important to consider office buildings where employees, who are not responsible for utility bills, might lack motivation to save energy. A previous study found that environmental factors and educational initiatives positively influence energy-saving behaviors in Bangkok.[28].

Most research on energy-saving focuses on social and behavioral aspects. However, the key behavioral factors are not fully understood in existing studies [29, 30]. This research aims to construct a theoretical model based on the Theory of Planned Behavior (TPB) to analyze the factors influencing individual energy-saving behavior in the office. TPB includes three main variables: attitude, perceived behavioral control, and subjective norm. Many scholars have applied TPB to explore pro-environmental behavior, such as household energy-saving behavior and sustainable consumption. Norton et al. [31] used TPB to investigate pro-environmental behavior in office settings. Therefore, TPB is a suitable choice for the integrated theoretical framework in this research to understand individual energy-saving behavior in offices.

Shi et al. [32] combined the Norm Activation Model (NAM) with TPB to analyze behavioral intentions for reducing particulate matter PM 2.5. The Ability-Motivation-Opportunity (AMO) model hypothesizes that employee performance can be enhanced by leveraging these three concepts in a mutually beneficial manner. The AMO model includes three factors: ability, motivation, and opportunity. Abilities refer to the cognitive, emotional, financial, physical, or social resources available to perform a specific behavior. Motivation is the incentive for behavior, influenced by an individual's needs and wants. Opportunity refers to the constraints that enable behavior. For employees, motivation can be provided by incentives and rewards that benefit the organization. Opportunities, such as engaging employees in activities that help the organization succeed, can lead to new abilities through training and increased knowledge and skills.

Existing studies, such as those by Li et al. [11], have employed integrated frameworks like the Motivation-Opportunity-Ability (MOA) framework, combining constructs from the Theory of Planned Behavior (TPB) and the Norm Activation Model (NAM), to analyze energy-saving behaviors in office environments. These frameworks primarily focus on identifying the determinants of energy conservation within workplace settings, particularly in government and similar organizational structures. While these studies provide valuable insights into the role of social-psychological factors in influencing energy-saving behaviors, they offer limited exploration of these behaviors within private companies, especially in the context of Thailand. Furthermore, much of the existing research has focused on organizational influences in specific workplace types, leaving a gap in understanding how these determinants may vary across different sectors and regions.

This study seeks to bridge these gaps by employing a similar integrated AMO framework to examine energy-saving behaviors in the office buildings of the National Science and Technology Development Agency (NSTDA) for Case 1 and Case 2, which closely align with the methodologies and contexts of prior research. However, Case 3 introduces a novel dimension by focusing on private companies in Thailand, an organizational setting that remains underexplored in the existing body of literature. Through this comparative approach, the study offers fresh insights into the determinants of energy-saving behaviors across a more diverse array of organizational contexts, thereby expanding the scope of current understanding in this field.

1.6 Research Significance

This study makes substantial contributions to the academic field by presenting a comprehensive theoretical model of energy-saving behavior, aimed at identifying the determinants of such behaviors in the workplace. By doing so, we clarify the influential factors of behavior and measure the impacts of these behaviors on energy-saving. The proposed variables have proven to be effective predictors of energy-saving behavior, thereby supplementing the AMO model.

1. Theoretical Contributions: Theoretical Contributions:

   Integration of Models: By integrating the Norm Activation Model (NAM) and the Theory of Planned Behavior (TPB) with the Ability-Motivation-Opportunity (AMO) framework, this study provides a multi-dimensional perspective on energy-saving behaviors. NAM strengthens the implications by focusing on personal norms and moral obligations, while TPB reflects the cognitive deliberation process involved in effective behaviors.

Clarifying Influential Factors: The study identifies and elucidates the key determinants of energy-saving behavior, including personal norms, awareness of consequences, subjective norms, and perceived behavioral control. This detailed analysis enhances our understanding of the factors that drive such behaviors in the workplace.

2. Practical Implications:

   Policy Development: The implications of this study can enhance the efficiency of energy interventions by informing policymakers about the need to adapt strategies to the specific characteristics of workers in different contexts. Policies designed with an understanding of these determinants can be more targeted and effective.

   Behavioral Interventions: By understanding the role of personal norms, awareness, subjective norms, and perceived behavioral control, organizations can develop interventions that foster a culture of energy-saving. This can include training programs, awareness campaigns, and incentive structures tailored to these factors.

3. Flexibility and Adaptability:

   Modifiability of the Framework: The proposed framework is flexible and can be modified to suit different indicators, allowing for a comprehensive understanding of the characteristics of workers in various workplace settings. This adaptability makes the model useful for a wide range of applications and contexts.

   Cross-Cultural Applicability: While this study was conducted in Thailand, the model can be extended to examine energy-saving behaviors in other countries. This cross-cultural applicability allows for comparative studies and the generalization of findings across different cultural and organizational contexts.

This study significantly contributes to the academic understanding of energy-saving behaviors in the workplace by developing and validating an integrated theoretical model. The insights gained from this research offer valuable guidance for both theoretical exploration and practical application, enhancing the effectiveness of energy-saving interventions and policies in diverse workplace environments.

1.7 Study Area Scope

The scope of the study was defined as follows.

- This study focuses on workers' energy-saving behavior in Thailand.
- The online survey was distributed twice: once at the NECTEC building of the National Science and Technology Development Agency (NSTDA) and at several private companies in Thailand, with the survey conducted between July 2021 and April 2022.
- PLS-SEM is used to analyze the data.

1.8 Organization of the Thesis

There are five chapters in this study. The chapters are arranged as follows:

- Chapter 1 "Introduction" divides into 6 sections: Background of Thailand's Energy Sector, energy-saving Behavior and Workers, Research Gap and Study Purpose, Study Area Scopes, and Organization of the Thesis.

- Chapter 2 is Theoretical framework and research hypothesis.
- Chapter 3 is Methodology that introduces the partial least square structural equation (PLS-SEM).
- Chapter 4 explains the result and discussion.
- Chapter 5 illustrates the conclusion and recommendation which discusses the overall work for this research.

Chapter 2

Theoretical Framework and Research Hypotheses

2.1 Overview of Global Sustainable Energy Practices

Sustainable energy practices have become a focal point in global efforts to mitigate climate change and transition away from fossil fuels. Nations worldwide are increasingly adopting renewable energy sources, such as solar, wind, and biomass, to reduce greenhouse gas emissions and enhance energy security [33]. However, the effectiveness of these practices varies significantly across different countries due to factors like socioeconomic conditions, technological capabilities, and policy environments. Understanding these global trends and challenges provides a foundation for examining the specific approaches taken by Thailand and Japan [10].

2.2 Sustainable Energy Practices in Thailand

Thailand's approach to sustainable energy development is characterized by a strong reliance on policy-driven initiatives. The Alternative Energy Development Plan 2018 (AEDP 2018) is central to these efforts, aiming to increase the share of renewable energy in the national energy mix to 30% by 2037. This plan emphasizes expanding solar and biomass energy, targeting the rural-urban energy divide, and improving energy access nationwide [9].

Additionally, the Thailand Power Development Plan (TPDP) for 2015–2036 outlines a comprehensive strategy for reducing total electricity demand by 25% while increasing the use of alternative energy by the same percentage over the plan's duration. These initiatives reflect Thailand's commitment to reducing its reliance on imported fossil fuels and enhancing energy security through domestic renewable energy production [7].

Despite these ambitious plans, Thailand faces several challenges in its transition to sustainable energy [34]. Financial constraints, technological limitations, and the need for widespread public acceptance are significant barriers. The country's reliance on imported energy and its developing economy further complicate efforts to implement large-scale renewable energy projects. This section examines the successes and challenges of Thailand's sustainable energy policies, drawing insights from recent studies and government reports.

2.3 Comparative Insights: Japan's Approach to Sustainable Energy

In contrast to Thailand's policy-driven approach, Japan's strategy for sustainable energy development is heavily focused on technological innovation and regulatory reforms. Following the Fukushima disaster, Japan shifted its energy policy to prioritize renewable energy sources, particularly solar energy. The introduction of the Feed-in Tariff (FiT) system in 2012 significantly boosted investments in solar energy, leading to substantial increases in solar energy capacity [35]. Japan's emphasis on integrating smart grids and advanced energy management systems has further enhanced energy efficiency and grid stability [36].

Japan's approach demonstrates the role of technological leadership and regulatory stability in overcoming structural barriers to energy innovation. While Thailand focuses on policy frameworks to drive energy transitions, Japan leverages its technological capabilities to achieve similar goals. This comparative perspective provides valuable insights into how different nations, depending on their unique contexts, can successfully navigate the challenges of transitioning to renewable energy.

2.4 Socioeconomic and Policy Impacts on Sustainable Energy Adoption

Socioeconomic factors play a critical role in shaping the adoption of sustainable energy practices. In Thailand, public awareness campaigns and government incentives have been central to encouraging energy-efficient behaviors and promoting renewable energy technologies. Programs like the "No. 5 Energy Label" and "EGAT's energy-saving Campaign" aim to raise public awareness about energy conservation and promote the use of energy-efficient appliances [6].

Conversely, Japan's approach to promoting sustainable energy practices focuses more on technological innovation and regulatory measures. The "Cool Biz" and "Setsuden" campaigns, for example, were launched to reduce energy consumption during peak periods, particularly after the Fukushima disaster [4]. These campaigns, coupled with technological advancements like smart meters and home automation systems, have significantly influenced energy-saving behaviors in Japan.

2.5 Factors Influencing Energy-Saving Behavior

Beyond these broad socioeconomic and policy influences, specific factors at the individual and community levels significantly impact energy-saving behaviors. Understanding these factors is essential for designing effective policies and interventions that align with cultural, demographic, and psychological characteristics. Research has shown that energy-saving behaviors are influenced not only by economic and policy incentives but also by sociodemographic factors, psychological motivations, and contextual conditions [37, 11].

Energy-saving is a domain instance where behavioral changes have beneficial effects on carbon emission reduction and global warming prevention [38, 39]. Not only because of the above behavior but also attracted attention of many researchers in recent years. Most studies focused on residential (domestic) settings [40, 20, 24]not in the workplace. There are three general groups with different themes.

The first theme is focused on the effect of the socio-demographic factors [41, 42, 43]. Demographic variables comprising gender, education, income, age, marital status, and home ownership status were observed as statistically related to residential' energy-saving activities and behaviors [41, 40]. Yang et.al showed that females contribute more energy-saving than males as in a family, most of the energy-saving actions are observed by wives [42]. Ding et.al pointed out that urban residents tend to have more positive saving behavior and engage in more energy reduction activities than rural residents [43]. They also suggested that low-income residents are more focused on energy-saving than those of high-income, which is not wonderful.

The second theme is focused on the government's energy management policy to prompt the household owner to save energy. The most used interventions are taxes and subsidies, prizes, feedback, and money [40]. Many studies mentioned that financial rewards are a favorable method for reducing electricity consumption [44]. Nonetheless, other studies give feedback that financial rewards can only be helpful for short periods. Some studies showed that the comparison of saving levels among neighborhoods or social groups can reduce their consumption [41].

The last one is focused from the perspective of psychological behaviors which have strong effects in reaching the goals of energy-saving. The perspective of psychological behavior targets realizing the domestic electricity consumption saving by underscoring specific factors from psychology, such as attitudes, social norms, beliefs, environmental awareness, and values to activate energy-saving behaviors [41]. There are many psychological theories and frameworks that have been presented in previous studies for interpreting energy-saving behavior in families. Among those models and theories, TPB was largely utilized. Some researchers also believe that moral norms, emotion, and habit are also influential in energy-saving behavior [24].

Many people generally put in two-thirds of their time in the workplace. Workers' energy-saving behavior in the workplace can be noted as an environmental behavior, and important to reduce the energy cost and carbon emissions. Moreover, workers are not responsible for electricity costs, group dynamics, and normative beliefs become major factors in reducing electricity consumption. Therefore, many researchers have also started to focus on the antecedent of energy-saving behavior in the workplace [20]. Emerging studies have mainly concentrated on the impacts of workers' psychological factors as well as the characteristics of socio-demographics on energy-saving behavior. Many studies targeted energy-saving for reducing electricity consumption in office buildings do not identify the goals or reasons they used to boost workers for reducing energy use.

Since energy in the workplace is often considered a public asset, energy is more likely to be wasted in the workplace than in the residential sector. Zhang et. al examined the influencing factor of workers' energy-saving behavior in the organization. Findings showed that personal norms positively affect on energy-saving behavior, whereas energy-saving behavior in the workplace moderates the effect of personal norms [39]. Gao et. al explored the individual's energy-saving intention and improved the intention model, which increased explanatory power by twelve percent by extending the original TPB model. Findings pointed out that the workers' attitude, personal moral norm, perceived behavioral control, and descriptive norms positively influenced the energy-saving behavior intention, whereas the subjective norm is not supported [20]. Hong and Lin explored the consumption of electricity among occupants such as cooling/or heating set-point turning on/ off behavior in the private office [16]. They suggested that 50 % of electricity can be reduced if the occupants are proactive in energy-saving.

In sum, the above-mentioned studies provide insights into the energy-saving area, and there is still more emphasis on researching energy-saving behavior in the workplace. Most researchers extend the studies in household energy-saving behavior studies. Although workers are a crucial target in the energy-saving area, there are few studies focused on energy-saving behavior to promote workers' motivation in the workplace. Moreover, some started to explore the workers' behavior, they mostly used the theory of NAM or TPB. This study presents the essential knowledge gap by targeting an integrated theoretical model of interdisciplinary research.

2.6 Theoretical Integrated Framework

Knowledge gained from energy-saving areas, especially in the workplace where social norms exist can give detailed insight into the determinants of energy-saving behavior. The environment of the workplace is interesting research since the workers may lack interest in the behavior of saving where they are not responsible for the electricity bill. A previous study conducted in Bangkok found that environmental factors and education of people have a positive relationship with energy-saving behavior [28]. The majority of energy conservation research is based on social and behavioral research. However, important behavioral factors in energy-saving have not been fully understood in existing research [29, 30]. Constructing a theoretical model based on the TPB requires analyzing the factors that dominate an individual's energy-saving behavior in the office. The three key variables in the TPB are attitude, perceived behavior control, and subjective norm. Many researchers have applied the TPB to investigate the pro-environmental behavior of individuals, such as household energy-saving behavior, and the sustainable consumption behavior of others. Norton et al. used the TPB to investigate an individual's pro-environmental behavior in an office/workplace setting [31].

Therefore, it is suitable to incorporate the Theory of Planned Behavior (TPB) into the theoretical framework of this research to understand individual energy-saving behaviors in the workplace. Shi et al. combined the Norm Activation Model (NAM) with TPB to investigate behavioral intentions to reduce particulate matter PM 2.5 [32].

The Ability-Motivation-Opportunity (AMO) model posits that employee performance can be enhanced by an organization's ability to leverage these three concepts beneficially for both parties. The AMO model includes three key factors: ability, motivation, and opportunity. Ability refers to the cognitive, emotional, financial, physical, or social resources an individual can utilize to perform a specific behavior. Motivation involves the incentives or encouragement for the behavior, influenced by an individual's needs and desires. Opportunity is described as the relevant constraints that enable behavior. For employees, motivation is provided through incentives and rewards that promote behaviors beneficial to the organization. Opportunities, such as involving employees in activities that contribute to the organization's success, can lead to the development of new abilities through training and skill enhancement.

