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Identifying Energy-Use Behavior and Energy-Use Profiles of Hotel Guests

Hevar Palani * and Aslihan Karatas

Department of Civil and Architectural Engineering, Lawrence Technological University, 21000 West 10 Mile Road, Eng. Building Room E109, Southfield, MI 48075, USA; akaratas@ltu.edu
* Correspondence: hpalani@ltu.edu

Abstract: There are about 47,000 hotels in the United States that spend an average of $2200 per room on energy annually. Studies found that hotel guests' energy consumption behavior is one of the key reasons that affects hotel buildings' energy consumption. However, there has been little research study that provides efficient energy-use reduction interventions based on guests' energy-related behavior in hotel buildings. To address this research gap, this research study aims to develop an integrated energy-use framework in four steps: (1) integrating four energy-related behavior models (i.e., Motivation-Opportunity-Ability, Norm Activation Model, Theory of Planned Behavior, and Pro-environmental Behavior); (2) developing a set of hypotheses and their relevant measures to examine the relationship between the energy-related behavior models and hotel guests' energy-use behavior; (3) conducting an energy-use survey to analyze the effect of each determined measure on hotel guests' energy-use behavior; (4) analyzing the energy behavior data to identify energy-use behavior of hotel guests in hotel buildings; (5) analyzing the energy behavior data to identify energy-use profiles (i.e., Prone, Indifferent, or Resistant to Change) of hotel guests in hotel buildings. In this study, Prone to Change refers to good energy consumption behavior, Indifferent to Change refers to moderate energy consumption behavior, and Resistant to Change refers to bad or dark energy consumption behavior. From the energy-use survey, 370 responses were collected. Then, the 370 responses were analyzed to identify the energy-use profiles of hotel guests. The results from the analysis indicated that 168 out of 370 (45%) respondents have Resistant to Change energy-use profile, 146 out of 370 (40%) respondents have Indifferent to Change energy-use profile, and 56 out of 370 (15%) respondents have Prone to Change energy-use profile. The findings can provide decision-makers in hospitality industry with a better understanding of their guests' energy-related behavior; and accordingly develop effective interventions to reduce energy consumption in hotel buildings.

Keywords: energy use behavior; hotel buildings; buildings energy consumption; energy saving in buildings

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1. Introduction

In the United States, there are about 47,000 hotels, spending an average of $2200 per room on energy each year [1]. Studies have found that occupants' energy-related behavior is one of the main factors that affects energy consumption in hotel buildings [2–11]. Moreover, occupants' energy-related behavior (e.g., actions or reactions of a person to adapt to ambient environmental conditions such as temperature, indoor air quality, and sunlight) also constitutes a leading source of uncertainty in predicting energy use of buildings [7,12,13]. Accordingly, this study focuses on identifying the energy-use behavior and energy-use profiles of hotel guests to provide decision makers (e.g., hotel owners and hotel managers) with a better understanding of their guests' energy-related behaviors.

Although occupant energy-related behavior has a significant impact on reducing energy consumption in hotel buildings, there are many challenges that result in an inaccurate estimation of the energy consumption level of occupants in hotel buildings: (1) guests are not responsible for paying electrical bills [14]; (2) guest satisfaction is the number one priority in hotels to provide maximum comfort, convenience, and a positive brand experience for their guests [1,10]; (3) guests feel less restricted with their daily life routine [14]; (4) guests in the same room may behave differently due to diversity in guests' behavioral patterns [12,15]; (5) energy reduction efforts in hotel buildings have majorly focused on behaviors that save relatively small amounts of energy (e.g., unplugging one's cell phone charger), while other more effective behaviors (e.g., turning HVAC off when not needed) have been neglected [9]. Therefore, there is a pressing need by the decision makers of the hotel industry (e.g., hotel owners and hotel managers) to design and deliver effective and practical interventions for hotel guests to reduce their energy consumption.

There are several studies that have investigated various energy reduction strategies primarily focusing on the observation, understanding, and prediction of occupants' energy-use behavior in commercial and residential buildings [2–11]. These strategies include: (i) the challenge to increase the knowledge of occupants about energy-related issues, encouraging them to change their behaviors for the better and, at the same time, to monitor and assess the occupants' energy-related behaviors in a short or limited period of time [16]; (ii) occupant energy use data/feedback to compare occupants' current energy use with their historical use and monitor progress [6,16–19]; (iii) rewards/penalties to offer incentives to change occupants' behavior or to force extra administrative costs of regulations and sanctions on occupants [7,8,20]; (iv) technologies to save energy without any human involvement by retrofitting existing buildings and/or installing high energy-efficient products (e.g., energy-efficient light bulbs and occupancy sensors) [8,15,20]. Despite the significant contributions of these research studies on analyzing the impact of occupants' behavior on energy performance of residential and office buildings, there is little or no research study that provides practical and efficient energy-use reduction strategies based on occupants' energy-related behavior in hotel buildings. To address this research gap and overcome the aforementioned challenges for hotel buildings, this study aims to develop a model that analyzes the impact of hotel guests' energy-use behavior and energy-use profiles on hotel buildings' energy consumption. To achieve this, the study will first develop and then implement an integrated framework to measure the energy-related behaviors and intentions of hotel guests.

2. Objectives

The goal of this study is to develop an integrated framework that is capable of identifying the energy-use behavior and energy-use profiles of hotel guests. To achieve this, three main objectives are developed to: (1) identify and synthesize the most effective energy-related behavior models to understand the influential factors that impact hotel guests' energy-related behavior; (2) develop an energy-use framework that integrates the identified energy-related behavior models; (3) implement and validate the integrated framework.

3. Background

Many studies have proposed energy-related behavior models to understand the factors that influence human energy-use behavior [7,21,22]. The models that have been used in this research are: (1) Motivation-Opportunity-Ability (MOA) (e.g., [8,23]); (2) Norm Activation Model (NAM) (e.g., [8,24,25]); (3) Theory of Planned Behavior (TPB) (e.g., [8,26–28]); (4) Pro-Environmental Behavior (e.g., [29–32]). A detailed description of each model from literature is provided below.

3.1. Motivation-Opportunity-Ability (MOA) Model

The Motivation-Opportunity-Ability (MOA) model was originally developed and implemented to understand occupants' engagement in processing brand information and purchasing behavior [33–36]. In this study, the MOA model was adopted to investigate and understand hotel guests' energy-related behavior in hotel buildings. The MOA model is divided into three main constructs: Motivation, Opportunity, and Ability (see Figure 1.).

- Motivation (M) refers to occupants' desire, willingness, and concern to process energy saving information and to implement the required energy conservation behavior [7,37–39].
- Opportunity (O) refers to occupants' surrounding environmental factors that are not under their control to enable desired actions [7,33,35,40].
- Ability (A) refers to the occupants' prior knowledge about energy consumption behavior, the impact and consequences of that behavior, and knowledge about possible conservation strategies [7,20,40].

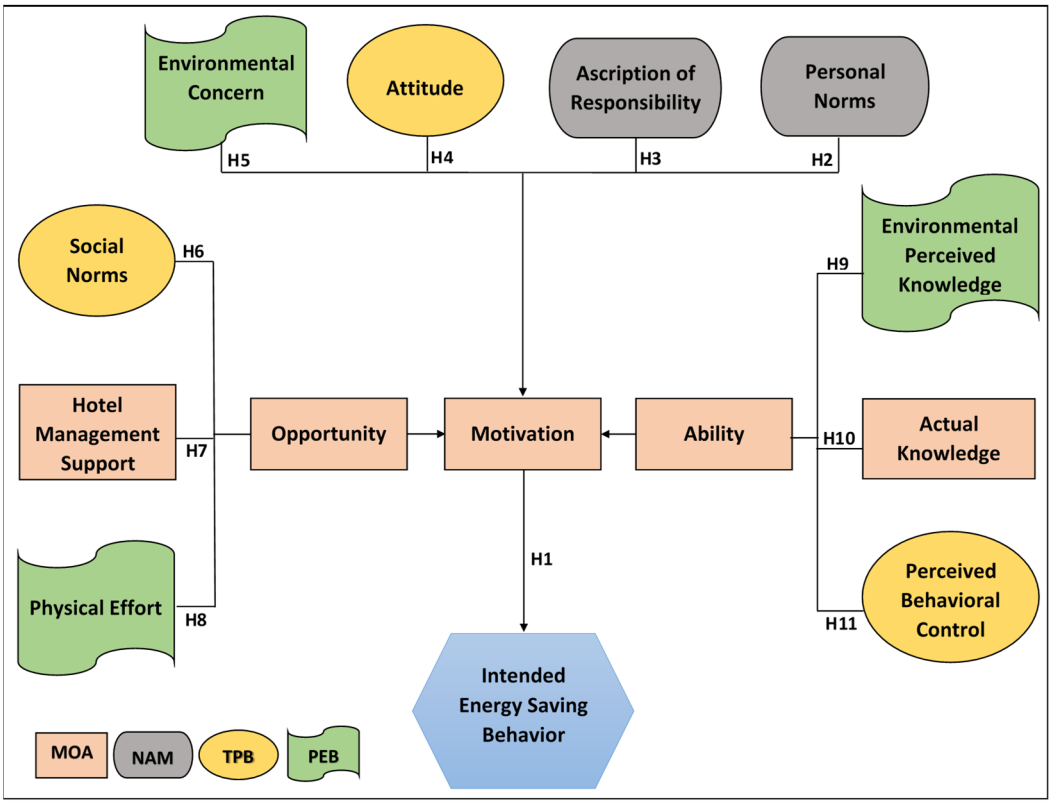

Figure 1. The Integrated Energy-Use Framework.

