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Research on the Driving Factors for the Application of Energy Performance Contracting in Public Institutions

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Abstract: Building energy efficiency in public institutions is crucial for achieving energy conservation and emissions reduction goals. The application of energy performance contracting (EPC) can effectively reduce energy consumption in these buildings and promote the development of the energy-saving service industry. However, there is a lack of initiative among public institutions to adopt EPC. This study aims to investigate the factors that drive the intention and behavior of public institutions to apply EPC and enhance their proactive engagement in building energy efficiency retrofitting. By considering the current status of EPC application in public institutions and drawing on relevant decision-making and behavioral theories, this paper identifies the key factors that drive the intention and behavior of public institutions, and constructs a theoretical model of the intentional and behavioral driving factors. In the empirical testing phase, research data are collected through online questionnaires. Structural equation modeling is employed to validate and analyze the extent of the driving factors and their interrelationships. The key findings are that (1) perceived usefulness, trust, and perceived risk significantly drive the behavior intention of public institutions to apply EPC; (2) perceived behavioral control and perceived ease of use significantly positively drive the behavior of public institutions, with behavior intention being the most influential factor; and (3) policy system and organizational support play a significant moderating role in the process from intention to behavior. Based on these findings, this paper proposes the critical tasks and suggests countermeasures for stakeholders in EPC projects.

Keywords: energy performance contracting (EPC); public institutions; intention and behavior; driving factors; energy conservation and emissions reduction

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1. Introduction

The construction and operation of buildings contribute significantly to China's total energy consumption. As mentioned in the "China Building Energy Consumption Research Report (2021)", in 2019, the entire building process accounted for approximately 46% of the country's total energy consumption, totaling 2233 million tce. To achieve China's energy conservation and emissions reduction goals, it is crucial to promote green and low-carbon development in the building sector and improve building energy efficiency. In the context of building an ecologically civilized society, public institutions play an important role in implementing the strategic national energy-saving and emissions reduction decisions and leading the way in the construction of ecological civilization. At the same time, with the continuous development of China's economy and society and the promotion of urbanization, the energy consumption problem generated in this process is becoming increasingly prominent. Therefore, energy conservation in public buildings has become an indispensable part of the construction of ecological civilization. However, scholars have identified a lack of initiative in energy efficiency retrofitting and insufficient attention to energy saving in public institutions [1,2]. Several factors contribute to this situation, including the perceived costlessness of energy use, the complexity of the energy use

structure [3], and the absence of effective incentive mechanisms [4]. Additionally, public institutions often face challenges related to the availability of energy-saving funds, energy-saving technologies, and specialized energy-saving expertise. To address these challenges, China has introduced energy performance contracting (EPC), which emerged in Western countries in the 1970s. The country's first EPC project was initiated in 1996 [5,6]. Huang et al. [7] recognized the importance of EPC in facilitating the development of a robust market system for energy conservation services and supporting the energy-saving transformation of public institutions in China.

According to the national standard, "Guidance on Energy Performance Contracting", the concept of energy performance contracting involves the signing of a contract between an energy service company (ESCO) and an energy user. The contract outlines the services to be provided by the ESCO, the energy-saving targets that need to be achieved, and the agreement that the ESCO will receive input subsidies from the energy-saving benefits of the energy user, along with a reasonable profit. The introduction of market mechanisms into the political arena is a significant feature of this energy efficiency service mechanism [8]. EPC, as a market-based energy-saving mechanism, offers several benefits, such as stable energy savings and reduced transformation risks [9–11]. However, due to a lack of policy guidelines and market regulations, public institutions often show limited initiative in applying EPC to building energy efficiency retrofitting. When public institutions do not adopt EPC, it reduces the potential for demonstration and fails to stimulate the wider adoption of EPC in the building energy efficiency market. Researchers have explored ways to promote the application of EPC and achieve better retrofitting results. Factors such as differences in budget allocation, prior experience, managers' attitudes towards EPC, and proactive policy guidance have been identified as influencing the motivation of public institutions to adopt EPC [12,13]. Meanwhile, in the research conducted by Zhang et al. [14], it was suggested that strict regulations and mandatory policies play a significant role in driving public institutions such as governments, schools, and hospitals to adopt EPC. Conversely, factors such as a lack of trust in ESCOs, insufficient management capacity within public institutions, and limitations of the current system hinder the adoption of EPC by public institutions [15–17]. To address these challenges, scholars have proposed various countermeasures. Chen et al. [18] recommended government-led and research-promoted approaches for adoption in colleges and universities, advocating the implementation of the energy-cost trust model (a business model for EPC) in similar institutions. Zhang [19] suggested that institutional-level improvements, such as refining budget rules, implementing energy resource consumption management, managing cost quotas, and simplifying the bidding process, could effectively promote the application of EPC. Wang [20], focusing on the issue of moral hazard for ESCOs, emphasized the importance of prioritizing client satisfaction in EPC projects. From a third-party perspective, Chen and Tang [21] and Wang et al. [22] proposed relevant suggestions regarding financing, improving taxation policies, establishing sound assessment mechanisms, and building a legal system. Additionally, some scholars have analyzed the sources of risk and risk sharing for the involved parties in the EPC application process within public institutions, providing measures to mitigate risk from a risk management perspective [23–25].

The previous research has primarily focused on objective perspectives or perspectives outside public institutions when studying the barriers and paths for promoting EPC in building energy efficiency retrofitting. These studies have mainly centered around incentive policies and increasing ESCO participation, but they may have overlooked the complexity and dynamic nature of the behavioral drivers within public institutions. As a result, they have not adequately addressed the fundamental issue of the lack of native motivation within public institutions. This research aims to tackle this problem by focusing on stimulating the subjective initiative and internal driving force of public institutions in adopting EPC for energy efficiency retrofitting. The research will primarily examine the behavioral patterns and characteristics associated with the adoption of EPC in public institutions. It first identifies the behavioral drivers that influence public institutions'

decision to adopt EPC. Based on this, a theoretical model is constructed, and specific impact paths and development countermeasures are derived. Through empirical analysis and research, the objective is to enhance the subjective initiative of public institutions in applying EPC and establish a foundation for promoting building energy conservation and EPC adoption.

2. Review of Relevant Theories

The research is focused on the energy-saving management of public institutions and aims to investigate how to stimulate these institutions to actively adopt EPC. The theoretical background for this study encompasses two key aspects: the theoretical foundation of energy-saving management in public institutions and the theoretical foundation of behavioral drivers.

