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How Social Impressions Affect Public Acceptance of Nuclear Energy: A Case Study in China

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Abstract: Expanding the proportion of nuclear energy to shift the current energy structure and reduce carbon emission has been acknowledged by the China National Energy Administration. As a typical NIMBY facility, nuclear power plants are faced with a dilemma. Increasing the public acceptance of nuclear power is important for its development. Although multiple studies have shown the factors affecting the public acceptance, few of them focused on the effects of social impression brought about by nuclear power on public attitudes. In this study, a theoretical model was established to examine the impact of social impression (including impression management and stigmatization), knowledge, social trust, perceived risk, and perceived benefit on the public acceptance of nuclear energy. The data in this study were obtained through a questionnaire survey (N = 577) of residents near the Fangchenggang Nuclear Power Plant in China. The results showed that impression management did not directly affect the acceptance but had a positive effect on knowledge. Knowledge and perceived risk or perceived benefit play roles as chain intermediaries between impression management and public acceptance. Stigmatization negatively affects the social trust and public acceptance of nuclear energy. Social trust and perceived risk or perceived benefit act as chain intermediaries between stigmatization and public acceptance. The path "impression management affects knowledge, and knowledge affects perceived risk, then perceived risk finally affects public acceptance" is optimal among all the paths. Moreover, knowledge has no significant effect on public acceptance but negatively affects perceived risk. Social trust positively affects perceived benefit and public acceptance. It is also indicated that perceived benefit has a stronger effect on public acceptance than perceived risk. The findings in this study could inform the government regarding potential social management and recommendations on policy making.

Keywords: public perception; nuclear energy; public acceptance; risk communication

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1. Introduction

As of October 2021, 132 countries or regions have proposed their carbon neutral targets [1]. Compared with those developed countries, such as the United States and Germany, which have established advanced energy strategy and mature industrial systems, China's road to carbon neutrality is more complicated and challenging. China's fossil energy consumption accounts for more than 80% of the total, particularly coal, which has the highest carbon intensity, reaching 58% [2]. Continuous economic growth has led to the increasing demand for electricity production, which has slowed down significantly in terms of its growth rate [3]. Therefore, developing clean energy and reducing the fossil energy utilization have become the best means to achieve the goal of carbon neutrality after carbon peaking.

Investments in non-fossil energy sources have been increasing, expanding the proportion of wind power, hydropower and other forms in China [4]. However, wind power and photovoltaics are limited by environmental conditions, and hydropower is pressured with flow shortages and ecological sustainability [5,6].

There is great potential for nuclear power development in China. In 2020, nuclear power generation was 366.243 billion kWh, equivalent to reducing the burning of standard coal by 104.7419 million tons [7]. Its high efficiency and clean-energy features can contribute to the realization of carbon neutrality. The construction of third-generation nuclear reactors along the coastal area is accelerating. Prior to 2025, the installed nuclear power capacity in China will be up to 70 GW, and new nuclear reactors will be built at a rate of six per year [8]. However, the construction of nuclear energy facilities in mainland China has not been smooth sailing because most people are skeptical or even unsupportive for new nuclear power plants construction.

Nuclear energy disasters have attracted much attentions around the world, significantly affecting public attitudes toward nuclear power. Several incidents of public opposition to the construction of nuclear energy facilities have arisen, such as those in Rushan, Jiangmen, and Lianyungang [9]. Continual antinuclear NIMBY (not-in-my-backyard) movements have hindered China's ambitious nuclear expansion plan [10]. Public acceptance has become a restrictive factor for the development of nuclear energy, and how to guide the public and gain their support is the decisive point to the legal construction of nuclear power plants. Thus, the factors influencing the attitude of local residents towards the construction of nuclear power plants should be further understood.

The benefits of nuclear energy always accompany with its immense risks [11]. According to previous studies, perceived benefit and perceived risk of the nuclear power plants are crucial determinants of public acceptance [12]. People with a high level of nuclear knowledge can rationally judge the risks and benefits of nuclear power, which in turn influences their attitudes towards nuclear power [13]; however, in the absence of sufficient knowledge, decisions and judgments can be guided by social trust, and distrust in government may lead to a low acceptance of nuclear energy [14].

By this token, knowledge and social trust are also key factors influencing public acceptance of nuclear power. In recent years, the worsening environmental pollution problem in China has awakened the public awareness of environmental protection, and the environmental advantages of nuclear energy are in line with the public desire to reduce air pollution. Thus, environmental beliefs expressing willingness to protect the environment may be the driving force behind public acceptance of nuclear energy [15]. Wang et al.'s research showed that the Chinese public environmental beliefs positively affect nuclear attitudes [16].

This also shows that positive impressions of nuclear power can indeed change public attitudes towards it. However, people with a low level of acceptance of nuclear energy believe that nuclear power threatens public safety and pollutes the environment, which is dominated by negative impressions. The social group's impression of nuclear energy is not entirely skewed towards the good or the bad side, positive and negative recognition of nuclear energy constitutes its social impression.

Positive recognition of nuclear energy means affirmation of its advantages and correct perception of risks [17]. China's nuclear power has been operating safely for 30 years and has advanced nuclear reactor technology with independent intellectual property rights. In this context, the public should have full confidence in nuclear safety; however, in fact the public still has a fear of nuclear energy, exaggerating the frequency of nuclear accidents and the impact of nuclear radiation [18].

This negative recognition is actually a stigma against nuclear energy and hinders the public willingness to accept nuclear power. Nuclear energy is highly scrutinized and more vulnerable to stigmatization [19], which is a stereotype of the characteristics of nuclear-related projects.

The high concern of nuclear power failed to lead the public to examine the nuclear energy issue calmly but makes them fall into a situation of looking for the negative effects of nuclear energy. This rigid impression prevents the discovery of other features of nuclear energy [20]. Thus, when considering the influence of social impression on nuclear energy acceptance, it is necessary to start from two perspectives, positive recognition and negative

recognition; however, previous studies have only focused on one of them. How social impressions affect public acceptance is rarely discussed but the direct influence between them is frequently discussed.

Given the significance of social impression in shifting public attitudes towards nuclear energy, this study tries to find the detailed effect paths of social impressions on public acceptance of nuclear energy (fission-based nuclear power). The structural equation modeling was used to verify the hypothesis and explore the pathways that may affect public acceptance of nuclear power. The results can contribute to explaining the influence and mechanism of social impression on public acceptance of nuclear power. Moreover, this study may inform domestic policymakers about public misconceptions towards nuclear energy development, clear management direction and formulate policies to promote public attitudes in nuclear energy.

2. Literature Review

2.1. Significant Factors Affecting Public Acceptance: Public Perception

Public acceptance of nuclear energy is defined as the degree of public acceptance of the application of nuclear technology, the construction of nuclear power plants (NPP), and nuclear energy development policies. It determines whether the nuclear technology or energy policy can be successfully implemented and promoted. Judging from the risk studies of nuclear energy, the main reason for the public ambiguous attitude towards nuclear energy is the difficulty in weighing the relationship between benefits and risks.

Thus, perceived risk and perceived benefit are considered to be the main factors affecting public acceptance of nuclear energy [21]. Visschers and Siegrist conducted a longitudinal study based on two surveys in Sweden before and after Fukushima Daiichi nuclear accident, respectively. The results demonstrate that perceived risk and perceived benefits determine the acceptance of nuclear power stations both before and after the accident [22].

Perceived risk refers to individual perception of uncertainty about specific events or behaviors and their possible consequences [23]. The magnitude of perceived risk is determined by the danger and potential loss. A negative relationship between risk perception and public attitudes towards nuclear energy has been confirmed in previous studies. For example, Groot et al. found that the acceptance of nuclear power states was discouraged by risk perception, the stronger perceived risk would lead to lower public acceptance [12].