The NAM and TPB are frequently used to study energy-saving behaviors. Relevant studies on NAM, TPB, and AMO are listed in Table 2.2. To address gaps in existing research, we propose an integrated AMO framework that combines social-psychological constructs from TPB and NAM to examine the determinants of energy-saving behaviors in both government and private companies. Figures 2.1 and 2.2 illustrate how these three models are integrated. The perceived behavioral control (PBC) construct within TPB complements one's ability by incorporating physical ability and perceived ease in enacting a behavior. In the workplace, employees may be hesitant to save energy if it is inconvenient or requires significant effort. In this study, PBC is used to measure ability in the energy-saving behavioral process.

The attitude construct of TPB, which reflects the evaluation of the favorability or unfavorability of behavior concerning associated costs and benefits, serves as the primary psychological aspect. The more positive the employees' attitude towards energy-saving, the more motivated they are to perform the behavior. While NAM focuses on individual moral considerations, it often neglects the social environment, which significantly impacts behavior and

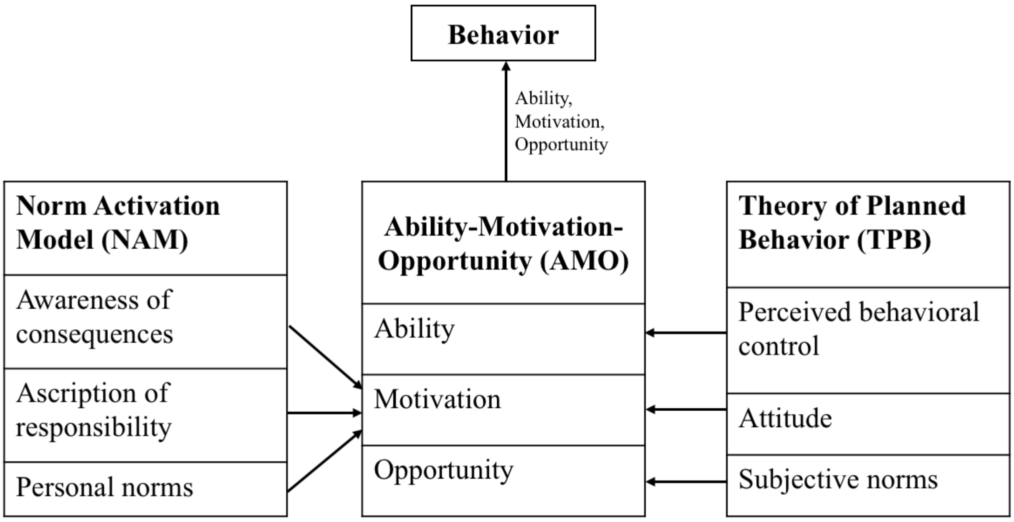

Figure 2.1: Integration of NAM, AMO, and TPB Models (1): Conceptual Framework for Assessing Energy-Saving Behavior

perception. Since employees are part of a collective environment, their behavior and perception are heavily influenced by their work context. Therefore, the attitude from TPB is used to measure motivation.

Subjective norms within TPB reflect the behavioral expectations of others. In the workplace, the expectation that colleagues will turn off the lights when leaving a room is an example of subjective norms improving opportunities through social interaction. The more inclined individuals are to save energy, the more likely they are to do so. Motivation supports intention, which in turn significantly influences energy-saving behavior. The integrated research framework for government and private companies in Thailand is depicted in Figure 2.3.

While subjective norms of the TPB reflect the behavioral expectations of others, descriptive norms (an extension of the TPB) reflect the impact of social influences. In the workplace, the majority of workers expect other workers to turn off the lights when they leave. Both subjective and descrip-

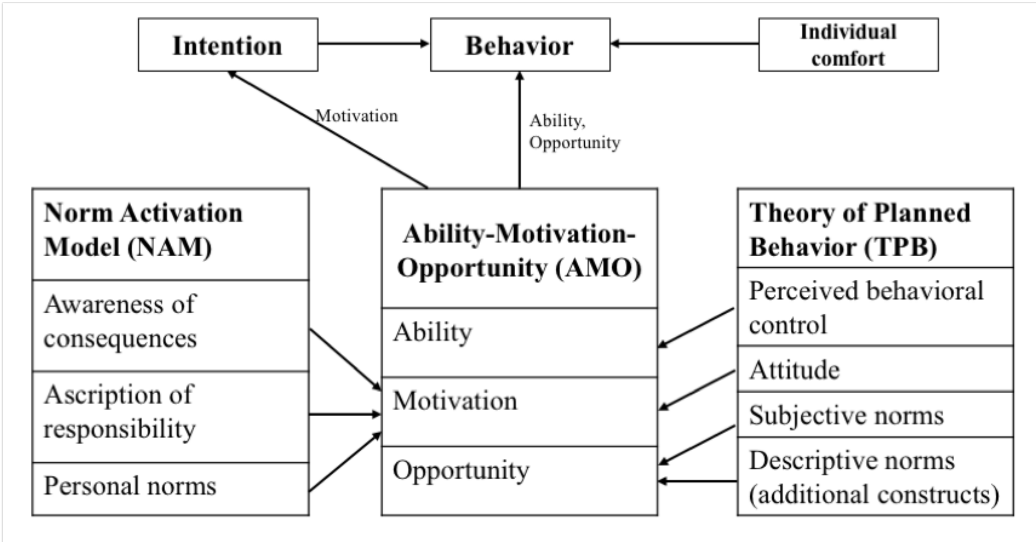

Figure 2.2: Integration of NAM, AMO, and TPB Models (2): Detailed Framework for Energy-Saving Behavior Determinants

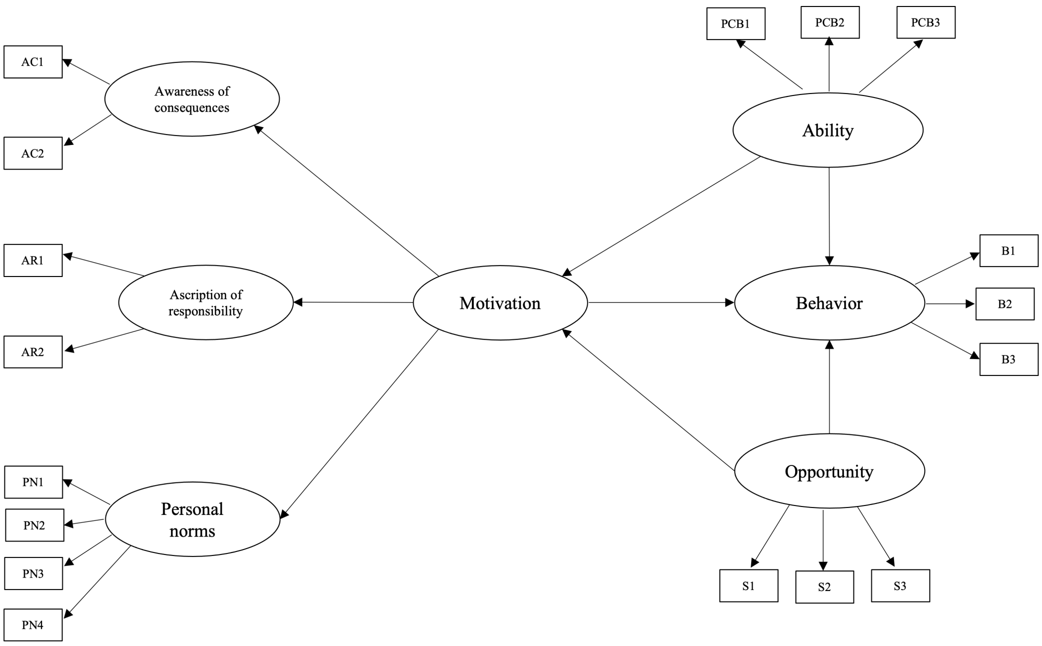

Figure 2.3: Research Framework (1): Theoretical Structure for Analyzing Energy-Saving Behavior

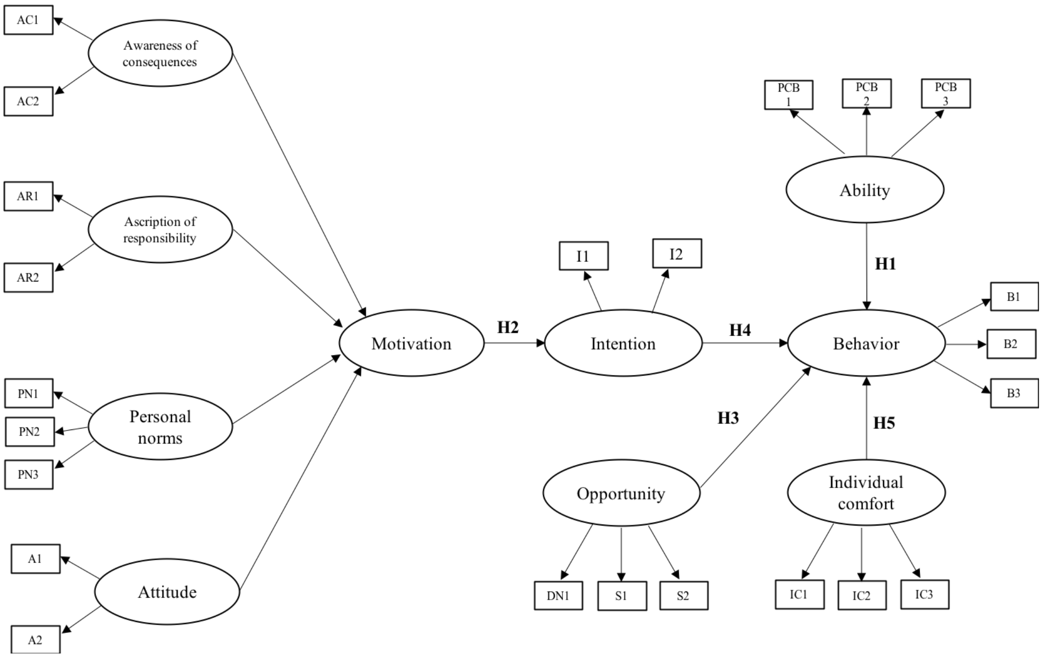

Figure 2.4: Research Framework (2): Expanded Theoretical Model for Energy-Saving Behavior Analysis

tive norms will improve the opportunity via social interaction. Thus, these two norms are regarded as a measurement of opportunity. The extended construct is intention which is the essential impact factor of behavior and reflects how keen individuals are in planning to decide [45]. In the workplace, workers are assumed to have an effective intention of saving energy. The last construct is the individual's comfort. Thailand's climate is subtropical, so the weather is hot and humid year-round. Individual comfort is closely related to energy saving. While the weather is very hot, it may not be easy to reduce the use of AC in the workplace, so it is included as part of the integrated model. The integrated research framework of private companies in Thailand is shown in Figure 2.4.

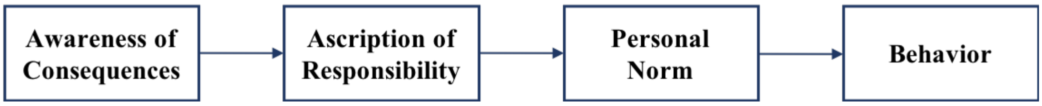

Figure 2.5: Graphical Representation of Norm Activation Model

2.7 The Norm Activation Model

The norm activation model (NAM) aims to increase the understanding of pro-environmental decision-making. NAM theory was published in 1977 and is owned by Shahlom Schwartz [46]. NAM is the exploration of the anticipated guilt and pride in pro-environmental behavior such as sharing [47], environmental protection [48], recycling [49], energy-saving behaviors [50, 24, 51]. There are three key antecedents of NAM personal norm, ascription of responsibility, and awareness of consequences. Mostly, behaviors are influenced by personal norms which are obligations and expectations [46]. Being aware of the action consequences is awareness of consequences. Ascription of responsibility is defined as the responsibility feeling to take action. The latter two variables are the essential antecedent variables to the personal norm as shown in Figure 2.5. NAM is mainly focusing on the individual inner moral considerations and neglects the social environment where an individual lives which has a great impact on their behavior and perception. In particular, workers are not alone, and they participate in the workplace which has a great effect on behavior and perception. In the study, NAM is used as a measurement of the capturing of Motivation in the energy-saving behavior process.

The Theory of Planned Behavior (TPB) is a psychological theory that connects the belief of behavior proposed by Icek Ajzen [52]. TPB is based on the Theory of Reason Action. TPB states that one's behavior is a function of three constructs: Attitude, Subjective Norms, and Perceived Behavioral

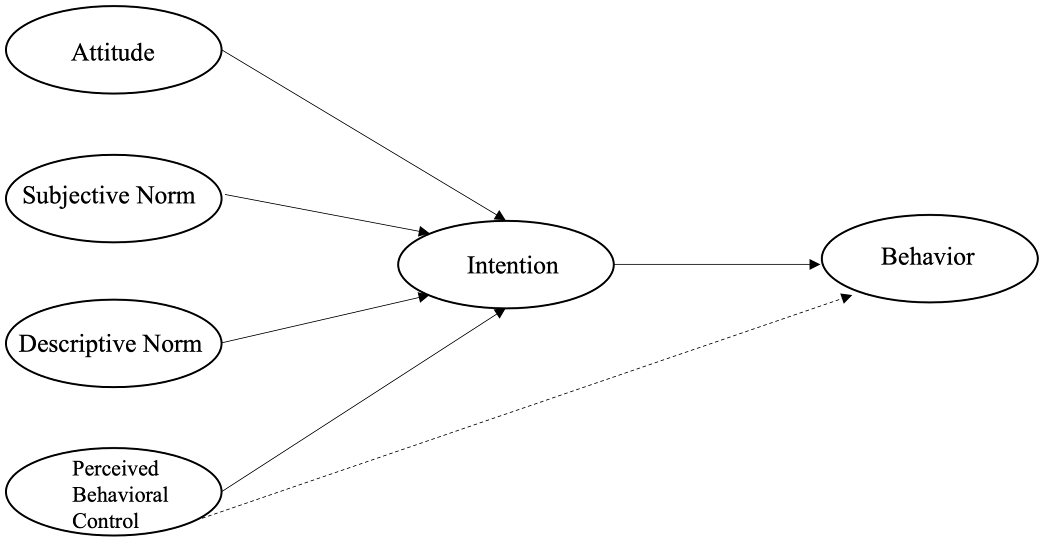

Figure 2.6: Graphical Representation of The Theory of Planned Behavior

Control. These three constructs lead to the desire to perform behavior as shown in Figure 2.6. Descriptive Norms are also included as an additional construct in TPB recently [53, 54]. According to TPB, attitudes indicate the behavioral evaluation that is favorable or unfavorable. Subjective norms specify the thinking of others to execute the behavior. Perceived behavioral control describes how easy or difficult it can do the act.

