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Socioeconomic and Environmental Determinants of Household Willingness to Pay for Improved Electricity Services: A Case Study of Nowshera, Pakistan

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ABSTRACT

Electricity is critical to our daily lives, and frequent interruptions in the electricity supply impact not only industrial productivity and economic growth but also disrupt household activities and daily routines. This study aims to determine the factors influencing a household's willingness to pay additional charges for improved electricity service. The study collected primary data through the contingent valuation method from 285 households from Nowshera, Pakistan, and applied binary logistic regression estimation. The findings show that a household's education level, household size, monthly income, monthly electricity bill, and service reliability significantly influence consumers' willingness to pay additional charges to get satisfactory electricity service. Furthermore, as various household activities rely on electricity, households are typically willing to pay an extra amount for better electricity service. The study also highlights that environmental awareness and attitudes towards renewable energy resources influence consumer preferences. Furthermore, those who are more conscious of sustainability exhibit a greater willingness. This study is unique in that it comprehensively assesses the socioeconomic and behavioural aspects affecting the willingness to pay for reliable power in a developing country, specifically Nowshera, Pakistan. Unlike earlier studies, it investigates the impact of household activities on willingness to pay, shedding light on how cultural, religious, and social interactions influence energy preferences. Furthermore, the study emphasizes the adoption of renewable energy as an electricity service for the consumer, providing a dual benefit of improved service reliability and a sustainable energy source.

Keywords: Environmental; Socioeconomic; Uninterrupted Electricity; Reliable Supply; Willingness to Pay; Pakistan

1. INTRODUCTION

Energy exists in various forms, both renewable and non-renewable, and plays a vital role in our daily lives. Electrical energy is crucial in economic development (Ahmad et al., 2019; Strielkowski et al., 2021). Presently, it has wide application in our daily lives, and the interruption negatively affects daily activities (Gupta et al., 2016).

A consistent supply of electrical energy can achieve optimal level of agriculture and industrial productivity (De Nooij et al., 2007). An increase in per capita electricity consumption will also improve the standard of living (Niu et al., 2016). Water and Power Development Authority (WAPDA) and Karachi Electric (K-Electric) are the two public sectors which primarily generate, transmit, and distribute electricity in Pakistan (Kamran et al., 2019). However, 42 other independent power producers (IPPs) play a significant role in the electricity-generating sector to meet the country's increasing demands (Qudrat-Ullah, 2015). There are 13 distribution companies (DISCO) under Pakistan Electric Power Company (PIPCO), assigned with the authority to distribute electricity to their respective areas (Masroor et al., 2021).

According to Government of Pakistan Finance Division (2023), data indicates that the country's cumulative capacity of electricity generation is 41,000 MW. Hydel power generators contribute 25.8% of the total electricity generation capacity. In contrast, the installed capacity of thermal, nuclear, and renewable is about 58.8%, 8.6%, and 6.8% respectively, with an addition of 3% by Thar coal-based power projects that achieved commercial operations during the current fiscal year. In addition to this, the Government of Pakistan approved the framework guidelines for fast-track solar initiatives on October 18, 2022. Its key pillars include substituting expensive imported fossil fuels with solar photovoltaic (PV) energy, solar PV generation on 11 kV feeders, and solarization of public buildings. Moreover, the six nuclear power projects, which had an installed capacity of 3,530 MW, supplied about 18,739 million units of electricity to the national grid during FY 2023 (Mar–July).

Khyber Pakhtunkhwa is the land of hospitality, comprehensive culture, astonishing history, legendary conquerors, and prevails as a hub of tourism. The province is located in the northwestern region of the country. Its total area is 101,741 km², and its 35 million population makes 11.9% of Pakistan's population. The province contributes 10% of Pakistan's GDP and 20% of mining output (KPITB, n.d.).

The national transmission and distribution companies had about 62 stations of 220KV. They intended to build 23 grid stations of 500 KV and extend their transmission lines up to 9,000 km. To close this gap, 12,000 km of 120 KV transmission lines were being planned. However, due to inadequate infrastructure, we cannot yet achieve this (Kamal, 2022). **T**he main problem in Pakistan is load shedding, which threatens economic growth and living standards. Though it can be mitigated by improving financial management and fully utilizing existing power generation capacity. Addressing circular debt through timely government tariff subsidies will help distribution companies and IPPs receive payments. Reducing power generation costs by cutting electricity theft and line losses can also lower tariff subsidies (Anwar & Saeed, 2023).

As a counter-measure to electricity shortage, precautionary measures are taken by the government either by installing new plants, taking financial support, or importing energy-producing resources from neighboring countries. The incapacity of hydropower plants due to the unavailability of water causes a shortage in electricity generation, leading to public disturbance and economic loss. Ultimately, owing to a shortage of electricity supply, factories cannot produce surplus material to increase exports and enhance the foreign exchange reserves. Moreover, the shutdown of different industries substantially increases unemployment and poverty levels (Sibtain et al., 2021). This entails that there is an increasing demand of electricity supply nation-wide. Government policies, if not well-regulated according to the energy needs of all sectors of society, negatively affect the economy. The closure of factories may be attributed to the rising cost of crude oil for electricity production and it led to a significant rise in unemployment rates and contribute to a poverty level of 5.96% in 2016 (Yang et al., 2022).

Despite rich natural resources rich, Pakistan's energy sector struggles with a supply-demand gap, with demand quadrupling over the past two decades. Energy is crucial for economic growth and influences foreign policy. Pakistan should be an energy-rich Central Asian country but faces political and strategic hurdles, including regional security while securing its energy needs. Therefore, Pakistan requires foreign policy practices (Adnan et al., 2023; Daneshvar et al., 2020).

According to the World Economic Forum (2019), Pakistan continuously struggles to generate more energy. Despite expanding its installed generation capacity from 23,000 MW in 2014 to 33,744 MW by 2019, it still needs to fulfil the country's growing demand. The power-producing system received less attention to enhance the transmission and distribution capacities, infrastructure, and overall system performance, which resulted in 18.3% distribution loss and 2.4% transmission loss. Moreover, unpaid power payments resulted in ongoing circular debt, estimated to be around Rs 1.6 trillion ($7.2 billion). The World Economic Forum Energy Transition Index (ETI) indicates that a sustained government effort might raise the system of incentive energy generation by as much as 46%.