Conversely, perceived benefit is considered to be positively associated with public acceptance. Perceived benefit refers to the extent to which individuals or social groups benefit from the development of nuclear energy, and the benefits come in various forms, ranging from the reduction of the greenhouse effect, the providing of employment opportunities, the upgrading of local infrastructure, etc. [11]. Jang and Park indicated that perceived benefits played a key role in determining the public's intention to use NPPs [21]. Even after the nuclear accident, the perceived benefits of nuclear energy still had a positive effect on public acceptance [24].

In sum, individual acceptability of nuclear energy depends to a large extent on the rational analysis of the risks and benefits. Reducing risk perception and increasing benefit perception are efficient ways to motivate the public to accept nuclear energy [23]. If the public perceives low risks, they are more likely to accept nuclear power [25]. There is no sufficient evidence to prove which factor has the greater influence on public acceptance; however, they serve to link other factors with public acceptance, and deserve primary consideration.

2.2. Key Factors Affecting Public Acceptance: Knowledge and Social Trust

Several studies have been conducted to prove the theory that knowledge of specific technology could significantly affects benefit-risk perceptions [16]. In nuclear technology, corresponding knowledge includes the public understandings of nuclear power generation, operation and nuclear radiation knowledge risks. The findings regarding the relationship between knowledge and risk perception on nuclear power are mixed. Some scholars

support that grasping relevant knowledge is beneficial for mitigating perceived risk [26,27], while others hold the opposite view, such as the more knowledge, the higher perceived risk [28] or there is no linear relationship between the two [22].

The dissimilar educational background and economic ability of the respondents may explain these differences; thus, these characteristics in research should be considered instead of jumping to conclusions. According to Wang et.al, knowledge could significantly and positively affect perceived benefit [23]. This is a good explanation for why experts emphasize the advantages of promoting nuclear power, while the public pays more attention to the risks. If the knowledge gap between experts and the public narrows, their attitudes towards the same issue may converge.

Knowledge can also affect public acceptance directly or indirectly through public perception. As studied, the public with a high level of knowledge can objectively assess the risks and benefits, and then make reasonable decisions on the accepting of nuclear power [21]. People with more knowledge about renewable energy were found to have stronger adoption intentions [29]. However, Pauzi et al. found that more educated people were less willing to accept nuclear energy in Malaysia [30]. Therefore, the relationship between knowledge and public acceptance varies with social environment and needs to draw conclusions from the actual situation.

Xia proposed that the public relies mainly on trust to assess nuclear risks and benefits in absence of knowledge [15]. Wang and Li found that trust had a positive relationship with perceived benefit and a negative relationship with perceived risk [16]. Similarly, prior studies have shown that trust can enhance benefit perceptions and guide public acceptance of nuclear energy [11,31]. High levels of trust in nuclear experts, nuclear plant operators, and regulatory authorities can promote public acceptance of nuclear power (Ryu et al., 2018). From the perspective of duration, trust follows the asymmetry principle, and its pace of erosion is faster than that of formation. Negative events could have a greater impact on trust than positive events [12]. Social trust depends on how effectively the authority supervises the operation of nuclear power plants.

Generally, knowledge and social trust are critical factors affecting public acceptance of nuclear power. Similarly, they may also act as intermediaries for connecting discussed factors with public acceptance, just as the role of public perceptions. Hence the potential impact relationships are worth figuring out.

2.3. Ignored Factors Affecting Public Acceptance: Social Impression

As the product of technological progress, the popularity of nuclear energy varies widely across countries and regions, a large part of the reason is the different social impressions of nuclear power. Given the special site selection of nuclear power plants, most people are unfamiliar with them. In the absence of understanding, the public will rely on existing information to form impressions of nuclear facilities. On this basis, social impression represents the common views or attitudes of the public towards nuclear technology, which is polarized with the times, gender, and occupations, etc.

This is formed by the perceiver through the process of collecting, integrating and analyzing social information [32]. Regardless of whether the information is positive or negative, social impression reflects the public recognition of them, and are also the basis for social judgement [33]. The media coverage plays an important role in building the public impression of nuclear energy.

In the 1970s, the superiority of nuclear power was hyped, and its application was highlighted by the media for it could actively promote economic, social, and technological development [34]. With the environmental risks of nuclear energy and the anti-nuclear struggle, nuclear energy gradually fallen into a poor public opinion environment. At the beginning of the 21st century, nuclear energy was reframed as an effective tool to deal with climate change and regained popularity [35]. This mass promotion of positive information is called impression management, which means managing one's impressions in satisfactory ways. On this basis, impression management develops as a description of self-expression

and self-action, in which individuals consciously control their own behavior to influence their impressions of the target audience [36].

Currently, impression management of nuclear energy is mainly carried out by nuclear safety and health. After the Fukushima nuclear accident, the construction of nuclear safety culture has been emphasized many times as a guarantee for the operation of nuclear power plants [37]. Under normal circumstances, nuclear power enterprises will shape the image of safety by promoting technological advancement and careful design. For example, South Korea boosts citizens' confidence in nuclear technology safety by reporting exports of its own nuclear power plants, and this approach obtains a better response [21].

Several accidents have made the public suspicion of the government, and thus strict supervision, information transparency and a sound system have become the focus of reshaping the image of nuclear safety [38]. Radiation safety stresses the point that the radiation generated by operation will not cause health hazards to the surrounding residents. It is difficult to create an absolutely healthy and harmless image of nuclear power owing to the effect mechanism of nuclear radiation.

The presence of random effects, dominated by the Linear No Threshold model, adds to this uncertainty [39]. Nonetheless, relevant scholars have made efforts to quantify the health risks caused by nuclear power plants, such as carcinogenic risks or the health benefits of replacing coal-fired power generation [40]. These authentic and credible data have indeed reduced the public concerns about health threats to some extent, which sends a signal that nuclear power has insignificant impacts on human health.

Exposure to information related to certain issues can help individuals process, understand, and memorize information to form their self-beliefs, impression management acts the same function that make the public receive more information, thus, further forming their knowledge [41,42]. Studies showed that exposure to risk information can affect risk knowledge [43]. Zhu found that more frequent use of social media can enhance public knowledge about nuclear power [44].

Information strategies based on environmental concern and energy shortage belief guides the public to understand the advantages of nuclear energy, overcoming the negative effects of perceived risk and increasing their openness to nuclear power plant [45]. Impression management follows this principle and enhances the exposure of positive information to target audience, which further advances public understanding of nuclear technology.

Even though the mass propaganda of nuclear safety and health effects has been conducted, the public still believes that nuclear power involves more risks than other energy sources, because its damage is difficult to be eliminated. Although nuclear disasters are rare, their consequences show an obvious negative sign, namely nuclear power generation has unusual risks. In this case, there is the stigmatization of nuclear energy and technology [46].

In the risk society, the ability of technological innovation to magnify the catastrophic potential of industrial activity beyond what is possible to understand. Major engineering decisions, such as nuclear power plants are often made jointly by experts, the government and nuclear enterprises, reflecting the interaction of society, system, culture, etc. Under such conditions, nuclear-related projects are likely to trigger public security crisis because of their mysterious and professional characteristics [47].

Nuclear power plants are marked as "harmful" to warn others to be excluded, which is a phenomenon of "stigmatization" [48]. People often create stereotypes about nuclear power based on untrue or compelling information, hence the misunderstanding of high accident rates and dangerous operation. Generally speaking, this stigmatization can be considered as a sign of a crisis of trust, which is caused by the public's wrong emotional perception of nuclear risks and media stigma [49]. With the rapid dissemination of information, the media can filter information with ulterior motives, thus exaggerating the nature and scope of objective risks.