Descriptive norm determines one belief about the behavior of others. TPB is self-interest theory which is the rational choice of one benefits as the opposite of NAM. TPB has contributed to the prediction of behaviors which include health-related behavior [45, 55], Environmental Psychology [56], voting behavior [57], and energy-saving behavior [24, 20, 58, 59].

2.8 Ability Motivation Opportunity Framework

The ability-motivation-opportunity (AMO) framework was developed by Macinnis, Moorman, and Jawoeski [60] and applied to understand the behavior of

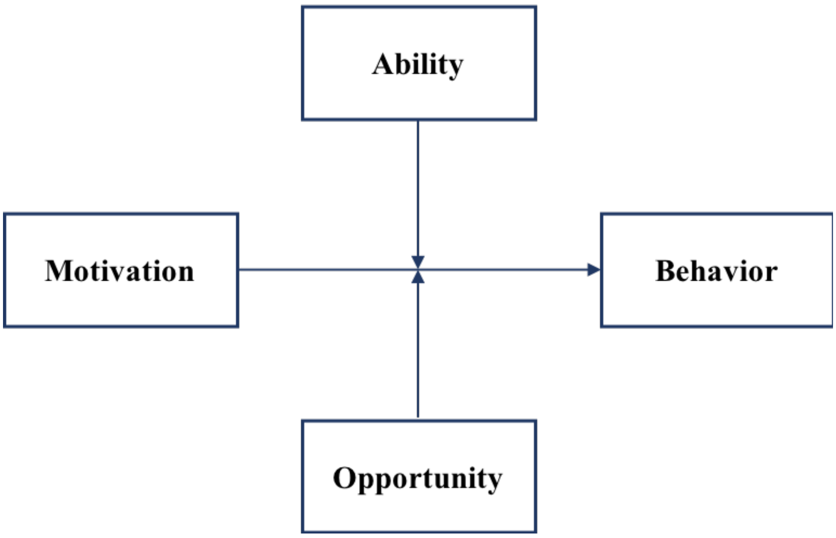

Figure 2.7: Graphical Representation of Ability-Motivation-Opportunity

consumers in the process of information in advertisement [61, 62, 63, 64]. AMO hypothesizes the workers' performance that can be influenced by the ability of the organization to leverage upon the three concepts (Figure 2.7) as a win-win capacity.

Ability reflects one's belief in the accessing of results and the capacity of the performance. Applied to the energy-saving context, ability refers to the workers' perception of their capacity to apply energy-saving in the workplace. This perception has a significant effect on saving behavior. Motivation directs individual viewing as a force towards a goal. Under the AMO approach, motivation organizes readiness, interest, desire, and willingness to engage as a determined behavior. Extending this to the context of energy-saving, motivation refers to the worker's desire to save energy because of the perceived benefits of the organization. Opportunity indicates the availability of favorable conditions which enable the action. In the energy-saving context, opportunity is speculated to be available and it occurs when the workers have time and desire to save energy. The AMO framework has been strongly accepted for explaining numerous types of behaviors such as health motivation [64], enjoyment [65], Financial advantages [66]. Recently, the AMO framework has also been addressed in the energy-saving behaviors [37].

While both the Motivation-Opportunity-Ability (MOA) framework used in the referenced study [11] and the Ability-Motivation-Opportunity (AMO) framework used in this thesis share the same core components, they differ in the emphasis and order of these components. The AMO framework prioritizes 'ability' as a crucial starting point for understanding energy-saving behaviors, particularly in the context of Thailand. This adjustment is not merely semantic; it reflects a theoretical adaptation to better suit the unique socio-cultural and technological challenges faced in Thai office settings. Furthermore, this thesis introduces Case 3, which expands the framework's application to new contexts, providing a broader understanding of energy-saving behaviors.

2.9 Integrated AMO framework and hypotheses

2.9.1 Case 1 and 2: Integrated AMO Framework and Hypotheses for the Government and Private Companies Workplace

This study advanced an integrated AMO framework for analyzing the determinants of behavior and characteristics of energy-saving according to social psychology and the disciplines of building science. The three factors which are ability, motivation, and opportunity are the main factors in the AMO framework. They are the high-level outlines of the behavioral antecedents. Generally, the three main factors in the AMO framework are not precisely indicated from the survey measures however they are implied from other constructs. Therefore, NAM and TPB models are integrated with the AMO framework to give a clear understanding and define measurable components. Each factor in the AMO framework incorporates various constructs. Unique factors in the integrated AMO framework are outlined as follows.

Ability

Ability refers to the skills necessary for performing specific mental or physical acts, as well as existing competencies and the basic physical and psychological capabilities required to achieve a result [67]. In this study, perceived behavioral control from the Theory of Planned Behavior (TPB) is used as a measurable component representing ability. Perceived Behavioral Control (PBC) indicates the perceived difficulty or ease of executing a particular behavior [68]. In other words, people are more likely to perform a behavior if they perceive it as easy to do [32, 24], proving that PBC significantly affects awareness of energy-saving. In the workplace, employees may be reluctant to save energy if they perceive the behavior as requiring significant physical effort. Based on previous studies, the first hypothesis of this study is:

Based on the previous study, the first hypothesis of this study is

H1. Ability has a direct and positive influence on energy-saving behavior

H7. The effect of ability on energy-saving behavior will be determined by motivation.

Motivation

Motivation is generally regarded as the force that drives individuals toward goals and desired behaviors [67]. In the workplace, motivation encompasses employees' values, needs, involvement, and concern in performing the behavior. From a social-psychological perspective, three constructs of the Norm Activation Model (NAM) are adopted to represent motivation: personal norm, awareness of consequence, and ascription of responsibility.

- Personal Norm: Acts as a form of self-expectation and serves as an internal requirement for committing to pro-environmental or pro-social behavior.
- Awareness of Consequence: This construct highlights the importance of expectancy in driving behavior and plays a crucial role in cognitive choice-based theories of motivation.
- Ascription of Responsibility: This cognitive component is also significant in motivation theory.

The following hypotheses are proposed:

H2. Motivation has a direct and positive influence on energy-saving behavior

H4. Motivation has a direct and positive influence on personal norm

H5. Motivation has a direct and positive influence on the ascription of responsibility

H6. Motivation has a direct and positive influence on awareness of consequences.

Opportunity

Opportunity refers to the external factor that inhibits or enables a behavior. In the workplace, it incorporates both interpersonal and environmental factors that constrain or facilitate energy-saving behavior. Subjective norms

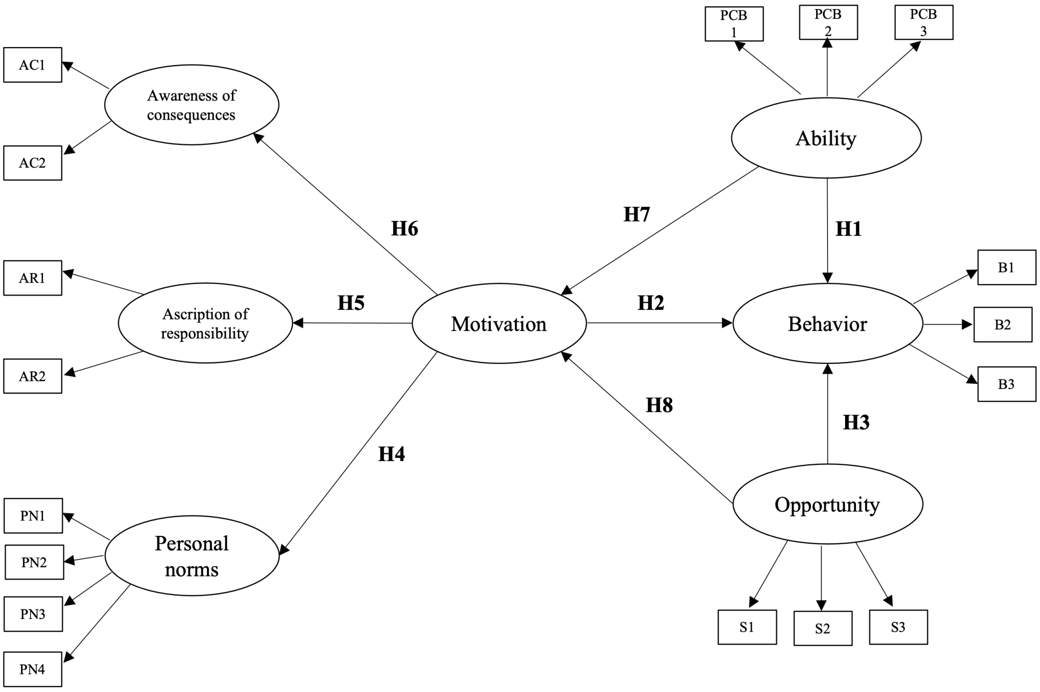

Figure 2.8: Case1 and 2: Research Framework of Government and Private Companies' Energy-saving Behavior in Thailand

from the TPB theory are adopted to stand for the opportunity as a measurable component.

- Subjective Norms: Defined as the belief about whether most people approve or disapprove of the energy-saving behavior.

H3. Opportunity has a direct and positive influence on energy-saving behavior

H8. The effect of opportunity on energy-saving behavior will be determined by motivation.

The research framework for the case 1 and 2 is shown in Figure 2.8.

2.9.2 Case 3: Integrated AMO Framework and Hypotheses for the Private Companies Workplace

In Case 3, two constructs are Intention and Individual Comfort added in the first case as shown in Figure 2.9.

Intention

Intention is the essential impact factor of behavior which reflects how keen individuals are in planning to decide [45]. In the workplace, workers are assumed to have an effective intention of saving energy. The extended hypothesis is

H4. Intention has a direct and positive influence on energy-saving behavior

Individual Comfort

Saving energy should not come at the expense of individual comfort. There is a strong association between individual comfort and energy-saving measures. Implementing energy-saving strategies while compromising individual comfort is challenging, as it involves navigating the trade-off between energy conservation and maintaining thermal comfort for individuals.

H5. Individual Comfort has a direct and positive influence on energy-saving behavior

Table 2.1: Research Hypotheses Summary

H1	Ability has a direct and positive influence on energy-saving behavior
H2	Motivation has a direct and positive influence on energy-saving behavior
H3	Opportunity has a direct and positive influence on energy-saving behavior
H4	Intention has a direct and positive influence on energy-saving behavior
H5	Individual Comfort has a direct and positive influence on energy-saving behavior

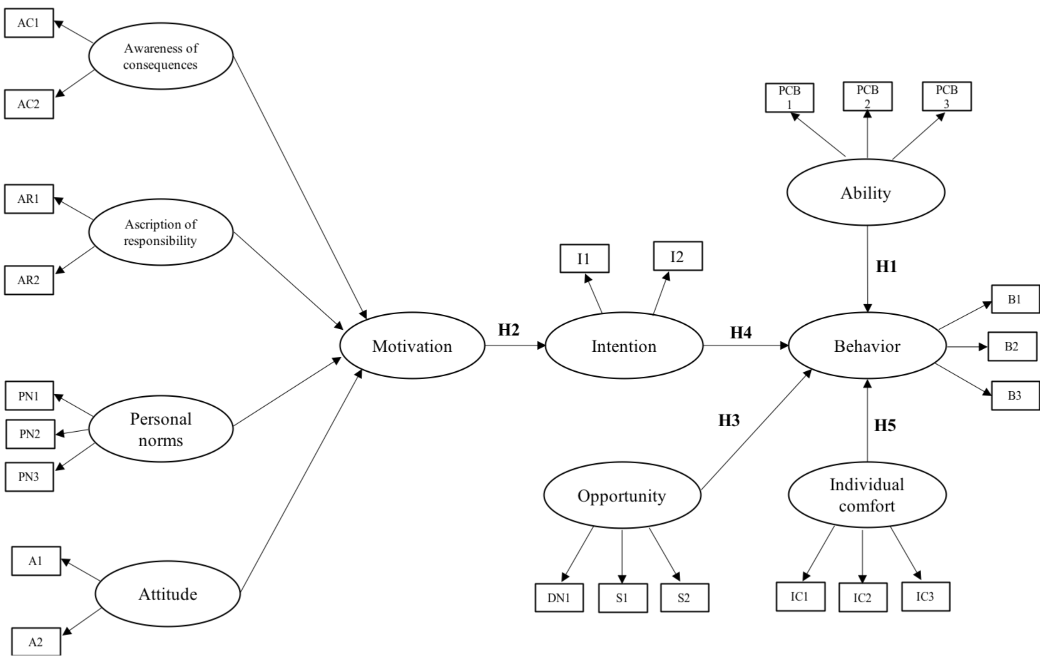

Figure 2.9: Case 3: Research Framework of Private Companies' Energy-saving Behavior in Thailand

Table 2.2: List of research on energy-saving Behavior

No.	References	Samples	Research	Model
1	[69]	564 employees in China	Energy Concern Influence	TPB
2	[70]	546 employees in China	Determinant of energy conservation in the workplace	TPB
3	[71]	658 residents in China	saving energy on affect people's willingness	TPB, NAM
4	[72]	1050 consumers in South Korea	consumers motivation for energy-saving	TPB
5	[23]	400 household in Bangkok, Thailand	homeowners energy-saving	Latin Hypercube Method
6	[73]	512 occupants Malaysia	influence on attitude and behavior	NAM
7	[43]	250 workers, Sweden	significant reduction in energy intensity	Review
8	[14]	occupants in USA	potential changes in energy use behavior	new agent-based approach
9	[74]	854 workers, China	influence of social-psychological in the workplace factors on energy-saving	TPB
10	[15]	-	energy wasted during non-occupied hours	State of the art energy auditing equipment

No.	References	Samples	Research	Model
11	[16]	-	occupant behavior on energy use of private offices	Building simulation
12	[17]	294 workers,UK	scale to measure motivations to save energy at work	Scale development
13	[20]	52 workers,China	determinants of individual's energy saving behavior in workplace	extended TPB
14	[21]	450 respondents in eastern China	individual's energy-saving intention	extended TPB
15	[75]	-	reduce the amount of wasted energy in office lighting	Wireless Sensor Network (WSN) and Particle Swarm Optimization (PSO)
16	[76]	447 employee, UK	Focuses on both energy-saving and water saving, at home and in the workplace	qualitative survey methodology
17	[77]	249 response, China	impact of circumstance stimulus and internal psychological states on employee's energy-saving intention	stimulus-organism-response theory
18	[59]	72 published literature	identify the psychological determinants of ESB in buildings	an adaptation approach
19	[78]	295 participants,Italy	determinants of 'switching off non-essential lights' and 'completely switching off electronic devices	extended TPB

No.	References	Samples	Research	Model
20	[79]	147 faculty, staff and administrators	explore factors associated with individual computer energy-saving behavior	TPB
21	[80]	143 replies, Singapore	main barriers to energy efficiency	Motivation, Opportunity, and Ability
22	[81]	218 responses,Germany	influencing factors, the extent of energy related projects	Motivation, Opportunity, and Ability
23	[11]	612 full-time office employees , USA	improving the effectiveness of energy-saving behavior in office building	Motivation, Opportunity, Ability , TPB, and NAM
24	[29]	22 employees, UK	identifying the types of behaviour change intervention	Systematic Review
25	[82]	289 response, Pakistan	determinants of the energy-saving behavior of individuals in the workplace	TPB
26	[83]	251 responses, Norway	understanding energy-saving behaviors	TPB
27	[84]	84 office workers,USA	feedback on attitude and behavior change in setting AC at workplace	Interactive feedback
28	[85]	16 staffs , Indonesia	effective on attitude toward energy-saving	TPB and NAM
29	[86]	359 responses, India	energy-saving behaviour at workplace and home	TPB
30	[87]	29 respondents, Turkey	influencing factors on Pro environmental behavior in workplaces	value belief norm

Chapter 3

Methodology

3.1 Data Collection

There are two cases, conducting the surveys for this study. The first one is targeting the workers in the government building in Thailand. Therefore, the workers in the NECTEC building of the National Science and Technology Development Agency (NSTDA) were sent an online survey for evaluation. The targeted next case is the private company building. The online survey was distributed to the workers in private companies in Thailand.