In terms of energy-saving management in public institutions, the concept of new public management (NPM) is relevant. NPM represents the integration of traditional public administration norms with management methods adopted by business enterprises. It emphasizes economic efficiency and effectiveness, with a focus on private sector management approaches. NPM advocates for the utilization of private enterprise methods, technologies, and efficiencies to enhance the effectiveness of government operations and management. In the context of this study, EPC can serve as a market mechanism to improve energy management efficiency within public institutions. By providing financial support and energy-saving technologies, EPC can assist public institutions in reducing energy consumption and associated costs. Public choice theory encompasses three key elements. The first element is the assumption of rational economic man. According to this assumption, an individual participating in the market acts as an "economic man" and aims to maximize their own interests while minimizing costs. The second element is transaction politics. Political transactions are driven by transaction motives and behavior, which encompass not only tangible goods but also various intangible interests. These transactions form the basis of political decision-making. The third element is methodological individualism. This perspective asserts that social choices are ultimately a collection of individual choices. It recognizes that individuals possess the capacity for rational analysis and decision-making. In the context of public institutions, even though the choices may be perceived as collective decisions, the ultimate decision-making power lies with the public officials within those institutions. Therefore, whether a public institution adopts EPC hinges on the individual decisions made by energy efficiency-related managers and leaders within the institution.

This research incorporates several behavior-driven theories, including the ABC theory, the theory of planned behavior (TPB), and the technology acceptance model (TAM). The ABC theory emphasizes the impact of external environmental factors on individual attitudes and behaviors. It states that individual behaviors are influenced not only by personal attitudes but also by the external environment, including policies, regulations, and social norms. Positive external contextual factors are more likely to lead to specific behaviors, whereas unfavorable external conditions make behavior change closely tied to individual attitudes. The theory of planned behavior (TPB) posits that an individual's intention to act is a key determinant of behavior. It reflects the likelihood that an individual expects to engage in a particular action and is influenced by attitudes, subjective norms, and perceived behavioral control. A positive attitude towards the behavior, supportive evaluation by significant others, and a higher perceived ability to control the behavior all contribute to a greater intention to act. Conversely, a negative attitude leads to a lower intention to act. The technology acceptance model (TAM) suggests that users' attitudes towards using a system are influenced by perceived ease of use and perceived usefulness. Perceived usefulness refers to learners' subjective belief that using a certain system will improve their learning performance, while perceived ease of use pertains to learners' perception of the difficulty or effort required to use the system [26]. Attitude towards system use affects user behavior through the mediating role of willingness to use. Additionally, external

environmental factors indirectly influence willingness to act and behavior generation by influencing perceived usefulness and perceived ease of use.

The NPM theory and public choice theory highlight the significance and need for public institutions to adopt EPC in order to attain green and low-carbon-development objectives. Behavioral theories such as the ABC theory provide the groundwork for analyzing the behavioral factors that drive public institutions' adoption of EPC. The conceptual models within these theories form the basis for constructing a theoretical model that explains the behavioral drivers behind public institutions' adoption of EPC.

3. Research Design

The research design, as depicted in Figure 1, addresses the issue of stimulating the initiative of public institutions to adopt EPC through a combination of theoretical analysis and empirical testing. In the initial stage, this research undertakes a theoretical analysis of the behavior of public institutions and identifies the behavioral driving factors that influence their adoption of EPC. By establishing a theoretical framework, the study formulates relevant hypotheses and constructs a theoretical model that explains the behavioral driving factors behind public institutions' application of EPC. Subsequently, the research employs questionnaire surveys as a data collection method. The collected data are then subjected to analysis using structural equation modeling (SEM) to test the formulated hypotheses. Based on the findings from the analysis, the theoretical model may be modified and refined. Finally, the research provides policy recommendations to facilitate the wider application of EPC in public institutions.

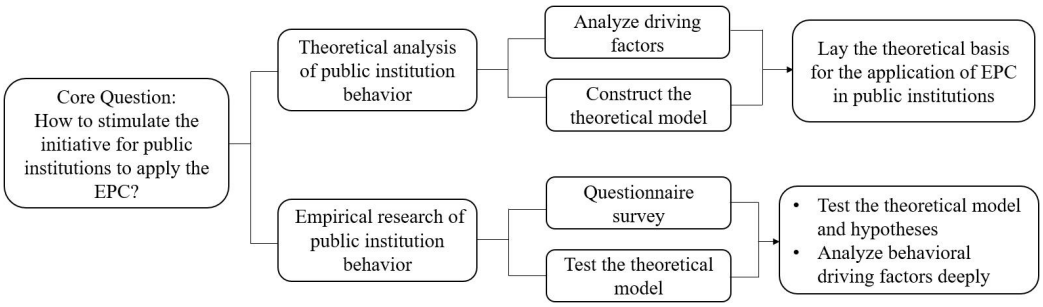

Figure 1. Research design (authors' own work).

In the theoretical analysis of the driving factors influencing public institution behavior, this study primarily focuses on the TPB and incorporates the TAM as the theoretical basis. To empirically investigate these behavioral drivers, the following steps are undertaken. First, a five-point Likert scale method is used to design the questionnaire, which is meant to gather data on the behavioral drivers of public institutions. The questionnaire is typically administered online to maximize convenience and reach a larger sample size. Second, the valid questionnaire data are analyzed with descriptive statistics for reliability and validity. SEM, which integrates factor and path analysis, is more effective at analyzing multiple-regression relations between latent variables than traditional path analysis and is more suitable for simultaneously testing complex hypotheses of causality. Based on the sample data, SEM analysis and hypothesis testing are conducted using AMOS 22.0 to identify the key driving factors and their effects. Through correction, this research obtains the optimal model. Meanwhile, the mediating effect of the mediating variables and the moderating effect of the external context variables are tested. Finally, the mechanism and effect of driving factors are analyzed, and a forward countermeasure suggestion is put forward.

4. Driving Factors and Hypotheses

4.1. Internal Psychological Driving Factors and Hypotheses

The behavior intention of public institutions to adopt EPC for energy efficiency retrofitting in buildings is primarily influenced by psychological factors. This can be

seen as a process through which public institutions recognize the need for energy efficiency retrofits, understand the benefits of EPC, and subsequently develop the intention to collaborate with ESCOs to implement these retrofits. This research analyzes and identifies the factors that drive public institutions' intention to engage with ESCOs in EPC projects.

4.1.1. The Relationship between Perceptions of Energy Consumption and Behavior Intention

Based on the principle of reference dependence, an individual will compare their current situation or information with their past experiences (longitudinal comparison) and with the situations or information of others (horizontal comparison) when making a behavioral decision [27]. Before deciding to adopt EPC, public institutions often engage in a longitudinal comparison of their energy consumption and energy costs. This comparison involves evaluating their current energy usage and expenses in relation to their past records. Furthermore, public institutions may compare their energy consumption and costs with government-mandated energy efficiency targets or standards. This comparison and evaluation process helps public institutions recognize the need for energy efficiency retrofitting and forms the foundation for considering the adoption of EPC. It highlights the significance of having information about high energy consumption as a prerequisite for public institutions to see the value and benefits of implementing building energy efficiency retrofitting through EPC.