Anchoring effect can also be used to explain the occurrence of stigmatization. When people make certain decisions, they are easily dominated by first impressions or first-hand information [50]. In the shadow of nuclear weapon explosions, the public may associate

the nuclear technology with death, cancer, genetic defects, etc., which would extend to the field of civilian nuclear energy, accompanied by instinctive resistance. If nuclear companies or the government mechanically emphasize "absolute safety", the public's panic would not be eliminated but the misunderstanding of nuclear safety would be deepened [18].

Many researchers also focused on the influence and mechanisms of nuclear stigma. Sen et al. found that people with high levels of education would be more aware of nuclear power [51]. Hae et al. indicated that nuclear stigmatization could significantly affect perceived risk, further reducing public acceptance of nuclear energy [52]. Thus, no matter whether admit the positive or negative aspects, social impression is likely to affect public acceptance of nuclear energy and also indirectly affect it through other factors.

2.4. Research Status

Although a large number of research works have been conducted to distinguish key factors in altering public acceptance, the role of impression management which shapes positive image thereby affecting the acceptance has not been fully considered yet. In addition, social impressions are rarely related with other factors that affect acceptance, and it is impossible to judge whether other factors kick in the impact of social impressions on public acceptance. In this study, we incorporate impression management as a new indicator into the public social impression of nuclear power. In addition, the acceptable level and influencing factors of nuclear risk for the research object are clearly identified and quantified. Finally, the influence path of social impression on public acceptance and the interaction mechanism with other factors are thoroughly discussed.

3. Research Framework and Methodology

3.1. Research Hypothesis

A social impression basically consists of two parts, the recognition of positive information coming from impression management, and the recognition of negative information expressed by stigmatization. Impression management is the publicity of nuclear enterprises or governments on the advantages of nuclear energy, including low cost, zero carbon emission and high energy density, aiming to correct the public misunderstanding and change their bad impression of nuclear energy.

Under such initiative, the public may gain knowledge about nuclear technology, and be able to accept nuclear power. Conversely, stigmatization amplifies nuclear risk and depicts nuclear power plants as facilities posing a threat to public health and safety. In this scenario, the public will be anxious and reject nuclear energy, along with the social trust receiving challenges. Hence, the following hypotheses can be developed:

Hypothesis 1 (H1). *Impression management has a positive impact on the knowledge of nuclear energy*.

Hypothesis 2 (H2). *Impression management has a positive impact on the public acceptance of nuclear energy*.

Hypothesis 3 (H3). *Stigmatization has a negative impact on the social trust of nuclear energy*.

Hypothesis 4 (H4). *Stigmatization has a negative impact on the public acceptance of nuclear energy*.

In addition, the relationship between public perception and public acceptance has been proven by previous studies. We assume that perceived risk has a significant negative impact on public acceptance, and perceived benefit has a significant positive impact on public acceptance. When the residents have sufficient knowledge of nuclear technology, perceived risk will be reduced and perceived benefits will be increased, they may be more likely to accept nuclear power. Therefore, we assume that knowledge has a significant positive impact on perceived benefit, public acceptance, and have a significant negative impact on perceived benefit.

Likewise, social trust was found to follow the same logic. For this study, social trust is defined as the extent to which the public trusts the nuclear power enterprises and government. Huang et al. found that trust plays an important role in increasing public acceptance by affecting perceived risk negatively and perceived benefit positively [53]. Therefore, we can assume that social trust has a significant positive impact on perceived benefit, public acceptance, and has a significant negative impact on perceived risk.

Hypotheses about social trust, knowledge, and public perception are important parts of this study; they are designed to guide us in establishing the link between social impressions and public acceptance. Thus, we propose a conceptual social impression to public acceptance model (see Figure 1), and we have the following hypotheses:

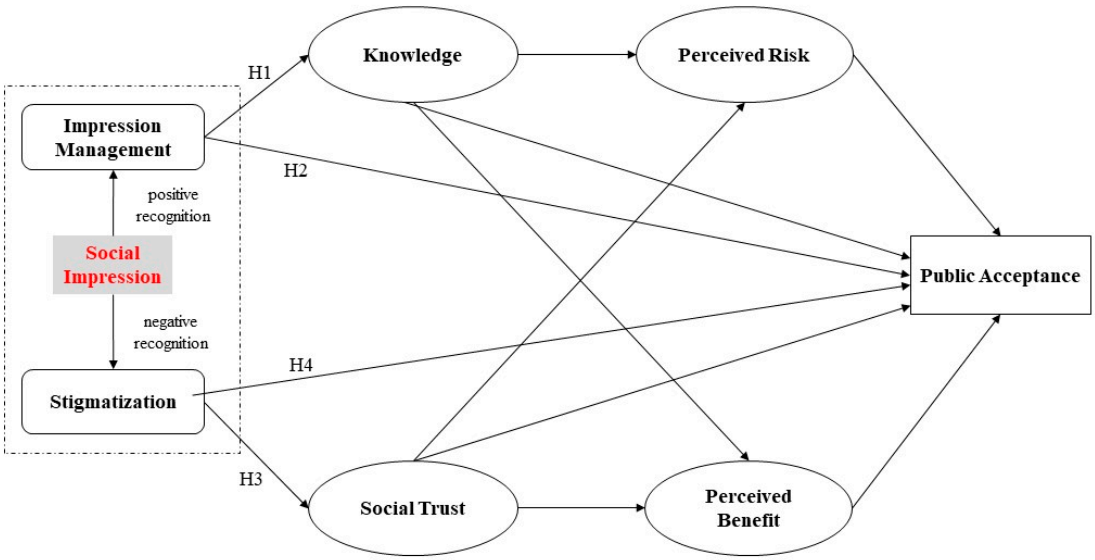

Figure 1. The conceptual Social Impression to Public Acceptance model.

Hypothesis 5 (H5). *Knowledge and perceived risk act as a chain intermediary between impression management and public acceptance.*

Hypothesis 6 (H6). *Knowledge and perceived benefit act as a chain intermediary between impression management and public acceptance.*

Hypothesis 7 (H7). *Social trust and perceived benefit act as a chain intermediary between stigmatization and public acceptance.*

Hypothesis 8 (H8). *Social trust and perceived risk act as a chain intermediary between stigmatization and public acceptance.*

3.2. Questionnaire Design and Measurement

In this study, to examine the proposed hypotheses, data were collected through questionnaire survey. Before conducting the survey, questionnaires were designed according to the psychometric paradigm method, with minor modifications to fit the subjects better and make these questions clearer to the respondents. The questionnaire consisted of three parts: The first part illustrated the research purpose, stated the identity of investigators, expressed the great gratitude to the respondents for their participation, and promised that data would be collected anonymously.

A brief introduction about nuclear energy was also presented, such as the generation of nuclear power, the forms of nuclear radiation, and the current development status of nuclear power industry in China. The second part was employed to gather research data of the designed constructs, and the quality of the data determines the credibility of this

research. The third part was designed to collect the demographic characteristics of the respondents, such as gender, age, educational levels, occupation, and income levels. The specific measurement items were presented in Appendix A.

3.3. Sample and Data Collection

For the study site, the coastal city Fangchenggang in Guangxi province (114°59.240′ E, 22°41.410′ N) was selected, for it is the first city to host a nuclear power plant in the west of Mainland China. Fangchenggang NPP was designed to build 6 million-kilowatt nuclear power generating units. The first two units were put into commercial operation in 2016. The third and fourth unit adopt the technology of 'Hualong One', and are expected to be operational within the next two years.

According to GB/T 17680.1-2008, the emergency planning area was divided into two parts, namely, the plume emergency planning area and the ingestion emergency planning area. With the nuclear reactor as the center, the radius of the former was ~10 km, and the latter was 30–50 km. In order to fully consider the scope of the nuclear accident, the residents living in plume and ingestion emergency planning zones were the main targets of nuclear risk assessment in this survey.

