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Antecedents of Electricity-Saving Behavior in Mountain Road Tunnel-Construction Sites: A Multi-Level Modeling Analysis

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Abstract: The electricity-saving behavior of construction workers is helpful in reducing construction costs, protecting the ecological environment, and preventing global climate change. However, there is insufficient research on the electricity-saving behavioral mechanisms of tunnel-construction workers, and their behavior is influenced by their surrounding people including supervisors and co-workers because they are nested in various construction sites and isolated from other acquaintances. This study aims to develop a hierarchical linear model that explores the interrelationships between tunnel-construction workers' electricity-saving behavior and four influencing factors theoretically and empirically. An organizational-level factor, electricity-saving climate, and three individual-level factors, including attitude, perceived behavioral control, and moral norms, are considered, and 1567 tunnel-construction workers from 41 construction sites mainly located in the southwest of China participated in this study. A six-step procedure for statistical analyses is adopted to test eight hypotheses using questionnaire survey data. The results supported all the hypotheses within the multi-level model and showed that the organizational-level factor played a leading role in predicting workers' electricity-saving intentions with three individual-level factors positively associated with workers' electricity-saving intentions. Further, the organizational electricity-saving climate also indirectly affects workers' electricity-saving intentions through three mediators (individual-level factors), and electricity-saving intention is positively associated with electricity-saving behavior. Consequently, cultivating an electricity-saving climate within an organization is of great benefit to electricity conservation and environmental protection, and several recommendations are provided to improve the practical operability of results. The findings enable a better understanding of electricity-saving behavioral mechanisms and promote a low-carbon lifestyle among tunnel-construction workers.

Keywords: road tunnel; electricity-saving climate; tunnel-construction sites; multi-level modeling analysis

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1. Introduction

With the rapid improvement of China's economy, infrastructure is continuously improving, and lots of road tunnels which are usually key points of the highways have been built to alleviate the traffic pressure. Unlike other projects, road tunnels are usually built below the ground and feature semi-closure structures. Apart from urban road tunnels, lots of road tunnels are located in mountainous areas to overcome the disadvantages of unfavorable terrain and reduce passage time. The construction procedure of road tunnels is complex and includes drilling and explosion, slag removal, reinforcement grid, spraying shotcrete, secondary lining, inverted arch, and so on. The whole process is highly energy-consuming due to the additional lighting to ensure the completion of tasks and additional ventilation to provide a healthy work environment for the construction workers. Consequently, electricity cost accounts for a non-ignorable part of the total cost during the whole process of road-tunnel construction [1]. Meanwhile, it is not easy to have access to electricity for mountain road tunnel-construction sites, which are far from the conventional power facilities in urban areas, and thus special electricity transmission lines are necessary to provide power, which undoubtedly increases the construction cost further. Therefore, workers' electricity-conservation behavior is of benefit to decreasing the total cost in terms of construction-project management. More importantly, electricity-saving behavior is also an important kind of green behavior and is of great significance to protect the ecological environment, including reductions in greenhouse gas emissions, mitigating global climate change, decreasing pollution, and avoiding an excessive consumption of limited natural resources, in addition to economic benefits [2–4].

It is widely believed that the dominant cause of most environmental problems is people [5], and the patterns of people's behavior play an important role in reducing electricity consumption [6–10]. Consequently, considering the negative environmental consequences and huge potential for electricity conservation, a series of measures should be taken to promote electricity-saving behavior. Generally, the measures targeting electricity-saving behavior could be classified into three categories, namely economic, technological, and psychological behavior-oriented perspectives. An economic-oriented perspective mainly represents price-based measures like peak-load pricing [11]. Previous studies found that these measures failed to achieve the expected results [12], and this may be due to the fact that a portion of people are not sensitive to electricity price variation and would not sacrifice their comfort in exchange for electricity conservation [13]. Technological-oriented perspective features energy-efficient technologies, materials, and appliances, and some evidence shows that this kind of measure may not be sufficient because of the existence of the rebound effect [14–17]. Therefore, considering the limited effects of economic- and technological-oriented perspectives, many scholars have researched the impact of various psychological factors on the residents' electricity-saving behavior at home or in workplaces, which is an essential kind of pro-environmental behavior, and these findings are meaningful in terms of developing effective and low-cost interventions to achieve electricity-consumption reduction and a sustainable development goal.

In the pro-environmental behavior domain, several behavioral theories, such as the theory of reasoned action (TRA), the norm-activation model (NAM), and the theory of planned behavior (TPB), have been applied to explore the determinants of pro-environmental behaviors. However, many scholars have criticized the TRA and the NAM for their limitations, like ignoring external factors and non-volitional factors [18,19], and thus the theory of planned behavior (TPB) has been extensively selected as the basic theoretical framework to understand electricity-saving behavior [4,20]. Du and Pan proposed a social psychological model based on the TPB model to explore gender differences in energy-saving behaviors among young people who bear enormous pressure in fighting climate change and protecting the environment [21], and the results showed that TPB constructs were important predicting factors for both female and male participants. Apart from TPB constructs, it should be noted that several psychological factors and variables can also be added to obtain the explanatory power of the proposed model. Due to the conceptual dissimilarity with TPB variables, self-identity, connectedness to nature, and moral norms also have been adopted by many previous studies to enhance the explanation power of the proposed model in the field of pro-environmental behaviors [4,22–24].