3.2. Norm Activation Model (NAM)

The Norm Activation Model (NAM) was developed by Schwartz (1977) to explain altruistic behaviors including recycling, volunteering, and other pro-social behaviors such as driving and energy-saving behaviors [8,25,31]. NAM is divided into three main categories: (1) Personal Norms, (2) Awareness of Consequence, and (3) Ascription of Responsibility.

- Personal Norms are behaviors that are influenced by "expectations, obligations, and sanctions anchored in the self" [8,41].
- Awareness of Consequences refers to individuals being aware of the consequences of their actions that are caused by energy use [8,25,41].

- Ascription of Responsibility means the assignment of responsibility for taking actions or attribution of responsibility for the negative consequences of not acting proactively [41].

3.3. Theory of Planned Behavior (TPB)

The Theory of Planned Behavior (TPB) states that the main antecedent of individuals' behavior is their intention toward the behavior [6,27]. TPB is divided into three main categories: (1) Attitude towards a Behavior (Attitude); (2) Social Norms (Subjective and Descriptive Norms); (3) Perceived Behavioral Control (PBC) [8,26,27].

- Attitude illustrates occupants' overall evaluation of the behavior or the degree of individuals' performance of the behavior that is either positively or negatively valued by the occupants [28].
- Social Norms are divided into two major sub-categories: subjective and descriptive norms. First, subjective norm would apply to energy consumption when occupants believes that they are under social pressure by surrounding people/peers to engage or not engage in energy saving behaviors [8,27]. Second, descriptive norm captures the perceptions of others' actual behaviors (e.g., the perception of companions' actual wasting or saving energy behaviors in hotel buildings) [8,42,43].
- Perceived Behavioral Control is a function of the occupants' perception of how easy or difficult it would be to perform the desired energy-related behavior [8,27,28].

3.4. Pro-Environmental Behavior (PEB)

Pro-Environmental Behavior (PEB) is a behavior that intentionally seeks to mitigate the negative impact of occupants' actions on the environment [29,32]. PEB may include such behaviors as composting organic waste, reducing waste production, recycling in households, reducing car use, and minimizing resources and energy consumption [31,44–47]. In this study, three main categories of PEB were used: (1) Environmental Perceived Knowledge; (2) Environmental Concern; (3) Physical Effort.

- Environmental Perceived Knowledge are those behaviors that change toward PEB as a function of occupants' existing environmental knowledge [30,48,49]. Appropriate behavior cannot occur without sufficient and appropriate environmental knowledge [32].
- Environmental Concern refers to the evaluation of facts, or an attitude towards facts with consequences for the environment [50,51]. The Environmental Concern of occupants may increase when they understand the scientific relationship between personal behavior, such as energy consumption and global warming [24].
- Physical Effort refers to the physical demonstration of occupants toward conducting specific actions such as reducing energy consumption. When occupants feel that the actions are bothersome or inconvenient to do, they may not conduct them [32].

4. Methodology

In this section, the proposed integrated energy-use framework was developed in six main stages (see Figure 1): (1) integrating four energy-related behavior models (i.e., Motivation-Opportunity-Ability, Norm Activation Model, Theory of Planned Behavior, and Pro-environmental Behavior); (2) developing a set of hypotheses and their relevant measures to examine the relationship between the energy-related behavior models and hotel guests' energy-use behavior; (3) conducting an energy-use survey to analyze the effect of each determined measure on hotel guests' energy-use behavior; (4) performing energy behavior data analysis to analyze the energy-use survey questions and answers to identify the Motivation, Opportunity, and Ability (MOA) levels for each hotel guest; (5) analyzing the energy behavior data to identify energy-use behavior of hotel guests in hotel buildings; (6) analyzing the energy behavior data to identify energy-use profiles of hotel guests in hotel buildings. Each stage of this Methodology section is provided below.

4.1. Incorporating Energy-Related Behavior Models

In this section, the energy-related behavior models (i.e., Motivation-Opportunity-Ability, Norm Activation Model, Theory of Planned Behavior, and Pro-environmental Behavior) are identified to design the integrated framework of this study. The energy-related behavior models are incorporated to provide a comprehensive and holistic approach to identifying hotel guests' energy-use behavior. The proposed framework assigned Motivation-Opportunity-Ability (MOA) model to act as a moderator for the other three energy-related behavior models: Norm Activation Model (NAM), Theory of Planned Behavior (TPB), and Pro-environmental Behavior (PEB). The three main categories of the MOA model (i.e., Motivation, Opportunity, and Ability) are designed to have high impact on intended energy saving behavior in this study. To accurately define and measure the components for each of the three levels of MOA, the authors adopted categories from the aforementioned energy-related behavior models (i.e., NAM, TPB, and PEB) to identify the energy-use behaviors of hotel guests, based on a comprehensive literature review of the hospitality industry and social psychology.

Motivation (M) captures occupants' (i.e., hotel guests in this study) goals, concerns, and involvement in the performance of energy reduction behavior [7,8,20]; and it is directly associated with intended energy saving behavior of the occupants [7,52]. In this study, hotel guests' desire for energy reduction in hotel buildings are investigated as a measure of their Motivation level. Moreover, according to Li et al. (2019), NAM can be used to extend several important psychological measurements to capture the essential aspects of hotel guests' Motivation level in hotel buildings. Therefore, in order to capture the social-psychological factors of hotel guests in Motivation, this study adopted: (i) two NAM categories of "Personal Norms" and "Ascription of Responsibility"; (ii) one TPB category of "Attitude"; (iii) one PEB category of "Environmental Concern". Personal Norms category of NAM is designed as an internalized need to commit to pro-environmental behavior of hotel guests in hotel buildings. The Ascription of Responsibility category of NAM is applied on hotel guests to measure their degree of responsibility toward energy saving behavior in hotel buildings. The Attitude category of TPB is developed to evaluate hotel guests' energy saving performance level in hotel buildings. This is based upon the hotel guests' expectations about the outcomes of a particular energy saving behavior (e.g., the consequences of adjusting hotel room temperature, turning off lights) and whether these outcomes are desirable from the hotel guests' perspective. Furthermore, the Environmental Concern category of PEB is designed to activate hotel guests' sense of responsibility to perform energy-related behavior.

Opportunity (O) is an external factor lying outside of the occupant that enables or inhibits a behavior [53,54]. In this study, Opportunity (O) measures the controllability and accessibility of hotel guests to hotel room energy systems (e.g., lighting, HVAC, appliances, and electronics) in hotel buildings. Opportunity has three categories in this study: (i) one TPB category of "Social Norms"; (ii) one MOA category of "Hotel Management Support; (iii) one PEB category of "Physical Effort." The Social Norms category of TPB are positively correlated and essential in influencing occupants' behavior [8]. Social Norms is divided into two sub-categories: Subjective Norms and Descriptive Norms. The Subjective Norms (e.g., peer pressure from room companion) can affect hotel guests' energy consumption behaviors when the guest tends to perform a particular behavior in the hotel room if it is approved by the room companion(s). In this case, guests' perception of what behavior is approved or disapproved by a room companion(s) becomes the external factor influencing behavioral intention. Descriptive Norms capture the perceptions of hotel room companions' actual energy consumption behaviors [42,55]. The Hotel Management Support category of MOA reflects the hotel management's commitment and/or encouragement level in promoting energy saving behavior in hotel buildings, such as hotel management rewards for guests saving energy [56,57]. The Physical Effort category of PEB is

designed to evaluate hotel guests' level of tendency to make changes in their energy-related behavior in hotel buildings when the energy-related behavior is easy and convenient to perform from hotel guests' perspective [32].

Ability (A) is individuals' perceived knowledge and proficiency in interpreting energy-use knowledge toward reducing energy consumption [7,8,20]. Ability depends on two main factors: individuals' perception of their energy consumption level and individuals' knowledge about energy consumption facts [7]. In the context of energy consumption behaviors in hotel buildings, the authors in this study adopted three main categories to capture a hotel guest's Ability: (i) one PEB category of "Environmental Perceived Knowledge"; (ii) one MOA category of "Actual Knowledge"; (iii) one TPB category of "Perceived Behavioral Control". Both the Environmental Perceived Knowledge category of PEB and the Actual Knowledge category of MOA address individuals' mental capabilities to perform an energy-related behavior [8]. Environmental Perceived Knowledge refers to hotel guests' perception of their energy-related knowledge about reducing CO_2 and greenhouse gas emissions including reducing energy consumption in hotel buildings. It reflects the necessary existing energy-related knowledge to achieve the desired outcome. The Actual Knowledge category measures individuals' mental capabilities [8,58]. In this study, it measures hotel guests' body of information and actual energy-related knowledge in hotel buildings. The Perceived Behavior Control category of PEB measures individuals' Ability level relative to his/her physical capability and perceived knowledge on how easy it is to conduct a behavior [8,28]. In this study, this category is adopted to measure hotel guests' existing knowledge and their overall evaluation about the simplicity of conducting energy-related behavior in hotel rooms.