H1. *Energy consumption information will significantly and positively drive the behavior intention of public institutions to apply EPC.*

4.1.2. The Relationship between Perceptions of EPC and Behavior Intention

TPB posits that behavior intention reflects how an individual likely expects to act. Behavior intention is the most direct determinant of an individual's behavior and is influenced by behavioral attitudes, perceived behavioral control, and subjective norm. In the context of EPC adoption by public institutions, this theory suggests that their intention to implement energy efficiency retrofitting is shaped by their attitudes towards EPC, their perceived ability to control and implement it successfully, and the influence of social norms. Additionally, TAM is often applied to understand users' acceptance and usage behavior of new technologies and systems. TAM proposes that perceived ease of use and perceived usefulness are key factors influencing individual behavior. In the case of public institutions, their perception of the usefulness of EPC is primarily contingent upon factors such as financial feasibility, the potential benefits of energy efficiency, and access to professional and comprehensive energy services. On the other hand, perceived ease of use factors into their attitudes and intentions, which are primarily influenced by improvements in government guidelines and the promotion of EPC by ESCOs and associated community groups. Perceived ease of use is also known to have a significant impact on perceived usefulness. Furthermore, the subjective norm plays a role in driving behavior, as individuals are influenced by the social pressure exerted by important individuals or groups around them. In the case of public institutions, decision-makers may perceive external pressures from similar institutions, influential figures, and successful cases of implementing EPC. These subjective norms can influence their behavior and lead to pro-environmental actions.

H2. *Perceived usefulness will significantly and positively drive the behavior intention of public institutions to apply EPC.*

H3. *Perceived ease of use will significantly and positively drive the behavior intention of public institutions to apply EPC.*

H4. *Subjective norm will significantly and positively drive the behavior intention of public institutions to apply EPC.*

H5. *Perceived ease of use will significantly and positively drive perceived usefulness.*

4.1.3. The Relationship between Perceptions of Cooperation and Behavior Intention

Perceived behavioral control refers to an individual's belief in their ability to perform a particular action. It takes into consideration past experiences and available resources, as well as the anticipated difficulties and obstacles involved. Perceived behavioral control can directly or indirectly influence behavior. Regarding perceptions of cooperation, research has extensively explored the roles of "trust" and "perceived risk" in shaping intentions to engage in cooperation. Trust helps foster positive relationships by establishing behavioral dispositions between parties. On the other hand, perceived risk creates uncertainty and reduces the willingness to take action. In the context of public institutions adopting EPC, one of the main factors influencing their decision is the recognition that ESCOs possess the necessary expertise and comprehensive management capabilities. This creates a professional trust and reliance on ESCOs. However, perceived risks can hinder the adoption of EPC by public institutions. These risks can include concerns about capital costs, time commitments, and the potential failure to meet performance targets in achieving energy efficiency goals. Public institutions' perception of risk may deter public institutions from choosing to implement EPC projects.

H6. *Trust will significantly and positively drive the behavior intention of public institutions to apply EPC.*

H7. *Perceived risk will significantly and negatively drive the behavior intention of public institutions to apply EPC.*

Perceived behavioral control within public institutions is heavily influenced by the decision-maker's sense of self-efficacy, which refers to their confidence in their ability to address potential challenges and utilize available resources effectively. Self-efficacy plays a crucial role in shaping perceived behavioral control, as it directly impacts an individual's belief in their capacity to carry out cooperative actions [28–30]. Furthermore, it is important to note the facilitative effect of behavior intention on actual behavior.

H8. *Perceived behavioral control will significantly and positively drive the behavior intention of public institutions to apply EPC.*

H9. *Perceived behavioral control will significantly and positively drive the behavior of public institutions to apply EPC.*

H10. *Behavior intention will significantly and positively drive the behavior of public institutions to apply EPC.*

4.2. External Contextual Factors and Hypotheses

The decision-making processes of public institutions are influenced by external environmental factors stemming primarily from two sources. Firstly, government involvement plays a significant role, encompassing policy system and organizational support. Policies that provide guidance and offer financial incentives can instill confidence and interest among public institutions in adopting EPC. Additionally, a flexible regulatory environment can help mitigate risks associated with EPC implementation. Organizational support entails monitoring and impartial services provided by professional agencies throughout the project implementation process. Research has identified a lack of supervision as a factor hindering the intention of public institutions to adopt EPC. Secondly, the market environment also impacts decision-making. An open and transparent market with readily available information helps reduce information asymmetry and uncertainty in decision-making processes. Healthy competition among ESCOs strengthens their capabilities and enhances public

institutions' willingness to collaborate with them. Furthermore, the influence of social values and social monitoring on the cooperative intentions of public institutions should not be underestimated.

H11: *Policy system will moderate the relationship between the intention and behavior of public institutions to apply EPC.*

H12. *Organizational support will moderate the relationship between the intention and behavior of public institutions to apply EPC.*

H13. *Market environment will moderate the relationship between the intention and behavior of public institutions to apply EPC.*

5. Theoretical Model

5.1. Theoretical Model Construction

Nowadays, there is no specific research paradigm for studying the behavior and decision-making of public institutions. However, in environment–behavior studies (EBS), the study of comprehensive multidisciplinary behavior models has been receiving increasing attention from scholars. Stern and Gardner [31] highlighted the role of psychology in providing research support for energy policy formulation, and behavior-oriented energy problem analysis can make significant contributions to research in this field. In recent years, there has been a growing research trend towards a multidisciplinary integration framework in environment–behavior studies, with the behavior model being the most vital component. Existing research in environment–behavior indicates that scholars both domestically and internationally tend to integrate psychological variables and variables related to the social environment to establish comprehensive behavior models, upon which they conduct relevant research.

Through the analysis of public institutions' intention to adopt EPC for energy efficiency retrofitting and the identification of driving factors, this paper proposes a research model of behavioral driving factors for public institutions, as shown in Figure 2. The theoretical model primarily consists of two path relationships. Firstly, factors such as energy consumption information, perceived usefulness, perceived ease of use, subjective norm, trust, perceived risk, and perceived behavioral control indirectly influence behavior through behavior intention. Secondly, policy systems, organizational support, and the market environment moderate the relationship between behavior intention and behavior. The specific direction of influence is suggested by the research hypotheses.