Apart from the individual-level factors above, some scholars have considered some group-level factors like organizational energy-saving climates, group norms, and so on [25–27], while the influence of these factors varies due to the differences in a social environments and the various functions of these spaces [26]. In shared places like open-plan offices, workers who adopt a wasteful lifestyles consume twice the standard amount of energy while those with an austere lifestyle use 50% less energy than the standard [28], which indicates the potential for the reduction in energy waste in shared workplaces like tunnel-construction sites through changing workers' behavior toward efficient electricity use. In order to unleash the potential of energy conservation, networks of social relations can not be ignored within an organization because the thoughts and behaviors of employees are influenced by others subliminally through communication and behavioral interaction, besides the individual-level constructs of the TPB theory mentioned above. Especially for tunnel-construction workers, mountain tunnel-construction sites are generally far from urban areas. It is not realistic that construction workers commute between home and work locations daily. Consequently, they spend most of their time on construction sites, and thus their lives are isolated from other people except for their supervisors and colleagues. The workers are not supposed to be treated as discrete individuals since their thoughts and behaviors can be predicted by the organizational climate cultivated by all the members within an organization, which indicates that the variation among the organizations in terms of the organizational climate predicting the workers' behaviors. In the context of electricity-saving behavior, it can also be assumed that the organizational-level factor may play a leading role in predicting the individuals' electricity-saving behavior because the workers are nested in an organization and can not be independent of the other members. Considering the great normative pressure from others within an organization, a multiple-level model is more suitable to predict the behavior of employees to avoid a problem called individualistic fallacy (or atomistic fallacy) compared with other models like the structural equation model, which many previous studies have adopted [22,24,26,29]. Further, although many studies researched the determinants of electricity-saving behavior, few scholars regard road tunnel-construction workers as their target group. On one hand, promoting electricity-saving behavior among workers is of great significance to environmental protection, including carbon and air pollution particle-emission reduction and resource conservation like other pro-environmental behaviors. On the other hand, energy conservation is also beneficial in lowering construction costs due to additional lighting and ventilation. Considering the isolation of workers from other acquaintances during the construction process, it is of necessity to build a multi-level model to consider the variation in terms of organizational-level factors, and the objectives of this study are as follows:

(1) Identify the organizational-level factors and individual-level factors that influence the workers' electricity-saving behavior and establish a hypothetical model indicating their interactions on the basis of the TPB theory;
(2) Validate the dominant role of the organizational-level factor and its direct and indirect impact on the workers' intentions and behaviors.

To achieve these objectives, this study adopted a multi-level model to explore the electricity-saving behavioral mechanisms of tunnel-construction workers. Compared with previous studies, this study contributes to the following aspects. First, to the best of our knowledge, few studies focus on tunnel-construction workers' electricity-saving behavior, while the positive behavioral transformation to low-carbon lifestyles of the workers not only leads to a positive impact on the ecological environment but also decreases the cost in terms of the project construction. Second, many previous studies applied the structural equation model (SEM) to explore interrelationships between electricity-saving behavior and its influencing factors even for employees within an organization, ignoring the hierarchical nature of research data. Unlike other employees from other organizations, mountain tunnel-construction workers spend the most time in construction sites and are easily influenced by their supervisors and co-workers, and it is more appropriate to adopt a multi-level model to reflect the organizational variation among construction workers across different sites, and then hierarchical linear modeling (HLM) is adopted in this study. Finally, the empirical findings could practically help project managers design behavioral strategies for electricity saving in mountain tunnel-construction sites.

2. Literature Review and Research Framework

During the development of the multi-level model, two or more levels of factors should be identified in the framework based on the research objectives and nature of the questionnaire survey data. Taking a two-level model as an example, the model generally consists of group-level (or organizational-level) and individual-level variables. The organizational-level variables represent the variation among different organizations, and it is supposed to be consistent within each organization. As for individual-level variables, there are generally explanatory and outcome variables that reflect the variation among individuals, and outcome variables are influenced by organizational-level and explanatory individual-level variables while the relationship between explanatory individual-level and organizational-level variables depends on the research framework. In this study, a two-level model including one organizational- and five individual-level factors is developed, and the factors and their relationships are as follows.

2.1. The Organizational-Level Factor

China is a collectivist society with a strong emphasis on group cohesiveness, and how individuals think and behave is influenced by others, especially for the people who share considerable time with their colleagues, family, or friends. Most electricity-consumption behavior occurs in the presence of others within an organization, and thus the conduct of an individual is influenced by supervisors and co-workers. Consequently, people's behavior in shared spaces like construction sites should be studied in group contexts rather than in isolation [30].

An organizational climate is a series of common values perceived by the members within the organization, which allows the employees to know and understand the organization. Therefore, the organizational electricity-saving climate is a set of cognitive aspects closely related to an individual's electricity-saving behavior. It has been proved that common values, shared norms, interaction, etc., would unavoidably affect individuals' behaviors consciously and unconsciously [31]. Comprehending the group dynamics occurring within the organization contexts is of great significance due to the imperceptible influence on the targeted behavior. Zhu et al. proposed a model based on the dynamic group theory to explore the influence of group-level factors and found that common group values and group interaction are important predictors of individuals' energy-saving intentions while direct suggestions or instructions given to an individual have limited influence [26]. Evidence has shown that it is less likely for lights to be switched off in unoccupied rooms than in shared offices because individuals have a stronger intention to improve their pro-environmental behaviors influenced by the opinions of their peers within a group, which indicates that common values or goals are of benefit to motivate pro-environmental behaviors and achieve sustainable goals [32]. Another study also shows that people would follow the good examples set by their group members within the same organization [33], and thus it is reasonable to assume that one member's electricity-saving behavior would favorably guide other members. Zhang et al. argued that organizational measures to save energy entailed active employee participation to achieve sustainable-development goals, and confirmed that the organizational electricity-saving climate was the antecedent of energy-saving behaviors [27]. Road tunnel-construction sites are usually located in mountainous areas and are far from urban areas, and there are living and labor areas to satisfy the living and work demands of construction workers. Therefore, construction workers spend most of their time with supervisors and co-workers during the tunnel-construction period except for short-term vacations. It is natural that individuals care about their self-image within their interpersonal circle and would make efforts to match their beliefs with common values, and thus the impact of organizational climate is supposed to be great for tunnel-construction workers. Consequently, the first hypothesis is as follows:

H1. *Organizational electricity-saving climate is positively associated with electricity-saving intention.*

2.2. Individual-Level Factors

2.2.1. Attitude

Attitude refers to an individual's positive or negative evaluations of a specific behavior. Generally, it is believed that an individual who holds a more affirmative attitude towards a certain behavior shows a stronger intention to carry out the behavior.

Concerning green behaviors, Stern argued that attitude should be prioritized over other TPB variables [34]. The powerful predictive capacity of attitude has been proved by many studies regarding various pro-environmental behaviors: bicycle commuting to reduce vehicle pollution emissions [35], waste cycling [36], and some other pro-environmental behaviors [24]. In the domain of energy conservation, attitude also plays an important role in predicting an individual's behavioral intentions like purchasing energy-efficient appliances [37] and energy saving [38]. So, it is reasonable that construction workers are prone to saving electricity if they positively evaluate electricity-saving behavior.