According to Malik (2023), Pakistan has the potential to generate up to 60,000 MV of energy. Limitations exist as its hydroelectric project can only produce a fraction—7000 MV—due to issues related to management and infrastructure. Urgent measures are required from the government to ensure an energy mix system that relies on local production rather than imported energy resources (Unwin, 2019). This study focused on the impact of planned and unplanned power outages on daily life activities, leisure activities, and social life activities and the contributing factors that affect their willingness to pay an additional amount in their monthly electricity bill to get an uninterrupted electricity supply and their satisfactory use. The study investigates a household's willingness to pay for a reliable, continuous electricity supply.

This study is crucial as it addresses the significant issue of energy supply in Pakistan and its broader implications on daily life and economic development. Reliable electricity is fundamental for economic activities and affects industrial output, agricultural productivity, and overall quality of life. With Pakistan facing substantial energy deficits and frequent load shedding, understanding households' willingness to pay for improved electricity services can inform effective policy measures. Additionally, the study highlights the potential of renewable energy sources, which can diversify the energy mix and reduce reliance on imported fossil fuels. By focusing on the determinants influencing willingness to pay and the impact on social and cultural activities, the study provides compelling insights. In this study, the dilemma of improved electricity services is targeted to enhance energy policies, improve living standards, and support economic growth in regions like Khyber Pakhtunkhwa, which plays a crucial role in electricity production through hydropower.

2. LITERATURE REVIEW

2.1 Factors Affecting the WTP for Improved Electricity Service

Taale and Kyeremeh (2016) analyzed factors influencing households' willingness to pay for reliable electricity in Ghana. Using Tobit regression, they found that marital status, education level, monthly income, meter ownership, prior notice of power outages, business ownership, and household size significantly affect willingness to pay, accounting for up to 44% of the monthly bill. In contrast, age, gender, house ownership, and monthly electricity expenditures were insignificant factors. Similarly, Twerefou (2014) examined factors influencing the willingness to pay for improved electricity in Ghana.

Poor energy infrastructure, low tariffs, and growing demand led to unmet requests and economic loss for consumers. Consequently, consumers are willing to pay 1.5 times more than the current average rate of Ghanaian cedi (GH¢) 0.2734 per kilowatt-hour. Income, gender, education, and household size significantly affect this willingness to pay. Another researcher Adjei-Mantey (2013), found that people are willing to pay an average GH¢ 0.2667 for uninterrupted electricity service, which is 47% more than the current tariff. Factors such as income, household size, sex of the household head, education level and regular interruptions in current electricity supply influence the willingness to pay. The study recommends government investment in infrastructure, gradual increase in tariffs, providing employment opportunities, higher wages, promotion of education, and installation of hydropower plants.

Improved reliability is one of the key features that consumers demand in an electricity supply. In this regard, Ozbafli and Jenkins (2015) found that households are willing to accept 13.5% increase in monthly electricity bills for improved reliability, generating an economic benefit of $37.7 million from the residential sector alone. This amount could finance power system upgrades to eliminate outages. Replacing old plants with fuel-efficient ones would save $44.6 million in fuel costs. Adopting a high-reliability electricity policy would yield a net benefit of $226 million over five years despite challenges from political instability and misguided policies.

Another study was carried out in India to observe consumer willingness. While using a two-stage model, Gunatilake et al., (2013) studied willingness to pay (WTP) for improved electricity in rural India. They found that bids should be increased from the current electricity service levels to avoid downward bias in WTP estimates for unimproved service. The estimated WTP for improved electricity service is Rs. 340 per month. The study showed that WTP is directly linked to income and is similar across all income groups. The block tariff system effectively managed demand, causing higher-income households to reduce consumption, thereby conserving energy.

Babawale and Awosanya (2014) investigated the willingness to pay for improved electricity using non-market valuation techniques like conjoint, contingent, and multivariate analysis. They concluded that wind power is the most cost-effective method for electricity generation. The "pay-back" analysis revealed low WTP among estate consumers, indicating a lack of support for private sector electricity supply. Factors such as household income, household size, frequency of generator use, employment status of the household head, and the cost of running generators influenced the WTP for improved electricity services.

2.2 Factors of Adapting Renewable Energy

Farhar-Pilgrim (1999) examined consumers' attitudes and knowledge about renewable energy and their willingness to pay (WTP). The study concluded that education about renewable energy enhances customers' readiness to adopt it—however, the percentage of customers willing to pay decreases as the cost of renewable energy increases. Similarly, Duffy et al., (2007) investigated consumer willingness to pay (WTP) for green energy and factors hindering subscription to green energy programs. The study found that lack of awareness is a significant barrier. Awareness campaigns and advertisements can boost consumer interest and increase WTP for green energy. Shih and Chou (2011) initiated a study to observe the factors affecting the adaptation of renewable energy. The researchers examined consumer uncertainties and willingness to pay (WTP) for leasing versus purchasing solar power systems. They found that leasing reduces the risk of adopting new technology.

Conjoint analysis showed that government subsidies, electricity prices, reliability, and latest designs significantly impact WTP for shorter leasing times. Cluster analysis revealed a preference for shorter leasing periods, with leasing times over 20 years equating to purchasing. Furthermore, to analyze the impact of economic and environmental factors on consumer willingness to pay (WTP) for green electricity, Bösche (2016) used linear probability and probit models. The study concluded that environmental factors do not significantly influence WTP, even for those affected by environmental conditions. Instead, economic factors, particularly price levels, are more influential. The study also found that government subsidies have a limited impact on WTP due to consumers' low financial conditions and limited awareness about environmental protection.

In the case of public opinion and willingness to pay (WTP), they have a significant impact on integrating renewable energy into the electricity mix. In this regard, Ntanos et al., (2018) found that lack of awareness and high costs hinder the adoption of renewable energy sources. It stated that increasing environmental awareness leads to greater acceptance of green energy investments. The estimated WTP for 10% renewable energy penetration is 26.5 euros per quarterly electricity bill. The logit model showed a positive association between WTP and factors such as educational level, government energy subsidies, renewable energy implementation, and socio-political motivation. However, several disadvantages involving economic concerns, lack of awareness, and perceived effectiveness might hinder the willingness to pay. To evaluate the differences between consumers' willingness to pay (WTP) for renewable energy and WTP influenced by study design, Ma et al., (2015) used meta-regression analysis. The researchers concluded that study design and administration have a more significant impact on WTP variation than factors like the type of renewable energy, socioeconomic patterns, and energy consumption patterns. The study concluded that consumers showed significantly higher WTP for solar energy than wind and hydro-energy sources.