3.1.1 Data Collection at the Government Workplace

The data for our evaluation were collected by conducting an online survey targeting workers in the NECTEC building of the National Science and Technology Development Agency (NSTDA) in Thailand. The survey was distributed in August 2021. A total of 121 responses were collected.

3.1.2 Data Collection at the Private Companies Workplace

The data were collected by conducting an online survey through mail to the company's directors and managers in Thailand. Then, they distributed within the companies. More than three hundred companies were sent emails from this survey. A total of 105 responses were collected.

3.2 Questionnaire Design

3.2.1 Design of Questionnaire for Government Workplace

The survey consisted of the following major measures in the following order: (1) behavior (e.g., turning off electrical devices when not using), (2) ability (perceived behavioral control), and (3) motivation (i.e., personal norms, ascription of responsibility, awareness of consequences, and attitude), and (4) opportunity (subjective norms). These measures were taken from the previous studies [88, 89, 90, 91]. Variables were measured on a 5-point Likert-like scale, a minimum of 1 and a maximum of 5.

3.2.2 Questionnaire Design for the Private Companies Workplace

There are two parts extended in this survey. Intention and Individual comfort are also included. The survey consists of the following orders: (1) behavior (e.g., turning off electricity devices when not using), (2) ability (perceived behavioral control), (3) motivation (i.e., personal norms, ascription of responsibility, awareness of consequences, and attitude), and (4) opportunity (subjective norms), (5) Intention and (6) Individual Comfort. These measures are taken from the previous studies [69, 30, 71, 92, 70]. Variables were evaluated on a 5-point Likert-like scale, with a minimum of 1 and a maximum of 5.

3.3 Adaptation of Measurement Factors for the Thai Context

In adapting the AMO framework to the Thai context, this thesis employs modified measurement factors that better capture the local nuances of energy-saving behaviors. Unlike the MOA framework applied in American office settings [11], where motivation and opportunity were emphasized, this research focuses on ability as a starting point, reflecting the technical knowledge gaps and infrastructural challenges prevalent in Thailand. The measurement factors include additional variables such as access to energy-efficient technologies and technical training, which are critical in the Thai office environment [11]. These modifications not only enhance the explanatory power of the models (Case 1 and Case 2) but also provide a more contextually relevant analysis.

3.4 Survey Structure and Measure

Table 3.1 to 3.3 show the survey structure of detailed measures for each case.

Table 3.1: Survey Items on Energy-Saving Behaviors at the Workplace

Constructs	**Description**
Energy-Saving Behaviors	How frequently do you turn off the following devices when they are not in use to save energy? 1. Light 2. Computer 3. Air Condition (AC)

Table 3.4.1 outlines the key survey items used to measure energy-saving behavior constructs for Case 1 and Case 2. These constructs focus on three primary dimensions: ability, motivation, and opportunity. Ability measures the respondents' perceived control over energy-saving actions within the workplace, reflecting their confidence and skills. Motivation is assessed through various psychological aspects such as the sense of responsibility, personal norms, and emotional responses related to energy-saving behaviors. Opportunity captures the social expectations within the workplace, where colleagues' behaviors influence the respondent's energy-saving practices.

Table 3.4.2 presents the survey items designed for Case 3, which extends the constructs of ability, motivation, and opportunity with additional factors such as intention and individual comfort. In this case, intention assesses the respondents' willingness and effort to engage in energy-saving behaviors. Individual comfort evaluates personal satisfaction with workplace environmental conditions, like temperature and lighting, and how these conditions influence their energy-saving decisions. This extension aims to capture a broader range of determinants that affect energy-saving behavior in private companies, distinguishing Case 3 from Cases 1 and 2.

3.4.1 Case 1 and 2

Table 3.2: Survey Items (1 and 2): Measurement Items for Government Workplace and Private Companies' Workplace Energy-Saving Behavior

Construct	Items
3***Ability**	1. Raising energy-saving behavior in the workplace is entirely within my control.
	2. I am confident that if I want I can save energy in the workplace.
	3. I have the knowledge and skills to save energy in the workplace.
7***Motivation**	1.1. When I reduce electricity use in my workplace, I do something good.
	1.2. When I reduce electricity use in my workplace, I cut down the cost
	2.1 I feel responsible for the energy use in the workplace.
	2.2 I feel responsible for reducing energy use in the workplace.
	3.1 I feel good about myself when I do not use a lot of Energy.
	3.2 I feel guilty when I use a lot of energy in the workplace.
	3.3 I think I have a responsibility to save energy in the workplace.
3***Opportunity**	1. Most of my colleagues expect me to turn off the computer when leaving.
	2. Most of my colleagues expect me to turn off the light when leaving.
	3. Most of my colleagues expect me to shut down or change the thermostat setting according to weather conditions.

3.4.2 Case 3

Table 3.3: Survey Item (3): Measurement Items for Private Companies' Workplace Energy-Saving Behavior

Construct	Items for measurement
3***Ability**	1. Raising energy-saving behavior in the workplace is entirely within my control.
	2. I am confident that if I want I can save energy in the workplace.
	3. I have the knowledge and skills to save energy in the workplace.
9***Motivation**	1.1. When I reduce electricity use in my workplace, I do something good.
	1.2. When I reduce electricity use in my workplace, I cut down the cost
	2.1 I feel responsible for the energy use in the workplace.
	2.2 I feel responsible for reducing energy use in the workplace.
	3.1 I feel good about myself when I do not use a lot of Energy.
	3.2 I feel guilty when I use a lot of energy in the workplace.
	3.3 I think I have a responsibility to save energy in the workplace.
	4.1 energy-saving in my workplace can contribute the sustainability development of our society
	4.2 energy-saving in my workplace contributes to alleviating energy shortage issues

Construct	Items for measurement
3***Opportunity**	1. Most of my colleagues expect me to turn off the computer when leaving.
	2. Most of my colleagues expect me to turn off the light when leaving.
	3. Most of my colleagues expect me to shut down or change the thermostat setting according to weather conditions.
2***Intention**	1. I will make an effort to save energy in my workplace.
	2. I am willing to save energy in my workplace.
3***Individual Comfort**	1. I am satisfied with the temperature in my workplace.
	2. I am satisfied with the light in my workplace.
	3. I am satisfied with other indoor environments in my workplace.

3.5 Research Method

3.5.1 Structural Equation Modeling (SEM)

Structural Equation Modeling (SEM) is a statistical family model that looks to explain the relationship among the variables. SEM is an analytical tool that extends from the concepts the structural model was developed. the late 1970s, Joreskog [93] introduced the emergence of the measurement model and the advancement of the common factor-based structural equation modeling (CB-SEM). Variables are the actual components that are measured by surveys, measurement devices, and observation. Constructs are latent or observable factors which are described by a variate consisting of multiple variables. There are two models needed for developing a measurement specification model and a structural specification model. There are six stages in the decision process [94, 95, 96, 97].

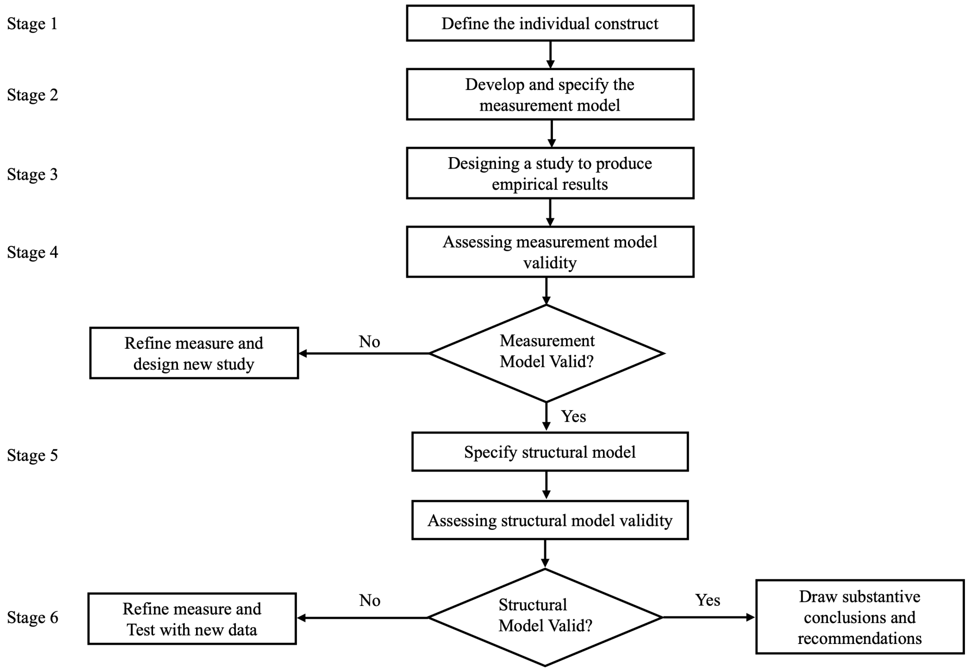

Figure 3.1: Six Stages Process for SEM

3.5.2 Partial Least Squares Structural Equation Modeling

Partial Least Squares Structural Equation Modeling (PLS-SEM) is a combination of dependence and interdependence techniques that belongs to the statistical family model continuously seeking to explain the relationship among the variables. Representing how the measures variables, perform the constructs is the measurement model while showing how the constructs are correlated with each other. The measurement model is referred to as the outer model, while the structural model is known as the inner model.

Measurement Model

The measurement model defines the latent constructs and gives the relationship between a latent variable and its measures. In former times, researchers have tried to identify latent constructs or variables that are factor-based and composite-faced [98]. As the covariance-based modeling, PLS-SEM gives the metrics for evaluating the validity, reliability, and associated measurement error with the constructs.

Structural Model

The structural model represents the relationships between latent variables. It illustrates the dependency relationships between dependent and independent constructs/variables, even when a dependent variable becomes an independent construct/variable in another relationship.

3.6 SmartPLS

SmartPLS is a graphical user interface software designed for variance-based structural equation modeling (SEM), utilizing the partial least squares (PLS) path modeling method. It is a new beneficial product and is mainly used in the management and information systems environment to create, validate, and calculate the models. It is a technique of the second SEM generation that validates the theoretical hypotheses, explains the causal mechanism, and utilizes predictive-oriented measures [99].

Moreover, SmartPLS presents the path model which can describe the relationship between the indicators and variables. It shows an essential point providing a comprehensible picture and supporting to demonstrate the outcomes.

3.6.1 Difference between SmartPLS and Amos

The common factor-based approach to structural equation modeling (SEM) uses common factors to represent unobserved conceptual variables. Amos is a software package for estimating factor-based models. In contrast, the composite-based approach to SEM uses weighted composites to represent unobserved conceptual variables, with SmartPLS being a software package designed for estimating composite-based models. Amos does not estimate composite-based models, and SmartPLS does not estimate factor-based models. SmartPLS is primarily used for developing new theories (exploratory research), whereas Amos is used for testing existing theories (confirmatory research).

Chapter 4

Result and Discussion

4.1 Analytical Strategy

In this study, we used the multivariate statistical tool which is PLS-SEM for testing the integrated model. SmartPLS [100, 101] is used to analyze the collected data. It represents a significant advancement in latent variable modeling, integrating state-of-the-art methods such as Importance-Performance Map Analysis (IPMA), complex bootstrapping routines, and Partial Least Squares Prediction-Oriented Segmentation (PLS-POS) within an easy-to-use and intuitive graphical user interface. Bootstrapping is a non-parametric procedure that tests the statistical significance of various PLS-SEM results, including path coefficients, Cronbach's alpha, HTMT, and R^2 values. Since PLS-SEM does not assume normally distributed data, parametric significance tests (e.g., those used in regression analyses) cannot be applied to determine the significance of coefficients like outer loadings, outer weights, and path coefficients. Instead, PLS relies on non-parametric bootstrapping procedures to test the significance of the estimated path coefficients in PLS-SEM.

4.2 Case 1: Energy-saving Behavior in the Government Workplace

There are two models to fit the structural equation model: the PLS-SEM measurement model and the structural model with Bootstrapping which are portrayed in Figures 4.1 and 4.2.

4.2.1 Determining Measurement Model Validity and Reliability for Case 1

A solution is predicted to provide the empirical result of the relationship of the constructs and variables represented by the theory once the structural model equation is defined.