4.2. Developing Energy-Use Behavior Hypotheses and Their Relevant Measures

A set of eleven hypotheses and their relevant measures is developed to investigate and validate the relationship between the energy-related behavior models and energy-use behavior of hotel guests as shown in Figure 1. It is noteworthy to mention that each energy-related behavior model is color-coded to match its relevant category in Figure 1. For example, TPB categories "Attitude", "Social Norms", and "Perceived Behavioral Control" are highlighted in yellow, and each of these categories is linked to Hypothesis of H4, H6, and H11, respectively.

Hypothesis 1 (H1), Hypothesis 2 (H2), Hypothesis 3 (H3), Hypothesis 4 (H4), and Hypothesis 5 (H5), are designed to test the Motivation level of hotel guests as presented in Table 1 and Figure 1. H1 is designed to predict if guests' high motivation levels have an impact on their energy reduction behavior. H2 is designed to investigate if guests with high personal norms have an effect on their energy reduction behaviors in the presence of energy reduction motivation. H3 is designed to predict if hotel guests' ascription of responsibility has an effect on their energy reduction behaviors in the presence of energy reduction motivation. H4 is designed to determine whether positive attitude can change guests' energy consumption behavior when they are also motivated to reduce energy. H5 is designed to investigate if guests' environmental concern levels have any impact on their energy reduction behaviors in the presence of energy reduction motivation. Accordingly, the related hypotheses are stated as follows:

Hypothesis (H1). *Occupants with higher energy conservation Motivation levels will perform more energy conservation behaviors than will occupants with lower energy conservation Motivation levels.*

Hypothesis (H2). *Occupants with higher Personal Norms toward a behavior will perform more energy conservation behaviors than will occupants with lower Personal Norms toward a behavior when energy conservation Motivation is high as opposed to low.*

Hypothesis (H3). *Occupants with higher Ascription of Responsibility toward a behavior will perform more energy conservation behaviors than will occupants with lower Ascription of Responsibility when energy conservation Motivation is high as opposed to low.*

Hypothesis (H4). *Occupants with higher positive Attitude towards a behavior will perform more energy saving behaviors than will occupants with lower positive Attitude towards a behavior when energy conservation Motivation is high as opposed to low.*

Hypothesis (H5). *Occupants with higher levels of Environmental Concern will perform more energy conservation behaviors than will occupants with lower levels of Environmental Concern when energy conservation Motivation is high as opposed to low.*

Table 1. Energy-Related Hypotheses and Measures for Motivation.

Research Hypothesis	MOA Level	Energy-Use Behavior Model	Measures	References
H1	M	MOA	Adjusting lighting control. Adjusting indoor climate conditions. Adopting energy conservation strategies. Personal motivation.	[7,8,23,59–61]
H2	M	NAM	Hotel guests' moral obligation to reduce energy consumption in their hotel room.	[8,25,41,62,63–66]
H3	M	NAM	Hotel guest's degree of responsibility.	[8,41,64,66,67]
H4	M	TPB	Positive and negative energy conservation attitudes of hotel guests.	[26,41,63,64,68]
H5	M	PEB	Environmental concern levels of hotel guests.	[63,69,70]

Hypothesis 6 (H6), Hypothesis 7 (H7), and Hypothesis 8 (H8), are designed to test the Opportunity level of hotel guests as presented in Table 2 and Figure 1. H6 is designed to predict if guests' social norm levels have an impact on energy-related conservation behaviors in the presence of energy conservation motivation. H7 is designed to investigate if support from hotel management have an impact on energy-related conservation behaviors when energy motivation is high. Finally, H8 is designed to predict if guests' physical effort levels have an impact on energy-related conservation behaviors in the presence of energy conservation motivation. Accordingly, the corresponding hypotheses are stated as follows:

Hypothesis (H6). *Occupants with higher levels of Social Norms will perform more energy conservation behaviors than will occupants with lower levels of Social Norms when energy conservation Motivation is high as opposed to low.*

Hypothesis (H7). *Occupants with better Support from Hotel Management will perform more energy conservation behaviors than will occupants with less support from hotel management when energy conservation Motivation is high as opposed to low.*

Hypothesis (H8). *Occupants with higher Physical Effort levels toward a behavior will perform more energy conservation behaviors than will occupants with lower Effort levels when energy conservation Motivation is high as opposed to low.*

Table 2. Energy-Related Hypotheses and Measures for Opportunity.

Research Hypothesis	MOA Level	Energy-Use Behavior Model	Measures	References
H6	O	TPB	Hotel management's expectations toward hotel guest's energy conservation behavior (e.g., lighting control, adjusting indoor climate conditions, and window blinder control). Room companion(s) expectations toward hotel guest's energy conservation behavior (e.g., lighting control, adjusting indoor climate conditions, and window blinder control). Peer pressure. Room companion(s) concern level about energy consumption in the hotel room.	[26,62–64,68]
H7	O	MOA	Hotel management's policy, regulations, and/or recommendations provided to hotel guests about reducing their energy consumption.	[8]
H8	O	PEB	Physical efforts to conduct energy saving behaviors that are not bothersome or inconvenient to the hotel guest in the hotel room.	[14,32,71]

Hypothesis 9 (H9), Hypothesis 10 (H10), and Hypothesis 11 (H11), are designed to test the Ability level of hotel guests as presented in Table 3 and Figure 1. H9 is designed to predict if guests' environmental perceived energy-related conservation knowledge level has an impact on their energy conservation behaviors when they are motivated to conserve energy. H10 is designed to determine if guests' knowledge levels of energy consumption facts (actual knowledge on energy consumption) have an impact on energy-related conservation behaviors when energy motivation is high. H11 is designed to investigate whether guests perceived behavioral control levels have an impact on energy-related conservation behaviors when energy motivation is high. Accordingly, the related hypotheses are stated as follows:

Hypothesis (H9). *Occupants with higher levels of Environmental Perceived Knowledge will perform more energy conservation behaviors than will occupants with lower levels of Environmental Perceived Knowledge when energy conservation Motivation is high as opposed to low.*

Hypothesis (H10). *Occupants with better Actual Knowledge will perform more energy conservation behaviors than will occupants with less Actual Knowledge when energy conservation Motivation is high as opposed to low.*

Hypothesis (H11). *Occupants with higher Perceived Behavioral Control will perform more energy conservation behaviors than will occupants with lower Perceived Behavioral Control when energy conservation Motivation is high as opposed to low.*

Table 3. Energy-Related Hypotheses and Measures for Ability.

Research Hypothesis	MOA Level	Energy-Use Behavior Model	Measures	References
H9	A	PEB	Perceived self-knowledge capacity of energy conservation. Perceived self-knowledge capacity of adjusting indoor climate conditions (HVAC system). Perceived self-knowledge capacity of lighting usage.	[7,8,23,29,35,41,59–61]
H10	A	MOA	Knowledge of plug loads. Knowledge of adjusting indoor climate conditions (HVAC). Knowledge of lighting controls. Knowledge of energy conservation strategies. Knowledge of renewable resources.	[7,8,59–61]
H11	A	TPB	Hotel guest's physical capability and perceived ease to enact a behavior. Hotel management's physical capability and perceived ease to enact a behavior.	[62,63]

4.3. Energy-Use Survey Design

In this section, an energy-use survey is designed to classify energy-use behavior in hospitality industry settings. The developed energy-use survey helps to predict the impact of each of the identified measures on the energy-use profile of hotel guests. The energy-use survey is designed with a goal to examine the effect of each identified measure on hotel guests' energy-use behavior. To achieve this, fifty-two questions are designed to measure eleven hypotheses of this study as summarized in Appendix A and Tables 1–3. In the 52-question energy-use survey, 18 questions are asked to measure Motivation level of hotel guests (represented as "M" in Table 1) including: (1) ten questions to measure Motivation level impacting energy-use behavior directly (H1) (e.g., "*My personal comfort in a hotel room is more important to me than reducing energy consumption*"); (2) two questions to measure Personal Norms (H2) (e.g., "*I feel morally obligated to reduce energy consumption in my hotel room*"); (3) three questions to measure the Ascription of Responsibility (H3) (e.g., "*Hotel management is responsible for reducing energy consumption in the hotel, not the guest*"); (4) one question to measure Attitude (H4) (e.g., "*When travelling, saving energy in my hotel room is not important at all.*"); (5) two questions to measure Environmental Concern (H5) (e.g., "*How much are you concerned about your personal energy consumption in your hotel room?*"). In the energy-use survey, questions from 1–18 measuring the Motivation level of hotel guests are presented in Appendix A.

Moreover, 11 questions are asked to measure the Opportunity level of hotel guests (represented as "O" in Table 2) including: (1) eight questions to measure Social Norms (H6) (e.g., "*In general, the hotel management expects me to turn off the lights when leaving the room or when not needed.*"); (2) two questions to measure Hotel Management Support (H7) (e.g., "*Hotels that I have visited often encourage guests to save energy by providing education and information.*"); (3) one question to measure Physical Efforts (H8) (e.g., "*It usually takes more physical effort than it is worth to reduce energy consumption in a hotel room.*"). In the energy-use survey, questions from 32–42 measuring the Opportunity level of hotel guests are presented in Appendix A.