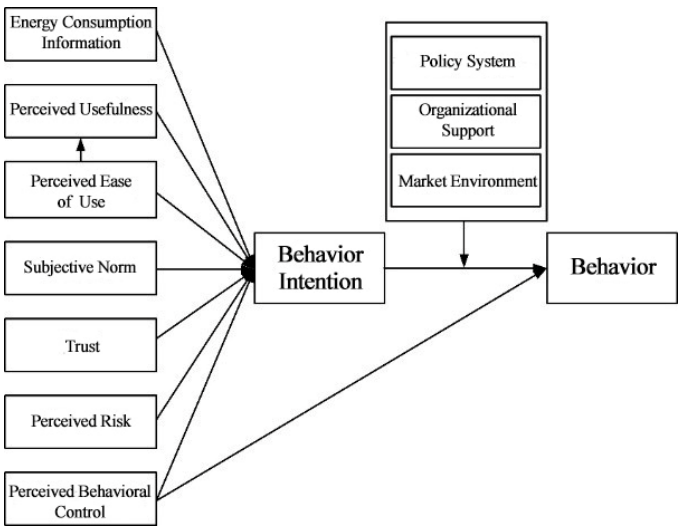

Figure 2. Behavior-driven model (authors' own work).

5.2. Data Source

This research involved field visits and investigations of institutions such as the State Organ Affairs Administration in Beijing, Tianjin, Shenzhen, and several non-first-tier cities, as well as projects implementing EPC in these areas. With the assistance of the aforementioned institutions, a questionnaire survey was conducted for government agencies, educational institutions, hospitals, and other groups and organizations. The survey was primarily distributed online. The respondents were divided into two groups: middle or senior managers responsible for energy efficiency in public institutions from Beijing, Tianjin, Shenzhen, and several non-first-tier cities, and senior staff members from energy efficiency service companies. The participating public institutions had previously implemented various types of EPC projects, including the share savings model, the energy-cost trust model, the guaranteed savings model, and hybrid models. This ensures the reliability of the questionnaire data.

The survey questionnaire consisted of two parts. The first part provided an overview of the questionnaire and explained the research objectives to the respondents. The second part consisted of specific measurement items. The questionnaire was developed based on the conceptual model (Figure 2) of this study. It adjusted the descriptions of specific items by combining the behavioral drivers identified in the previous sections with the relevant characteristics and usage scenarios of public institutions implementing building energy retrofit projects using EPC. The questionnaire comprised a total of 22 items. Specifically, there were four measurement items related to policy support and three measurement items each for energy consumption information, perceived usefulness, perceived ease of use, subjective norms, trust, perceived risk, perceived behavioral control, organizational support, and market environment. The response options were categorized into five levels: strongly agree, agree, neutral, disagree, and strongly disagree. A total of 234 questionnaires were collected, out of which 194 were considered valid.

5.3. Data Analysis

In this research, there were 12 variables, and the measurement items were developed based on previous research coupled with practical situations. The items for perceived usefulness and perceived ease of use were adapted from the scale by Venkatesh et al. [32], while the items for subjective norm were adapted from the scale by Wan et al. [33]. The scale for trust was adapted from the study by Handfield and Bechtel [34], and the scale for perceived risk was adapted from the research by Wang et al. [35]. The items for perceived behavioral control were adapted from the scale proposed by Ajzen [36], and the items for behavior intention and behavior were adapted from the scale developed by Chan [37]. Additionally, the items for energy consumption information, policy system, organizational support, and market environment were developed based on the aforementioned analysis, taking into consideration the current policy, market environment, and prevailing situation of energy efficiency in public institutions. All items were measured using a five-point Likert scale.

The reliability and validity of the scale are presented in Table 1. The reliability of the questionnaire data was assessed using Cronbach's alpha. The Cronbach's alpha values for all variables exceeded 0.7, indicating high reliability. A goodness-of-fit test was also conducted to assess the suitability of the data for exploratory factor analysis (EFA) by examining the Bartlett's test of sphericity (BTS) and the Kaiser–Meyer–Olkin measure of sampling adequacy (KMO). The results show that BTS was highly significant at the 0.000 level, and the KMO values for all parts of the questionnaire exceeded 0.8, indicating good fitness for EFA. The factor loadings of the measurable variables were all above 0.5, indicating good scale validity. Additionally, the average variance extracted (AVE) for the latent variables exceeded 0.7, indicating good convergent validity. The results of discriminant validity are presented in Table 2. The square root of AVE for each factor was greater than the correlation coefficient of that factor with other factors, indicating good discriminant validity.

Table 1. The reliability and validity of the scale.

Variables	Items	α	FL	KMO	AVE
ECI	ECI1	0.863	0.918	0.707	0.807
	ECI2		0.898		
	ECI3		0.841		
PEOU	PEOU1	0.875	0.880	0.716	0.824
	PEOU2		0.930		
	PEOU3		0.883		
PU	PU1	0.902	0.866	0.841	0.760
	PU2		0.897		
	PU3		0.864		
	PU4		0.736		
	PU5		0.888		
SN	SN1	0.836	0.760	0.650	0.801
	SN2		0.923		
	SN3		0.925		
TRU	TRU1	0.927	0.949	0.732	0.893
	TRU2		0.958		
	TRU3		0.904		
PR	PR1	0.846	0.885	0.704	0.792
	PR2		0.830		
	PR3		0.906		
PBC	PBC1	0.875	0.881	0.738	0.871
	PBC2		0.909		
	PBC3		0.896		
POL	POL1	0.902	0.786	0.787	–
	POL2		0.930		
	POL3		0.925		
	POL4		0.887		
ORG	ORG1	0.914	0.905	0.714	–
	ORG2		0.955		
	ORG3		0.913		
ME	ME1	0.953	0.947	0.772	–
	ME2		0.961		
	ME3		0.959		
BI	BI1	0.933	0.929	0.759	0.908
	BI2		0.953		
	BI3		0.940		
BEH	BEH1	0.797	0.846	0.669	0.713
	BEH2		0.797		
	BEH3		0.899		

Note: "ECI" for energy consumption information, "PO" for perceived usefulness, "PEOU" for perceived ease of use, "SN" for subjective norm, "TRU" for trust, "PR" for perceived risk, "PBC" for perceived behavioral control, "POL" for policy system, "ORG" for organizational support, "ME" for market environment, "BI" for behavioral intention, "BEH" for behavior, "FL" for factor loadings.

Table 2. Pearson correlation with AVE square root value.