In construction sites, workers share a large proposition of living and working spaces where they share energy resources. Workers closely interact with each other almost every moment in terms of many aspects, and it is reasonable that their behavioral beliefs and behaviors are more likely to be influenced by the organizational climate. Consequently, the workers' common values regarding conscious and efficient electricity use have the potential to influence their evaluations of electricity conservation and are of great benefit in promoting people's electricity-saving behavior within shared spaces. A previous work found that an individual would show a positive attitude toward one pro-environmental behavior if he or she perceived the benefits of executing this behavior [39]. Through interaction, which is conducive to increasing the visibility of common values, workers can be aware that electricity-saving behavior not only prevents negative impacts on the environment but also reduces construction costs, which can contribute to a positive evaluation of electricity-saving behavior. Zhang et al.'s work also validated the important role of organizational electricity-saving climates in predicting individuals' electricity-saving beliefs [27]. Consequently, the hypotheses are as follows:

H2. *Attitude mediates the relationship between organizational electricity-saving climates and electricity-saving intentions.*

H2a: *An organizational electricity-saving climate is positively associated with attitude.*

H2b: *Attitude is positively linked to electricity-saving intention.*

2.2.2. Perceived Behavioral Control

Perceived behavioral control (PBC) is an individual's perception of the ease or difficulty in performing the behavior. In the context of the TPB model, people's intention to conduct one specific behavior is supposed to be stronger if they perceive great control over it.

In the field of energy-saving behaviors, personal capabilities are supposed to shape users' energy-usage behavior to some extent. If a worker knows lots of energy-efficient manners and has an abundance of resources to save electricity, he or she would like to live a more efficient lifestyle with a perception that electricity saving is an easy practice for them. Many previous studies have validated the significant role of PBC in predicting energy-saving behaviors. Zhang et al. regarded PBC as a control variable and validated that it was a significant predictor of electricity-saving intention [40]. Additionally, Wang et al. also found that PBC was positively associated with energy-saving intention like the other two TPB constructs [4].

In an organization with a positive electricity-saving climate, it can be inferred that individuals with more energy-saving skills, knowledge, and implements are more likely to activate the interaction regarding energy saving, and spread essential tips and useful experience to reduce other workers' perceived difficulties, which inevitably promotes energy-saving behavior and pursues organizational interests. Meanwhile, apart from daily communication, it is supposed that witnessing others' pro-environmental behavior provides ideas and manners for others to imitate [41], which means that workers within the organization would feel it easy to conduct energy-saving behaviors when the people surrounding them are doing so. Consequently, the organizational electricity-saving climate featuring the interaction and visibility of electricity-saving behavior could improve the workers' PBC. As a result, the following hypotheses are below:

H3. *PBC mediates the relationship between the organizational electricity-saving climate and electricity-saving intention.*

H3a: *Organizational electricity-saving climates are positively associated with PBC.*

H3b: *PBC is positively linked to electricity-saving intention.*

2.2.3. Moral Norm

The moral norm is a normative variable and refers to feelings of moral obligations to adopt or refuse to adopt a behavior [42]. In many other behavioral theories, similar variables are adopted to predict human behavior [43], e.g., personal norms in the norm-activation model [42], personal norms in the value-belief-norm theory [44], and personal norms and perceived responsibility in the phase model of behavior change [45]. Wittenberg et al. argue that moral norms are an effective factor in assessing altruistic or pro-social behavior and behavioral intention [46].

When employees share the workplace, it is less likely for them to conduct one specific behavior that they believe is only beneficial for the organization. There is evidence that it is more likely for employees to leave the lights on instead of switching off them at workplaces than at home [47], which is an important cause of electricity waste in organizations, and this behavior deviation between the workplace and home is because they may believe that they save electricity for the organization rather than themselves. However, the sense of moral obligations could promote altruistic behaviors at workplaces, like electricity-saving behavior, which has been validated by many studies. An individual with moral norms may believe that one behavior is beneficial for the group is also conducive to himself, and there are more possibilities for him or her to possess a stronger intention to conduct such behaviors like saving electricity [48]. If individuals are aware of the serious consequences of their behavior on the environment, they would feel an obligation to protect the environment by trying to conduct pro-environmental behaviors like purchasing energy-efficient appliances [37].

Collective behavior like energy consumption in a shared space is a group phenomenon, as it results from behaviors by group members and is motivated by the social environment. In shared spaces, peoples' behavior is observed by others, and an individual may be reminded by others if he behaves less sustainably in terms of energy consumption due to the violation of the electricity-saving climate. Mutual interactions with each other in construction sites where employees live and work could spread the common values and goals contained by the organizational electricity-saving climate, which could cultivate a sense of obligation for the workers to save electricity. Except for this, if one group member's pro-environmental behavior like saving energy is witnessed by other members, there are more possibilities for others to imitate this behavior and realize that such altruistic behavior could benefit all members and is a responsibility for those who share the workplaces [49]. Therefore, the following hypotheses are below:

H4. *Moral norms mediate the relationship between the organizational electricity-saving climate and electricity-saving intention.*

H4a: *Organizational electricity-saving climates are positively linked with the moral norm.*

H4b: *Moral norms are positively associated with electricity-saving intention.*

2.2.4. Electricity-Saving Intention

The Theory of Planned Behavior (TPB) is one of the pioneer studies to investigate the relationship between an individual's behavioral intention and behavior [50], and behavioral intention has been validated as a significant predictor of an individual's behavior. Gkargkavouzi et al. proved that intention is the most important predictor of pro-environmental behavior [24], and Du and Pan's work also validated the powerful capacity of intention in predicting energy-saving behavior for both female and male students [21]. It is reasonable that tunnel-construction workers' strong intention is beneficial in promoting their electricity-saving behavior. Therefore, the following hypothesis is developed:

H5. *Electricity-saving intention is positively associated with electricity-saving behavior.*

2.3. Research Framework

Based on the hypotheses above, the two-level model is constructed to explore the cross-level interrelationships underlying the mechanisms of tunnel-construction workers' electricity-saving behavior, as shown in Figure 1.