To lower the cost and increase the diversity of surveyed individuals, the questionnaire survey was prepared on an online survey platform, namely, Wenjuanxing (https://www.wjx.cn (accessed on 1 March 2021)). As the current mainstream data acquisition method, several studies about public acceptance were also conducted through the site [54,55], and the data obtained proved to be comparable to offline surveys. All the samples were selected through a stratified random sampling method. The questionnaire platform first distributes the questionnaire to users in designated areas, and users can also share the questionnaire link to the people around them to answer.

After collecting a certain number of questionnaires, the platform will take back the questionnaires and eliminate those that do not meet the requirements through IP addresses. With 95% confidence interval and no more than 5% margin of error, the required sample size is 384 based on the Cochran formula ($n = \frac{Z_{\alpha/2}{}^2 p(1-p)}{E^2}$, $Z_{\alpha/2} = 1.96$, $p = 0.5$, $E = 0.05$) [56]. The survey was conducted between 3 March and 10 March 2021, and 600 adults in total were investigated with a response rate of 96.1% (N = 577), which met the requirements of the sample statistics. The details of the respondents are shown in Table 1.

Table 1. Characteristics of the respondents.

Demographic Indicator	Number	Percentage
Gender		
Male	303	52.5%
Female	274	47.5%
Age (years)		
18–24	58	10.1%
25–30	195	33.8%
31–40	123	21.3%
41–50	130	22.5%
51–60	53	9.2%
Above 60	18	3.1%
Education level		
Elementary school and below	29	5.0%
Junior high school education	44	7.6%
High school/technical school education	286	49.6%
College and undergraduate education	169	29.3%
Master degree and above	49	8.5%

Table 1. *Cont.*

Demographic Indicator	Number	Percentage
Occupation		
Government official	89	15.4%
Corporate employee	75	13%
Professional (Doctor, Teacher, etc.)	45	7.8%
Worker	59	10.2%
Owner of individual	36	6.2%
Farmer/Fishermen/Growers	160	27.8%
Business/Service Workers	38	6.6%
Freelancer	15	2.6%
Student	56	9.7%
Others	4	0.7%
Monthly income (RMB)		
Below 2200	96	16.6%
2200–4000	298	51.7%
4000–6000	69	12.0%
6000–8000	54	9.3%
Above 8000	60	10.4%
Distance to NPP (km)		
0–5	208	36%
10–5	111	19.2%
15–10	84	14.6%
15–3	64	11.1%
30–50	110	19.1%
Total	577	100%

Briefly, 52.5% of the respondents were male, 56.1% wer aged over 30, and 62.2% had a senior high school or lower qualification. About 68.3% of respondents had a monthly income of below RMB 4000, while the per capita disposable income was RMB 3090 per month in Fangchenggang, as stated in the economic and social development statistical communique in 2021. In terms of the distance to nuclear power plants, up to 36% of respondents were within 5 km of nuclear power plants.

If some characteristics have the same distribution in the sample as in the population, it can be concluded that the sample is well represented [57]. The gender composition, age distribution, and education level in the sample are close to the demographic characteristics of the surveyed area. For example, the proportion of female population in the sample is 1.9% higher than the actual proportion (45.6%) in this region, and thus the sample is representative. In general, the respondents' demographic characteristics (i.e., gender ratio, age structure, educational background, and income level) conform to the actual situation of the destination.

3.4. Data Analysis and Methods

The structural equation modeling (SEM) was used to analyze the collected data and examine the proposed hypotheses. SEM is a useful method for determining extent to which a set of variables can confirm the theory about the relationship between the variables [58,59]. It consists of two models, namely, the measurement model and structural model [59]. The measurement model mainly focuses on the associations between the measurement items and latent variables, while structural model on exploring the associations between the latent variables. In this study, constructs, such as social impression, cannot be directly measured; therefore, at least two or more observed variables are required to explain it.

Relationships between different variables are intertwined, and it could be anticipated that perceived risk may be associated with knowledge, social trust, and public acceptance. Therefore, the structural model takes these connections into account as much as possible.

For these control variables of demographic characteristics, regression models were used to analyze their effects on public acceptance, impression management and stigmatization. In the following data analysis, with the support of Amos and SPSS software package, the measurement model was analyzed to evaluate the reliability and validity of the variables, and structural model was used to verify the hypothesis relationships between the variables.

4. Results

4.1. Descriptive Statistics Analysis

Descriptive statistics analysis was employed to figure out the means, standard deviations and correlations of the constructs studied. As shown in Table 2, the respondents showed the highest level of trust (Mean = 3.63), followed by the mean of perceived risk (Mean = 3.49). The respondents had confidence in the operation of nuclear power plants but cannot play a significant role in reducing their risk perceptions.

Table 2. Means and correlations among variables.

Variable	1	2	3	4	5	6	7
1. Impression management	1						
2. Knowledge	0.472 **	1					
3. Perceived risk	−0.136 **	−0.296 **	1				
4. Perceived benefit	0.324 **	0.540 **	−0.480 **	1			
5. Social trust	0.371 **	0.420 **	−0.199 **	0.440 **	1		
6. Stigmatization	−0.170 **	−0.347 **	0.143 **	−0.302 **	−0.326 **	1	
7. Public acceptance	0.270 **	0.469 **	−0.571 **	0.472 **	0.357 **	−0.295 **	1
Mean	3.28	3.31	3.49	3.03	3.63	2.91	2.93
Variance	0.86	0.97	0.86	0.83	0.83	0.96	0.96

Note: ** $p < 0.01$.

The mean of public acceptance (Mean = 2.93) was slightly lower than the midpoint of the scale (Median = 3), as the mean of stigmatization (Mean = 2.91) was also at a moderate level. In addition, judging from the means of impression management (Mean = 3.28), knowledge (Mean = 3.31) and perceived benefit (Mean = 3.03), it can be initially inferred that residents show moderate impression and understanding of nuclear energy, along with insignificant benefit perceptions. Significant correlations were found between constructs, and all the correlation coefficients were lower than 0.6, indicating that there was no multicollinearity between variables, and further analysis should be conducted.

4.2. Reliability and Validity Analysis

Confirmatory factors analysis (CFA) was performed to obtain the model fit indices. The results of model fitness analysis are shown in Table 3. The value of RMR is slightly higher than the threshold value (0.05); however, other fitting indexes meet the request of recommended level. Therefore, the research model proposed in this study is in good agreement with the survey data.

Composite reliability values and Cronbach's alpha value were adopted to measure the reliability of the variables. According to the principle proposed by Fornell and Larcker, when the value of Cronbach's alpha and composite reliability is higher than 0.70, it is generally considered that the reliability of variables is sufficient [60]. The values of composite reliability and Cronbach's alpha of these six variables are shown in Table 4, all reliability values are obviously above the threshold level (0.70). Therefore, it can be determined that the reliability of the variables is acceptable.

Table 3. The results of model fitness analysis.

Fitting Index		Recommended Level	Index Value	Result
Absolute fitting measures index	Chi-square/df	<3.00	1.987	Support
	GFI	>0.90	0.932	Support
	RMSEA	<0.10	0.041	Support
	RMR	<0.05	0.052	Not support
Incremental fitting measures index	CFI	>0.90	0.977	Support
	NFI	>0.90	0.948	Support
	NNFI	>0.90	0.964	Support
Parsimonious fitting measures index	PNFI	>0.5	0.788	Support
	PCFI	>0.5	0.813	Support

Note: GFI, goodness-of-fit index; RMSEA, root mean square error of approximation; RMR, root mean square residual; CFI, comparative fit index; NFI, normal fit index; NNFI, non-normed fit index; PNFI, parsimony normed fit index; PCFI, parsimony comparative fit index.