	ECI	PU	PEOU	SN	TRU	PR	PBC	BI	BEH
ECI	**0.898**								
PU	0.648	**0.872**							
PEOU	0.592	0.775	**0.908**						
SN	0.577	0.765	0.783	**0.895**					
TRU	0.526	0.748	0.740	0.737	**0.945**				
PR	0.223	0.322	0.302	0.425	0.394	**0.890**			
PBC	0.375	0.455	0.445	0.525	0.583	0.412	**0.934**		
BI	0.487	0.616	0.585	0.641	0.674	0.315	0.500	**0.953**	
BEH	0.434	0.596	0.611	0.638	0.679	0.300	0.618	0.821	**0.845**

Note: Bold numbers represent the square root of AVE.

5.4. Fitness Analysis of Structural Equation Model

This study employed AMOS 22.0 software to construct a structural equation model and conducted path analysis on the data. Eleven important fit indices were selected to assess the goodness of fit of the structural equation model. It was observed that the initial structural equation model required refinement. By introducing or removing paths and adjusting the covariance relationship of the error terms, the modified structural equation model, as shown in Figure 3, was obtained. The fit index test results are presented in Table 3. The correction parameters for each fit index met the acceptable criteria, indicating that the modified structural equation model demonstrated a strong fit to the data and had good overall model fitness.

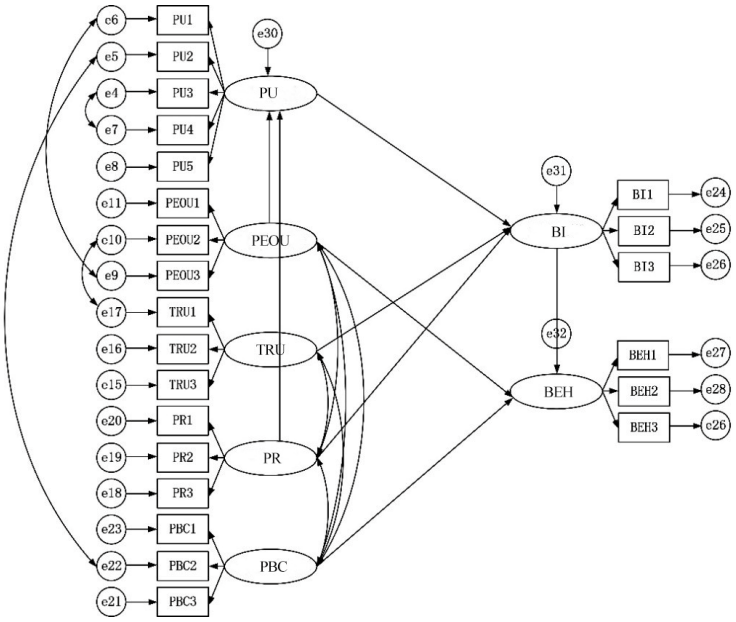

Figure 3. Structural equation model for driving factors (authors' own work).

Table 3. The fit index of the structural equation model.

Fit Index	Standard	Fitted Value	Whether the Standard Is Met
χ^2/df	1 < NC < 3	1.938	Yes
RMSEA	<0.05 (highly adaptable), <0.08 (well adapted)	0.070	Yes
RMR	<0.05 (ideal), <0.08 (acceptable)	0.051	Yes
GFI	>0.8	0.847	Yes
AGFI	>0.8	0.800	Yes
CFI	>0.9	0.943	Yes
TLI	>0.9	0.932	Yes
IFI	>0.9	0.944	Yes
PGFI	>0.5	0.651	Yes
PNFI	>0.8	1.938	Yes
PCFI	>0.8	0.070	Yes

Note: "χ^2/df" for chi-square/degrees of freedom, "NC" for normed chi-square, "RMSEA" for root mean square error of approximation, "RMR" for root mean square residual, "GFI" for goodness-of-fit index, "AGFI" for adjusted goodness-of-fit index, "CFI" for comparative fit index, "TLI" for Tucker–Lewis index, "IFI" for incremental fit index, "PGFI" for parsimony goodness-of-fit index, "PNFI" for parsimony normed fit index, "PCFI" for parsimony comparative fit index.

5.5. Mediation and Moderation Analysis

In this study, bootstrap analysis was combined with the mediation effect test program proposed by Zhonglin Wen to further examine the mediating effect of the antecedent variables of behavior intention on the outcome variables of behavior. A total of 1000 bootstrap tests were conducted, and the results are presented in Table 4. The significance of the mediating effects of perceived usefulness, trust, and perceived risk on behavior intention were all below 0.05, indicating the presence of a mediating effect. Among them, behavior intention partially mediated the relationship between perceived usefulness and trust, while it fully mediated the relationship with perceived risk.

Table 4. Bootstrap test of mediating effect.

Step	IV	DV	R^2	Standardized Regression Coefficient	Maximum	Minimum	Sig.
1	PU	BEH	0.189	0.434	0.599	0.291	0.001
2	PU	BI	0.234	0.483	0.671	0.332	0.001
3	PU	BEH	0.497	0.128	0.253	0.029	0.023
	BI			0.635	0.727	0.496	0.001
1	TRU	BEH	0.234	0.484	0.546	0.311	0.001
2	TRU	BI	0.263	0.513	0.581	0.358	0.001
3	TRU	BEH	0.507	0.172	0.265	0.030	0.012
	BI			0.608	0.716	0.479	0.001
1	PR	BEH	0.083	−0.289	−0.106	−0.427	0.003
2	PR	BI	0.105	−0.324	−0.141	−0.463	0.001
3	PR	BEH	0.489	−0.071	0.026	−0.191	0.262
	BI			0.673	0.756	0.541	0.001

Note: "IV" for independent variable", DV" for dependent variable, "R^2" for coefficient of determination, "Sig." for significance level.

At the same time, the moderating variables in this study included policy system, organizational support, and market environment, and the explanatory variable was behavioral intention. Because the four variables were continuous variables, hierarchical multiple regression was chosen to test the moderating effect. As shown in Table 5, the interaction of policy system with behavior intention was significant, and the interaction term coefficient was 0.152, indicating a positive moderating effect. Likewise, the interaction term coefficient of organizational support with behavior intention was 0.134, indicating a positive moderating effect. However, the interaction between market environment and behavior intention was not significant, with an interaction term coefficient was 0.073, indicating that market environment did not play a significant moderating role in the process of behavior intention to behavior in public institutions.

Table 5. Results of the moderating effect test.