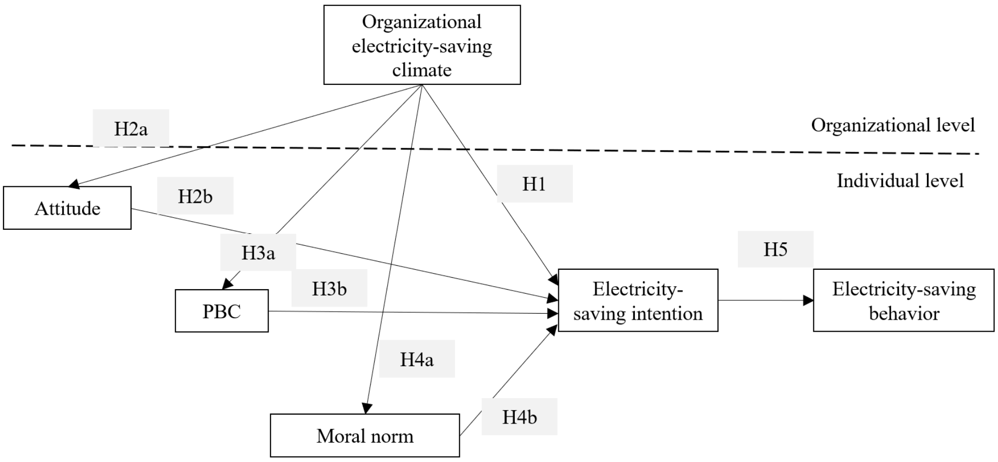

Figure 1. Framework of the HLM model in this study.

3. Methodology

3.1. Sample and Data Collection

The research protocol in this study was approved by the Ethics Committees of Sichuan Normal University. In order to explore the electricity-saving intention of workers in different construction sites, 41 tunnel-construction sites are selected in this study, which is shown in Figure 2, and most of them are located in western China. The reasons for the sample selection are as follows: (1) western China is mountainous and features lots of road tunnels; (2) and the research team could contact many construction-site managers.

The electronic version of the questionnaire was sent to the 41 leaders of the construction sites first, and we ensured that the leaders are aware of the research purpose and research procedure. The data collection procedure is below. At first, the leader of the construction sites would fill out the questionnaire concerning the organizational-level variable to evaluate the organizational electricity-saving climate of the construction sites because the leader has a clearer understanding of the organizational electricity-saving climate compared with the workers. Consequently, the variation across the construction sites in terms of the organizational level factor is obtained. Then, the site supervisors would hand out the questionnaire to the workers and explain the details of the questions, and both workers and supervisors filled out the questionnaire regarding the individual-level variables anonymously and were informed that the results were only used for academic research. The inclusion criteria for workers were as follows: the workers should have worked on the site for at least three months to ensure that they fit into their surrounding co-workers. It should be noted that most of the workers (more than 98 percent) are male in tunnel-construction sites, and female workers are generally responsible for rear service work. Consequently, only male workers are included in this study. At last, 1621 workers including the site supervisors participated in the study while 54 workers did not meet the requirements of the inclusion criteria. So, the results of 1567 workers are adopted in the analysis procedure, and there are 27 to 47 workers for each site. The basic demographic parameters of valid participants are listed in Table 1.

Figure 2. Locations of tunnel-construction sites.

Table 1. Basic demographic parameters of participants.

Demographic Parameters		Sample	Percentage (%)
Age			
	20–29	123	7.85
	30–39	421	26.87
	40–49	647	41.29
	50–59	327	20.87
	60 or above	49	3.13
Education			
	Junior High School or below	234	14.93
	Senior High School	923	58.91
	University or above	410	26.16
Working Experience			
	≤5 years	94	6.00
	6–10 years	323	20.61
	11–15 years	347	22.14
	16–20 years	381	24.31
	≥21 years	422	26.94
Average Work Hours Daily			
	≤8 h	87	5.55
	8–12 h	1109	70.77
	≥12 h	371	23.68

3.2. Measurements

The measurements consist of three parts, which are demographic information, an organizational-level factor, and five individual-level factors. The measurement items adopted in this study are listed in Table A1 in Appendix A.

3.2.1. Demographic Information

The basic demographic parameters of road tunnel-construction workers are collected in this study, and the participants would provide information regarding their age, education, working experience, and average work hours daily. Additionally, there is one question adopted to eliminate the invalid participants who do not meet the requirements of the inclusion criteria. The question is "Have you worked in the construction site for at least three months?", and two options including "yes" and "no" follow.

3.2.2. The Organizational-Level Factor

The organizational electricity-saving climate is measured by five questions within the definition to establish the variation across the construction sites in terms of the organizational climate, and the measuring items were adapted from previous studies [27,51,52]. The questionnaire concerning the organizational-level factor (organizational electricity-saving climate) is filled by the leaders of the construction sites.

3.2.3. Individual-Level Factors

The five individual-level variables are measured by three to four measuring items to evaluate the workers' attitude, PBC, moral norms, intentions, and electricity-saving behaviors, and the measuring items are developed according to the definitions of the variables. In this study, reversed questions are avoided to eliminate misunderstandings among the construction workers.

Attitude, which refers to the individual's beliefs regarding a certain behavior based on expected results, contains four items adapted from several studies [21,27]. PBC presents the perceived difficulty level of conducting a specific behavior and is measured by three measuring items which are referred to a few previous studies [4,53]. The moral norm reflects an individual's feelings of moral obligations to behave in a certain manner and is obtained by three questions according to several works of similar research [37,53]. Electricity-saving intention is assessed using questions adapted from Chen's work [54]. The measuring items of electricity-saving behavior consist of three items, which are popular strategies referring to electricity-saving tips and common practices in tunnel-construction sites [21,37]. All measures were rated based on a five-point Likert scale, and higher scores mean positive electricity-saving attitudes, stronger control over electricity saving, a higher sense of moral responsibility to save electricity, stronger intention, and more frequent electricity-saving behaviors. Both the supervisors and workers would fill out the questionnaire regarding individual-level variables.

Before being delivered to the target population to collect data, the questionnaire was checked by three experts who possess abundant research experience regarding pro-environmental behavior to ensure the validity and accuracy of the questions.