Table 4. The results of reliability and validity analysis.

Variable	Item	Loading	Cronbach's Alpha	Composite Reliability	AVE	$\sqrt{\text{AVE}}$
Impression management	IA1	0.858	0.766	0.810	0.611	0.782
	IA2	0.870				
	IA3	0.458				
Knowledge	K1	0.885	0.858	0.860	0.608	0.779
	K2	0.760				
	K3	0.757				
	K4	0.695				
Perceived risk	PR1	0.734	0.828	0.830	0.552	0.743
	PR2	0.809				
	PR3	0.734				
	PR4	0.677				
Perceived benefit	PB1	0.806	0.909	0.911	0.673	0.821
	PB2	0.856				
	PB3	0.858				
	PB4	0.826				
	PB5	0.739				
Social trust	ST1	0.578	0.883	0.886	0.573	0.756
	ST2	0.552				
	ST3	0.822				
	ST4	0.852				
	ST5	0.838				
	ST6	0.821				
Stigmatization	S1	0.816	0.614	0.822	0.826	0.783
	S2	0.695				
	S3	0.835				
Public acceptance	PA1	0.760	0.830	0.831	0.552	0.743
	PA2	0.786				
	PA3	0.759				
	PA4	0.674				

Note: AVE, average variance extracted.

Convergent validity and discriminant validity are generally used to judge the validity of variables. Factor loading of the item and average variance extracted (AVE) are frequently employed to measure convergent validity. When the variables and the values of factor loadings are larger than the threshold level (0.70), and the values of AVE are above the benchmark value (0.50), it can be concluded the convergent validity is adequate. As shown in Table 4, the factor loading values of all items belonging to corresponding variables are larger than 0.70.

The values of AVE are ranged from 0.552 to 0.673, indicating that the convergent validity is acceptable. When the values of $\sqrt{\text{AVE}}$ are larger than the correlation among variables, the discriminant validity is acceptable. Comparing the data in Table 2 with those in Table 4, the $\sqrt{\text{AVE}}$ value of each variable is bigger than its correlation with other variables in certain columns. It is clear that the validity of discriminant validity can be proved. In brief, the validity and reliability of each variable are reliable and acceptable.

4.3. Regression Analysis

Taking gender, age, education level, monthly income, and distance to NPP as independent variables and stigmatization, impression management, and public acceptance as dependent variables, respectively, multiple linear regression analysis was performed. As shown in Table 5, the coefficient between gender, education level and impression management are 1.329 and 0.217, with a statistically significant relationship ($p < 0.05$). The results shows that both gender and education level have a significant positive impact on impression management.

Table 5. The results of linear regression analysis.

Variable	Impression Management		Stigmatization		Public Acceptance	
	B	**SE**	**B**	**SE**	**B**	**SE**
Constant	1.778 ***	0.028	1.433 ***	0.043	2.867 ***	0.142
Gender	1.329 ***	0.011	0.047 ***	0.016	−0.013	0.055
Age	0.006	0.004	0.133 ***	0.006	−0.045 *	0.022
Education level	0.217 ***	0.003	−0.391 ***	0.005	0.041	0.017
Monthly income	−0.001	0.004	−0.006	0.007	0.038 *	0.023
Distance	−0.007	0.003	−0.003	0.004	0.007	0.015

Note: B, regression coefficient value; SE, standard error; * $p < 0.05$ and *** $p < 0.001$.

Similarly, the coefficient between gender, age, and stigmatization are 0.047 and 0.133, with a statistically significant relationship ($p < 0.05$). The results shows that gender and age have a significant and positive effect on stigmatization. However, the coefficient between education level and stigmatization is −0.391 ($p < 0.05$); this means that highly educated people are less likely to stigmatize nuclear power. The coefficients between age, monthly income and public acceptance of nuclear energy are −0.045 and 0.038, with a statistically significant relationship ($p < 0.05$).

The results indicates that age has a significant negative impact on public acceptance while monthly income has a positive impact. It also means that older people are less likely to accept nuclear power, and higher-income groups are more likely to accept nuclear power. Moreover, the coefficient between gender, education level, distance to NPP and public acceptance are not statistically significant ($p > 0.05$). The results indicates that there is no significant difference in public acceptance of nuclear energy among males and females. The level of education does not significantly affect the acceptance of nuclear energy, nor does the distance to the nuclear power plant.

4.4. Structural Model Analysis

The results of structural model analysis are shown in Table 6. Apart from the path from social trust to perceived risk, knowledge to public acceptance and impression management to public acceptance, the rest of the path relationships are established. The standardized path coefficient from impression management to knowledge is 0.565, with a statistically significant relationship ($p < 0.001$). Therefore, impression management has a significant and positive effect on knowledge, which supports Hypothesis 1. The standardized path coefficient from impression management to public acceptance is −0.03, with no statistically significant relationship ($p > 0.05$); therefore, impression has no significant effect on public acceptance, which rejects Hypothesis 2.

Table 6. The results of structural model analysis.

Hypothesis	Path Coefficient	Testing Result
Perceived risk→Public acceptance	−0.348 ***	Support
Perceived benefit→Public acceptance	0.753 ***	Support
Social trust→Perceived Benefit	0.131 **	Support
Social trust→Public acceptance	0.061 *	Support
Social trust→Perceived risk	−0.02	Not support
Knowledge→Perceived risk	−0.379 ***	Support
Knowledge→Public acceptance	0.016	Not support
Knowledge→Perceived Benefit	0.601 ***	Support
Perceived risk→Perceived benefit	−0.105 *	
H1: Impression management→Knowledge	0.565 ***	Support
H2: Impression management→Public acceptance	−0.03	Not support
H3: Stigmatization→Social trust	−0.363 ***	Support
H4: Stigmatization→Public acceptance	−0.083 *	Support

Note: * $p < 0.05$, ** $p < 0.01$, and *** $p < 0.001$.

The standardized path from stigmatization to social trust is −0.363, with a statistically significant relationship ($p < 0.001$). Therefore, stigmatization has a significant and negative effect on social trust, which supports Hypothesis 3. The standardized path from stigmatization to public acceptance is −0.083, with a statistically significant relationship ($p < 0.05$). Therefore, stigmatization has a significant and negative relationship with the public acceptance of nuclear energy, which supports Hypothesis 4.

The hypothesis about the relationships between public perceptions, social trust and knowledge are also tested. The standardized path coefficient from knowledge to public acceptance is 0.016, with no statistically significant relationship ($p > 0.05$), suggesting that knowledge has no significant effect on public acceptance of nuclear energy. In addition, Table 6 also presents the effects of variables other social impression on public acceptance.

For example, the standardized path coefficient from social trust to public acceptance is 0.061, with a statistically significant relationship ($p < 0.05$). Therefore, social trust has a significant and positive relationship with the public acceptance of nuclear energy. However, the standardized coefficient from social trust to perceived risk is −0.02, with no statistically significant relationship ($p > 0.05$). Therefore, social trust has no significant effect on perceived risk.

Though the hypothesis about the relationship between perceived risk and perceived benefit was not proposed, we also tested the effect of perceived risk on perceived benefit. As presented in Table 5, the standardized path from perceived risk to public benefit is −0.105, with a statistically significant relationship ($p < 0.05$). It suggested that perceived risk negatively and significantly affects perceived benefit. Furthermore, the results of the hypothesis are presented in a more intuitive way in Figure 2.

4.5. Mediation Test

In order to further analyze and verify the mediating effect of related variables, the procedure proposed by Preacher and Hayes based on bootstrap sampling method was adopted. According to Preacher and Hayes, the non-parametric percentile bootstrap method for deviation correction was operated as follows. First, repeated sampling with replacement was performed on the basis of the original sample (sample size: 577), and the bootstrap sample was obtained.