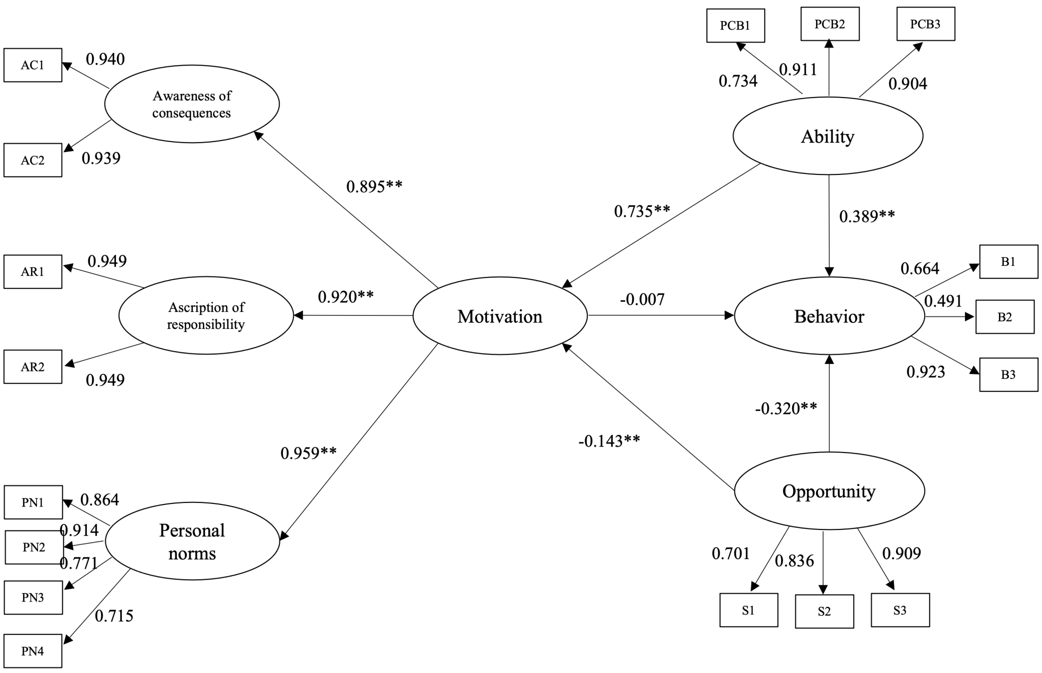

Figure 4.1: PLS-SEM Measurement Model for Case 1 ($*p < 0.05$, $**p < 0.001$)

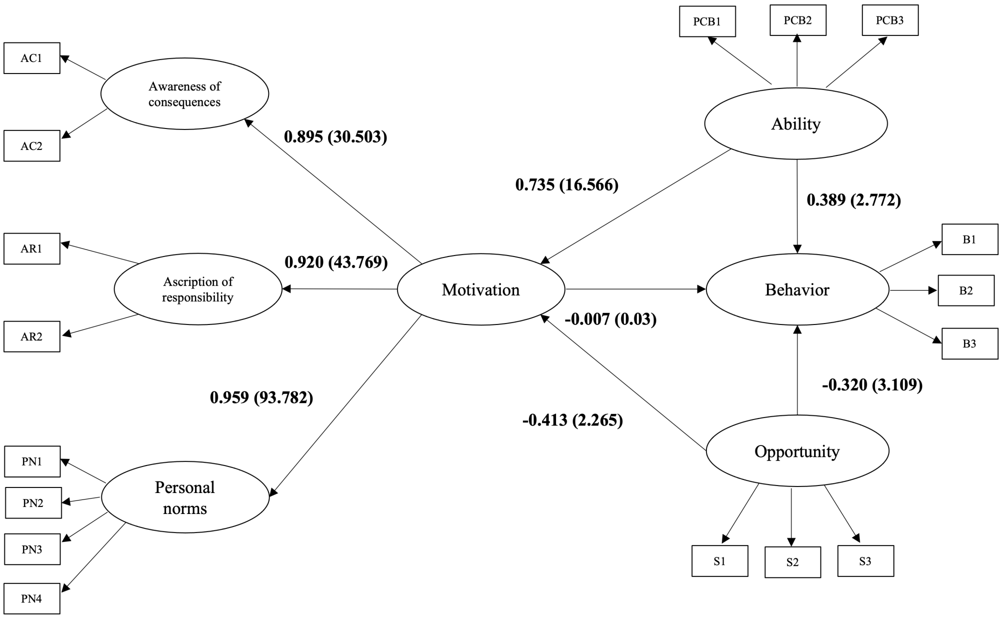

Figure 4.2: Structural Model with Bootstrapping for Case 1

Path Coefficient

The relationship between the constructs and the indicators which is the path estimates to link constructs to variables of the indicators is one of the most basic conditions in evaluating the measurement model [102, 103]. Table 4.1 is the path coefficient for the relationship between each construct. Loading can be effectively significant when the p value is less than 0.05 and considerably below 0.5. Except for behavior motivation, the rest are within the range.

Construct Reliability (CR)

Reliability is the degree measurement of the variables which is based on how greatly interrelated the indicators are with each other. There are two approaches in the PLS-SEM [104]. The traditional approach is Cronbach's Alpha (CA) as composite reliability (CR)[105]. The reliability coefficient of CA is normally between 0 and 1. A value of 0.80 or higher is considered

Table 4.1: Path Coefficient for Case 1

	Original Sample	Sample Mean	Standard Deviation	t-value	p- value
Ability _ Behavior	0.385	0.38	0.139	2.772	0.000
Ability _Motivation	0.734	0.732	0.044	16.566	0.000
Motivation _Behavior	0.004	0.023	0.141	0.03	0.976
Motivation _Ascription of Responsibility	0.92	0.92	0.021	43.769	0.000
Motivation _Awareness of consequences	0.895	0.892	0.029	30.503	0.000
Motivation _ Personal Norms	0.959	0.959	0.01	93.782	0.000
Opportunity _ Behavior	-0.308	-0.308	0.099	3.109	0.002
Opportunity _ Motivation	-142	-0.14	0.063	2.265	0.024

a good scale, an acceptable scale is 0.7, and 0.60 is an exploratory scale. Except for behavior, all the other indicators were acceptable. CA ranges from a low of 0.742 for the Behavior construct to a high of 0.943 for the Motivation construct, as shown in Table 4.2. Composite reliability (ComR): ComR is a preferred alternative to CA as a test of convergent validity in a reflective model. It may be preferred as a reliability measure since CA may overestimate or underestimate scale reliability, usually the latter. ComR varies from 0 to 1, with 1 representing excellent estimated reliability. For a model suitable for exploratory purposes, ComR should be at least 0.6; for a model suitable for confirmatory research, it should be at least 0.70; and

Table 4.2: Construct Reliability and Validity for Case 1

	Cronbach's Alpha	Composite Reliability	AVE
Ability	0.815	0.889	0.729
Motivation	0.93	0.943	0.676
Opportunity	0.789	0.857	0.669
Behavior	0.526	0.742	0.512
Personal Norms	0.833	0.89	0.672
Ascription of Responsibility	0.889	0.948	0.9
Awareness of Consequences	0.868	0.938	0.883

for confirmatory research, it should be at least 0.80. The results of this analysis indicate that CR values of ability (0.889), motivation (0.943), and opportunity (0.857) prove that all have internal consistency reliability.

Construct Validity (CV)

Construct Validity (CV) refers to the degree to which a measured set accurately reflects the latent construct it is intended to measure. Confirmatory composite analysis evaluates CV based on the Average Variance Extracted (AVE). The AVE estimates range from 51.2% for Behavior to 90% for Ascription of Responsibility, as shown in Table 4.2.

Discriminant Validity (DV)

Discriminant Validity (DV) refers to the extent to which a construct is distinct and separate from other constructs. The two methods for assessing DV which is provided by SmartPLS software are Fornell-Larcker [106, 107] and Heterotrait-Monitor Ratio (HTMT) [101]. Fornell-Larcker Criterion (FL) is the most commonly used one which compares the mean-variance extracted values of any two constructs within the estimated correlation square between these two constructs. HTMT is the ratio between trait correlations which is utilized in this study for assessing DV. HTMT is the average of all indicators' correlation between different constructs relative to the mean of indicator correlation of the same construct. The value of HTMT which is above 0.9 suggests a lack of DV. The suggested value is lower than 0.85 [108]. The HTMT test result is shown in Table 4.3.

All ratios except motivation to the ascription of responsibility and motivation to awareness of consequence which are 1.0074 and 0.9923 are below 0.85 significant levels giving strong evidence of DV.

Most researchers used bootstrapping to derive the distribution of HTMt-value. Bootstrapping is handled with HTMT statistic for deriving the standard errors of the estimates which are used to advance confidence intervals of bootstrapping. The value of confidence level 1 means a lack of DV. Table 4.4 shows the confidence intervals for the HTMT test. There are no estimated confidence intervals including 1. This table provides additional evidence of DV.

Nomological Validity

Latent correlation variables for each construct developed by SmartPLS software are shown in Table 4.5. The result shows there is a negative relation between motivation and opportunity. The rest supports the estimation that these constructs are positively related to each other.

Table 4.3: Discriminant Validity for Case 1

	Ability	Ascription of Responsibility	Awareness of Consequence	Behavior	Motivation	Opportunity	Personal Norm
Ability							
Ascription of Responsibility	0.7877						
Awareness of Consequence	0.7106	0.8416					
Behavior	0.6279	0.3782	0.3003				
Motivation	0.8146	1.0074	0.9923	0.4112			
Opportunity	0.2777	0.3000	0.0630	0.4328	0.2044		
Personal Norm	0.8365	0.6603	0.6154	0.4682	0.8233	0.2162	

Table 4.4: Biased Confidence Intervals derived for HTMT testing for Case 1

	Original Sample (O)	Sample Mean (M)	Bias	2.5%	97.5%
Ability ->Behavior	0.3850	0.3800	-0.0050	0.0980	0.6320
Ability ->Motivation	0.7340	0.7320	-0.0030	0.6390	0.8110
Motivation ->Ascription of Responsibility	0.9200	0.9200	0.0000	0.8670	0.9490
Motivation ->Awareness of Consequence	0.8950	0.8920	-0.0030	0.8180	0.9340
Motivation ->Behavior	0.0040	0.0230	0.0190	-0.2570	0.2680
Motivation ->Personal Norm	0.9590	0.9590	0.0000	0.9280	0.9720
Opportunity ->Behavior	-0.3080	-0.3080	0.0000	-0.4710	-0.0620
Opportunity ->Motivation	-0.1420	-0.1400	0.0020	-0.2730	-0.0290

Table 4.5: Latent Variable Correlations for Case 1

	Ability	Ascription of Responsibility	Awareness of Consequence	Behavior	Motivation	Opportunity	Personal Norm
Ability	1.0000	0.6702	0.6246	0.4444	0.7286	-0.0757	0.7142
Ascription of Responsibility	0.6702	1.0000	0.7482	0.3259	0.9206	-0.3040	0.8269
Awareness of Consequence	0.6246	0.7482	1.0000	0.2200	0.8935	0.0326	0.7845
Behavior	0.4444	0.3259	0.2200	1.0000	0.3388	-0.3101	0.3646
Motivation	0.7286	0.9206	0.8935	0.3388	1.0000	-0.1595	0.9589
Opportunity	-0.0757	-0.3040	0.0326	-0.3101	-0.1595	1.0000	-0.1537
Personal Norm	0.7142	0.8269	0.7845	0.3646	0.9589	-0.1537	1.0000

Table 4.6: f^2 Effect size for Case 1

	Ability	Ascription of Responsibility	Awareness of Consequence	Behavior	Motivation	Opportunity	Personal Norm
Ability				0.1279	1.1272		
Ascription of Responsibility							
Awareness of Consequence							
Behavior							
Motivation		5.5593	3.9590	0.0006			11.4212
Opportunity				0.1059	0.0239		
Personal Norm							

4.2.2 Evaluating Structural Model Validity for Case 1

Assessing the structural model are the following steps: evaluating the significance of the path relationship, assessing R^2, and examining the f^2 effect as shown in Table 4.6. Bootstrapping run to get the significant levels. The information in Table 4.7 shows the coefficient, t-value, and p-value.

1. The p-value of the hypothesized path of ability to behavior is 0.000. Therefore, the inner model of this path is statistically significant.

2. The p-value of the hypothesized path of ability to motivation is 0.000. Therefore, the inner model of this path is statistically significant.

3. The p-value of the hypothesized path of motivation to behavior is 0.976. Therefore, the inner model of this path is not statistically significant.

4. The p-value of the hypothesized path of motivation to the ascription of responsibility is 0.000. Therefore, the inner model of this path is statistically significant.

5. The p-value of the hypothesized path of motivation to awareness of consequence is 0.000. Therefore, the inner model of this path is statistically significant.

6. The p-value of the hypothesized path of motivation to personal norms is 0.000. Therefore, the inner model of this path is statistically significant.

7. The p-value of the hypothesized path of opportunity to behavior is 0.002. Therefore, the inner model of this path is statistically significant.

8. The p-value of the hypothesized path of opportunity to motivation is 0.024. Therefore, the inner model of this path is statistically significant.

Except for Motivation to Behavior, all the path coefficients are statistically significant.

4.2.3 Key Findings of Case 1

The measurement model confirms several relationships critical to understanding energy-saving behavior in the workplace. Specifically, it verifies the following connections:

- Ability to Energy-Saving Behavior: Employees' ability significantly influences their energy-saving behaviors.
- Ability to Motivation: Employees' ability also positively affects their motivation to engage in energy-saving activities.
- Opportunity to Energy-Saving Behavior: The opportunities available to employees are crucial for promoting energy-saving behaviors.
- Opportunity to Motivation: Opportunities also enhance employees' motivation to save energy.
- Motivation to Ascription of Responsibility: Motivation influences how employees ascribe responsibility for energy-saving.
- Motivation to Awareness of Consequences: Motivated employees are more likely to be aware of the consequences of their energy use.
- Motivation to Personal Norms: Motivation also strengthens personal norms related to energy-saving.

However, the model indicates no statistically significant direct effect of motivation on energy-saving behavior. This suggests that while motivation impacts other factors, it does not directly translate into energy-saving actions.

From the Structural Equation Modeling (SEM) results, the path coefficients for awareness of consequences and personal norms, which are components of motivation, are relatively low. This indicates that these motivational aspects are not strong predictors of energy-saving behaviors in this context.

Another significant finding pertains to the specific devices used for energy-saving behaviors. Among the three devices studied (lights and computers), the path coefficient for computers is notably low. While most workers habitually turn off lights and air conditioning when not in use, computers tend to remain plugged in and running even when not needed.

In the case of NECTEC, a government workplace, numerous experiments have been conducted focusing on computer usage. Despite these efforts, computers often remain on even when employees leave for the day, due to specific operational requirements. This highlights a particular area where energy-saving practices could be improved, emphasizing the need for targeted interventions to encourage the shutdown of computers when not in use.

Table 4.7: Structural Model Path Coefficient and Significance Test for Case 1

		Original Sample	Sample Mean	Standard Deviation	t-value	p-value	Support
H1	Ability ->Behavior	0.3850	0.3800	0.1390	2.7720	0.0000	Yes
H2	Motivation ->Behavior	0.0040	0.0230	0.1410	0.0300	0.9760	No
H3	Opportunity ->Behavior	-0.308	-0.308	0.099	3.109	0.002	Yes
3*H4	Motivation ->Ascription of Responsibility	0.9200	0.9200	0.0210	43.7690	0.0000	3*Yes
	Motivation ->Awareness of consequences	0.8950	0.8920	0.0290	30.5030	0.000	
	Motivation ->Personal Norms	0.959	0.959	0.01	93.782	0.000	
H7	Ability ->Motivation	0.7340	0.7320	0.0440	16.5660	0.0000	Yes
H8	Opportunity ->Motivation	-142	-0.14	0.063	2.265	0.024	Yes

4.3 Case 2: Energy-saving Behavior in the Private Companies Workplace

The two models fitting the structural equation model are the PLS-SEM measurement model and the structural model with Bootstrapping which are portrayed in Figures 4.3 and 4.4.

4.3.1 Determining Measurement Model Validity and Reliability for Case 2

Path Coefficient

Loading can be effectively significant when the p value is less than 0.05 and considerably below 0.5. Except for Motivation and the Opportunity to behavior, the rest are within the range.

Construct Reliability (CR)

CR ranges from a low of 0.628 from motivation constructs to a high of 0.930 from Motivation constructs, as shown in Table 4.8.

Construct Validity (CV)

AVE estimates the range from 0.5437 for ability to 1.06 for Ascription of Responsibility, as shown in Table 4.8.