3.3. Research Procedure

In the context of social sciences, data is supposed to be hierarchical or multi-level in nature because employees are nested within organizations and the independence between employees may not hold due to the existence of social networks. In this situation, hierarchical linear modeling (HLM) is more suitable for exploring the relationships between the outcome variable and influencing factors within a multi-level model. Generally, HLM is regarded as an extension of the structural equation model (SEM), considering the hierarchical nature of research data. The improvement of the predictive capacity by taking the variation across groups or organizations into account has been validated [55].

In this study, four HLM sub-models will be used [29], and they are as follows: a null model or one-way ANOVA (analysis of variance) model with random effects (hereafter, model 0); a random coefficient regression model (hereafter, model 1); an intercept model (hereafter, model 2); and a full model (hereafter, model 3). Generally, an individual-level variable is set to be the outcome variable. In the null model, only the outcome variable and group number are input, and several indices are used to examine whether the HLM model is suitable, i.e., ICC1 and ICC2. ICC1 is called the intra-class correlation coefficient, and reflects the difference between groups. If ICC1 is too low, it indicates that the HLM model is not suitable for the research problem. ICC1 $\leq$ 0.059, 0.059 < ICC1 < 0.138, and ICC1 $\geq$ 0.138 indicate the low, medium, and high differences between groups [56]. ICC2 represents the reliability of averages and should be larger than 0.7 [57]. In model 1, other individual-level variables are input as explanatory variables, and their capacity in predicting the outcome variable is investigated. In model 2, the influence of group-level variables is explored while individual-level variables are not considered. In the full model, both group-level and individual-level variables are input to predict the outcome variable.

Considering the hypotheses H2a, H3a, and H4a, three individual-level variables (attitude, PBC, and moral norms) are the outcome variables of the organizational electricity-saving climate, and three simple two-level models should be constructed. Meanwhile, a model with electricity-saving intention as the outcome variable and other individual-level variables (attitude, PBC, and moral norm) and the organizational-level factor (organizational electricity-saving climate) as explanatory variables can be adopted to validate hypotheses H1, H2b, H3b, and H4b. Consequently, a six-step research procedure is adopted in this study, as shown in Figure 3. From steps 1 to 3, the between-group and within-group variance of construction workers' attitudes, PBC, and moral norms, and the influence of the organizational-level factor (organizational electricity-saving climate) on attitude, PBC, and moral norms, are also explored (H2a, H3a, and H4a), which means that the path coefficients and their corresponding *p*-values are obtained. In step 4, we aim to examine the between-group and within-group variance of construction workers' electricity-saving intentions, and the influence of both organizational-level and individual-level factors are investigated using models 0 to 3 (H1, H2b, H3b, and H4b), where path coefficients and *p*-values are obtained. Sobel's test is adopted to examine the mediation effects (H2, H3, and H4) in step 5. In the final step, the relationship between electricity-saving intention and behavior is explored by simple linear regression (H5). The statistical software of SPSS18 and HLM6.0 were adopted to conduct data analysis.

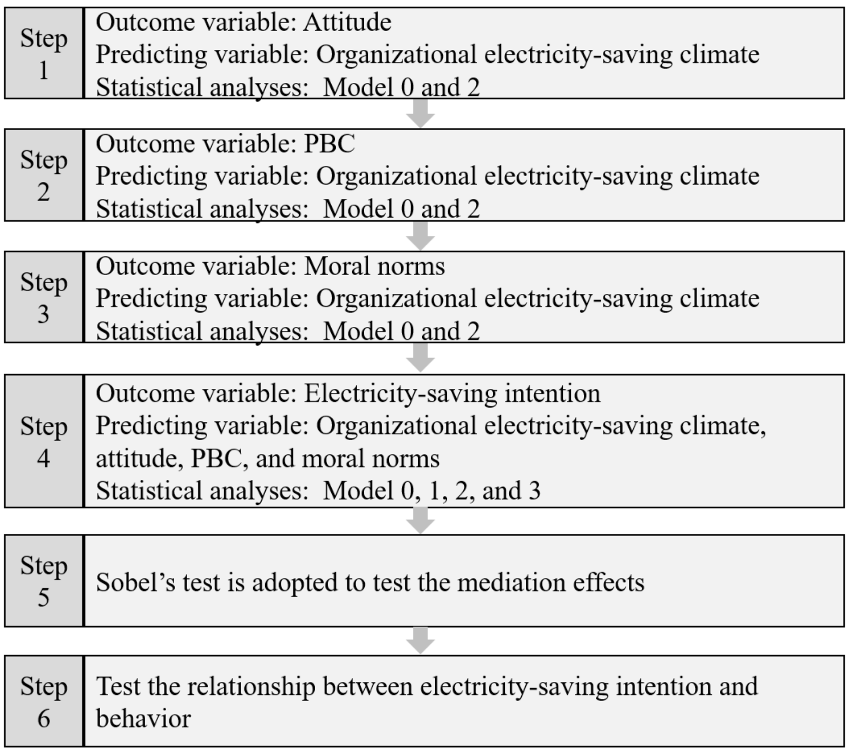

Figure 3. The process of statistical analyses.

4. Results

4.1. Correlation of Variables at Both Organizational and Individual Levels

The Cronbach's alpha coefficient was adopted to carry out a reliability analysis to ensure the internal consistency of the scales. The lowest acceptable criterion of Cronbach's alpha is 0.7 in the reliability test. Analyzing the obtained data, the results showed that values of Cronbach's alpha for organizational electricity-saving climate, attitude, PBC, moral norms, intention, and behavior were 0.813, 0.796, 0.714, 0.866, 0.756, and 0.826, respectively, which were all larger than 0.7. Consequently, the internal stability of all constructs was satisfied.

Table 2 lists the descriptive analysis results of all constructs including the means, standard deviations, and intercorrelations of the studied variables. Both the organizational-level variable (the organizational electricity-saving climate, r = 0.462, $p < 0.01$) and three individual-level variables (attitude, r = 0.432, $p < 0.01$; PBC, r = 0.321, $p < 0.05$; and moral norm, r = 0.337, $p < 0.05$) were positively associated with electricity-saving intention. Meanwhile, organizational electricity-saving climate was positively linked to three individual-level behavioral intention predictors (attitude, r = 0.364, $p < 0.05$; PBC, r = 0.348, $p < 0.05$; and moral norm, r = 0.289, $p < 0.05$). At last, the relationship between behavioral intention and behavior was relatively strong among all the variables (r = 0.475, $p < 0.01$).