	Model I			Model II			Model III		
	Standardized Regression Coefficient	t	*p*	Standardized Regression Coefficient	t	*p*	Standardized Regression Coefficient	t	*p*
BI	0.672	12.576	0.000	0.462	7.582	0.000	0.435	7.224	0.000
POL				0.359	5.895	0.000	0.343	5.729	0.000
BI × POL							0.152	3.042	0.003
BI	0.672	12.576	0.000	0.456	7.446	0.000	0.396	6.090	0.000
ORG				0.364	5.965	0.000	0.363	6.017	0.000
BI × ORG							0.134	2.459	0.015
BI	0.672	12.576	0.000	0.456	7.446	0.000	0.396	6.090	0.000
ME				0.319	4.726	0.000	0.311	4.604	0.000
BI × ME							0.073	1.306	0.193

6. Discussion

6.1. Theoretical Model Revision

After conducting tests on the theoretical model using SPSS 22.0 and AMOS software, a modified theoretical model was derived, illustrating the optimal driving factors for promoting behavior in public institutions to adopt EPC for building energy efficiency retrofits (refer to Figure 4). The results of hypothesis testing, as outlined in Section 5, indicate that hypotheses H1, H3, H4, and H8 were rejected. Specifically, energy consumption information, perceived ease of use, subjective norm, and perceived behavioral control were not found to have a significant positive influence on the behavioral intention of public institutions to implement energy efficiency retrofits using the EPC method. However, the remaining nine hypotheses were supported. Additionally, two additional paths, namely, H14 and H15, were incorporated into the optimal model. The two paths indicate that perceived risk has a significant negative impact on perceived usefulness, and perceived ease of use has a significantly positive effect on the implementation of energy efficiency retrofits in public institutions through the utilization of EPC. Based on Figure 4, we can observe several relationships between the variables. Trust and perceived usefulness have a positive impact on behavior intention, while perceived risk has a negative impact on behavior intention. Behavior intention, perceived ease of use, and perceived behavioral control positively influence behavior. Moreover, the policy system and organizational support play a role in facilitating the translation of behavior intention into actual implementation of EPC in public institutions. In addition to the direct relationships between the driving factors and behavior intention or behavior, there are also indirect influences among the driving factors. Perceived risk negatively affects perceived usefulness, while perceived ease of use positively affects perceived usefulness. These relationships highlight the interconnected nature of the variables within the proposed model.

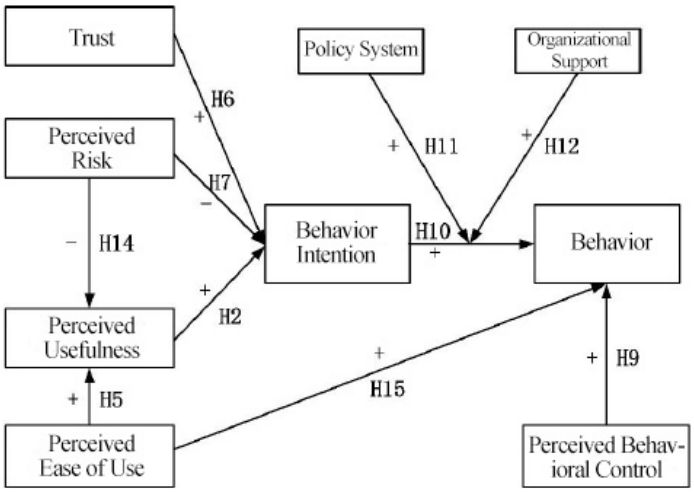

Figure 4. Modified behavior-driven model (authors' own work). Note: "+" for positive drive, "−" for negative drive.

6.2. Explanation of Behavior-Driven Model

6.2.1. Analysis for the Internal Driving Factors' Effect

The revised theoretical model provides insights into the direct and indirect relationships between the driving factors of energy efficiency retrofits in public institutions using the EPC. Table 6 presents the standardized path coefficients and significance levels, which were obtained through quantitative analysis using AMOS 22.0. The findings indicate that behavior intention is the most influential factor driving actual behavior. Additionally, perceived ease of use significantly contributes to perceived usefulness. The path coefficients for perceived usefulness→behavior intention, trust→behavior intention, and perceived risk→behavior intention demonstrate that perceived usefulness, trust, and perceived risk

directly impact the generation of behavioral intention. Among these variables, perceived usefulness has the greatest contribution. Therefore, it is crucial to strengthen trust, reduce perceived risk, and increase the perceived usefulness of the EPC for public institutions in order to enhance their intention to adopt the EPC approach. Currently, public institutions face certain limitations in their understanding of building energy consumption standards and EPC models. They also lack clear judgments regarding the energy consumption of their buildings' operations. As a result, they may not fully grasp the potential benefits of the EPC for improving building energy efficiency. Thus, improving perceived usefulness can effectively promote the application of the EPC in public institutions.

Table 6. Summary of effects (standardized).

Path Relationship			Direct Effect	Indirect Effect	Total Effect
PU	→	BI	0.321		0.321
PU	→	BEH		0.232	0.232
TRU	→	BI	0.303		0.303
TRU	→	BEH		0.219	0.219
PR	→	PU	−0.180		−0.180
PR	→	BI	−0.257	−0.058	−0.315
PR	→	BEH		−0.227	−0.227
PBC	→	BEH	0.203		0.203
PEOU	→	PU	0.673		0.673
PEOU	→	BI		0.216	0.216
PEOU	→	BEH	0.150	0.156	0.306
BI	→	BEH	0.721		0.721

Note: The direct effect uses path coefficients to directly reflect the degree of influence of the independent variable on the dependent variable. The indirect effect uses the product of the path coefficients to reflect the degree of influence of the independent variable on the dependent variable with the mediating effect. The total effect is the sum of the direct and indirect effects.

Furthermore, the path coefficient for perceived behavioral control→behavior indicates that perceived behavioral control has a significant positive influence on the behavior of public institutions. When it comes to perceived behavioral control, factors such as experience, resources, and self-efficacy have a similar impact, suggesting that enhancing the experience of public institutions in implementing the EPC, improving the availability of resources and talent-training mechanisms, and developing operation guidelines for the EPC can effectively enhance the perceived behavioral control of decision-makers within public institutions. This, in turn, drives the adoption of EPC by public institutions.

6.2.2. Analysis for the Moderating Role of External Contextual Factors

According to Table 5, the contextual variables of policy system and organizational support have a significant impact on the relationship between behavior intention and behavior in public institutions adopting the EPC. The interaction term "BI × POL" suggests that well-developed policies, clear guiding policies, a flexible tendering and fiscal system, and effective economic incentives strengthen the influence of behavior intention on the behavior of public institutions. Currently, the policy system for EPC implementation is not perfect, lacking flexibility and effective economic incentives, which hinders the behavior intention of public institutions to adopt the EPC. The interaction term "BI x ORG" indicates that the support provided by a third-party organization during the tendering and procurement process, as well as the supervision and risk assurance throughout the process, can enhance the strength of behavior intention on behavior. This is primarily due to public institutions' limited attention to their own building energy consumption information and their limited knowledge of the energy efficiency service industry. Additionally, the behavior of public institutions in implementing energy efficiency improvements is not solely driven by personal motivations but is also influenced by social norms.