Discriminant Validity

All ratios except awareness of consequence to ability, awareness of consequences to the ascription of responsibility, motivation to the ascription of responsibility, motivation to awareness of consequence, the personal norm

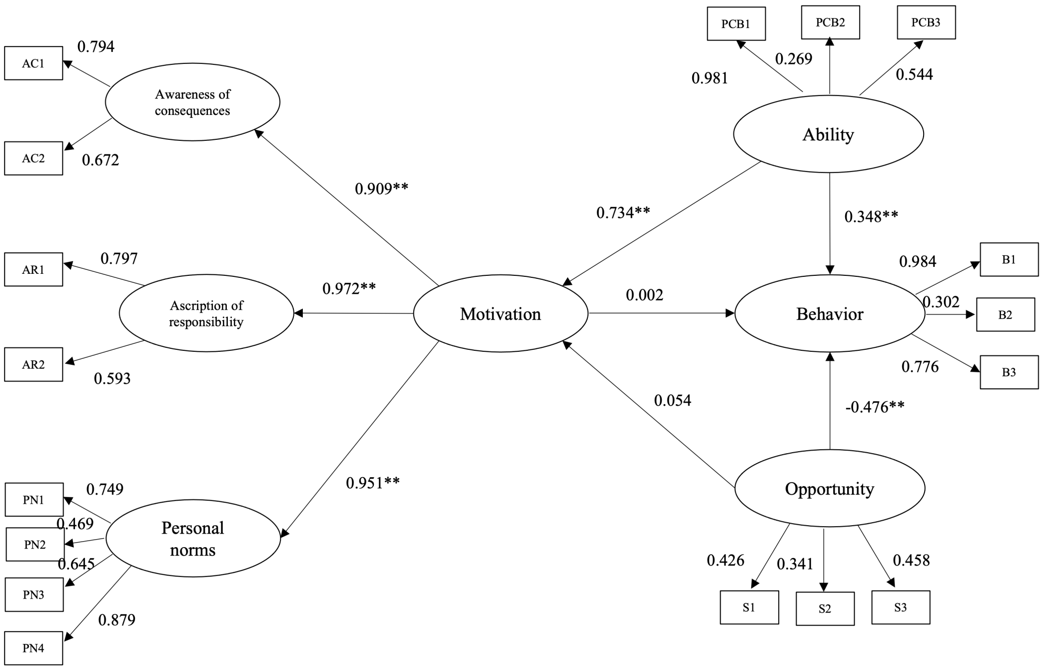

Figure 4.3: PLS-SEM Measurement Model for Case 2 ($*p < 0.05$, $**p < 0.001$)

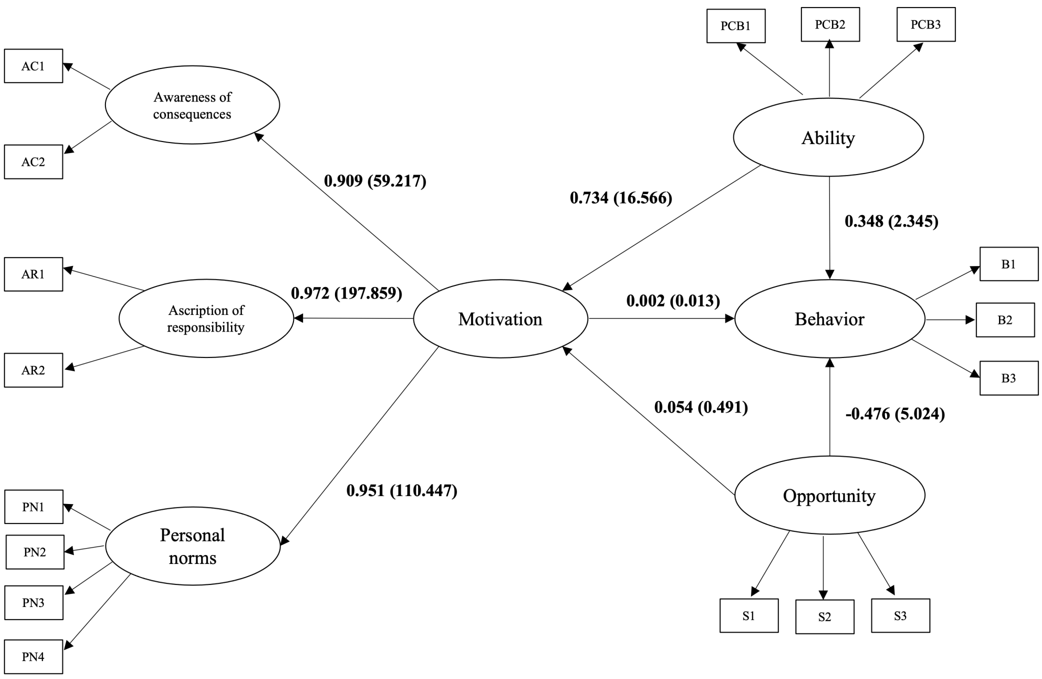

Figure 4.4: Structural Model with Bootstrapping for Case 2

Table 4.8: Construct Reliability and Validity for Case 2

	Cronbach's Alpha	Composite Reliability	AVE
Ability	0.761	0.768	0.542
Motivation	0.913	0.930	0.628
Opportunity	0.647	0.757	0.517
Behavior	0.690	0.821	0.635
Personal Norms	0.853	0.901	0.695
Ascription of Responsibility	0.663	0.821	0.696
Awareness of Consequences	0.744	0.847	0.735

to the ascription of responsibility, and personal norm to the ascription of responsibility are below 0.85 significant level, giving the low effect of DV, as shown in Table 4.10. Table 4.11 shows the confidence intervals for the HTMT test. There are no estimated confidence intervals including 1. This table provides additional evidence of DV.

Nomological Validity

Latent correlation variables for each construct developed by SmartPLS software are shown in Table 4.12. The result shows there is a negative relation between motivation and opportunity. The rest supports the estimation that these constructs are positively related to each other.

Table 4.9: Path Coefficient for Case 2

	Original Sample	Sample Mean	Standard Deviation	t-value	p-value
Ability _ Behavior	0.348	0.373	0.148	2.345	0.019
Ability _Motivation	0.734	0.732	0.044	16.566	0.000
Motivation _Behavior	0.002	-0.013	0.147	0.013	0.990
Motivation _Ascription of Responsibility	0.972	0.972	0.005	197.859	0.000
Motivation _Awareness of consequences	0.909	0.910	0.015	59.217	0.000
Motivation _ Personal Norms	0.951	0.951	0.009	110.447	0.000
Opportunity _ Behavior	-0.476	-0.476	0.095	5.024	0.000
Opportunity _ Motivation	0.054	0.045	0.110	0.491	0.624

4.3.2 Evaluating Structural Model Validity for Case 2

Assessing the structural model are the following steps: evaluating the significance of the path relationship, assessing R^2, and examining the f^2 effect as shown in table 4.13. Bootstrapping run to get the significant levels. The information in Table 4.14 shows the coefficient, t-value, and p-value.

1. The p-value of the hypothesized path of ability to behavior is 0.000. Therefore, the inner model of this path is statistically significant.

2. The p-value of the hypothesized path of ability to motivation is 0.000. Therefore, the inner model of this path is statistically significant.

Table 4.10: Discriminant Validity for Case 2

	Ability	Ascription of Responsibility	Awareness of Consequence	Behavior	Motivation	Opportunity	Personal Norm
Ability							
Ascription of Responsibility	0.994						
Awareness of Consequence	1.037	1.531					
Behavior	0.904	0.611	0.609				
Motivation	0.806	1.345	1.169	0.451			
Opportunity	0.617	0.447	0.543	0.730	0.382		
Personal Norm	0.710	1.227	0.973	0.362	1.075	0.324	

Table 4.11: Biased Confidence Intervals derived for HTMT testing for Case 2

	Original Sample (O)	Sample Mean (M)	Bias	2.5%	97.5%
Ability ->Behavior	0.348	0.373	0.025	0.148	2.345
Ability ->Motivation	0.734	0.732	-0.002	0.044	16.566
Motivation ->Ascription of Responsibility	0.972	0.972	0.000	0.005	197.859
Motivation ->Awareness of Consequence	0.909	0.910	0.001	0.015	59.217
Motivation ->Behavior	0.002	-0.013	-0.015	0.147	0.990
Motivation ->Personal Norm	0.951	0.951	0.000	0.009	110.447
Opportunity ->Behavior	-0.476	-0.476	0.000	0.095	5.024
Opportunity ->Motivation	0.054	0.045	-0.009	0.110	0.491

Table 4.12: Latent Variable Correlations for Case 2

	Ability	Ascription of Responsibility	Awareness of Consequence	Behavior	Motivation	Opportunity	Personal Norm
Ability	1.0000	0.6702	0.6246	0.4444	0.7286	-0.0757	0.7142
Ascription of Responsibility	0.6702	1.0000	0.7482	0.3259	0.9206	-0.3040	0.8269
Awareness of Consequence	0.6246	0.7482	1.0000	0.2200	0.8935	0.0326	0.7845
Behavior	0.4444	0.3259	0.2200	1.0000	0.3388	-0.3101	0.3646
Motivation	0.7286	0.9206	0.8935	0.3388	1.0000	-0.1595	0.9589
Opportunity	-0.0757	-0.3040	0.0326	-0.3101	-0.1595	1.0000	-0.1537
Personal Norm	0.7142	0.8269	0.7845	0.3646	0.9589	-0.1537	1.0000

Table 4.13: f^2 Effect size for Case 2

	Ability	Ascription of Responsibility	Awareness of Consequence	Behavior	Motivation	Opportunity	Personal Norm
Ability				0.1279	1.1272		
Ascription of Responsibility							
Awareness of Consequence							
Behavior							
Motivation		5.5593	3.9590	0.0006			11.4212
Opportunity				0.1059	0.0239		
Personal Norm							

3. The *p*-value of the hypothesized path of motivation to behavior is 0.990. Therefore, the inner model of this path is not statistically significant.

4. The *p*-value of the hypothesized path of motivation to ascription of responsibility is 0.000. Therefore, the inner model of this path is statistically significant.

5. The *p*-value of the hypothesized path of motivation to awareness of consequence is 0.000. Therefore, the inner model of this path is statistically significant.

6. The *p*-value of the hypothesized path of motivation to personal norms is 0.000. Therefore, the inner model of this path is statistically significant.

7. The *p*-value of the hypothesized path of opportunity to behavior is 0.002. Therefore, the inner model of this path is statistically significant.

8. The *p*-value of the hypothesized path of opportunity to motivation is 0.624. Therefore, the inner model of this path is not statistically significant.

Except for Motivation to Behavior and Opportunity to Behavior, all the path coefficients are statistically significant.

4.3.3 Key Findings of Case 2

The measurement model for Case 2 confirms several critical relationships related to energy-saving behavior in the workplace. Specifically, it validates the following connections:

- Ability to Energy-Saving Behavior: Employees' ability significantly influences their energy-saving actions.

- Ability to Motivation: Employees' abilities also enhance their motivation to engage in energy-saving behaviors.
- Opportunity to Motivation: The availability of opportunities positively affects motivation, although this relationship is not statistically significant in this case.
- Motivation to Ascription of Responsibility: Motivation influences how employees ascribe responsibility for energy-saving.
- Motivation to Awareness of Consequences: Motivated employees are more likely to be aware of the consequences of their energy use.
- Motivation to Personal Norms: Motivation strengthens personal norms related to energy-saving.

However, the model indicates that there is no statistically significant direct effect of motivation on energy-saving behavior, nor is there a significant effect of opportunity on motivation. This suggests that while motivation influences other factors, it does not directly lead to energy-saving actions. Similarly, the presence of opportunities does not necessarily enhance motivation in this context.

The SEM results reveal that the path coefficients for personal norms and awareness of consequences, which are components of motivation, are relatively low. This indicates that these motivational aspects are not strong predictors of energy-saving behaviors in this particular case. Moreover, the relationship between opportunity and energy-saving behavior shows a negative effect. This suggests that even when opportunities for energy-saving actions exist, such as management-led initiatives to save energy, they may not be effectively utilized or perceived by the workers.

Additionally, the relationship between opportunity and motivation also shows a negative effect. This implies that the more opportunities employees have, the less motivated they may feel to take energy-saving actions. One possible explanation for this counterintuitive finding is that, in the workplace context, most workers are not directly responsible for paying the electricity bills. As a result, they may lack the personal financial incentive to be motivated, even when opportunities for energy-saving behaviors are present.

In summary, the key findings from Case 2 highlight several critical insights:

- The direct impact of motivation on energy-saving behavior is limited.
- Opportunities for energy-saving do not necessarily enhance motivation and may even reduce it.
- There is a need for more effective strategies to increase workers' awareness and personal norms related to energy-saving.
- Management-led initiatives should focus not only on providing opportunities but also on enhancing motivation and personal responsibility among employees.

These insights suggest that policymakers and organizational leaders need to consider these dynamics when designing and implementing energy-saving interventions in the workplace.

Table 4.14: Structural Model Path Coefficient and Significance Test for Case 2

		Original Sample	Sample Mean	Standard Deviation	t-value	p-value	Support
H1	Ability ->Behavior	0.348	0.373	0.148	2.345	0.019	Yes
H2	Motivation ->Behavior	0.002	-0.013	0.147	0.013	0.990	No
H3	Opportunity ->Behavior	-0.476	-0.469	0.095	5.024	0.000	Yes
3*H4	Motivation ->Ascription of Responsibility	0.972	0.972	0.005	197.859	0.0000	3*Yes
	Motivation ->Awareness of consequences	0.909	0.910	0.015	59.217	0.000	
	Motivation ->Personal Norms	0.951	0.951	0.009	110.447	0.000	
H7	Ability ->Motivation	0.7340	0.7320	0.0440	16.5660	0.0000	Yes
H8	Opportunity ->Motivation	0.054	0.045	0.110	0.491	0.624	No

4.4 Case 3: Energy-saving Behavior in the Private Companies Workplace with New Framework

The two models fitting the structural equation model are the PLS-SEM measurement model and the structural model with Bootstrapping which are portrayed in Figures 4.5 and 4.6.

4.4.1 Determining Measurement Model Validity and Reliability for Case 3

Path Coefficient

A load can be significantly effective when the *p* value is less than 0.05 and considerably below 0.5. All are satisfied with the condition.

Table 4.15: Path Coefficient for Case 3

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	*t*-value	*p*-value
Ability ->Energy Saving Behavior	0.3078	0.3344	0.0928	3.3160	0.0010
Individual Comfort -> energy-saving Behavior	-0.3565	-0.3545	0.1180	3.0220	0.0026
Intention ->Energy Saving Behavior	0.3036	0.3049	0.0998	3.0426	0.0025
Motivation ->Intention	0.7621	0.7582	0.0388	19.6267	0.0000
Opportunity ->Energy Saving Behavior	-0.4194	-0.4073	0.0718	5.8387	0.0000

Construct Reliability (CR)

CR ranges from a low of 0.6467 from the Opportunity construct to a high of 0.9003 from the Motivation constructs, as shown in Table 4.16.

Construct Validity (CV)

AVE estimates the range from 0.5437 for ability to 1.06 for Ascription of Responsibility, as shown in Table 4.16.