Table 2. Correlation matrix of constructs. (* denotes $p < 0.05$; ** denotes $p < 0.01$).

Constructs	Mean	S.D.	1	2	3	4	5	6
1. Organizational energy-saving climate	3.62	0.705	-					
2. Attitude	4.01	0.437	0.364 *	-				
3. PBC	3.97	0.678	0.348 *	0.314 *	-			
4. Moral norms	3.54	0.619	0.289 *	0.148	0.083	-		
5. Energy-saving intention	3.75	0.637	0.462 **	0.423 **	0.321 *	0.337 *	-	
6. Energy-saving behavior	3.89	0.564	0.371 **	0.341 *	0.342 *	0.296 *	0.475 **	-

4.2. Test of the Hypotheses

In the procedure of analyzing the multi-level model, the differences between the groups or organizations need to be tested before the hypotheses are verified. From Figure 3, it can be inferred that four multi-level models were constructed, and four null models were established to examine whether the between-organization variances for the dependent variables (attitude, PBC, moral norms, and electricity-saving intention) were significant. ICC1 reflects the difference between groups and ranges from 0 to 1 [58]. ICC1 could be computed by the following equation:

$$\text{ICC1} = \frac{\tau_{00}}{\tau_{00} + \sigma^2} \tag{1}$$

where τ_{00} represents the between-group variance and σ^2 reflects the within-group variance.

From Table 3, the ICC1 for attitude, PBC, moral norms, and electricity-saving intention were 0.305, 0.243, 0.235, and 0.264, which are all greater than 0.138 [56]. It can be inferred that differences in workers' attitudes, PBC, moral norms, and electricity-saving intentions existed among different construction sites, which may have resulted from differential organizational climates in terms of electricity saving according to the strongly positive associations between organizational electricity-saving climate and three individual-level behavioral-intention predictors in Section 4.1. Additionally, all the ICC2 for four multi-level models were greater than 0.7.

The estimated results for the four multi-level models using HLM are listed in Table 3. For attitude, organizational climate seemed to be a significant predictor ($\gamma = 0.257$, $p < 0.001$), which corresponds with the positive association between organizational climate and attitude, and H2a was supported. The divergence in PBC among different construction sites was significant, and this might be due to the various organizational electricity-saving climate ($\gamma = 0.368$, $p < 0.001$), which indicated that H3a was supported. Similarly, the organizational climate was a significant predictor of the moral norm ($\gamma = 0.197$, $p < 0.01$), and H4a was proved valid. For the intention, it seemed that organizational electricity-saving climate appeared to play the dominant role ($\gamma = 0.246$, $p < 0.01$), and H1 was valid. Meanwhile, all three individual-level variables were significant predictors, which proved the reliability of H2b, H3b, and H4b, and the path coefficients for attitude ($\gamma = 0.156$, $p < 0.01$), PBC ($\gamma = 0.148$, $p < 0.01$), and moral norms ($\gamma = 0.143$, $p < 0.01$) were comparable.

Table 3. The estimation of fixed effects (with robust standard errors) and random effects (variance components). (* denotes $p < 0.05$; ** denotes $p < 0.01$; *** denotes $p < 0.001$).

	Attitude		PBC		Moral Norm		Energy-Saving Intention			
	Model 0	**Model 2**	**Model 0**	**Model 2**	**Model 0**	**Model 2**	**Model 0**	**Model 1**	**Model 2**	**Model 3**
Fixed effects										
Intercept	3.97 ***	3.61 ***	3.94 ***	3.57 ***	3.52 *	3.36 *	3.87 ***	3.43 ***	3.55 ***	3.26 ***
Individual-level										
Attitude								0.237 **		0.156 **
PBC								0.229 **		0.148 **
Moral norm								0.206 **		0.143 **
Organizational-level										
Climate		0.257 ***		0.368 ***		0.197 **			0.331 ***	0.246 **
Random effects										
σ^2	0.523	0.522	0.421	0.421	0.608	0.607	0.897	0.615	0.896	0.623
τ_{00}	0.229 ***	0.189 ***	0.135 ***	0.096 ***	0.187 ***	0.122 ***	0.321 ***	0.329 ***	0.204 ***	0.215 ***

Then, the mediation effects of three individual-level variables including attitude, PBC, and moral norms on the relationships between organizational electricity-saving climate and intention were tested separately, and the results of Sobel's test are listed in Table 4. Organizational electricity-saving climate had a positive influence on all individual-level factors, while all the individual-level factors were in a significant positive relationship with electricity-saving intention. Meanwhile, the results of Sobel's test showed that all mediation effects were proved valid (path: climate -> attitude -> intention, $p < 0.05$; Path: climate -> PBC -> intention, $p < 0.01$; path: climate -> moral norm -> intention, $p < 0.05$), which indicated that H2, H3, and H4 were supported. Consequently, organizational electricity-saving climate also had indirect effects on electricity-saving intention through three mediators apart from the direct influence. In the last step, the path coefficient from electricity-saving intention to behavior was 0.359 and statistically significant ($p < 0.01$), and thus H5 was supported.

Table 4. Results of Sobel's test.

	Path 1		Path 2		Sobel's Test	
	Coefficient	**Standard Error**	**Coefficient**	**Standard Error**	**t Value**	***p* Value**
Climate -> Attitude -> Intention	Climate -> Attitude 0.257	0.072	Attitude -> Intention 0.156	0.053	2.27	0.023
Climate -> PBC -> Intention	Climate -> PBC 0.368	0.063	PBC -> Intention 0.148	0.051	2.60	0.009
Climate -> Moral norm -> Intention	Climate -> Moral norms 0.197	0.048	Moral norm -> Intention 0.143	0.047	2.44	0.015

5. Discussion

5.1. Findings in This Study

If the drivers of electricity behaviors are identified precisely, it is more likely for behavioral-based interventions to be more successful in encouraging sustainable energy use [5]. In this study, a multi-level model is developed to explore the intrinsic relationship between organizational-level and individual-level factors to identify the facilitators of electricity behavior. One organizational factor, organizational electricity-saving climate, and five individual-level factors, attitude, PBC, moral norms, and electricity-saving intention and behavior, are considered. The direct and indirect influence of organizational electricity-saving climates on electricity-saving intention have been highlighted.