Secondly, the corresponding estimate of mediation effect ($\hat{a}\hat{b}$) was calculated according to the bootstrap sample obtained in Step 1. The above procedure should be repeated for several times (n) to obtain an ordered sequence (C) of n effect values. Thirdly, the estimated intermediated effect point ($\hat{a}\hat{b}^*$) was calculated according to the original sample data, and its percentile rank in sequence C was also calculated. The percentage value represents the probability of $\hat{a}\hat{b}$ being less than $\hat{a}\hat{b}^*$, which is expressed by $\Phi(z_0)$. The value z_0 can be solved according to $\Phi(z_0)$ in the standard normal cumulative distribution function.

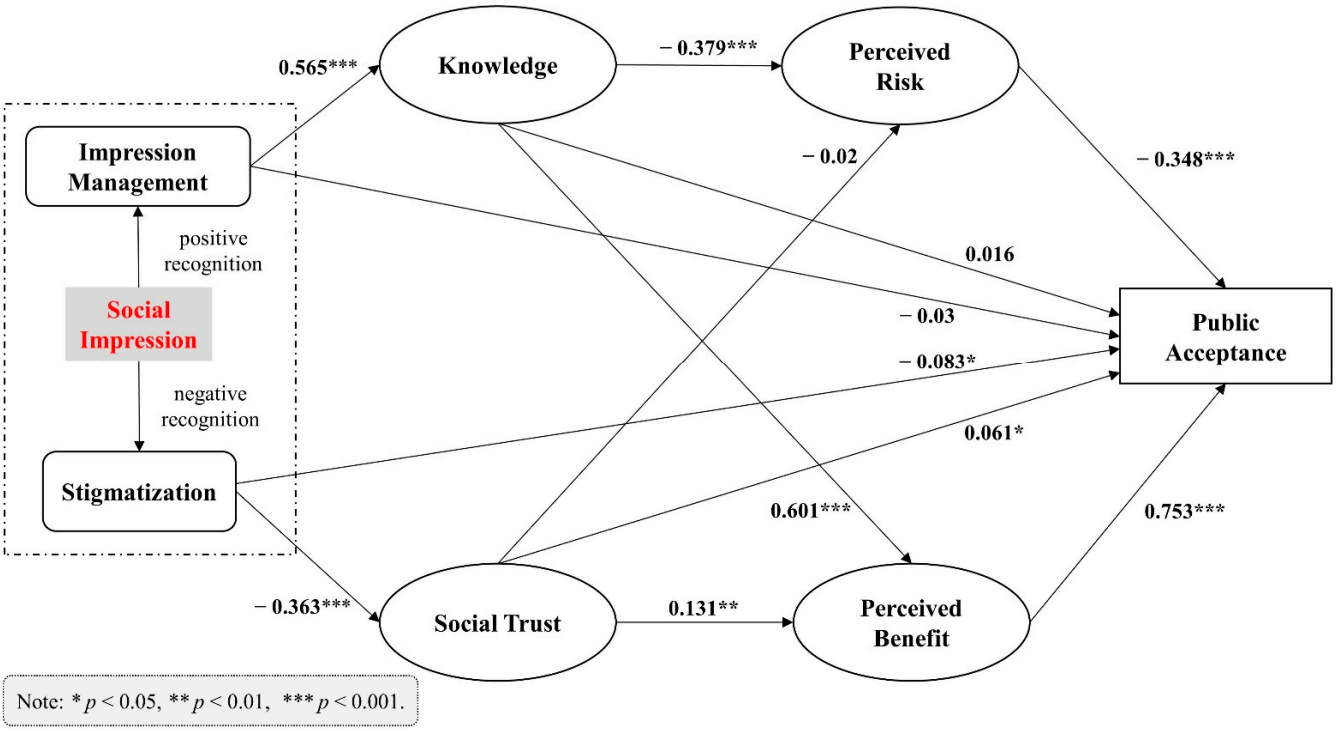

Figure 2. The results of hypotheses testing.

Finally, a confidence interval for the mediating effect with the confidence of 1-α was constructed; the upper and lower limits of the interval were the percentile values of $\Phi(2z_0 \pm z_\alpha)$ in the sequence C. If the confidence interval does not contain 0, the mediating effect is significant. In this study, 577 samples were analyzed by bootstrap for 2000 times. The results of mediating effect analysis are shown in Table 7. As shown in Table 7, the mediating effect of knowledge and perceived risk is significant in the influence of impression management on public acceptance, with an indirect effect value of 0.067 ($p < 0.001$), and the 95% confidence interval is [0.046, 0.096]. This interval does not contain 0, which supports Hypothesis 5.

Table 7. The analysis results of intermediary path.

Path	Effect	BootSE	BootLLCI	BootULCI	z	*p*
H5: Impression management→Knowledge→Perceived risk→Public acceptance	0.067	0.013	0.046	0.096	5.161	0.000
H6: Impression management→Knowledge→Perceived benefit→Public acceptance	0.172	0.018	0.131	0.202	9.815	0.000
H7: Stigmatization→Social trust→Perceived risk→Public acceptance	−0.093	0.013	−0.115	−0.063	−6.942	0.000
H8: Stigmatization→Social trust→Perceived benefit→Public acceptance	−0.028	0.009	−0.048	−0.014	−3.273	0.001

In addition, aiming at the intermediary path from impression management to knowledge, knowledge to perceived risk, and perceived risk to public acceptance, the 95% interval does not include the number 0 (95% CI: 0.131–0.202). Therefore, there is a mediating effect, which supports Hypothesis 6. In the path with stigmatization as the independent variable and public acceptance as the dependent variable, the chain mediating effect of social trust and perceived benefit is significant.

The indirect effect value is −0.093 ($p < 0.001$), and the 95% confidence interval is [−0.115, −0.063], excluding 0, which supports Hypothesis 7. The chain mediating effect

of social trust and perceived risk is also significant in the influence of stigmatization on public acceptance. The indirect effect value is −0.028 ($p < 0.001$), and the 95% confidence interval is [−0.048, −0.014]. It is obvious that there is an intermediary path, which supports Hypothesis 8.

5. Discussions

In this study, the influence path of social impressions on the acceptance of nuclear energy was examined. Although the findings were not entirely consistent with the proposed hypotheses, the image of nuclear energy to the public would greatly affect their judgment. The results supported Hypothesis 1 that the public recognizing the positive image of nuclear energy would have a higher reserve of knowledge, and the level of knowledge can help them judge the pros and cons of developing nuclear energy. When the public are willing to accept the image management about nuclear energy from the government and nuclear enterprises, they are more patient to verify the so-called positive effects by digging for relevant information.

Combined with the information behavior patterns, impression management is the motivation for individuals to acquire, process and use various data about nuclear energy. Highly concerned groups are more able to understand nuclear energy. In addition, knowledge can influence perceived benefits or risks to further influence public acceptance. Raising the public attention to nuclear power is conducive to enhancing their mastery of basic knowledge. Knowledge has diametrically opposite and significant effects on perceived benefits and perceived risks, which is consistent with previous conclusions [14,24].

Experts inform the public about the advantages of nuclear energy on a professional level and play a major role in impression management. They have paid more attention to the actual benefits brought by the use of technology rather than the risk consequences. As an object of impression management, the public will accept the propaganda of nuclear energy knowledge to reduce risk concerns. The degree of knowledge mastery plays an important role in this process. Since the risk is inevitable, a balance between risk and benefit should be carefully made before making an objective judgment. The rejection of Hypothesis 2 suggested that impression management to nuclear energy did not directly influence their acceptance; however, it also signified the existence of intermediate variables from the side.