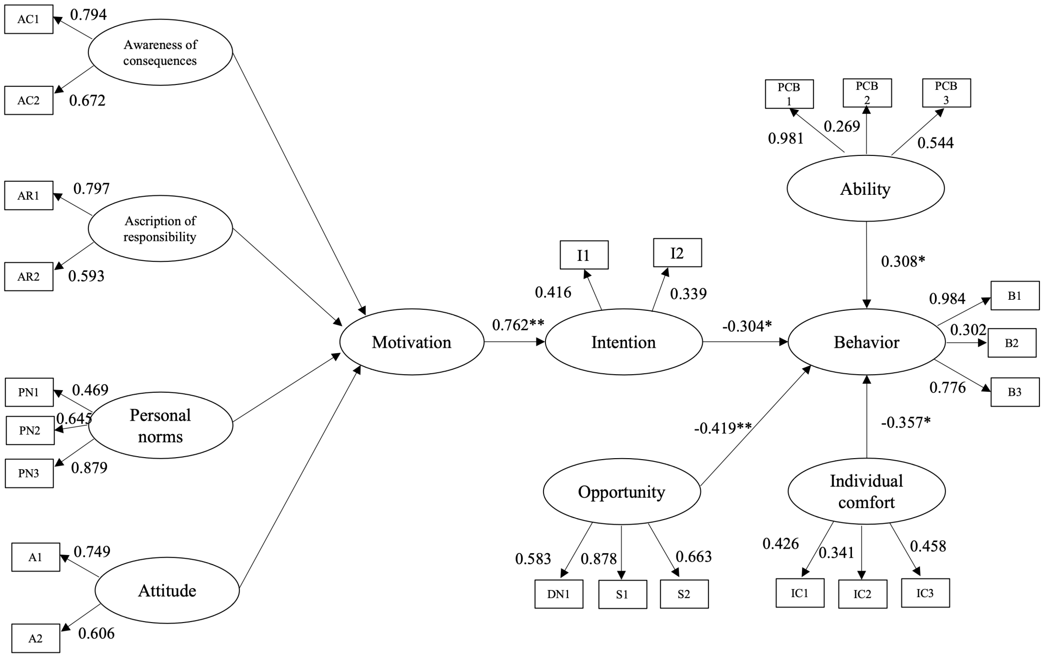

Figure 4.5: PLS-SEM Measurement Model for Case 3 ($*p < 0.05$, $**p < 0.001$)

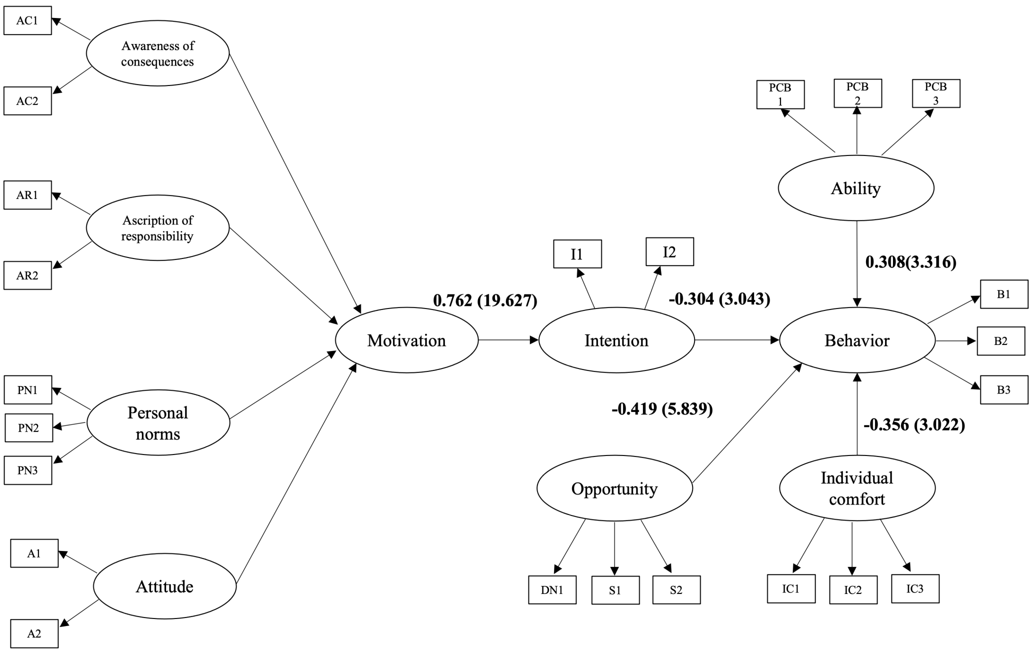

Figure 4.6: Structural Model with Bootstrapping for Case 3

Discriminant Validity

All ratios except motivation to individual comfort and Individual comfort to ability which are 1.0750 and 0.9790 are below 0.85 significant level, giving the strong evidence of DV, as shown in Table 4.17. Table 4.18 shows the confidence intervals for the HTMT test. There are no estimated confidence intervals including 1. This table provides additional evidence of DV.

Nomological Validity

Latent correlation variables for each construct developed by SmartPLS software are shown in Table 4.19. The result shows there is a negative relation between opportunity and individual comfort. The rest supports the estimation that these constructs are positively related to each other.

Table 4.16: Construct Reliability and Validity for Case 3

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
Ability	0.7612	0.8503	0.6586	0.5437
Energy Saving Behavior	0.7898	0.8868	0.7606	0.5539
Individual Comfort	0.6562	0.3820	0.3759	0.5693
Intention	0.6490	1.7410	1.0405	1.0600
Motivation	0.9003	0.9065	0.8939	0.5908
Opportunity	0.6467	0.8659	0.5954	0.5947

4.4.2 Evaluating Structural Model Validity for Case 3

Assessing the structural model are the following steps: evaluating the significance of the path relationship, assessing R^2, and examining the f^2 effect, Table 4.20. Bootstrapping run to get the significant levels. The information in Table 4.21 shows the coefficient, t-value, and p-value.

1. The p-value of the hypothesized path of ability to energy-saving behavior is 0.0010. Therefore, the inner model of this path is statistically significant.

2. The p-value of the hypothesized path of motivation to intention is 0.000. Therefore, the inner model of this path is statistically significant.

3. The p-value of the hypothesized path of opportunity to energy-saving behavior is 0.0000. Therefore, the inner model of this path is not statistically significant.

4. The p-value of the hypothesized path of Intention to energy-saving be-

Table 4.17: Discriminant Validity for Case 3

	Ability	Energy Saving Behavior	Individual Comfort	Intention	Motivation	Opportunity
Ability						
Energy Saving Behavior	0.8040					
Individual Comfort	1.0750	0.8590				
Intention	0.7910	0.3210	0.7640			
Motivation	0.7660	0.4710	0.9790	0.7940		
Opportunity	0.6170	0.7300	0.6910	0.6090	0.4250	

Table 4.18: Biased Confident Intervals derived for HTMT testing for Case 3

	Original Sample (O)	Sample Mean (M)	Bias	2.5%	97.5%
Ability ->Energy Saving Behavior	0.3078	0.3344	0.0266	0.0852	0.4668
Individual Comfort ->Energy Saving Behavior	-0.3565	-0.3545	0.0020	-0.5722	-0.1408
Intention ->Energy Saving Behavior	-0.3036	-0.3049	-0.0012	-0.5309	-0.1261
Motivation ->Intention	0.7621	0.7582	-0.0039	0.6860	0.8336
Opportunity ->Energy Saving Behavior	-0.4194	-0.4073	0.0121	-0.5456	-0.2784

havior is 0.0025. Therefore, the inner model of this path is statistically significant.

5. The p-value of the hypothesized path of Individual Comfort to energy-saving behavior is 0.0026. Therefore, the inner model of this path is statistically significant.

Table 4.19: Latent Variables Correlations for Case 3

	Ability	Energy Saving Behavior	Individual Comfort	Intention	Motivation	Opportunity
Ability	1.0000	0.6688	-1.0841	0.4440	0.6000	-0.6021
Energy Saving Behavior	0.6688	1.0000	-0.8654	0.1392	0.2119	-0.7504
Individual Comfort	-1.0841	-0.8654	1.0000	-0.8084	0.1511	0.6517
Intention	0.4440	0.1392	-0.8084	1.0000	0.6066	-0.1462
Motivation	0.6000	0.2119	1.1511	0.6066	1.0000	0.0346
Opportunity	-0.6021	-0.7504	0.6517	-0.1462	-0.0346	1.0000

Table 4.20: f^2 Effect size for Case 3

	Ability	Energy Saving Behavior	Individual Comfort	Intention	Motivation	Opportunity
Ability		-5.0185				
energy-saving Behavior						
Individual Comfort		-0.2263				
Intention		0.0464				
Motivation				0.5823		
Opportunity		0.4439				

Table 4.21: Structural Model Path Coefficient Significance Test for Case 3

		Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	t-value (—O/STDEV—)	p-value	Support
H1	Ability ->Energy Saving Behavior	0.3078	0.3344	0.0928	3.3160	0.0010	Yes
H2	Motivation ->Intention	0.7621	0.7582	0.0388	19.6267	0.0000	Yes
H3	Opportunity ->energy-saving Behavior	-0.4194	-0.4073	0.0718	5.8387	0.0000	Yes
H4	Intention ->energy-saving Behavior	0.3036	0.3049	0.0998	3.0426	0.0025	Yes
H5	Individual Comfort ->energy-saving Behavior	-0.3565	-0.3545	0.1180	3.0220	0.0026	Yes

4.4.3 Key Findings of Case 3

The measurement model for Case 3 confirms several critical relationships concerning energy-saving behavior in the workplace. Specifically, it validates the following connections:

- Ability to Energy-Saving Behavior: Employees' ability significantly influences their energy-saving actions.
- Motivation to Intention: Motivation positively impacts employees' intentions to save energy.
- Opportunity to Energy-Saving Behavior: The availability of opportunities directly affects energy-saving behaviors.
- Intention to Energy-Saving Behavior: Employees' intentions strongly predict their actual energy-saving actions.
- Individual Comfort to Energy-Saving Behavior: Personal comfort levels also play a significant role in energy-saving behaviors.

The results from Partial Least Squares Structural Equation Modeling (PLS-SEM) indicate that opportunity, intention, and individual comfort have a positive and direct impact on energy-saving behavior. However, the presence of a negative coefficient in some relationships requires further consideration.

Among the three factors of the AMO framework, ability has the strongest effect on energy-saving behavior, followed by motivation and intention. Despite workers having the ability and motivation to save energy, a lack of opportunity, intention, and individual comfort in private companies in Thailand reduces the overall impact on energy-saving behavior.

Given Thailand's hot climate, individual comfort is a critical factor. For example, turning off air conditioning to save energy can significantly reduce comfort levels, leading workers to use electricity excessively to maintain a comfortable environment. This highlights a unique challenge where energy-saving efforts may conflict with maintaining comfort in the workplace.

Moreover, as a developing country, Thailand faces additional challenges in advancing energy-saving initiatives. There is a need for focused efforts to create energy-saving zones that provide opportunities for effective energy conservation. Additionally, the presence of a bystander effect among employees—where an individual believes that their energy-saving efforts are unnecessary because others will compensate—hinders the establishment of strong organizational norms in energy-saving.

Addressing individual comfort is crucial given the hot climate of Thailand. Strategies to maintain comfort while saving energy could involve investing in energy-efficient air conditioning systems or promoting flexible working hours to reduce peak cooling demands. Enhancing opportunities by creating dedicated energy-saving zones and providing clear opportunities for employees to engage in energy-saving behaviors can help bridge the gap between ability and action. Building strong social norms is also essential to counteract the bystander effect. Organizations should emphasize the importance of collective effort in energy-saving by highlighting the actions of individuals and teams who consistently engage in these practices, thereby encouraging others to follow suit.

Incentivizing energy-saving behaviors is another effective strategy, especially since employees are not directly responsible for electricity costs. Introducing social and financial rewards, such as recognition programs, bonuses, or other incentives, can enhance motivation and intention, encouraging active participation in energy-saving efforts. Additionally, conducting educational campaigns to raise awareness about the importance of energy-saving and specific actions employees can take is essential. These campaigns should focus on improving motivation by helping employees understand why energy needs to be saved and highlighting descriptive norms by showing how others are contributing to energy-saving efforts.

The findings from Case 3 underscore the complexity of promoting energy-saving behaviors in the workplace. While ability, motivation, and intention are crucial, they must be supported by opportunities and considerations for individual comfort to be effective. By addressing these factors through targeted interventions and fostering a culture of collective responsibility, organizations can enhance their energy-saving efforts and contribute to broader sustainability goals.

4.5 Comparison of Cases 1, 2, and 3

The study explores energy-saving behaviors in the workplace through three distinct cases, each highlighting different factors and dynamics. The comparison of Cases 1, 2, and 3 reveals critical insights into the determinants of energy-saving behaviors and the effectiveness of various interventions.

In Case 1, conducted at NSTDA (a government organization in Thailand), the measurement model confirms that ability significantly predicts energy-saving behavior. Motivation indirectly influences behavior through other factors but does not have a significant direct effect on energy-saving behavior. Opportunity significantly impacts energy-saving behavior, although there is no significant direct effect of motivation on energy-saving actions. Case 2, which focuses on private companies in Thailand, similarly finds that ability strongly influences energy-saving actions, with motivation affecting intention but not directly impacting energy-saving behavior. The presence of opportunities also does not significantly enhance motivation, and it negatively impacts energy-saving behavior, possibly due to contextual factors within the private sector. In Case 3, also set in private companies, ability remains a substantial factor, while motivation positively impacts intention, which in turn influences energy-saving behavior. This case highlights a clear pathway from motivation to action through intention, with opportunity and individual comfort positively and directly influencing energy-saving behavior.

The three cases present different organizational dynamics and contextual challenges. Case 1, set in a government workplace, suggests enhancing ability and opportunity but lacks specific policy recommendations. In contrast, Case 2 identifies a lack of opportunity and intention in private companies, pointing to organizational and cultural barriers to energy-saving. Case 3 emphasizes the need for creating energy-saving zones and addressing the bystander effect, where employees rely on others to take energy-saving actions. The hot climate of Thailand is a significant factor in Case 3, where maintaining individual comfort can conflict with energy-saving efforts. This is particularly challenging in a developing country like Thailand, where there is much progress to be made in terms of energy-saving initiatives.

The cases underscore the importance of addressing individual comfort, especially in hot climates, to prevent excessive electricity use. They also highlight the need for creating opportunities and strong social norms within organizations to enhance energy-saving behaviors. While all cases suggest enhancing ability, motivation, and opportunity, Case 3 provides the most detailed and actionable recommendations, including improving individual comfort, creating dedicated energy-saving zones, building social norms, incentivizing behaviors, and conducting educational campaigns. Table 4.22

presents a comparison of energy-saving behavior drivers across three workplace settings.