In terms of socioeconomic factors, Williams (2012) investigated consumer willingness to pay (WTP) for renewable energy, classifying respondents into concerned, protesting class, and WTP classes using Latent Class Modeling. The study identified preference heterogeneity based on attitudes, perceptions, and climate change knowledge. Results showed significant WTP variation among classes, with 83% willing to pay for renewable energy. Tobit regression analysis revealed that age and gender significantly influenced WTP in the concerned group, while the protest class showed no significant socioeconomic factors. In the WTP class, younger individuals and women were more likely to pay for renewable energy.

2.3 Environmental Aspects in Switching Towards Green Energy Resources

Study conducted by Štreimikienė and Mikalauskienė (2014), household willingness to pay (WTP) for renewable energy is compared against WTP with government-supported feed-in prices. The study found that households' WTP for renewable energy is significantly lower due to a lack of awareness about environmental protection in electricity generation compared to subsidized feed-in prices. David (2014) examined consumers' WTP for renewable energy, highlighting that switching from conventional to renewable sources benefits the environment. The study found that economic factors and consumer behavior towards environmental protection and self-image are critical drivers for higher WTP for renewable energy. External factors influencing WTP include electricity price, household income, household size, and education. Jung et al., (2015) studied substituting nuclear energy with renewable energy and found that consumers' ethical reasons rather than economic ones drive more willingness to pay (WTP).

Through multiple regression analysis, the study estimated the per capita WTP for renewable energy at 38,921 won, with an additional annual cost of about 2 trillion. Even with nuclear power generating 20 trillion won annually, the unit cost of renewable energy is three times higher, with generating charges of 40 trillion won, posing challenges for its promotion.

2.4 Black Outages and Negative Externalities of Green Energy on WTP

Nkosi (2016) quantified households' willingness to pay for renewable and nuclear energy to avoid outages. Using Heckman's selection model and Cragg's two-step model, the study found that people prefer planned outages over unplanned ones to manage their activities. Despite environmental hazards, nuclear energy provides job opportunities and is favorable in the face of severe unemployment. Preference toward renewable energy is just for its safety and cleanliness. Aweke (2018) also investigated households' willingness to pay (WTP) to avoid blackouts and the negative externalities of wind power. The study concluded that consumers are willing to pay 499 birrs per year (34% of their annual electricity bill) to reduce outages and 374 birrs per year (24% of their perennial bill) to avoid the external costs of wind power. WTP increases with income, household size, number and duration of outages, and a reduction in consumer preference for wind farms. Male respondents have a significantly higher WTP to avoid both effects.

2.5 Self Generation and WTP

Oseni (2017) examined the role of self-generation in households' willingness to pay (WTP) for reliable electricity. The study found that households with self-generation are more willing to pay for reliable electricity despite the marginal cost. Regardless of income level, households are willing to pay 84% more than the current tariff for improved service, preferring reliable, expensive electricity over subsidized, low-quality supply.

Pasha and Saleem (2013) quantified the impact of power outages and the cost of self-generating electricity. They concluded that the people prefer to pay more for uninterrupted power to maintain economic activity. Load-shedding rates vary across Pakistan, affecting social activities and the economy. Self-generation is expensive but prevalent in Sindh and KPK among high-income communities. Moreover, 28% of people use generators and 30% use Uninterrupted Power Supply (UPS). The study suggests substantial improvement in the power transmission and distribution sector.

2.6 Government Strategies and WTP

Cust et al. (2007) discussed rural electrification demand and technology options, proposing a Distributed Decentralized Generation (DDG) project using renewable energy to reduce reliance on the costly national grid. This approach encourages community support for renewable energy and bill payment regulation. The study suggests that collaboration between local groups and external agents is more effective than individual leadership. Large-scale electrification requires regulatory adjustments and financial support for implementation, operation, and maintenance, promoting the expansion of rural electrification.

Graber et al. (2018) compared solar microgrids and centralized grid systems, using choice experiments to assess reliability, availability and price. The study found that non-consumers prefer microgrids due to better power, price, and reliability despite the lower costs of centralized grids lacking these attributes. It recommends that policymakers should focus on expanding microgrid electrification.

Alinsato (2015) investigated household preferences for reliable electricity service to avoid outages. Through a random parameter as Tobit model, the study found that consumers prefer electricity availability during weekends over nighttime on weekdays and that willingness to pay increases with the duration of outages. The study noted that effective pricing policies do not encourage consumer preferences for reliability, suggesting that the government should improve electricity planning and operations.

Ward (2010) examined consumer willingness to pay (WTP) for two energy programs: Energy Star (energy efficiency) and Green Power Partnership (green energy purchasing). Through conditional and mixed logit models, the study found that WTP for Energy Star labels ranges from $237.81 to $350.54 and for Green Power Partnership labels from $48.52 to $70.95. Demographic and attitudinal factors influence WTP, with consumers (especially males) showing greater WTP for Energy Star labels. It is noted that energy labels significantly impact consumers' decisions when purchasing electrical appliances.

Ali and Nawaz (2013) concluded that energy crises in Pakistan stem from mismanagement in the power sector, causing the textile sector to suffer production losses of 23%-65% during 8-hour shifts and 21%-60% during 10-hour shifts due to frequent electricity interruptions. The spinning, dying, and chemical processing subsectors face significant losses, exacerbating unemployment. The study found that 79% of textile firms are willing to pay Rs 1 to Rs 20 per energy unit for uninterrupted services. The government must take action to prevent further decline in the textile sector.