Two situations were reflected: the first one was that people are spatially and socially distanced from nuclear power plants, although they currently agree with the advantages of nuclear power, once nuclear facilities are built around them, they will consider whether the values generated by these positive impressions can offset the upcoming risks [61]; The second one was that they paid little attention to such positive news but showed great support because high consciousness made them support nuclear development as a national policy [62].

Although this direct path failed, the public can learn about relevant information through various channels and transform such information into cognition, which, in turn, could affect public attitudes towards nuclear power. Furthermore, impression management had an indirect effect on public acceptance of nuclear energy via knowledge and perceived risk. From the analysis of the mediation effect, the proven path was "impression management first affects knowledge, then knowledge affects perceived risk, and perceived risk finally affects public acceptance", perceived risk can be replaced by perceived benefit in the path relationships.

Stigmatization has a direct path to affect public acceptance unlike impression management. Judging from the results supporting Hypothesis 4, the higher the stigmatization, the harder it is for the public to accept nuclear energy. The public is exposed to the negative images of nuclear energy amplified by public media and social networks, and misfortune of past accidents increases their anxiety about the operation of nuclear power plants, which eventually led to opposition. The support of Hypothesis 3 indicates that stigmatization is the external manifestation and deepening development of lack of social trust.

It is necessary to maintain the relationship between stigmatization and social trust, and social trust can further affect perceived benefits; finally, they could affect public acceptance of nuclear energy. For part of the influence path, stigmatization has a significant and negative effect on social trust, which corresponds to what found by Nam-Speers et al. [63], indicating that nuclear energy risk should focus on the social context of nuclear energy, thus reducing stigmatization and increasing trust in government.

The operation and management of nuclear power plants have always been regarded by outsiders as a professional and unique field. Public communication related to these procedures is often considered conservative and lacking transparency. If the risk management measures do not achieve the expected results, the public will be suspicious of managers and more sensitive to nuclear risks. At the same time, they will naturally use stigmatization to verify their concerns [64]. Therefore, the stigma effect will aggravate the degree of public distrust of the regulatory authorities and operating units.

As a key variable, social trust positively affects perceived benefit, and has a stronger impact on acceptance than knowledge. This result is contrary to the conclusion of Li et al., who found that knowledge has a more significant effect than trust [65]. It may be that the timing of the two surveys is different, our survey was longer since the Fukushima nuclear accident. The respondents were exposed to more nuclear information and deepened their knowledge of nuclear energy. Increasing knowledge makes them more cautious about developing nuclear energy, which in turn leads to their uncertain attitude towards nuclear power.

However, with the implementation of public participation system, the credibility of the government has been enhanced, and the building of social trust has been greatly promoted [66,67]. In this case, the public is more dependent on the authority of the government to make decisions and judgments on nuclear energy. Nuclear power enterprises conduct short-term trust building by open visits to nuclear power bases and offline micro-interviews. Long-term trust building is inseparable from nuclear power science, fulfilling corporate social responsibilities, and establishing risk communication mechanisms. The rising voices of support indicated that these measures have practical value, which are also consistent with previous studies [11,68].

However, social trust does not directly affect perceived risk, which is inconsistent with the findings of several studies proving that trust has a negative effect on perceived risk [69]. Nuclear risk does exist, and it cannot be changed by human will. It seems that the increase in trust cannot reduce the public anxiety about the risks of nuclear power. Most of the public came into contact with nuclear energy through nuclear accidents, and this preconceived impression may affect the subsequent promotion of nuclear safety. Even if the public has a high level of trust, they will not ignore nuclear risks.

Moreover, there is a significant negative correlation between perceived risk and perceived benefit although this is not the focus of our hypothesis. When the individuals feel more deeply about the risks of nuclear power, the advantages of nuclear power are overlooked more easily. The effect value of the perceived benefit to public acceptance (0.753, $p < 0.001$) is much greater than that of the perceived risk to public acceptance (-0.348, $p < 0.001$). Clearly, increasing perceived benefit is more effective than lowering perceived risk.

Previous studies also proved that perceived benefit had a stronger impact on public acceptance [70]; however, the results of Qi et al. showed that perceived risk was dominant in driving public attitudes towards nuclear power [69]. The possible reason is that the local operation of nuclear power plants is not as dangerous as they thought, and they are more willing to get the actual benefits brought by the development of nuclear power. Therefore, the results reminded that the increase in the perceived benefit could better improve public acceptance compared with the reduction of the perceived risk.

In practice, the nuclear power enterprises have been attempting to increase public perception of benefits by promoting local economic and educational development. For example, China General Nuclear Power (CGN) has opened online and offline sales channels to promote agricultural products, which have increased economic income for farmers in

poverty-stricken counties. They also provide educational resources, improve teaching conditions, and allow more poor students to continue studying to avoid dropping out [71].

In addition to these basic factors mentioned above, demographic factors will also have an impact on the public acceptance of nuclear energy. High-income, low-age populations show more positive attitudes towards nuclear power. However, gender differences are not as pronounced in public acceptance, which is inconsistent with the general conclusion that women have more negative attitudes towards nuclear power [72]. A possible explanation for this difference is that both men and women have similar levels of exposure to nuclear power plants. They also received popular science propaganda about nuclear power from the government or nuclear companies. In this way, their attitudes towards nuclear power will subtly converge due to their close cognition.

Finally, analysis of the mediation effect makes it clear after figuring out all the direct effect between all variables. Considering that the proven path "Impression management to knowledge, knowledge to perceived benefit, and perceived benefit to public acceptance" presents the largest effect value, the focus is to raise public awareness of the benefits of nuclear power when we attempt to construct its positive images. High-yield publicity is more convincing for public to accept nuclear energy than depicting low risk in the process of impression management.

Although the two indirect paths from stigmatization to public acceptance are negative, the one involving perceived risk has a greater impact on outcomes. Thus, de-stigmatization of nuclear power is inseparable from the control of those exaggerated negative news, which decrease public panic and risk perception. To achieve this goal, we need to eliminate the sources of these false information, remove the public mindset, and finally guide the dissemination of information. If combined with above-mentioned measures of impression management, the public acceptance of nuclear energy will be greatly improved.

6. Conclusions, Policy Implications and Limitations

6.1. Conclusions

Public acceptance is vital to the development of nuclear energy. Based on previous studies on factors affecting public acceptance of nuclear energy, the ways in which social impressions, consisting of stigmatization and impression management, affect public acceptance were examined in this study. Multi-angle consideration of social impressions could explore different paths of its impact on public acceptance, prompting us to improve solutions in a targeted manner. Furthermore, the underlying mechanisms and conditions regulating how social impressions would affect public acceptance was also explored. The data were gathered from a total of 577 respondents in the areas around the Fangchenggang NPP.

Public acceptance could be positively affected by perceived benefit but in a negative way by perceived risk. The path effects from our study indicated that the increase of perceived benefits is more conducive to improving public acceptance than reducing perceived risks. Social trust has a positive and significant effect on perceived benefit and public acceptance. In addition, this study also found that social trust has no significant effect on perceived risk. Knowledge increase could improve perceived benefit and lower perceived risk according to our study. However, knowledge does not have a significant effect on public acceptance.

Though impression management has no direct and significant effect on public acceptance, it can indirectly affect public acceptance through knowledge and public perception in two paths: First, impression management positively affects knowledge, knowledge negatively affects perceived risk, and perceived risk negatively affects public acceptance. Secondly, impression management positively affects knowledge, knowledge positively affects perceived benefit, and perceived benefit positively affects public acceptance. Stigmatization can negatively and significantly affect public acceptance, and also indirectly affect it through social trust and public perception. As shown in this study, stigmatization can significantly and negatively affect social trust, then social trust will impact public acceptance via perceived benefit.