In summary, across all cases, ability consistently emerges as a crucial factor influencing energy-saving behavior. Motivation and opportunity also play significant roles, though their impact varies depending on the context and specific dynamics of each case. Case 3 uniquely highlights the importance of intention and individual comfort, providing a more comprehensive understanding of how these factors drive energy-saving behaviors. Each case underscores the unique challenges faced by workplaces in Thailand, particularly the need to balance energy-saving efforts with maintaining comfort in a hot climate and addressing organizational barriers. While all cases suggest the need for enhancing ability, motivation, and opportunity, Case 3 provides the most detailed and actionable recommendations for improving energy-saving behaviors through targeted interventions and policy measures. This comparative analysis highlights the multifaceted nature of energy-saving behaviors and the need for tailored strategies that consider both individual and contextual factors.

Table 4.22: Comparison of energy-saving behavior drivers across different workplace settings

Drivers	Case 1: Government Workplace	Case 2: Private Companies Workplace	Case 3: Private Companies Workplace with New Framework
Ability	Strong influence	Moderate influence	Strong influence
Motivation	Moderate influence	Strong influence	Strong influence
Opportunity	Moderate influence	Moderate influence	Strong influence
Intention	Not measured	Not measured	Strong influence
Individual Comfort	Not measured	Not measured	Moderate influence
Norm Activation Model (NAM)	Used to capture motivation	Used to capture motivation	Used to capture motivation
Perceived Behavioral Control	Strong influence on behavior	Moderate influence	Strong influence
Personal Norm	Strong influence	Strong influence	Strong influence
Ascription of Responsibility	Moderate influence	Moderate influence	Moderate influence
Awareness of Consequences	Moderate influence	Strong influence	Strong influence
Subjective Norms (TPB)	Moderate influence	Moderate influence	Strong influence

4.6 Comparative Analysis Between American and Thai Offices

A comparative analysis of the findings between American and Thai office settings reveals distinct differences in energy-saving behaviors influenced by organizational support, social norms, and access to energy-saving technologies. In American offices, as studied in the referenced paper, motivational factors such as organizational support and social norms play a dominant role. However, in Thai offices, the emphasis shifts towards enhancing the occupants' ability through technical training and knowledge dissemination. These differences underscore the need for context-specific strategies when applying behavior change frameworks like MOA or AMO, highlighting the unique challenges and opportunities in different socio-cultural settings. The following table is the summary of comparative analysis between American and Thai offices.

Table 4.23: Comparison of Effective Drivers for Energy-Saving Behavior in American and Thai Offices

Drivers	**Similarities**	**Differences**
Ability	Both American and Thai offices recognize ability as an important factor in energy-saving behavior.	**AMO framework** in Thai offices starts with **ability**, emphasizing technical training and skills development, while the **MOA framework** in American offices focuses on ability being secondary to motivation, often relying on existing technological systems.

Motivation	Motivation is a critical driver in both contexts and influences energy-saving behaviors.	In **American offices**, the **MOA framework** emphasizes **motivation** as the primary driver, supported by organizational incentives, while in **Thai offices**, motivation is shaped by **collective norms** and the ability to act, as highlighted by the **AMO framework**.
Opportunity	Opportunity in both settings affects behavior by enabling conditions conducive to energy-saving.	**American offices** tend to emphasize **individual autonomy** in accessing opportunities, whereas **Thai offices** focus on collective actions and opportunities driven by workplace policies under the **AMO framework**.
Intention	Both American and Thai workers exhibit strong intentions to save energy when they feel responsible.	In **American offices**, intention is more closely tied to **personal environmental values**, while in **Thai offices**, intention is linked to **organizational support** and collective group dynamics, reflecting the **AMO framework**'s focus on ability and opportunity.

Individual Comfort	Both acknowledge that individual comfort plays a role in energy-saving efforts, particularly in hot climates.	Comfort is a stronger factor in **Thai offices** due to the tropical climate, while **American offices** are more flexible about adjusting thermal comfort for energy-saving, aligned with the **MOA framework**'s focus on motivation and technological ability.
Norm Activation Model (NAM)	Personal norms are a driver in both American and Thai offices, influencing energy-saving behavior.	**American offices** emphasize individual responsibility under the **MOA framework**, whereas **Thai offices** highlight collective responsibility and norms as outlined by the **AMO framework**.
Perceived Behavioral Control	Both contexts recognize that perceived control over actions influences energy-saving behavior.	**American offices** associate perceived control with access to advanced technologies, while in **Thai offices**, it reflects the **AMO framework**'s emphasis on ability and the training necessary to take energy-saving actions.

Ascription of Responsibility	Workers in both settings feel responsible for contributing to energy-saving behaviors.	**American offices** frame responsibility as **individualistic**, driven by personal norms, while **Thai offices** focus on **collective responsibility** under the **AMO framework**, where the ability to act collectively is emphasized.
Awareness of Consequences	Awareness of the consequences of energy use drives behaviors in both contexts.	**American offices** raise awareness through **corporate initiatives**, while in **Thai offices**, **policy directives** play a stronger role, consistent with the **AMO framework**'s focus on ability and collective efforts.
Subjective Norms (TPB)	Subjective norms (what others think) influence behavior in both contexts.	**Subjective norms** play a stronger role in **Thai offices**, emphasizing **group conformity**, while **American offices** stress **individual motivation** through **MOA**.

Descriptive Norms (TPB)	Descriptive norms (what others do) impact energy-saving behavior in both contexts.	In **Thai offices**, descriptive norms are **peer-driven and visible**, aligning with the **AMO framework**'s collective focus, while in **American offices**, they align with **environmental trends** and individual action under the **MOA framework**.

Chapter 5

Conclusion

5.1 Integrated Framework and Findings

This study integrates the AMO model with the Theory of Planned Behavior (TPB) and the Norm Activation Model (NAM) to evaluate energy-saving behavior within Thai companies. The AMO model, focusing on Ability, Motivation, and Opportunity, is combined with TPB, which emphasizes Intention, and NAM, which highlights Norms and Responsibility. This multidimensional framework incorporates individual, social, and contextual factors to provide a comprehensive understanding of energy-saving behavior. The findings reveal that personal norms and awareness of the consequences of energy consumption significantly motivate energy-saving behaviors. Employees who understand the environmental impact of their actions and feel personally responsible are more likely to adopt energy-saving practices. Subjective norms, or the influence of others' expectations and behaviors, create opportunities for energy-saving behaviors, as employees are affected by their peers' actions and workplace expectations. Perceived Behavioral Control, a key component of TPB, influences employees' ability to engage in energy-saving behaviors. When employees believe they have control over their actions and access to necessary resources, they are more likely to practice energy-saving behaviors. Structural equation modeling (SEM) results indicate that Ability and Opportunity have a positive direct effect on energy-saving behavior, while Motivation does not show a significant direct effect. This suggests that, although motivational factors are important, practical aspects like Ability and Opportunity play a more crucial role in influencing energy-saving behaviors in the workplace.

5.2 Research Implications

This study offers several important implications for research and policy in the field of energy-saving behaviors. By developing an integrated framework that combines the AMO model, TPB, and NAM, we contribute to the literature by providing a new perspective on workplace energy-saving behaviors. The results highlight that while motivation alone may not be sufficient to drive energy-saving behaviors, a combination of ability and opportunity can effectively promote such behaviors.

1. Theoretical Contributions:

   Expanding Existing Models: The study extends the AMO model by incorporating social-psychological constructs from the TPB and NAM. This integrated model provides a more comprehensive understanding of the factors influencing energy-saving behaviors in the workplace.

   New Insights into Workplace Behaviors: The study offers new insights into how personal norms, awareness, and perceived behavioral control impact energy-saving behaviors, thereby enriching the existing knowledge base.

2. Practical Recommendations:

   Policy Development: The findings suggest that policies aimed at enhancing employees' abilities and opportunities for energy-saving behaviors are more effective than those focused solely on motivation. Organizations should consider implementing energy-efficient technologies and providing training to improve employees' skills and knowledge Incentive Structures: Introducing social and financial rewards can be an effective strategy to boost employees' motivation and reinforce energy-saving behaviors. Reward systems can align employees' personal norms with organizational goals, thereby creating a more supportive environment for energy efficiency.

3. Future Research Directions:

   Broader Scope: Future research should extend this model to different sectors, including government organizations and other building types, to compare behavioral intentions and identify sector-specific barriers and opportunities for energy savings.

   Detailed Analysis: Further research should explore more detailed aspects of the model, such as the interactions between different factors and their cumulative effects on energy-saving behaviors.

5.3 Policy Implication

Based on the findings of this research, several policy recommendations are proposed to enhance energy-saving efforts in Thailand. Recognizing that workers are a significant target group for energy conservation, policymakers and stakeholders should acknowledge the critical role employees play in this area. It is essential to prioritize initiatives that encourage energy-saving behaviors among workers to achieve substantial reductions in Thailand's overall energy consumption. To create energy-conscious workplaces, policies should be crafted to establish environments that support and value energy conservation. This includes setting clear, attainable energy-saving goals and providing the necessary support and guidance to help workers develop energy-saving habits. Promoting best practices can also increase awareness and knowledge about energy conservation within workplaces.

To effectively foster energy-saving behaviors, it is crucial to enhance both the opportunities and motivations for workers. The government should regularly launch public campaigns to educate the public about the negative impacts of excessive energy consumption, such as global warming and the depletion of energy resources. These campaigns should aim to raise awareness and motivate individuals to adopt more sustainable energy practices. Additionally, the government should implement supportive policies and incentives to encourage organizations to adopt energy-efficient practices. This could involve offering financial incentives for companies that meet energy-saving targets and recognition programs for businesses that lead in energy conservation efforts.

Regular training sessions and educational programs should be provided to workers to keep them updated on the latest energy-saving techniques and technologies, ensuring continuous engagement in energy conservation efforts. Encouraging collaboration between the government, the private sector, and non-governmental organizations can lead to the development of comprehensive energy-saving strategies. Partnerships can facilitate the sharing of resources, knowledge, and best practices, thereby amplifying the impact of energy-saving initiatives. By adopting these policy recommendations, Thailand can make significant progress in reducing energy consumption and promoting sustainable energy practices in the workplace.

5.4 Synthesis of Findings and Theoretical Implications for Energy-Saving Behaviors in Thai Workplaces

This study effectively combines the AMO (Ability-Motivation-Opportunity) framework with the TPB (Theory of Planned Behavior) and NAM (Norm Activation Model) models to present a comprehensive approach to understanding energy-saving behaviors in workplace settings. The research underscores the significance of ability and opportunity as key determinants of these behaviors, while motivation plays a less direct role. By addressing existing gaps in the literature and providing practical recommendations, this study advances the field of energy-saving behaviors and lays the groundwork for future research initiatives.

Furthermore, this thesis not only validates the applicability of the AMO framework in a new context but also introduces a unique Case 3 model, which explores additional dimensions of energy-saving behaviors that have not been previously covered. Focusing on the Thai context, this research offers valuable insights into how different behavioral frameworks can be adapted and applied across diverse cultural and organizational settings. This adaptation extends both the theoretical and practical understanding of energy conservation strategies, highlighting the need for tailored interventions that consider local socio-cultural and technological environments. The findings of this study provide a foundation for crafting effective strategies and policies aimed at promoting energy efficiency in workplaces, demonstrating the versatility and relevance of the AMO framework in diverse settings.

By integrating these new insights with existing theories, this research contributes uniquely to the academic discourse on energy-saving behaviors and suggests pathways for future research to explore additional contexts and variables. This work lays a critical foundation for further studies aimed at refining and expanding the understanding of the determinants of energy-saving behaviors, thereby enhancing the effectiveness of energy conservation efforts globally.

5.5 Limitations and Future Research

This study is limited to government organizations (NSTDA) and private companies in Thailand, which may not fully represent the diverse range of workplaces and sectors. Future studies should include a broader range of organizations, including public institutions, to validate and extend the findings. Additionally, future research should explore more specific and detailed aspects of energy-saving behaviors, such as individual differences in response to different energy-saving measures and the long-term effectiveness of various interventions.

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Appendix

Appendix A: Framework Terminology and Justifications

This appendix compares the Motivation-Opportunity-Ability (MOA) and Ability-Motivation-Opportunity (AMO) frameworks as applied in different contexts. The MOA framework, extensively applied in American office settings, emphasizes 'motivation' as the primary driver of energy-saving behaviors, whereas the AMO framework adopted in this thesis emphasizes 'ability' as the starting point, reflecting the specific needs of Thai office environments.

A.2 Measurement Factors and Their Contextual Relevance

The measurement factors used in this thesis have been adapted to better suit the Thai context. For instance, while the MOA framework in American settings emphasizes social norms and organizational support, the AMO framework used here integrates additional factors such as technical training and knowledge access, which are critical in the Thai context. This adaptation enhances the model's relevance and provides a more accurate representation of the determinants of energy-saving behaviors in different settings.

A.3 Implications for Future Research

The findings from this thesis suggest that while foundational frameworks like MOA can be universally applied, their specific adaptations, such as AMO, can provide more tailored insights. Future research should consider these contextual differences when designing and applying behavioral frameworks across different cultural and organizational environments.

Appendix B: Questionnaires for Case 1 and 2

Construct	Items
3***Ability**	1. Raising Energy-saving behavior in the workplace is entirely within my control.
	2. I am confident that if I want I can save energy in the workplace.
	3. I have the knowledge and skills to save energy in the workplace.
7***Motivation**	1.1. When I reduce electricity use in my workplace, I do something good.
	1.2. When I reduce electricity use in my workplace, I cut down the cost
	2.1 I feel responsible for the energy use in the workplace.
	2.2 I feel responsible for reducing energy use in the workplace.
	3.1 I feel good about myself when I do not use a lot of Energy.
	3.2 I feel guilty when I use a lot of energy in the workplace.
	3.3 I think I have a responsibility to save energy in the workplace.
3***Opportunity**	1. Most of my colleagues expect me to turn off the computer when leaving.
	2. Most of my colleague expect me to turn off the light when leaving.
	3. Most of my colleague expect me to shut down or change the thermostat setting according to weather condition.

Appendix C: Questionnaires for Case 3

Construct	Items for measurement
3*Ability	1. Raising Energy-saving behavior in the workplace is entirely within my control.
	2. I am confident that if I want I can save energy in the workplace.
	3. I have the knowledge and skills to save energy in the workplace.
9*Motivation	1.1. When I reduce electricity use in my workplace, I do something good.
	1.2. When I reduce electricity use in my workplace, I cut down the cost
	2.1 I feel responsible for the energy use in the workplace.
	2.2 I feel responsible for reducing energy use in the workplace.
	3.1 I feel good about myself when I do not use a lot of Energy.
	3.2 I feel guilty when I use a lot of energy in the workplace.
	3.3 I think I have a responsibility to save energy in the workplace.
	4.1 energy-saving in my workplace can contribute the sustainability development of our society
	4.2 energy-saving in my workplace contributes to alleviating energy shortage issues
3*Opportunity	1. Most of my colleagues expect me to turn off the computer when leaving.
	2. Most of my colleagues expect me to turn off the light when leaving.
	3. Most of my colleagues expect me to shut down or change the thermostat setting according to weather conditions.
2*Intention	1. I will make an effort to save energy in my workplace.
	2. I am willing to save energy in my workplace.
3*Individual Comfort	1. I am satisfied with the temperature in my workplace.
	2. I am satisfied with the light in my workplace.
	3. I am satisfied with other indoor environment in my workplace.