Additionally, 13 questions are asked to measure Ability level of hotel guests (represented as "A" in Table 3) including: (1) five questions to measure Environmental Perceived Knowledge (H9) (e.g., "*I know how to reduce the heating load (e.g., usage of furnace*) in my hotel room."); (2) four questions to measure Actual Knowledge (H10) (e.g., "*How long does it take for a 100-watt light bulb to consume 100 watts of energy*"): (3) four questions to

measure Perceived Behavioral Control (H11) (e.g., "*Adopting energy saving practices in my hotel room is completely within my control*"). In the energy-use survey, questions from 19–31 measuring the Ability level of hotel guests are presented in Appendix A.

Finally, ten questions are asked to measure the socio-demographics of the energy-use survey participants. In the energy-use survey, questions from 43–52 measuring the socio-demographics are presented in Appendix A.

Figure 2. shows the relationship or the process of how the energy-use survey questions are tied to identify the energy-use profiles of the hotel guests.

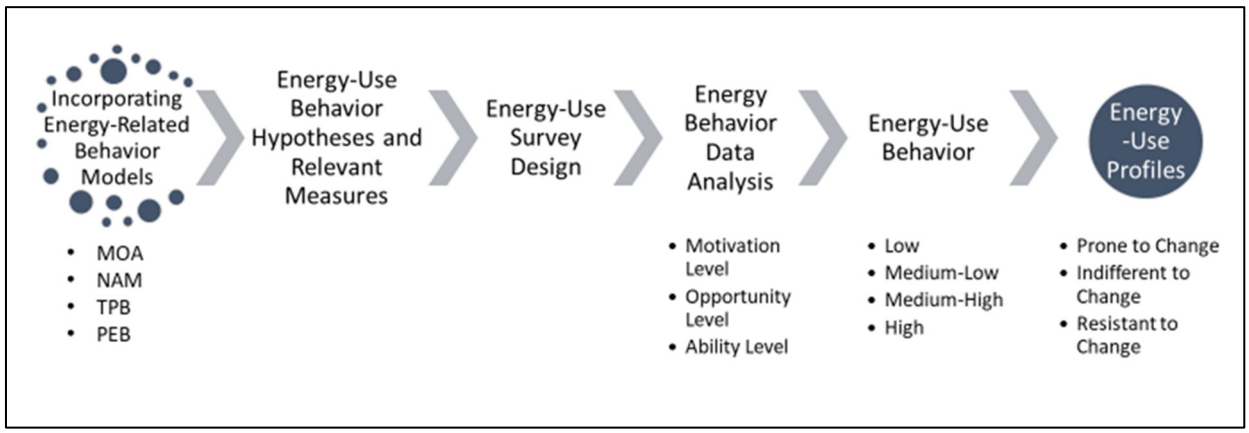

Figure 2. The Process for identifying Energy-Use Profiles of the Hotel Guests.

4.4. Energy Behavior Data Analysis

In this section, survey questions and answers are analyzed to identify MOA levels of hotel guests. Energy behavior reliability analysis needs to be conducted in order to check the internal consistency of multiple measure. A reliability analysis needs to be performed where the survey data is analyzed [72–75]. In this study, Exploratory Factor Analysis (EFA) is used as a statistical method for the purpose of reliability analysis to reduce the number of variables/questions to a smaller set of questions and select the reliable number of questions [75,76]. Reducing the number of variables helps to predict the most influential questions for the energy-use survey. To achieve this goal, reliability analysis needs to be performed to identify the energy use behavior of hotel guests. This analysis evaluates the recommended threshold of: Cronbach alpha (α) with a value of = 0.70 [77], and inter-item correlation with a value of 0.30 [76,78,79].

4.5. Energy-Use Behavior

After identifying the most influential variables/questions (i.e., questions with high correlation coefficients) from the energy behavior reliability analysis, the K-means clustering algorithm needs to be performed. The K-means clustering is a popular data clustering algorithm. To use the k-means clustering algorithm, it necessitates the number of clusters in the data to be pre-specified. Finding the appropriate number of clusters by K-means for a given data set is generally a trial-and-error process. In this study, the K-means clustering algorithm is performed to divide hotel guests into groups with similar clusters (e.g., Low energy-use behavior Motivation level or High energy-use behavior Ability level). Accordingly, the energy-use behavior of the hotel guests is identified for each of the three MOA levels. The results that can be obtained from this analysis can provide a better understanding of hotel guests' energy consumption in hotel buildings.

4.6. Energy-Use Profiles

In this section, the energy-use profiles of the hotel guests (i.e., energy-use survey participants in this study) are determined and divide them into energy-use profile groups

(e.g., dark energy-use profile and good energy-use profile). The energy-use profiles of hotel guests are determined based on a template of energy-use profile matrix (see Figure 3) adopted from [20]. This matrix is utilized to identify the energy-use profiles of hotel guests. For example, if a hotel guest has Low energy-use behavior Motivation (M) level, Low energy-use behavior Opportunity level, and Low energy-use behavior Ability (A) level, the guest will be identified to have dark energy-use profile. Moreover, if a hotel guest has High energy-use behavior Motivation (M) level, High energy-use behavior Opportunity level, and High energy-use behavior Ability (A) level, the guest will be identified to have good energy-use profile. Further, if a hotel guest has Low energy-use behavior Motivation (M) level, Low energy-use behavior Opportunity level, and High energy-use behavior Ability (A) level, the guest will be identified to have dark energy-use profile because the guest's energy-use profile will still be in the dark energy-use profile zone.

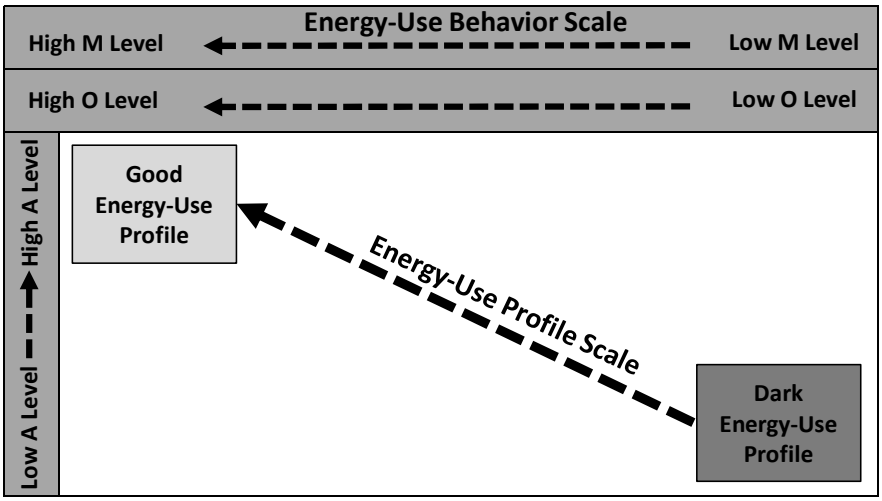

Figure 3. Template of Energy-Use Profile Matrix.

5. Integrated Energy-Use Framework Implementation

For the identification of the energy-use profiles of hotel guests in the hospitality industry, the integrated energy-use framework was implemented in four stages.

5.1. Conducting Energy-Use Survey

The energy-use survey of 52-question was designed in Qualtrics software and was deployed on Prolific (i.e., an online participant recruitment for surveys company) to collect responses. A total of 402 responses were collected. After eliminating the inaccurate responses from the energy-use survey, the total number of responses dropped to 370 responses (i.e., 92% of the total responses were accurately filled out with 8% error). The energy-use survey results from the socio-demographic questions can be presented as: (1) gender: 48% are female and 52% are male; (2) age: 5% are under 20 years old, 56% are between the ages of 20–30 years, 23% are between the ages of 31–39, 9% are between the ages of 40–49 years, 5% are between the ages of 50–59 years, and 2% are 60 years or older; (3) education: 2% are in high school (grades 9–12 with no degree), 30% are high school graduates (or equivalent), 40% have a bachelor's degree, 17% have a master's degree, 1% have a professional degree, 3% have a doctorate degree, and 7% have an associate degree; (4) ethnicity: 57% White, 17% Asian, 11% Hispanic, Latino, or Spanish Origin, 6% Black or African American, 5% Middle Eastern or North African, 3% other ethnicities, and 1% preferred not to answer; (5) frequency of travel annually: 11% travel once every few years, 27% travel once a year, 39% travel 2 or 3 times a year, 13% travel 4 or 5 times a year, and 11% travel more than 5 times a year; (6) purpose of travel: 89% travel for pleasure and 11% travel for business.

5.2. Energy Behavior Reliability Analysis

For the energy behavior reliability analysis, SPSS software was utilized. The 370 collected responses from the energy-use survey were used for energy behavior reliability analysis. This is considered to be a good sample size to run the energy behavior reliability analysis as it meets the requirements of the two theories for sample size estimation by Tabachnick and Fidell (51)—minimum of 300 responses ($370 > 300$) and Hogarty et al. [80]—minimum sample to variable ratio of 3:1 ($3 * 52 = 156 < 370$).