The lack of significance in the moderation of behavior intention to behavior by the market environment can be attributed to several reasons. Firstly, the insignificance of

the variable "energy consumption information" indicates that public institutions do not prioritize or pay much attention to the energy consumption information of their buildings. This suggests a lack of understanding regarding building energy-saving renovations and ESCO-related information. Consequently, the transparency of market information does not strengthen public institutions' awareness of the severity of their energy consumption issues, nor does it reduce their perceived risk associated with ESCO adoption. Secondly, public institutions have limited involvement in associations focused on energy conservation. As a result, the technological innovations and improvements in service quality brought about by healthy competition between ESCOs are not readily apparent to public institutions. Thirdly, the decision to implement building energy-saving renovations using the EPC in public institutions is not solely driven by personal motivations related to environmental protection. Additionally, there may be a limited influence of social norms at the ideological level. Therefore, values associated with energy conservation and environmental protection do not significantly moderate the behavior intention of decision-makers in public institutions.

7. Conclusions

Within China, public institutions play a vital role in promoting energy-efficient building renovations due to their large numbers, volume, and high energy consumption. Through the exemplary role of public institutions, the energy-saving awareness of the whole society can be effectively enhanced, and the goal of widespread environmental protection can be achieved. The main objective of this research is to examine how to stimulate the proactive motivation of public institutions to adopt EPC for building energy efficiency retrofits. Drawing on theories such as the theory of planned behavior and previous research findings, this study identified both internal psychological driving factors and external contextual driving factors that influence public institutions' decision to adopt EPC. Based on this, hypotheses were formulated to understand the relationships between these driving factors and the behavior of public institutions in adopting EPC. To test these hypotheses and optimize the behavior-driven model, a structural equation model was developed and an empirical study was conducted using a questionnaire. The research findings shed light on the behavioral characteristics of public institutions in adopting EPC.

(1) The internal psychological driving factors identified in this research for the adoption of EPC in public institutions encompassed factors such as energy consumption information, perceived usefulness, perceived ease of use, subjective norm, trust, perceived risk, and perceived behavioral control. Additionally, the external contextual factors considered were the policy system, organizational support, and market environment.

(2) The behavior-driven model proposed in this study aimed to understand the relationship between the driving factors and behavior in public institutions adopting the EPC. The model consisted of two pathways: the indirect influence of each internal driving factor on behavior through their impact on behavior intention, and the moderating effect of external contextual factors on the relationship between behavior intention and behavior.

(3) The findings from the model and hypothesis testing revealed several key insights. Among the internal psychological driving factors, energy consumption information, subjective norm, perceived ease of use, and perceived behavioral control did not significantly or positively influence the behavior intention of public institutions to adopt EPC. On the other hand, perceived usefulness and trust were found to significantly positively influence behavior intention, while perceived risk had a significant negative impact on behavior intention. Moreover, perceived behavioral control and perceived ease of use emerged as significant positive drivers for the behavior of public institutions, with behavior intention being the most crucial positive driver. Additionally, perceived usefulness was found to be significantly positively influenced by perceived ease of use. Among the external contextual factors, both the policy system and organizational support played a significant moderating role in the relationship between behavior intention and behavior in public institutions. This indicates that

these external factors influence the process from behavior intention to actual behavior in public institutions adopting EPC.

Based on the aforementioned findings, this paper puts forward three policy suggestions to enhance the proactive engagement of public institutions in adopting the EPC model for building energy efficiency retrofits.

(1) Harness the government's role and strengthen organization: The government should leverage its functions to raise awareness among public institutions regarding EPC. This can be achieved through extensive publicity campaigns, setting energy-saving targets, and emphasizing the responsibility of public institutions in adopting EPC. Additionally, the government should establish normative documents, optimize incentive mechanisms, and provide substantial support to public institutions. This can be accomplished by establishing supervision platforms and service delivery agencies, and promoting standardized management and supervision throughout the entire EPC process.

(2) Enhance the capabilities of ESCOs: ESCOs should improve their technical expertise and comprehensive capabilities. They should focus on developing advanced energy-saving retrofit technologies and implementing refined management practices. Furthermore, fostering closer collaboration between ESCOs and government institutions, universities, and research institutions can enhance the perceived ease of use and perceived behavioral control of EPC among public institutions. ESCOs can also support the government in formulating EPC-related standards. Lastly, establishing strategic alliances within the industry and strengthening talent-training programs, along with implementing a reasonable salary incentive mechanism, can collectively drive the development of the ESCO industry.

(3) Harness the potential of third-party support: Encouraging the involvement of association institutions as intermediaries and communication platforms between public institutions and ESCOs can be highly beneficial. These associations can facilitate the establishment of public information platforms and promote effective communication and collaboration between public institutions and ESCOs. Additionally, introducing third-party monitoring agencies can enhance the oversight of technical services and ensure risk mitigation throughout the entire process of EPC implementation.

While this research is innovative both in terms of its content and its methodology, there are a few limitations to consider. Firstly, the selection of driving factors in the theoretical model may have room for improvement, as there may be additional factors that could influence public institutions' adoption of EPC. Further research can explore and expand upon these factors. Secondly, since there is no existing research and no well-established scales for reference, the measurement items used in this study may require adjustments and enhancements in subsequent studies. Thirdly, the sample size and diversity of the questionnaire in this research may not fully represent the broader context. Therefore, future studies should aim to expand the coverage area and sample range, and consider incorporating interviews to supplement the study's findings with more detailed information.