In conclusion, the effects of different factors on public acceptance and the relationship among themselves were tested, and all the paths of social impressions affecting public acceptance of nuclear energy were identified. These findings can help to assess the rate of public acceptance of nuclear energy, improve the social image of nuclear power among the public, and change their attitudes in the nuclear decision-making process.

6.2. Policy Implications

In order to increase public acceptance of nuclear energy, the effect paths that have been drawn were combined with the influence relationship between each factor and public acceptance in this study. A good start is to enhance nuclear science popularization, strengthen public communication and promote benefit distribution.

First, in the process of publicizing China's nuclear power, nuclear-related government departments need to emphasize its advanced and safe features to deepen people's impression. By creating a positive image of China's nuclear power at home and abroad, it will greatly change the public's attitude towards nuclear energy. Nuclear power stigmatization stems from public lack of awareness and discrimination, the popularization of nuclear science can attract public attention to nuclear power, and plays a key role in removing stigma.

With the help of images, data and videos, the public can obtain concrete knowledge of nuclear power. For example, the popularity of short video software allows users to access science videos and gain scientific knowledge much easily. While paying attention to science, video producers create more vivid and interesting presentations to attract audiences, which can narrow the gap between audiences and nuclear technology, and educate them imperceptibly.

Judging from the degree of response, this type of popular science is very effective [73]. Therefore, such related videos should be encouraged to make more, and video creators deserve to be rewarded. The official website and account also need to participate in the construction of the nuclear and radiation safety science popularization platform. Nuclear and radiation safety knowledge should also be incorporated into school education to enrich students' understanding of nuclear power. Moreover, the popularization of nuclear science needs to be precisely targeted and correctly guided concerning the differences in education and age. At the national level, the science popularization plans of nuclear and radiation should be systematically formulated and carried out, and a long-term nuclear science popularization education project should be established.

Secondly, considering the mediating role of social trust and public perception linking stigmatization to public attitudes towards nuclear energy, public participation must be considered and practiced. Policymakers need to fully respect the public right to know, and eliminate the public doubts and fears about nuclear power. If the public has a sense of participation in specific site selection, construction, and operation of nuclear power plants, the appreciation of their participation and opinion will deepen their trust in decision-making.

In addition to traditional methods, such as seminars, hearings, and questionnaire surveys, another good options for nuclear enterprises to fulfill corporate responsibility are holding public open days, science quiz and keynote speeches. Increasing public participation is conducive to reshaping government credibility and strengthening authority, which should be supported by corresponding laws and regulations [74]. In the Nuclear Safety Law published by China State Council, the necessity of public participation is stipulated.

Nuclear power enterprises must insist on information disclosure. The safety information of nuclear power plants is delayed and not updated for a long time, which makes it impossible for the public to access required information. In addition, due to the summary of the notification after the accident, lack of information on the safety status of nuclear facilities, and effluents, etc., the information value is low. Therefore, it is particularly necessary to build a unified information disclosure platform to solve the problems of public feedback [75].

Government departments of nuclear-related countries should use new media and other platforms to build information communication networks, and clarify the content of

information disclosure. Robust oversight mechanisms should also be established to regulate the actions of government agencies and nuclear power operators, so that the information they provide to the public remains impartial and objective. Effective communication can reduce public worries and misunderstandings about nuclear risks, increase trust in the government and nuclear enterprises, and ultimately improve the acceptance of nuclear energy.

Thirdly, perceived benefit of residents near nuclear power plants is rational and long-term, while perceived risk is sensual and short-term. Hence, measures should be taken first to reduce the public perceived level of risk from nuclear power plants. The government and relevant regulatory agencies should formulate strict and specific nuclear energy safety regulations, perfect the management system, identify nuclear risks and strengthen the supervision of nuclear emergency capabilities. Furthermore, the government should pay more attention to the improvement of perceived benefits and find the balance of benefits for nuclear projects.

Residents close to the nuclear energy projects but not within the distance of the demolition, cannot enjoy compensation; however, they need to bear certain nuclear risks. In addition to providing employment opportunities and cheap electricity, regular medical examinations should be provided, along with radioactivity level detection of food and drinking water. In this way, their worries of "sacrificing health to economic development" can be lessened or even eliminated.

To a certain extent, environmental beliefs can also stimulate public perceptions of benefit. For those residents who cannot enjoy economic benefits, such as relocation compensation, NPPs could emphasize the health and environmental benefits compared with thermal power, especially the value in energy transition and cleaner production. In the long run, this will help the public understand the country's energy development strategy, and also contribute to the layout of nuclear power in the future.

6.3. Limitations

Although the contents of this study have been elaborated and meaningful conclusions have been drawn, there are still some limitations that cannot be ignored. Since the data were collected through a questionnaire survey only, their uncertainty may affect the obtained results. Hence, the research is only indicative. Only 577 respondents from Fangchenggang and Qinzhou, Guangxi Province, were included, which might threaten the applicability and validity of the paper in other locations. There is a lack of populations in areas where nuclear power is planned or under construction as the control group for the analysis of the survey results.

In the analysis of influencing factors, there was no comparison of the impact of using different media to receive nuclear power information on public acceptance. The impact of demographic variables on public acceptance was also not considered. To further determine the effect of the data uncertainty in the questionnaire survey on the obtained results, similar research using experimental and longitudinal designs to collect data should be conducted. On this basis, we shall focus on the selection of the control group, the adjustment of population variables, and other extended contents in the future study.

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Appendix A. Variables and Measurement Items

Variables	Measurement Items
Impression management (IA)	IA1: I think the development of nuclear power contributes to the technological progress of our country. IA2: I think nuclear power is an efficient and clean energy source. IA3: I think nuclear power has little effect on my health.
Stigmatization (S)	S1: Nuclear power plants have a high accident rate and are full of negative reports, so they are very dangerous. S2: Nuclear power plants are to blame for the high incidence of cancer in the surrounding residents. S3: Nuclear power plants are tools for the government to increase GDP at the expense of residents' health.
Knowledge (K)	K1: I understand the mechanism of nuclear power generation. K2: I understand the process and mode of action of nuclear radiation. K3: I understand the cause of the nuclear accident and the related harmful consequences. K4: I know the emergency measures in response to a nuclear accident.
Social trust (ST)	ST1: Nuclear power companies strictly abide by the rules and regulations for production. ST2: Nuclear power companies fulfil their social responsibilities. ST3: Nuclear power companies make emergency preparations for accidents. ST4: The government strictly supervises the operation of nuclear power plants. ST5: The government guarantees the safety of residents after the accident. ST6: The government can handle the nuclear accident.
Perceived risk (PR)	PR1: I am worried about the negative impact of nuclear radiation on the health of the surrounding residents. PR2: I am very worried that nuclear radiation will have genetic effects on offspring (such as carcinogenesis and teratogenicity). PR3: I am worried that the construction and operation of nuclear power plants will threaten the natural environment. PR4: Once a nuclear accident occurs, it will cause serious health and property losses.
Perceived benefit (PB)	PB1: Nuclear power plants bring sufficient and cheap electricity to residents. PB2: The construction of nuclear power plants has enabled surrounding residents to obtain economic benefits, such as compensation for land acquisition and employment opportunities. PB3: The planning of nuclear power plants promotes local economic development and increases visibility. PB4: The construction and operation of nuclear power plants have improved the local infrastructure and public facilities. PB5: My standard of living has also been improved due to the development and utilization of nuclear power plants.
Public acceptance (PA)	PA1: I am willing to support the operation of local nuclear power plants. PA2: I am willing to support nuclear power plants to install new reactors. PA3: I am willing to persuade my family, relatives and friends to support the development of nuclear energy. PA4: I am willing to support the development of China's nuclear power industry.

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