From the analysis, the Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy was found to be 0.807 which is above the recommended threshold of 0.6 suggested by Kaiser [81]. The Bartlett's Test of Sphericity reached statistical significance ($p = 0.000 < 0.05$) indicating the correlations were sufficiently large for Exploratory Factor Analysis (EFA). This proves that EFA is a practical and efficient statistical method to be used for data reliability analysis. Moreover, 13 out of 14 energy-related groups of questions were found to be reliable with Cronbach's alpha (α) above Nunnally's 0.70 threshold. Only one energy-related group of questions (energy-related group related to socio-demographics) had Cronbach's alpha (α) of 0.629 which is less than 0.70 and, therefore, it was eliminated from the study. The Cumulative percentage of variance for the reliable 13 energy-related groups of questions (after eliminating the two unreliable energy-related groups of questions) in this study was 60% which is still within the minimum suggested range of 50–60% [82]. Therefore, the most influential questions in the energy-use survey were determined for each of the three MOA levels.

5.3. Identifying Energy-Use Behavior of Hotel Guests

The most influential questions (i.e., questions with high correlation coefficients) were selected from the energy behavior reliability analysis to be used for K-means clustering algorithm to identify energy-use behavior of hotel guests. To achieve this objective, K-means clustering analysis was conducted using RapidMiner software to organize hotel guests in groups with similar clusters to identify energy-use behavior of hotel guests for each of the three MOA levels [83,84]. In this study, the value of K was tested four times with K = 3, K = 4, K = 5, and K = 6; to find the best K value (i.e., number of clusters) for this study. The result showed that the K value of 4 was the best fit for the integrated energy-use framework implementation due to its lowest error rate (−150). Accordingly, the hotel guests (i.e., energy-use survey participants in this study) were divided into four groups of energy-use behavior for each of the three MOA levels of hotel guests named: Low, Medium-Low, Medium-High, and High energy-use behavior. Low indicated hotel guests' lowest energy-use behavior and High indicated hotel guests' highest energy-use behavior (see Figures 4–6).

The energy-use behavior results of hotel guests' Motivation level illustrated that about 26% of the hotel guests (97 out of 370) had Low energy-use behavior Motivation level, about 25% of the hotel guests (90 out of 370) had Medium-Low energy-use behavior Motivation level, about 28% of the hotel guests (105 out of 370) had Medium-High energy-use behavior Motivation level, and about 21% of the hotel guests (78 out of 370) had High energy-use behavior Motivation level (see Figure 4).

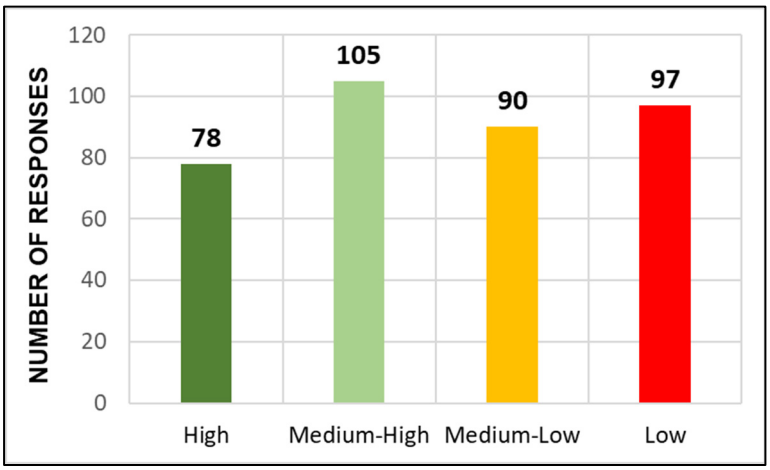

Figure 4. Energy-Use Behavior of Hotel Guests' Motivation Level.

The energy-use behavior results of hotel guests' Opportunity level illustrated that about 26% of the hotel guests (96 out of 370) had Low energy-use behavior Opportunity level, about 25% of the hotel guests (93 out of 370) had Medium-Low energy-use behavior Opportunity level, about 30% of the hotel guests (111 out of 370) had Medium-High energy-use behavior Opportunity level, and about 19% of the hotel guests (70 out of 370) had High energy-use behavior Opportunity level (see Figure 5).

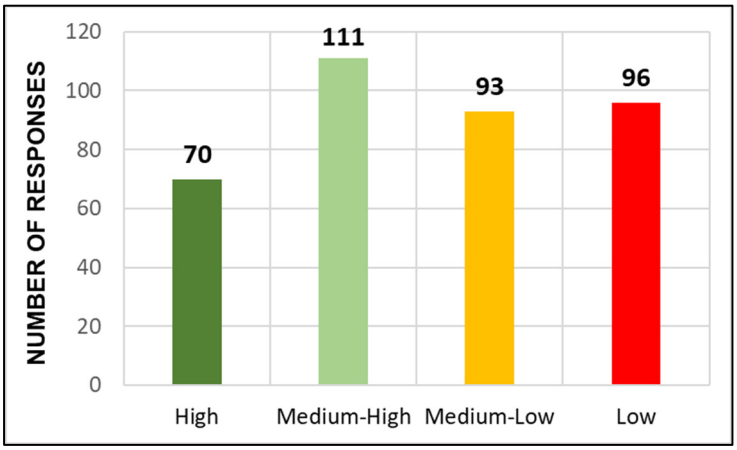

Figure 5. Energy-Use Behavior of Hotel Guests' Opportunity Level.

The energy-use behavior results of hotel guests' Ability level illustrated that about 19% of the hotel guests (71 out of 370) had Low energy-use behavior Ability level, about 34% of the hotel guests (127 out of 370) had Medium-Low energy-use behavior Ability level, about 20% of the hotel guests (73 out of 370) had Medium-High energy-use behavior Ability level, and about 27% of the hotel guests (99 out of 370) had High energy-use behavior Ability level (see Figure 6). Overall, at least 50% of the hotel guests' have Low or Medium-Low Levels of Motivation (187 out of 370), Opportunity (189 out of 370), and Ability (198 out of 370) (see Figures 4–6).

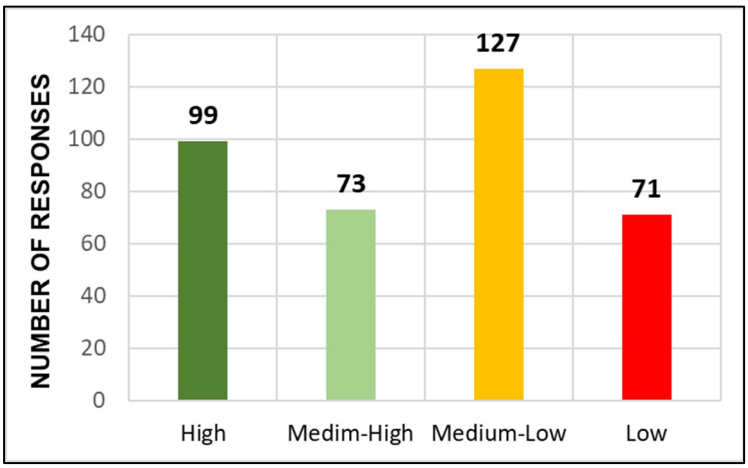

Figure 6. Energy-Use Behavior of Hotel Guests' Ability Level.

5.4. Identifying Energy-Use Profiles of Hotel Guests

In this section, the energy use-profiles of the hotel guests were classified based on energy-use profile matrix designed by the authors that depends on existing studies [4,17] and the template of energy-use profile matrix shown in Figure 3. It was then implemented for the identification of energy-use profiles of the hotel guests in hotel buildings (see Figure 7). The energy-use profiles of hotel guests in this study were: (i) Prone to Change (i.e., guests that are eager in adopting energy saving behavior), (ii) Indifferent to Change (i.e., guests that are neutral in adopting energy saving behavior), (iii) Resistant to Change (i.e., guests that are unwilling in adopting energy saving behavior). Figure 8 shows the energy-use profiles of the 370 participants of the energy-use survey. About 15% of the hotel guests (56 out of 370) were identified to have a Prone to Change energy-use profile in hotel buildings, about 40% of the hotel guests (146 out of 370) were recognized to have an Indifferent to Change energy-use profile, and about 45% of the hotel guests (168 out of 370) were identified to have a Resistant to Change energy-use profile.

Figure 7. Identification of Energy-Use Profiles Matrix [7,20].