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References

1. Vringer, K.; van Middelkoop, M.; Hoogervorst, N. Saving energy is not easy: An impact assessment of Dutch policy to reduce the energy requirements of buildings. *Energy Policy* **2016**, *93*, 23–32. [CrossRef]
2. Qin, G.; Guo, H. Research Summary on the Operational Theory of Energy—Saving Renovation Market of Existing Buildings. *Constr. Econ.* **2019**, *40*, 110–116.
3. Yu, X.; Zhao, H. The Path to Energy Conservation and Emission Reduction—Based on the Behavior Characteristics of Energy Consumption Parties. *Mod. Manag. Sci.* **2018**, *3*, 82–84.
4. Zhu, X.; Song, B.; Liu, S. Energy Efficiency Status and Technological Development for China Public Institutions. *Constr. Sci. Technol.* **2019**, *16*, 63–66.
5. Liu, G.; Lei, B. Inspiration of European EPC experiences for China. *Energy Sav. Environ. Prot.* **2009**, *9*, 25–28.
6. Lv, R.; Wang, J. Comparative study on China-overseas energy performance contracting. *Sino Glob. Energy* **2011**, *16*, 22–28.
7. Huang, F.; Yu, Z.; Hu, Y.; Chen, Q. Practice and Development Analysis of Energy Performance Contracting. *Energy Conserv. Technol.* **2011**, *29*, 375–378.
8. Savas, E.S. *Privatization and Public-Private Partnerships*; SAGE: Newcastle upon Tyne, UK, 2000.
9. Wang, J.; Ju, Y. Analysis on the Application Status of Energy Performance Contracting in Public Institutions. *Mod. Econ. Inf.* **2011**, *5*, 31+38.
10. Li, M.; Li, M.; Li, Y. Study on Energy management Practice of Application Contract of Energy-saving Renovation of Public Buildings in Hebei Province. *Fly Ash Compr. Util.* **2022**, *38*, 106–110.
11. Zhang, X. Energy Performance Contracting: A Solution for Peak Carbon Achievement and Carbon Neutrality in Public Institutions—The Case of Energy Performance Contracting in Shanghai Public Institutions. *Chin. Public Adm.* **2021**, *11*, 157–159.
12. Aasen, M.; Westskog, H.; Korneliussen, K. Energy performance contracts in the municipal sector in Norway: Overcoming barriers to energy savings? *Energy Effic.* **2016**, *9*, 171–185. [CrossRef]
13. Krøtel, S.M. Contracting for energy efficiency: The diffusion of novel contracting practices at local government level. *Local Gov. Stud.* **2015**, *41*, 794–813. [CrossRef]
14. Zhang, M.; Wang, M.; Jin, W.; Xia-Bauer, C. Managing energy efficiency of buildings in China: A survey of energy performance contracting (EPC) in building sector. *Energy Policy* **2018**, *114*, 13–21. [CrossRef]
15. Kostka, G.; Shin, K. Energy conservation through energy service companies: Empirical analysis from China. *Energy Policy* **2013**, *52*, 748–759. [CrossRef]
16. Polzin, F.; von Flotow, P.; Nolden, C. What encourages local authorities to engage with energy performance contracting for retrofitting? Evidence from German municipalities. *Energy Policy* **2016**, *94*, 317–330. [CrossRef]
17. Zhou, X.; Ding, J. Energy Management Contract Service Development Research on Shanghai Public Institution Field. *Shanghai Energy Conserv.* **2016**, *7*, 353–356.
18. Chen, X.; Lin, M.; Li, H.; Zhang, l.; Xia, L. Research on promotion model of energy outsourcing epc in colleges and universities. *Archit. Technol.* **2017**, *48*, 1259–1261.
19. Zhang, J. Thoughts on Promoting the Socialization of Energy Management in Public Institutions. *Energy China* **2019**, *41*, 13–16+37.
20. Wang, X. Research on Quality Assurance Contract of Energy Performance Contracting. *Sci. Technol. Manag. Res.* **2016**, *36*, 252–255.
21. Chen, X.; Tang, J. Research on Incentive Policy for Energy Performance Contracting. *Seeker* **2016**, *6*, 121–125.
22. Wang, L.; Yang, J.; Sun, J. Research on Economic Incentive Policy for Energy—Saving in Buildings of Public institutions. *Soc. Sci. Res.* **2015**, *3*, 134–136.
23. Chen, L.; Li, X.; Wang, Z. Study on Risk Hierarchy and Transmission Path of Existing Public Building Energy Saving Renovation Project Based on Fism. *Joumnal Civ. Eng. Manag.* **2021**, *38*, 155–162.
24. Chen, W.; Cheng, Z.; Zhang, Y.; Zhang, N. Study on the Preliminary Risk Sharing of Existing Building Energy Saving Renovation Projects Under EPC Mode. *Resour. Dev. Mark.* **2021**, *37*, 1166–1173.
25. Zhang, X.; Sun, K.; Wang, Z. Risk measurement and evaluation of building energy management contract projects. *Proj. Manag. Technol.* **2021**, *19*, 27–32.
26. Davis, F.D. Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Q.* **1989**, *13*, 319–340. [CrossRef]
27. Liu, M.; Yang, Q.; Chen, Y. The Effect of Feedback Information Framing on College Students' Intention to Energy Conservation from the Perspective of Reference Dependence. *Soft Sci.* **2017**, *31*, 66–69.
28. Feng, Z.; Zhang, Z. Analysis on the Influencing Factors of Potential Interdisciplinary Cooperation Behavior. *Inf. Stud. Theory Appl.* **2020**, *43*, 114–120+149.
29. Tan, C.; Zhu, C.; Gou, F. Cooperative Behavior Influencing Factors of Scientific Researchers in Virtual Academic Community—Based on Qualitative Analysis and Empirical Research. *Inf. Sci.* **2020**, *38*, 52–58+108.

30. Zhang, J.Z.; Tang, C.Y.; Guo, L.; Xu, H.J. A longitudinal investigation of customer cooperation in services: The role of appraisal of cooperation behaviors. *Psychol. Mark.* **2018**, *35*, 957–967. [CrossRef]
31. Stern, P.C.; Gardner, G.T. Psychological-research and energy-policy. *Am. Psychol.* **1981**, *36*, 329–342. [CrossRef]
32. Venkatesh, V.; Morris, M.G.; Davis, G.B.; Davis, F.D. User acceptance of information technology: Toward a unified view. *MIS Q.* **2003**, *27*, 425–478. [CrossRef]
33. Wan, C.; Shen, G.Q.; Choi, S. Experiential and instrumental attitudes: Interaction effect of attitude and subjective norm on recycling intention. *J. Environ. Psychol.* **2017**, *50*, 69–79. [CrossRef]
34. Handfield, R.B.; Bechtel, C. The role of trust and relationship structure in improving supply chain responsiveness. *Ind. Mark. Manag.* **2002**, *31*, 367–382. [CrossRef]
35. Wang, F.; Gao, L.; Pan, Y. Research on the effect of customer involvement on customer satisfaction—The mediation of perceived risk and the moderation of self-efficacy. *Res. Financ. Econ. Issues* **2017**, *6*, 101–107.
36. Ajzen, I. From intentions to actions: A theory of planned behavior. In *Action Control: From Cognition to Behavior*; Springer: Berlin/Heidelberg, Germany, 1985; pp. 11–39.
37. Chan, R.Y. Determinants of Chinese consumers' green purchase behavior. *Psychol. Mark.* **2001**, *18*, 389–413. [CrossRef]