Qasim and Kotani (2014) examined factors influencing energy consumption in Pakistan from 1970 to 2010 using co-integration and error correction models. They found that price levels, real income, power generation sources, and utilization of installed power plants significantly affect energy consumption patterns. The study concluded that consumer energy demands should adjust to prices in the long term, and private power producers should utilize underused fossil fuel plants. Encouraging private producers to provide an uninterrupted electricity supply is recommended. A non-linear relationship exists between electricity, oil, and gas demand. The study suggested that price adjustments are inefficient for addressing short-term power outages and emphasized improving the utilization rate of existing plants over new installations. Ifat (2018) examined factors influencing households' willingness to pay (WTP) for renewable energy, using data from 8,500 domestic units. Through ordered logit and binary probit models, the study concluded that solar awareness and socioeconomic determinants significantly impact WTP. Governments in developing countries should design policies for affordable solar home systems.

3. METHODOLOGY

3.1 Empirical Model

The framework incorporated in this study followed the Random Utility Model (RUM) (Lancaster, 1966; McFadden, 2001). The random utility model assumes that the utility acquired by the consumer "i" derived from any commodity "j" (U_{ij}) is the function of some visible aspects of the consumer for the commodity consumed and some unobservable random error e_{ij}. The utility function, which is related to the indirect utility function, can be expressed in Equation 1 as:

$$U_{ij} = U_i \ (Y_j, X_j, e_{ij}) \text{ ---------- Equation 1}$$

Here, Y_i is the income of the individual j, X_j is the noticeable aspect of the individual for a specific commodity, and e_{ij} is some unobservable random error.

If we measure a change in the quality of commodity through contingent valuation survey, then initiate a payment bid $Y_i *$. It indicates the consumer will agree to an additional payment suggestion if derived utility from improved quality is more than the initial one. It will be like:

$$U_{ij}\ (Y_j - Y_i *, X_j, e_{ij})\ > U_{ij}\ (Y_j, X_j, e_{ij})\ \ldots\ldots\ldots\ldots \quad \text{Equation 2}$$

Here $Y_i *$ shows the additional amount that the consumer is willing to pay for the improved quality of goods. It will have some probability, and all those responding yes in the survey asserted their preferences for the improvement. Thus, the probability (Pr) for the answer yes can be written as:

$$Pr\ (yes)\ = U_{ij}(Y_j - Y_j *, X_j, e_{ij})\ > U_{ij}\ (Y_j, X_j, e_{ij})\ \ldots\ldots\ldots\ldots \quad \text{Equation 3}$$

According to the basic formulation, the Random Utility Model (RUM) is additive. As a result, the utility function can be separated additively into observable and unobservable parts, following the model called Additive Random Utility Model (ARUM). Now Equation 1 is written as;

$$U_{ij}\ =\ U_{ij}\ (Y_j, X_j)\ + e_{ij} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad \text{Equation 4}$$

While, the probability for the answer "yes" showing their preferences for induced bid will become:

$$Pr\ (yes)\ =\ U_{1j}\ (Y_j - Y_i *, X_j)\ +\ e_{1j} > U_{0j}\ (Y_j, X_j)\ +\ e_{0j}\ldots\ldots\ldots.. \text{ Equation 5}$$

We knew that WTP is the extra amount an individual willingly pays for the improved electricity supply service. It is the function of consumer socioeconomic attributes and essential qualities of electricity supply. It means that any change in the utility derived from the improved electricity supply is considered an equal change in the deterministic and non-deterministic components of the Random Utility Model. Thus, the WTP may be written as;

$$WTP_i = \beta_i X_i + e_i \ldots\ldots\ldots\ldots\ldots\ldots \quad \text{Equation 6}$$

Here, β_i is the estimated parameter, X_i represents the consumer's socioeconomic attribute and essential qualities of electricity supply and e_i is the random variable concluding the other characteristics of the consumer's WTP that haven't been concluded. It assumed that random variable "e_i" followed the standard normal distribution with zero mean and variance of one. The estimated willingness to pay is presented as the following equation:

$$WTP_i = \beta_0 + \beta_1 SEX_i + \beta_2 HEDU_i + \beta_3 HSIZ_i + \beta_4 HMI_i + \beta_5 CMEB_i + \beta_6 REL_i + \beta_7 PRNTF_i + \beta_8 EDO_i + \beta_9 COD_i + \beta_{10} SPA_i + \beta_{11} RELA_i + \beta_{12} CULA_i + \varepsilon_i$$

3.2 Description of Explanatory Variables

3.2.1 Gender of the Household (SEX)

Gender is a dummy variable, with 1 representing males and 0 representing females. Males generally manage household expenditures and decide on payments for improved electricity services, though some employed females also contribute and influence decisions. The impact of gender on willingness to pay for improved electricity services is unclear and shows an unexpected pattern.

3.2.2 Household Educational Level (HEDU)

The household's educational level, a categorical variable, is positively related to willingness to pay for improved electricity supply. Highly educated individuals recognize its importance in development, leading to a higher willingness to pay. In contrast, those with little or no formal education are less likely to support paying for service improvements due to limited use.

3.2.3 Household Size (HSIZ)

Household size, a continuous variable, unpredictably influences willingness to pay (WTP) for improved electricity. Some larger households, needing more electricity, are willing to pay more due to frequent interruptions. However, other large households may not be willing to pay higher amounts if most members are unemployed and household expenses are focused elsewhere.

3.2.4 Household Monthly Income (HMI)

Household income, a continuous variable, represents the combined monthly income of all working members, typically led by the household head. Willingness to pay for better electricity service depends on the head's affordability. Contributions from other members may encourage the head to pay more for improved service, benefiting the entire household. According to consumer demand theory, a positive relationship exists between income and the demand for ordinary goods, meaning higher income leads to greater demand for improved electricity services.

3.2.5 Current Monthly Electricity Bill (CMEB)

The current monthly electricity bill, a continuous variable, reflects the electricity expenses of household. Families with high bills may resist paying more, believing they already pay enough. Others with high bills may continue to pay more for better service. Conversely, households with lower bills might be willing to pay extra for improvements, though some may not, due to minimal electricity use.

3.2.6 Reliability of Electricity Supply (REL)

Reliability is a dummy variable, with 1 representing reliable power and 0 representing unreliable power. Households with unreliable electricity are more willing to pay for improvements, while those with reliable service are less willing to pay extra. There is an expected negative relationship between power reliability and willingness to pay additional charges for improved service.