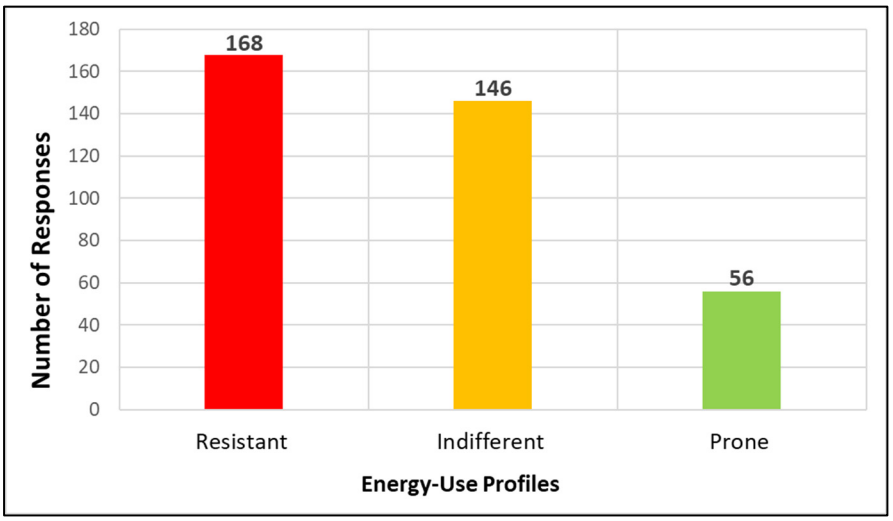

Figure 8. Energy-Use Profiles for Energy-Use Survey Participants.

6. Results and Discussion

In this study, an energy-use survey was designed with a goal to examine the effect of each identified measure on hotel guests' energy-use behavior. Accordingly, fifty-two questions were designed using Qualtrics software, as shown in Appendix A, to measure 11 hypotheses of this study (see Figure 1). In the 52-question energy-use survey, 18 questions were asked (questions 1–18 in Appendix A) to measure five categories representing five hypotheses (H1–H5). The results from these hypotheses were then used to measure the Motivation level of the hotel guests (see Figure 1). Moreover, 11 questions were asked (questions 32–42 in Appendix A) to measure three categories representing three hypotheses (H6–H8). The results from these hypotheses were then used to measure the Opportunity level of the hotel guests (see Figure 1). Additionally, 13 questions were asked (questions 19–31 in Appendix A) to measure three categories representing three hypotheses (H9-H11). The results from these hypotheses were then used to measure the Ability level of the hotel guests (see Figure 1).

The results from the reliability analysis indicated that the most influential questions in the energy-use survey for each of the three MOA levels are: (1) Motivation level: Questions 6, 7, 11, 13, 16, and 17; (2) Opportunity level: Questions 32, 34, 36, 40, and 41; (3) Ability level: Questions 28, 29, 30, and 31. The influential questions are highlighted in blue in Appendix A. These influential questions were then used to identify the energy-use behavior of the hotel guests in hotel buildings by performing the K-means clustering algorithm. After that, the energy-use behavior and energy-use profiles of hotel guests were identified in this study. The energy-use behavior of hotel guests was identified for each of the three MOA levels (i.e., Motivation level, Opportunity level, and Ability level). The energy-use behavior for the 370 hotel guests participated in this study varied from Low energy-use behavior to High energy-use behavior. The energy-use behavior of hotel guests in this study were as follows:

- Motivation level: the results for the Motivation level of hotel guests indicated that about 26% of the hotel guests have Low energy-use behavior, about 24% have Medium-Low energy-use behavior, about 29% have Medium-High energy-use behavior, and about 21% have High energy-use behavior (see Figure 9).

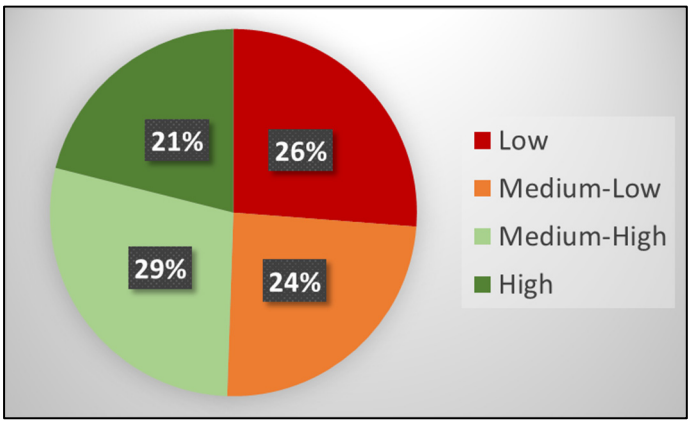

Figure 9. Hotel Guests' Energy-Use Behavior Motivation Level.

- Opportunity level: the results for the Opportunity level of hotel guests showed that about 26% of the hotel guests have Low energy-use behavior, about 25% have Medium-Low energy-use behavior, about 30% have Medium-High energy-use behavior, and about 19% have High energy-use behavior (see Figure 10).

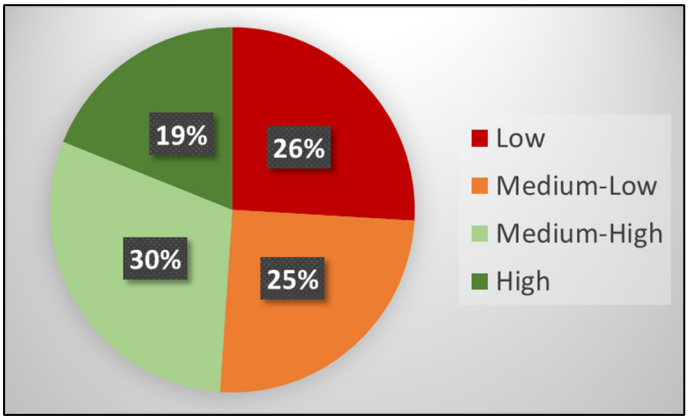

Figure 10. Hotel Guests' Energy-Use Behavior Opportunity Level.

- Ability level: the results for the Ability level of hotel guests indicated that about 19% of the hotel guests have Low energy-use behavior, about 34% have Medium-Low energy-use behavior, about 20% have Medium-High energy-use behavior, and about 27% have High energy-use behavior (see Figure 11).

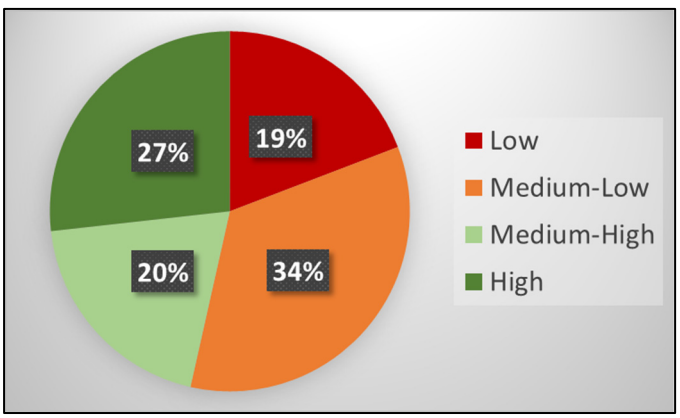

Figure 11. Hotel Guests' Energy-Use Behavior Ability Level.

After determining the energy-use behavior of hotel guests for each of the three MOA levels, the energy-use profiles of hotel guests were identified based on the energy-use profile matrix shown in Figure 7. The energy-use profiles of hotel guests in this study varied from Resistant to Change energy-use profile to Prone to Change energy-use profile. Resistant to Change energy-use profile indicates bad or dark energy consumption behavior of hotel guests and Prone to Change energy-use profile refers to good energy consumption behavior of hotel guests in hotel buildings. Figure 12 shows an example for the process of identifying the energy-use profile of a hotel guest (energy-use survey participant in this study) after the guest's energy-use behavior for each of the three MOA levels has been identified. The guest had Low energy-use behavior Motivation level (i.e., color coded in red), Medium-Low energy-use behavior Opportunity level (i.e., color coded in orange), and High energy-use behavior Ability level (i.e., color coded in green). Applying these findings on the energy-use profile matrix, the energy-use profile of the hotel guest was found to be Resistant to Change as shown in Figure 12.

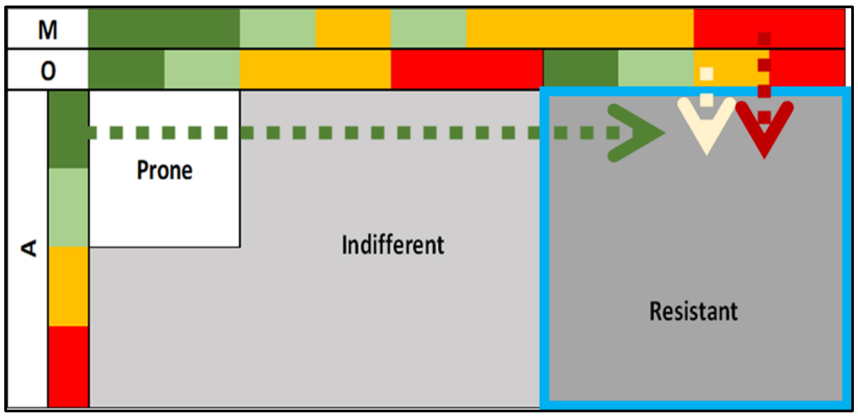

Figure 12. An Example for Identifying the Energy-Use Profile of a Hotel Guest.

Following the same process, the energy-use profiles for the 370 hotel guests participated in this study were identified. The results indicated that about 45% of the hotel guests have Resistant to Change energy-use profiles, about 40% have Indifferent to Change energy-use profiles, and only 15% of the hotel guests have Prone to Change energy-use profiles. This illustrates that 45% of the hotel guests have bad or dark energy consumption behavior, 40% have moderate energy consumption behavior, and only 15% of the hotel guests have good energy consumption behavior (see Figure 13).