For people living in private spaces, they may not know information about the energy-saving behavior of other acquaintances (i.e., families, friends, neighbors, colleagues), and the energy-related activities they participate in are not observed by others. Therefore, they may not feel pressure from close people around them, and the influence of social norms may be insignificant or limited [59,60]. However, an individual's social interactions with people who live in the same spatial context influence their behavioral intention, and this aligns with Chen and Knight's opinions that interpersonal interaction was conducive to behavioral intention concerning energy conservation among co-workers in workplaces [61]. Apart from daily communication, individuals have a direct observation of other's behavior in the shared space, and people may feel psychological pressure if they do not commit the behavior that the majority of their shared space-users perform, especially for the behaviors concerning common benefits. So, pro-environmental behaviors, especially behaviors benefiting the people who share the community, are supposed to be under the normative influence of surrounding people [62]. In this study, supervisors and workers in tunnel-construction sites not only share the same living and working places but also inherit the positive or negative consequences induced by their behaviors, which indicates that social interactions between colleagues in tunnel construction sites may be more influential compared with other organizations. The organizational electricity-saving climate refers to the common values concerning electricity saving perceived by both supervisors and co-workers who communicate frequently in a variety of respects due to the same spatial and temporal context, and is supposed to play an important role in predicting workers' electricity-saving intentions, and the research results have confirmed this. The tendency for individuals to keep to conformity and compliance with the opinions and actions of surrounding people is due to the fact that it is human nature to be accepted and liked by others, and following the behaviors of the majority, the common values, and the organizational climate is of great importance to maintain a close and healthy relationship with others in a shared space and avoid being isolated. A previous study also proved that the impact of organizational climate was supposed to be more effective than official energy-saving instructions [63]. Consequently, when individuals see people surrounding them do the same and the right thing collectively, they are motivated to do it as well.

The results show that attitude has a positive impact on electricity-saving intention. It is reasonable that an individual with an affirmative evaluation of one specific behavior is more desirable to conduct the behavior. Zhang et al. also found that employee's attitude toward electricity saving positively influenced their behavioral intention while the attitude was determined by environmental benefit, organizational benefit, enjoyment, and organizational electricity-saving climate [40]. In this study, it has been confirmed that PBC is positively associated with electricity-saving intention, which indicates that the possession of sufficient materials and competencies promotes behavioral intention. Scherbaum and Popovich explored the effects of individual-level factors on workers' electricity-saving behaviors at offices on the basis of value-belief-norm theory [64], and results showed that PBC was conducive to promoting energy-saving intentions. An individual with moral norms preferred to do things that complied with his or her moral senses to enhance one's sense of self-worth [65], and this study has confirmed the distinctive role of moral norms in predicting the tunnel-construction workers' electricity-saving intentions.

The research results also show that the organizational electricity-saving climate also has an indirect influence on workers' electricity-saving intentions through three individual-level factors including attitude, PBC, and moral norms, except for the considerable direct influence, and the mediation effects of individual-level factors have been validated. Formulating attitudes depends on an individual's belief about the perceived balance between the costs and benefits of behaving in a pro-environmental manner like electricity saving. Tunnel-construction workers are generally isolated from urban areas, and thus colleagues are geometrically connected in daily life. Consequently, it is difficult for workers to keep independence in the presence of supervisors and co-workers. The common values represented by the organizational climate would influence construction workers' evaluations of one specific behavior. It is reasonable that if supervisors and co-workers believe that electricity saving is beneficial to maintain the welfare of the construction sites, i.e., reducing construction costs and protecting the environment in the vicinity of the sites, other workers are more likely to have a more positive evaluation of electricity-saving behavior. Additionally, if the organization lays enough emphasis on energy saving, like issuing incentive policies, workers would realize that electricity saving is worth doing and show a more positive attitude. As a result, attitude is supposed to be a mediator between the organizational electricity-saving climate and workers' intentions. This finding aligns with a previous study's conclusion that people are easily influenced by their closest circle in physical space, which is beneficial to producing local agreements about attitudes and opinions [66]. In a previous study [26], over 70% of the respondents admitted that it was easy for them to reach a consensus regarding energy saving with people who shared the same living and working space, and they would comply with the opinions and behaviors of surrounding people. Additionally, the daily interactions between workers in construction sites could decrease the perceived difficulties in electricity saving. Kavulya and Becerik-Gerber found that putting appliances (computers, printers, laptops, etc.) on standby mode could lead to significant energy waste in offices [67]. So, reminders from co-workers regarding switching off electric construction instruments are beneficial to increase the intention to save electricity and improve energy efficiency in construction sites. Additionally, if one individual knows little about choices of appliances during the construction process to conserve energy, his co-workers may inform him about the selection of energy-efficient appliances according to the energy-efficient labels [37]. Consequently, common values shared by the workers could encourage the people to spread related resources, knowledge, and methods to promote other workers' PBC and facilitate their electricity-saving intention. The construction sites with a good climate regarding energy saving would sponsor training sessions to decrease the perceived difficulty of the workers to conduct electricity-saving behaviors. These prove that PBC mediates the relationship between organizational electricity-saving climates and workers' intentions. This study also found that the organizational electricity-saving climate would shape an individual's moral norms. If an individual is conscious of adverse consequences when not performing a behavior pro-socially and feels responsible for the negative consequences, he or she would have a feeling of moral obligation to engage in a specific behavior [68]. Therefore, the common values represented by the organizational electricity-saving climate may activate the workers' moral norms by informing them of negative consequences such as the possibility of a blackout due to the excessive load on the special power-supply equipment in the tunnel-construction sites. Meanwhile, workers would also engage themselves in electricity saving, which their co-workers think would benefit others like preventing environmental deterioration at a macro level and reducing the construction costs at the micro level, at which group interactions could spread among the workers. Consequently, it can be indicated that a good organizational climate improves the workers' moral norm, which promotes their pro-environmental behavior, which makes workers' moral norms a mediator between the organizational electricity-saving climate and their intention.

In several previous studies, behavioral intention representing the extent to which an individual is willing to conduct one specific behavior is supposed to be the most direct antecedent of behaviors [26,69], and the results of this study also confirmed this conclusion.