3.2.7 Prior Notification Given Before Electricity Shortage (PRNTF)

Prior notification is a dummy variable, with 1 indicating prior notification before blackouts and 0 indicating no notification. Households that receive prior notification experience fewer losses and are less likely to pay more for improved power service. In contrast, those facing unplanned outages, which cause significant losses, are more willing to pay for service upgrades. It reflects a negative relationship between prior notification and the willingness to pay for improved electricity service.

3.2.8 Effectiveness due to Outages (ADO)

Effectiveness due to outages is a dummy variable, with 1 indicating that outages significantly affect willingness to pay and 0 indicating no effect. Consumers heavily affected by power outages are highly willing to pay more for improved electricity service, while those less affected are not willing to pay additional charges.

3.2.9 Cost of Damage (COD)

The cost of damage, a continuous variable, represents the economic loss households face due to frequent power interruptions. It is positively related to willingness to pay, meaning households suffering significant financial losses are more likely to pay extra to avoid these disruptions. Conversely, those with minimal losses are less willing to pay for improved electricity service.

3.2.10 Sports Activities (SPA)

Sports activity is a dummy variable, with 1 indicating that power outages affect sports activities and 0 indicating no effect. Those whose sports activities are disturbed by outages are more willing to pay for better electricity service. In contrast, those whose activities are unaffected are unwilling to pay extra for improvements.

3.2.11 Religious Activities (RELA)

Religious activity is a dummy variable, with 1 indicating that outages affect religious activities and 0 indicating no effect. People whose religious activities are affected by power outages are more willing to pay for better electricity service. In contrast, those whose activities are unaffected are less likely to pay extra for improvements.

3.2.12 Cultural Activities (CULA)

Cultural activity is a dummy variable, with 1 indicating that power outages affect cultural activities and 0 indicating no effect. People whose cultural activities are disturbed by outages are more willing to pay for better electricity service, while those whose activities are unaffected are less likely to pay extra. Table 1 summarizes the explanatory variables and their expected effects.

Table 1. Categorization of Explanatory Variables and Their Expected Signs

Variables	Categorizations	Expected signs
Current Monthly Electricity Bill (CMEB)	Continuous	+/-
Gender of the Household (SEX) (Male = 1, Female = 0)	Dummy	+/-
Household Monthly Income (HMI)	Continuous	+/-
Household Size (HSIZ)	Continuous	+/-
Household Educational Level (HEDU)	Categorical	+
Reliability of Electricity Supply (REL) (Reliable = 1, Not reliable = 0)	Dummy	_
Prior Notification given before Electricity Shortages (PRNTF) (Yes = 1, No = 0)	Dummy	_
Effectiveness due to Outages (EDO) (Yes = 1, No = 0)	Dummy	+/-

Cost of Damage (COD)	Continuous	+
Sports Activities (SPA) (Agree=1, Disagree=0)	Dummy	+/-
Religious Activities (RELA) (Agree=1, Disagree=0)	Dummy	+/-
Cultural Activities (CULA) (Agree=1, Disagree=0)	Dummy	+/-

3.3 Type of Data Collected

The study collected data from a primary source within the area of Tehsil Nowshera in District Nowshera. The researcher directly inquired the respondents or households by asking questions about the current power supply situation in their area through questionnaires (Refer to the Appendix A).

3.3.1 Tool for Data Collection

The primary data for this survey was collected using a well-designed questionnaire. The questionnaire evaluated community satisfaction with power services in Tehsil Nowshera, including issues related to voltage reliability and power outages. Respondents were asked about their willingness to pay (WTP) for improvements in electricity service. To ensure accuracy and transparency, the questionnaire, based on the Contingent Valuation method, included questions about current electricity issues and respondents' socioeconomic attributes to assess their WTP for enhanced service.

3.3.2 Description of the Sampling Area

The study surveyed 287 electrified households in rural and urban Tehsil Nowshera, District Nowshera, and Khyber Pakhtunkhwa, Pakistan. Nowshera, located approximately 43 kilometers east of Peshawar in the Valley along the Kabul River, covers an area of 1,748 square kilometers. With a population of 120,131 as of 2017, Nowshera is a crucial economic zone due to the CPEC project and hosts numerous military installations and factories. The city is well-connected by airports, railways, and roads, facilitating communication across Pakistan.

3.3.3 Field Work

The research was conducted from mid-March 2020 to the end of May 2020. Each household in the selected area was interviewed using a convenient sampling technique. Responses were then reviewed for accuracy and consistency.

3.4 Data Analysis and Estimation Techniques

3.4.1 Contingency Valuation Method

Various techniques, such as travel-cost method and choice experiments, estimate non-market goods. This study employed the Contingent Valuation Method (CVM) to assess use and non-use values and determine households' willingness to pay for improved electricity service. The CVM measured how much each household would be willing to pay extra on their monthly bill to avoid the costs associated with power shortages.

During the fieldwork, respondents were asked about the current electricity service, its reliability, and their socioeconomic attributes based on a scenario of improved, reliable, and uninterrupted electricity supply.

3.4.2 Binary Logistic Regression Model

The study used binary logistic regression to estimate households' willingness to pay more for improved electricity service. Logistic regression is suitable for predicting outcomes with two possible values (e.g., yes/no, 1/0) based on one or more independent variables. Unlike simple linear regression, which assumes a linear relationship, logistic regression models assess the relationship between a binary dependent variable and multiple independent variables which can be continuous or categorical. This method allows for predicting one variable's effect while controlling the others' effects.

3.4.2.1 Log Odds of the Logistic Regression Model

Odds represent the ratio of the likelihood of an event occurring to the probability of not occurring, and they offer an alternative way to express probability. In logistic regression, the probability of an event converts into log odds, which is the ratio of the event occurring to the event not occurring. This conversion helps model the relationship between the dependent and independent variables.

3.4.2.2 Uses of the Logistic Regression Model

Logistic regression is used to evaluate the probability of a dichotomous event occurring and to address classification issues. It forecasts the likelihood of "yes" or "no" outcomes, helping data analysts make informed decisions. It can reduce risk, improve spending efficacy, and maximize profits.