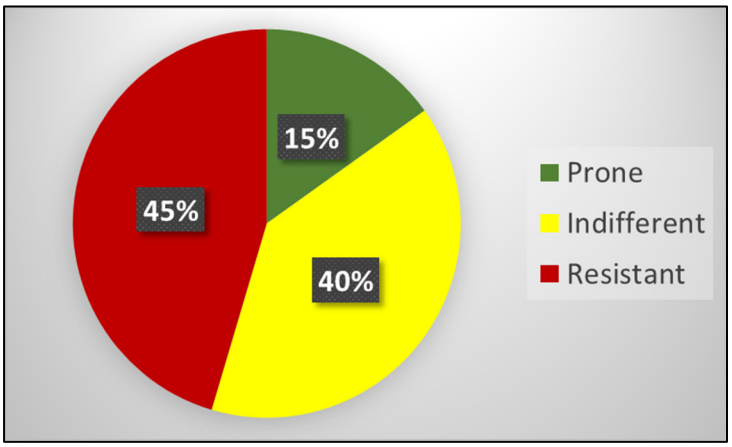

Figure 13. Hotel Guests' Energy-Use Profiles.

Therefore, based on the results, hotel owners and hotel managers in the hospitality industry need to provide aggressive strategies and expensive incentives to hotel guests

that have Resistant to Change and Indifferent to Change energy-use profiles to change their energy consumption behavior toward better. Incentives include providing financial incentives to hotel guests with Resistant to Change energy-use profiles and providing non-financial incentives to hotel guests with Indifferent to Change energy-use profiles. Non-financial incentives refer to those incentives that increase hotel guests' level of excitement, enjoyment, and comfortability in hotel buildings during their stay without money being spent from hotel management. Additionally, hotel guests with Prone to Change energy-use profiles are expected to change their energy consumption behavior by only educating them to increase their awareness about the importance of reducing energy consumption without providing any incentives as suggested by Lindenberg and Steg (9).

The strategies and incentives need to be designed to encourage hotel guests to reduce their energy consumption in hotel buildings and change their energy-related behavior without compromising hotel guests' comfort level. The authors of this study proposed a matrix that shows the possible incentives that can be provided to hotel guests based on their energy-use profiles to change their energy consumption behavior (see Table 4). The proposed incentives were developed in collaboration with a hotel chain in the United States to achieve a win-win outcome for hotel stakeholders (i.e., hotel owners, hotel managers, and hotel guests).

Table 4. Assigning proposed incentives to the hotel guests based on their energy-use profiles.

Energy-Use Profile	Incentives
Prone to Change	-
Indifferent to Change	Free Soft Drink, Hotel Room Upgrade, Free VIP Parking, Free Roll-up Bed
Resistant to Change	Meal Coupon for in Hotel Use, Discounts for Future Stays, Free Soft Drink Coupon, Travel Point on Hotel Reward Card

7. Conclusions

The main goal of this study was to identify the energy-use profiles of hotel guests (i.e., energy-use survey participants in this study) to reduce hotel guests' energy consumption in hotel buildings. To achieve this, an integrated energy-use framework was developed and implemented in six stages: (1) integrating four energy-related behavior models of Motivation-Opportunity-Ability (MOA), Norm Activation Model (NAM), Theory of Planned Behavior (TPB), and Pro-environmental Behavior (PEB) to design the integrated energy-use framework of this study as presented in Figure 1; (2) developing eleven hypotheses and their relevant measures to investigate the relationship among the energy-related behavior models (i.e., MOA, NAM, TPB, and PEB) and hotel guests' energy-use behavior (i.e., MOA levels) as presented in Tables 1–3; (3) conducting an energy-use survey in Qualtrics and distributing the energy-use survey in Prolific (see Appendix A) to analyze the impact of each identified measure on hotel guests' energy-use profiles in hotel buildings; (4) performing energy behavior data analysis using Exploratory Factor Analysis (EFA) in SPSS software to analyze the energy-use survey questions and answers to determine the Motivation, Opportunity, and Ability (MOA) levels for each hotel guest in hotel buildings; (5) analyzing the energy behavior data using K-means clustering algorithm in RapidMiner software to determine energy-use behavior of hotel guests for each of the three MOA levels in hotel buildings; (6) analyzing the energy behavior data using the energy-use profile matrix shown in Figure 7 to identify energy-use profiles of hotel guests in hotel buildings.

The results from the energy behavior data analysis for the energy-use behavior of hotel guests' Motivation level indicated that 50% of the hotel guests have Low to Medium-Low energy-use behavior and 21% have High energy-use behavior. This means that only 21% of the hotel guests (i.e., energy-use survey participants in this study) are highly motivated toward saving energy during their stay in hotel buildings. Additionally, the energy-use behavior of hotel guests' Opportunity level illustrated that 51% of the hotel

guests have Low to Medium-Low energy-use behavior and 19% have High energy-use behavior. This indicates that only 19% of the hotel guests feel that they have the complete accessibility and controllability to hotel room energy systems (e.g., lighting, HVAC, appliances, and electronics) in hotel buildings to save energy consumption. Further, the energy-use behavior of hotel guests' Ability level determined that 53% of the hotel guests have Low or Medium-Low energy-use behavior and 27% have High energy-use behavior**.** This illustrates that about 27% of the hotel guests have perceived knowledge or energy-use knowledge to reduce their energy consumption in hotel buildings.

On the other hand, the results from the energy behavior data analysis also illustrated that 85% of the hotel guests have Resistant to Change and Indifferent to Change energy-use profiles and only 15% of the hotel guests have Prone to Change energy-use profile. This shows that about 85% of the hotel guests have dark and moderate energy consumption behavior and only 15% of the only 15% of the hotel guests have good energy consumption behavior.

Therefore, based on the research findings, the decision makers (i.e., hotel owners and hotel managers) in the hospitality industry need to provide aggressive strategies/interventions and expensive incentives to hotel guests that have Resistant to Change or Indifferent to Change energy-use profiles to change their energy consumption behavior towards better and thus, reduce hotel guests' energy consumption in hotel buildings. For example, providing education and financial incentives to hotel guests that have Resistant to Change energy-use profiles to change their energy consumption behavior including: free soft drinks, free hotel room upgrade, free VIP parking, and free roll-up bed. Moreover, hotel guests that Indifferent to Change energy-use profiles are expected to change their energy consumption behavior by receiving education and incentives that increase their level of excitement, enjoyment, and comfortability such as meal coupon for in-hotel use, discounts for future stays, and travel points on hotel reward card. Additionally, hotel guests that have Prone to Change energy-use profiles are expected to change their energy consumption behavior by just receiving education to increase their awareness about the importance of reducing their energy consumption in hotel buildings without receiving any incentives as suggested by Lindenberg and Steg (9). The strategies and incentives need to be designed to motivate hotel guests to reduce their energy consumption in hotel buildings and change their energy-related behavior without compromising hotel guests' indoor environmental comfort level. The aforementioned incentives were developed in collaboration with a hotel chain in the United States to achieve a win-win scenario for hotel stakeholders (i.e., hotel owners, hotel managers, and hotel guests). The authors of this study will apply the proposed incentives on the hotel guests (i.e., energy-use survey participants in this study) and ask the energy-use survey questions again to measure to what extend the proposed interventions and incentives were effective to change hotel guests' energy-related behavior. This helps to reduce energy consumption in hotel buildings, reduce CO_2 and greenhouse gas emissions, increase hotel owners' profitability, and maintain hotel guests' indoor environmental comfort level. Moreover, the authors will analyze the socio-demographics of the of the 370 participants of this study to investigate if there is a connection between the participants' answer to the energy-use survey questions and the related energy-use profiles.

Author Contributions: Conceptualization, H.P. and A.K.; Methodology, H.P. and A.K.; Software, H.P.; Validation, H.P. and A.K.; Formal Analysis, H.P.; Investigation, H.P.; Resources, H.P. and A.K.; Data Curation, H.P. and A.K.; Writing—Original Draft Preparation, H.P.; Writing—Review & Editing, A.K.; Visualization, H.P. and A.K.; Supervision, A.K.; Project Admin, A.K. Both authors have read and agreed to the published version of the manuscript.

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Institution Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Institutional Review Board of Lawrence Technological University on 25 October 2020.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Not Applicable.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Appendix is the energy-use survey questions, and these questions are ordered based on their relevant hypotheses in the proposed integrated energy-use framework.

Table A1. Energy-Use Survey Questions.