5.2. Implications

It is necessary to explore the factors influencing individuals' energy-saving intentions and behaviors in shared places, especially for tunnel-construction sites where workers spend most of their time with supervisors and co-workers; further understanding of behavioral mechanisms is conducive to developing corresponding measures to promote a low-carbon lifestyle to fight against environmental degradation and global warming [70], and another bonus is the reduction in project costs for tunnel-construction sites.

At first, this study has several theoretical implications. Few studies pay attention to tunnel-construction workers' electricity-saving behaviors, and the workers are nested in construction sites while the organizational-level variable is supposed to play an important role in predicting workers' beliefs and behaviors. However, most studies explore the workers' behaviors within an organization through the conventional regression analysis or structural equation model, overlooking the intrinsic characteristics of nested data. Consequently, this study proposed a brand-new multi-level model which is more suitable for nested data to identify the drivers of workers' electricity-saving behaviors, and validated the leading role of the organizational-level variable. Additionally, the mediation effect also links individual-level predictors and organizational electricity-saving climates, and thus this research extends the influence of the organizational-level variable from the targeted intention to other individual-level predictors, which enriches the theoretical development in the field of electricity saving and provides an innovative viewpoint on promoting electricity-saving behavior.

Second, this study also provides valuable practical references for construction site managers to design corresponding strategies to promote electricity-saving behavior. The results show that workers' intentions and behaviors regarding energy saving are directly and indirectly influenced by the organizational climate, and thus cultivating a good organizational electricity-saving climate is the key to promoting a low-carbon life among construction workers. At first, it is of necessity to set a clear goal for the construction site to emphasize the importance of electricity saving and get across common values to the workers within the organization. Meanwhile, the managers should play a leading and exemplary role, and the workers are supposed to follow and take practical action on energy conservation. Additionally, construction sites ought to organize electricity-saving training sessions. The sessions could make the workers realize that electricity saving not only benefits the environment in many respects including reductions in greenhouse gas emissions, mitigating global climate change, and decreasing the consumption of limited natural resources, but also plays a positive role in project-cost control, which may alter their attitude towards electricity saving. On the other hand, the sessions may also include guidelines regarding how to save electricity at the construction sites, like adopting energy-efficient appliances or switching off the appliances when they are not in use, which decreases the perceived difficulty in conducting electricity-saving behaviors among the workers and even makes them form a habit. At last, incentive policies should be issued to encourage electricity-saving behaviors, like monetary rewards for setting a good example. Related policies could make workers aware that it is a responsibility to save electricity, and thus could be an activator for workers' moral norms and a cognitive preconditions for living a sustainable way. To summarize, cultivating a good organizational electricity-saving climate, which is a long and arduous process, requires a series of management measures and all the members at the construction sites to participate in electricity-saving activities.

5.3. Limitations

Despite some innovative viewpoints obtained from a multi-level model, there are several limitations to this study. First, the respondents in this research are limited to tunnel-construction workers, who are relatively isolated from urban areas, and this may place restrictions on the application scope of the findings. A broader sample size in different types of construction sites (i.e., bridge-construction sites, highway-construction sites, and railway-construction sites) is recommended in the future to generalize the findings. Second, the sample is limited to the southwest of China, which may restrict the generalizability of the findings. In the subsequent study, research on personnel from other regions can be conducted to expand the generalizability of the study. At last, the research findings are based on cross-sectional data, while people's behavior may vary with time. Consequently, future research could pay attention to behavioral-evolution mechanisms through longitudinal data.

6. Conclusions

Tunnel-construction workers work and live far from urban areas and spend most of their time with supervisors and co-workers, which indicates that workers' behavior could be influenced by the normative pressure on sites, and a multi-level model may be more proper. This study contributes to socio-psychological research by developing a multi-level model incorporating one organizational-level and three individual-level factors to identify drivers of electricity-saving behavior in tunnel-construction sites. Our results show that

(1) The organizational-level factor plays a dominant role in predicting workers' electricity-saving intentions in tunnel-construction sites; the organizational electricity-saving climate not only directly predicts workers' electricity-saving behaviors but also exerts an indirect influence through three individual mediators including attitude, PBC, and moral norms;
(2) Cultivating a good organizational climate is the key to promoting a low-carbon life among construction workers and is a long and arduous process accompanying a series of management measures like related guidelines, training sessions, and incentive policies.

The findings in this study are conducive to developing holistic and effective psychological behavior-based strategies for energy conservation in tunnel-construction sites.

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Appendix A

Table A1. The measuring items for each construct.

Constructs		Items
Attitude		
	ATT1	I think saving electricity in tunnel construction sites is useful to protect the environment
	ATT2	I think saving electricity in tunnel construction sites is important to reduce carbon emissions
	ATT3	I think saving electricity in tunnel construction sites is valuable in alleviating energy-shortage issues
	ATT4	I think saving electricity in tunnel-construction sites is a wise action
Perceived Behavioral Control (PBC)		
	PBC1	I think that I am capable of saving electricity in tunnel-construction sites
	PBC2	I have the knowledge and skills to save electricity in tunnel-construction sites
	PBC3	Whether or not I save electricity in tunnel-construction sites is completely up to me

Table A1. *Cont.*

Constructs		Items
Moral norms		
	MN1	I think I have a moral responsibility to save electricity in tunnel-construction sites
	MN2	I can save electricity in tunnel construction sites is depending on my moral obligations
	MN3	I would feel unhappy if I don't save electricity in tunnel-construction sites
Electricity-saving climate		
	ESC1	My company encourages electricity saving in tunnel-construction sites
	ESC2	My company puts much value on electricity saving in tunnel-construction sites
	ESC3	My company is actively committed to electricity saving in tunnel-construction sites
	ESC4	My company has announced policies related to electricity saving in tunnel-construction sites
	ESC5	Managers of my company try to save electricity in tunnel-construction sites
Electricity-saving intention		
	INT1	I am willing to save electricity in tunnel-construction sites
	INT2	I intend to engage in electricity-saving activities in tunnel-construction sites
	INT3	I will make an effort to save electricity in tunnel-construction sites
Electricity-saving behavior		
	BE1	I usually switch off appliances in tunnel-construction sites, e.g., lights, when they are not in use
	BE2	I usually use energy-efficient appliances in tunnel-construction sites
	BE3	I usually turn electrical appliances off completely rather than to a standby mode in tunnel-construction sites

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