4. RESULTS AND ANALYSIS

4.1 Demographic Information

In Nowshera, there is a single WAPDA unit for electricity supply. The sample in Table 2 includes 75 females (26.13%) and 212 males (73.18%). Most respondents (242, 84.32%) face unreliable electricity, resulting in a higher willingness to pay for better service corresponding to reliable electricity (45, 15.68%). Additionally, 232 respondents (80.84%) have not received prior outage notifications and are more willing to pay extra. Power interruptions affect 194 respondents (67.60%) in general activities, 117 (40.77%) in indoor/sports activities, 175 (60.98%) in religious activities, and 145 (51.22%) in cultural activities. Overall, 173 respondents (60.28%) are willing to pay extra for better electricity service, while 114 (39.72%) are not willing to pay for improved electricity service.

Table 2. Demographic Information

Variables		Frequency	Percentage (%)
Gender	Female	75	26.13
	Male	212	73.87
Reliability	Not reliable	242	84.32
	Reliable	45	15.68
Notification	No	232	80.84
	Yes	55	19.16
Effectiveness	No	93	32.40
	Yes	194	67.60
Willingness to pay	No	114	39.72
	Yes	173	60.28
Social activities	No	170	59.23
	Yes	117	40.77
Religious activities	No	112	39.02
	Yes	175	60.98
Cultural activities	No	140	48.78
	Yes	147	51.22

Note: Author's survey 2020

4.2 Socioeconomic Features

The socioeconomic survey presented by data in table 3 shows considerable variability across several measures. The mean WTP is 1264.46, with high variance and a right-skewed distribution (skewness: 5.746) and heavy tails (kurtosis: 53.496). Education levels average 6.254 with low variability, a left-skewed distribution (skewness: -1.764), and more extreme values (kurtosis: 6.772). Household size averages 7.526, showing moderate variability and a right-skewed, leptokurtic distribution (skewness: 2.346; kurtosis: 13.956). The mean income is 115,970.4 with high disparity, right-skewed distribution (skewness: 2.896), and extreme values (kurtosis: 12.336). Monthly bills average 6151.568 with substantial variability, exhibit right-skewed distribution (skewness: 1.789), and frequent extremes (kurtosis: 5.428). While the cost of damage averages 13,959.58 with significant variability, right-skewed distribution (skewness: 3.117), and numerous extremes (kurtosis: 18.796).

Table 3. Socioeconomic Details

Variable	Mean	Variance	Std. Dev	Skewness	Kurtosis
Maximum WTP	1264.46	4894677	2212.392	5.746	53.496
Education	6.254	1.841	1.357	-1.764	6.772
Household Size	7.526	13.075	3.616	2.346	13.956
Income	115970.4	1.81e+10	134514	2.896	12.336
Monthly bill	6151.568	3.71e+07	6093.564	1.789	5.428
Cost of damage	13959.58	5.38e+08	23201.27	3.117	18.796

Note: Author's survey 2020

4.3 Association of Electricity Attributes and Willingness to Pay

The person's chi-square and likelihood chi-square tests determine the association between them. Chi-square tests show no significant association between willingness to pay (WTP) for improved electricity and gender, reliability, prior notification, or effectiveness. As shown in table 4, among respondents, 30 females and 84 males are unwilling to pay extra, while 45 females and 128 males are willing. Being liable to unreliable service, 102 are reluctant, but 173 (140 unreliable, 33 reliable) are willing to pay more. Regarding prior notification, 93 without notice of power outage and 21 with notice exhibit no impact on their WTP, while 173 (139 without notice, 34 with notice) exhibit impact on their WTP. For effectiveness, 114 (44 unaffected, 70 affected) are unwilling, whereas 173 (49 unaffected, 124 affected) are willing to pay more.

Table 4. Willingness to Pay and Electricity Attribute

WTP	Gender		Reliability		Notification		Effectiveness	
	Female "0"	Male "1"	Unreliable "0"	Reliable "1"	No "0"	Yes "1"	No "0"	Yes "1"
No "0"	30	84	102	12	93	21	44	70
	29.8	84.2	96.1	17.9	92.2	21.8	36.9	77.1
Yes "1"	45	128	140	33	139	34	49	124
	45.2	127.8	145.9	27.1	139.8	33.2	56.1	116.9
Total	75	212	242	45	232	55	93	194
	75.0	212.0	242.0	45.0	232.0	55.0	93.0	194.0

Source: Author's Estimation 2020

Table 5 shows no significant association between willingness to pay (WTP) for improved electricity and sports, religious, or cultural activities, as all chi-square test results are below the critical value of 3.84 (α=0.05). For sports activities, 65 respondents are unaffected, and 105 are affected by electricity issues, but this does not impact their WTP. In religious activities, 50 are unaffected, and 64 are influenced, with neither group willing to pay extra. For cultural activities, 61 disagree, and 53 agree that outages affect them without impacting WTP. However, 79 disagree, and 94 agree that interruptions impact their traditional activities and serve as willing to pay extra for improved service.

Table 5. Willingness to Pay and Respondent's Activities

WTP	Sports		Religious		Cultural	
	Disagree "0"	Agree "1"	Disagree "0"	Agree "1"	Disagree "0"	Agree "1"
No "0"	65	49	50	64	61	53
	67.5	46.5	44.5	69.5	55.6	58.4
Yes "1"	105	68	62	111	79	94
	102.5	70.5	67.5	105.5	84.4	88.6
Total	170	117	112	175	140	147
	170.0	117.0	112.0	175.0	140.0	147.0

Source: Author's Estimation 2020

4.4 Results from Binary Logistic Regression

Binary logistic regression shown in table 6 analyzed factors influencing households' willingness to pay (WTP) for improved electricity. The model explains 8.7% of the variation in WTP (Pseudo $R^2 = 0.087$). The Likelihood Ratio (LR) test statistic of 33.47 exceeds the critical value of 21.03 (α=0.05), indicating a significant impact from the explanatory variables. Essential factors affecting WTP include household size (positively at 10%), reliability of electricity supply, education level, and monthly income (positively at 5%). Larger households, higher education, and higher income increase WTP, while more reliable electricity supply and higher bills decrease it. Sports activities also significantly influence WTP, with affected households more willing to pay. Factors such as household gender, prior notifications, impacts on religious and cultural activities, and cost of damage are statistically insignificant.