	Questions to Measure H1–Motivation	*MOA*
1	How often do you turn off the lights in your hotel room when not in use to save energy (e.g., sleeping, when not needed, and when not in the room)? Never Rarely Sometimes Often Always	M
2	How often do you adjust thermostat settings (i.e., heat down in winter or up in the summer) in your hotel room to save energy? Never Rarely Sometimes Often Always	M
3	When your hotel room is chilly/cold, which one are you most likely to do? a. Turning up the heat and/or adjusting the thermostat temperature. b. Wearing thicker layers of clothes. c. Asking for an extra blanket. d. Consuming hot drinks (e.g., coffee, tea) e. Do nothing	M
4	When your hotel room is warm/hot, which one are you most likely to do? a. Turning on the ceiling fan and adjusting the thermostat temperature to a higher degree b. Turning on the AC and turning off the ceiling fan c. Turning on the ceiling fan and turning off the AC d. Wearing thin layers of clothes e. Consuming cold drinks (e.g., ice water) f. Do nothing	M
5	I turn off the lights in my hotel room when my hotel room is bright enough. Never Rarely Sometimes Often Always	M
6	What best describes how you think about conserving energy in your hotel room? a. I never think about conserving energy. b. I rarely think about conserving energy. c. I sometimes look for ways to use less energy. d. I often think about my impact on energy use of the building. e. I am committed to reducing my impact on energy use.	M
7	My personal comfort in a hotel room is more important to me than reducing energy consumption. Strongly Disagree Disagree Neither Agree nor Disagree Agree Strongly Agree	M
8	My energy consumption behavior in my hotel room is different when I travel for business purposes than when I travel for pleasure. Strongly Disagree Disagree Neither Agree nor Disagree Agree Strongly Agree	M
9	How often do you use the stairs to access or to leave your hotel room? Never Rarely Sometimes Often Always	M
10	How often do you use the elevator to access or leave your hotel room?	M

	Never Rarely Sometimes Often Always	
	Questions to Measure H2–Personal Norms	**MOA**
11	I feel morally obligated to reduce energy consumption in my hotel room. Strongly Disagree Disagree Neither Agree nor Disagree Agree Strongly Agree	M
12	I feel good about myself when I save energy in my hotel room. Strongly Disagree Disagree Neither Agree nor Disagree Agree Strongly Agree	M
	Questions to Measure H3–Ascription of Responsibility	**MOA**
13	Hotel management is responsible for reducing energy consumption in the hotel, not the guest. Strongly Disagree Disagree Neither Agree or Disagree Agree Strongly Agree	M
14	My personal contribution to the hotel's energy consumption will be negligible. Strongly Disagree Disagree Neither Agree or Disagree Agree Strongly Agree	M
15	I believe that every hotel guest is responsible for the energy consumption of hotel buildings. Strongly Disagree Disagree Neither Agree nor Disagree Agree Strongly Agree	M
	Questions to Measure H4–Attitude	**MOA**
16	When travelling, saving energy in my hotel room is: Not important at all Slightly important Somewhat important Moderately important Very important	M
	Questions to Measure H5–Environmental Concern	**MOA**
17	How much are you concerned about your personal energy consumption in your hotel room? Not at all concerned Slightly concerned Somewhat concerned Moderately concerned Extremely concerned	M
18	I think environmental problems are important and cannot be ignored. Strongly Disagree Disagree Neither Agree nor Disagree Agree Strongly Agree	M
	Questions to Measure H6–Social Norms	**MOA**
32	In general, the hotel management expects me to turn off the lights when leaving the room or when not needed. Never Rarely Sometimes Often Always	O
33	In general, my room companion(s) expect me to turn off the lights when leaving the room or when not needed. Never Rarely Sometimes Often Always	O
34	The hotel management expects me to shut down or change the HVAC thermostat setting when leaving the room or when not needed. Never Rarely Sometimes Often Always	O
35	My room companion(s) expects me to shut down or change the HVAC thermostat setting when leaving room or when not needed. Never Rarely Sometimes Often Always	O
36	In general, the hotel management expects me to use the ceiling fan and adjust the thermostat setting when leaving room or when not needed. Never Rarely Sometimes Often Always	O
37	In general, my room companion(s) expects me to use the ceiling fan and adjust the thermostat setting when leaving room or when not needed. Never Rarely Sometimes Often Always	O
38	My room companion(s) is/are concerned about his/her energy consumption during our stay at a hotel room. Never Rarely Sometimes Often Always	O
39	My room companion(s) try to reduce his/her energy consumption during our stay at a hotel room. Never Rarely Sometimes Often Always	O
	Questions to Measure H7–Hotel Management Support	**MOA**
40	Hotels that I have visited often encourage guests to save energy by providing education and information.	O

	Strongly Disagree Disagree Neither Agree nor Disagree Agree Strongly Agree	
41	Hotels that I have visited are often committed to saving energy. Strongly Disagree Disagree Neither Agree nor Disagree Agree Strongly Agree	O
	Questions to Measure H8–Physical Effort	**MOA**
42	It usually takes more physical effort than it is worth to reduce energy consumption in a hotel room. Strongly Disagree Disagree Neither Agree nor Disagree Agree Strongly Agree	O
	Questions to Measure H9–Environmental Perceived Knowledge	**MOA**
19	Energy conservation is a topic that people like me can understand. Strongly Disagree Disagree Neither Agree nor Disagree Agree Strongly Agree	A
20	I am aware of the effects of global warming. Not at all aware Slightly aware Somewhat aware Moderately aware Extremely aware	A
21	I know how to reduce the cooling load (e.g., AC usage) in my hotel room. Strongly Disagree Disagree Neither Agree nor Disagree Agree Strongly Agree	A
22	I know how to reduce the heating load (e.g., usage of furnace) in my hotel room. Strongly Disagree Disagree Neither Agree nor Disagree Agree Strongly Agree	A
23	I know how to reduce the lighting usage in my hotel room (e.g., open the blinds to allow for natural light). Strongly Disagree Disagree Neither Agree nor Disagree Agree Strongly Agree	A
	Questions to Measure H10–Actual Knowledge	**MOA**
24	Which typically uses the least energy annually in an average hotel room in the US? a. Lighting b. HVAC (Heating, Ventilation, and Air Conditioning) c. Electronics d. Appliances e. Do not know	A
25	How long does it take for a 100-watt light bulb to consume 100 watts of energy? a. 1 s b. 1 min c. 1 h d. 1 day e. Do not Know	A
26	What is your total electric energy cost if your total electric usage for a month is 1000 kWh, at a utility rate of $0.10/kWh? a. $1 b. $10 c. $100 d. $1000 e. Do not know	A
27	Which of the following energy resources is not renewable? a. Solar b. Biomass (wood, waste, plants, alcohol fuels) c. Coal d. Water (hydro) power e. Geothermal	A
	Questions to Measure H11–Perceived Behavioral Control	**MOA**
28	Adopting energy saving practices in my hotel room is completely within my control. Strongly Disagree Disagree Neither Agree nor Disagree Agree Strongly Agree	A
29	Adopting energy saving practices in my hotel room is completely within the control of hotel management.	A

	Strongly Disagree Disagree Neither Agree nor Disagree Agree Strongly Agree	
30	I am confident that I can reduce my energy consumption in a hotel room during my stay. Never Rarely Sometimes Often Always	A
31	I usually have time and opportunity to save energy in my hotel room during my stay. Never Rarely Sometimes Often Always	A
	Socio-demographic Questions	**MOA**
43	What is your age? Under 20 20–24 25–30 31–35 36–39 40–44 45–49 50–54 55–59 60–65 65 and older Prefer not to answer	A
44	What is your gender? Male Female Prefer not to answer	A
45	What is your education level? * No schooling completed, or less than 1 year Nursery, kindergarten, and elementary (grades 1–8) High school (grades 9–12, no degree) High School graduate (or equivalent) Bachelor's degree (BA, BS, AB, etc.) Master's degree (MA, MS, MENG, MSW, etc.) Professional degree (MD, DDC, JD, etc.) Doctorate degree (PhD, EdD, etc.) Associate degree (AA, AS, AAA, AAS)	A
46	What is your ethnic background? White (e.g., German, Irish, English, Italian, Polish, etc.) Hispanic, Latino, or Spanish Origin (e.g., Mexican or Mexican American, Puerto Rican, Cuban, Salvadoran, Colombian, etc.) Black or African American (e.g., African American, Jamaican, Haitian, Nigerian, Somalian, etc.) Asian (e.g., Chinese, Filipino, Asian Indian, Vietnamese, Korean, Japanese, etc.) American Indian or Alaska Native (e.g., Navajo Nation, Blackfeet Tribe, Mayan, Aztec, Nome Eskimo Community, etc.) Middle Eastern or North African (e.g., Lebanese, Iraqi, Egyptian, Moroccan, Turkish, etc.) Native Hawaiian or Other Pacific Islander (e.g., Native Hawaiian, Samoan, Chamorro, Tongan, Fijian, Marshallese, etc.) Other Prefer not to answer	A
47	What is your annual income? Less than $20,000 $20,000 to $34,999 $35,000 to $49,999 $50,000 to $74,999	A

	$75,000 to $99,999 Over $100,000 Prefer not to answer	
48	How often do you travel annually? Once a year Once every few years 2 or 3 times a year 4 or 5 times a year More than 5 times a year Never	A
49	What the purpose of your trip(s) generally? Pleasure Business	A
50	What is your current employment status? Employed full time (40 or more hours per week) Employed part time (up to 39 h per week) Unemployed Student Retired Prefer not to answer	A
51	In general, what is your annual travel budget? Less than $500 $500–$1200 $1200–$2200 $2200–$4000 More than $4000	A
52	With whom do you travel most often? (choose all that apply) Spouse Family member(s) Co-worker(s) Friend(s) I usually travel solo	A

* Educational attainment from US census https://www.census.gov/hhes/socdemo/education/about/.

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