Table 6. Binary Logistic Regression

Willingness to pay (WTP)	Coefficients	Standard Error	P>lZl
Gender of the Household (male=1, female=0)	0.027	0.299	0.929
Household education level	0.220	0.101	0.030
Size of the household	0.066	0.039	0.092
Monthly income of household	3.73e-06	1.50e-06	0.013
Current monthly current bill	-0.00006	0.00003	0.028
Reliability of electricity supply (as reliable)	0.824	0.382	0.031
Prior notification before shortages (yes=1, no=0)	0.206	0.335	0.539
Effect of interrupted electricity (yes=1, no=0)	0.854	0.675	0.206
Sports activities (agree=1, disagree=0)	-0.886	0.352	0.012
Religious activities (agree=1, disagree=0)	-0.042	0.586	0.942
Cultural activities (agree=1, disagree=0)	0.401	0.430	0.352
Cost of damage	7.07e-06	7.11e-06	0.320
Constant	-2.079	0.798	0.009
Log likelihood -176.091			
LR Chi2 (12) 33.47			
Pseudo R2 0.0868			
*Significant at 10% **Significant at 5%	***Significant at 1%		

Source: Author's Estimation, 2020

4.5 Odds Ratio of Binary Logistic Regression

An odds ratio (OR) quantifies the strength of the association between exposure and outcome. It compares the odds of an outcome occurring with the exposure to the odds without it. An OR of 1 indicates no association; an OR more significant than 1 suggests a positive association (higher odds with exposure), while an OR less than 1 indicates a negative association (lower odds with exposure). Table 7 displays the odds ratios for various factors influencing households' willingness to pay (WTP) for improved electricity service. Males are 1.014 times more likely to pay extra compared to females. Each additional level of education increases WTP by 1.246 times, while a unit increase in household size raises WTP by 1.068 times. Monthly income shows no significant impact (OR = 1.000), and a higher electricity bill slightly decreases WTP (OR = 0.999). Reliable electricity strongly increases WTP (OR = 2.280), and receiving prior outage notifications increases WTP by 1.228 times. Those affected by service interruptions are more likely to pay for improvements (OR = 2.349). In contrast, those affected by sports or indoor activities are less likely (OR = 0.412), with slight inverse effects for religious activities (OR = 0.958) and positive effects for cultural activities (OR = 1.493). Economic loss from interruptions does not significantly affect WTP (OR = 1.000).

Table 7. Estimating Odds Ratio of Binary Logistic Regression

Willingness to pay (WTP)	Odds Ratio	Standard Error	P>lZl
Gender of the Household (male=1, female=0)	1.027	0.308	0.929
Household education level	1.246	0.126	0.030
Size of the household	1.068	0.042	0.092
Monthly income of household	1.000	1.50e-06	0.013
Current monthly current bill	0.999	0.00003	0.028
Reliability of electricity supply (as reliable)	2.280	0.872	0.031
Prior notification before shortages (yes=1, no=0)	1.228	0.411	0.539
Effect of interrupted electricity (yes=1, no=0)	2.349	1.585	0.206
Sports activities (agree=1, disagree=0)	0.412	0.145	0.012
Religious activities (agree=1, disagree=0)	0.958	0.562	0.942
Cultural activities (agree=1, disagree=0)	1.493	0.642	0.352
Cost of damage	1.000	7.11e-06	0.320
Constant	0.125	0.099	0.009

Source: Author's Estimation 2020

4.6 Marginal Analysis of Binary Logistic Regression

Marginal effects measure how explanatory variables change the probability of willingness to pay (WTP) for improved electricity service, holding other variables constant. Table 8 shows that females have a 62% predicted probability of WTP, while males have a 63% probability. For electricity reliability, a 1% improvement in reliability increases the possibility of WTP by 76%, whereas a 1% increase in unreliability raises it by 58%. Not receiving prior notice increases WTP probability by 61%, while receiving notice raises it by 66%. A 1% increase in effectiveness for regular outages raises WTP probability by 68% for those affected, compared to 48% for those unaffected. For sports or indoor activities, those affected have a 70% probability increase, while those unaffected have a 47% increase. For religious activities, affected individuals have a 62% increase in probability, and unaffected individuals have a 61% increase. Cultural activities show a 66% increase in chance for affected individuals and a 57% increase for those unaffected.

Table 8. Estimating Marginal Effect of Categorical Variables of Binary Logistic Regression

Willingness to pay (WTP)	Margins	Standard Error	P>lZl
Gender of the Household			
Female	0.615	0.608	0.000
Male	0.621	0.036	0.000
Reliability of electricity supply			
As not reliable	0.588	0.034	0.000
As reliable	0.765	0.064	0.000
Prior notification before shortages			
No	0.610	0.035	0.000
Yes	0.658	0.068	0.000
Effect of interrupted electricity			
No	0.477	0.117	0.000
Yes	0.682	0.056	0.000
Sports activities			

No	0.491	0.059	0.000
Yes	0.700	0.043	0.000
Religious activities			
No	0.616	0.062	0.000
Yes	0.626	0.089	0.000
Cultural activities			
No	0.570	0.062	0.000
Yes	0.664	0.056	0.000

Source: Author's Estimation 2020

Table 9 presents the marginal effects of education levels on households' willingness to pay (WTP) for improved electricity service. Education levels range from 1 (uneducated) to 8 (highly educated). The average marginal effect on WTP starts at 0.352 for uneducated households and increases incrementally, reaching 0.685 for households with higher education. It means that as education levels rise, the predicted probability of WTP for improved electricity services increases from 35.2% to 68.5%. Thus, higher education levels significantly boost households' willingness to pay for better electricity services.

Table 9. Estimating Marginal Effect of Education

	Delta –method Margins	Standard Error	P>lZl
_at			
1	0.352	0.110	0.001
2	0.398	0.095	0.000
3	0.446	0.077	0.000
4	0.494	0.057	0.000
5	0.544	0.039	0.000
6	0.593	0.028	0.000
7	0.639	0.032	0.000
8	0.685	0.044	0.000

Source: Author's Estimation 2020

Table 10 presents the marginal effects of households' monthly electricity bills on their willingness to pay (WTP) for improved electricity services, with increments of 1,500. For a bill of 500, the marginal effect on WTP is 0.667, meaning a 1% increase in the bill raises the predicted probability of WTP by 66.7%. As the bill increases to 2,000, the marginal effect drops to 0.649, while for a bill of 14,000, it further decreases to 0.498. It indicates that higher monthly bills reduce the likelihood of households paying more for improved electricity services.

Table 10. Estimating Marginal Effect of Monthly Electricity Bill

	Delta -method Margins	Standard Error	P>lZl
_at			
1 (500)	0.667	0.037	0.000
2 (2000)	0.649	0.032	0.000
3 (3500)	0.631	0.029	0.000
4 (5000)	0.613	0.027	0.000
5 (6500)	0.594	0.027	0.000
6 (8000)	0.575	0.029	0.000
7 (9500)	0.556	0.034	0.000
8 (1100)	0.536	0.040	0.000
9 (12500)	0.517	0.047	0.000

10 (14000)	0.498	0.054	0.000

Source: Author's Estimation 2020

Table 11 shows the marginal effects of monthly income on households' willingness to pay (WTP) for improved electricity services, with increments of 100,000. For a household with an income of 10,000, the marginal effect on WTP is 0.5265, meaning a 1% income increase raises the predicted probability of WTP by 52.65%. When income rises to 110,000, the marginal effect increases to 0.604, indicating a 60.4% increase in the probability of willing to pay. It suggests that higher monthly income makes households more likely to pay for better electricity services.

Table 11. Estimating Marginal Effect of Monthly Income of Household

	Delta –method Margins	Standard Error	P>lZl
_at			
1 (10000)	0.519	0.043	0.000
2 (110000)	0.602	0.028	0.000
3 (210000)	0.679	0.039	0.000
4 (310000)	0.749	0.057	0.000
5 (410000)	0.809	0.067	0.000
6 (510000)	0.857	0.070	0.000
7 (610000)	0.896	0.067	0.000
8 (710000)	0.925	0.060	0.000
9 (810000)	0.947	0.051	0.000
10 (910000)	0.962	0.042	0.000

Source: Author's Estimation 2020

Table 12 shows the marginal effects of household size on willingness to pay (WTP) for improved electricity services, with increments of 4. For a household size of 2, the marginal effect on WTP is 0.524, meaning a 1% increase in household size raises the predicted probability of WTP by 52.4%. When household size increases to 6, the marginal effect is 0.528, slightly raising the probability by 52.8%. This indicates that larger household sizes slightly increase the likelihood of paying more for better electricity services.

Table 12. Estimating Marginal Effect of Size of Household

	Delta –method Margins	Standard Error	P>lZl
_at			
1 (2 persons)	0.524	0.055	0.000
2 (6 persons)	0.583	0.030	0.000
3 (10 persons)	0.639	0.035	0.000
4 (14 persons)	0.694	0.057	0.000
5 (18 persons)	0.743	0.078	0.000
6 (22 persons)	0.787	0.093	0.000
7 (26 persons)	0.826	0.101	0.000
8 (30 persons)	0.859	0.104	0.000
9 (34 persons)	0.887	0.102	0.000

Source: Author's Estimation 2020

4.7 Discussion

Energy is crucial for daily life and economic development, with electrical energy playing a central part in regulation of our day-to-day activities. In Pakistan, electricity is provided by WAPDA, K-Electric, and independent power producers (IPPs), with a total installed capacity of 41,000 MW. It includes hydel (25.8%), thermal (58.8%), nuclear (8.6%), and renewables (6.8%) energy resources. Recent developments, such as Thar coal projects and renewable energy initiatives like solar and wind, aim to boost renewables in the power mix. Despite these efforts, Pakistan faces challenges like load shedding, circular debt, and inadequate infrastructure, impacting economic growth and living standard. The study investigates households' willingness to pay (WTP) for reliable electricity using the Random Utility Model (RUM) and contingent valuation method. Data from 287 households in Tehsil Nowshera showed that 84.32% of respondents had inconsistent energy and were willing to pay more for changes. Key factors positively influencing this attitude included household size, education level, income, and the reliability of power service, all consistent with findings from other studies.

Taale and Kyeremeh (2016) and Twerefou (2014) discovered that education, income, and household size all have a significant impact on willingness to pay (WTP) for reliable electricity in Ghana, echoing the positive correlation between higher education and income levels and a higher likelihood of paying more for improved electricity observed in Nowshera.Ozbafli and Jenkins (2015) found that families are willing to pay higher electricity rates for better reliability, underlining the economic benefits of such upgrades. This finding is consistent with the current study, demonstrating that reliable electricity considerably impacts WTP. However, the variability in WTP explained by the model was restricted to 8.7%, implying that additional unknown factors may be significant. The literature repeatedly emphasizes the role of socioeconomic factors in influencing WTP for improved electrical services. Adjei-Mantey (2013) and Babawale and Awosanya (2014) discovered that income, household size, and education levels significantly impact WTP, mainly when inconsistent electricity drives people to rely on self-generation. However, the effect of monthly bills on WTP is unclear, as larger bills may discourage extra payments for higher services.

The study also looked at the impact of other activities on WTP and discovered that cultural activities had a beneficial influence, whilst sports and religious activities had a detrimental and adverse effect. This conclusion differs from the broader literature, in which the importance of specific activities on WTP is less commonly highlighted, implying that these variables may be more context-dependent. Finally, the study emphasizes the importance of improved infrastructure and stable electrical supply, a recurring subject in the literature. Ozbafli and Jenkins (2015) and Gunatilake et al. (2013) highlight the economic benefits and consistent WTP across income groups for reliable electricity, particularly in rural areas, lending support to the study's findings that larger households with higher incomes and better education are more likely to pay for improved services.

4.8 Implications of the Study

The study's findings have several substantial implications. Policymakers should emphasize increasing power dependability and reducing socioeconomic gaps to boost households' willingness to pay (WTP) for better services. Raising public knowledge of renewable energy and its benefits can also help WTP and sustain the shift to cleaner energy sources.

Furthermore, deliberate government interventions, such as targeted expenditures and effective pricing regulations, are critical to encouraging renewable energy adoption and assuring a sustainable future.

5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This study aims to identify the factors influencing households' willingness to pay extra for improved, reliable electricity services. It also examines the impact of sports, religious, cultural, and social activities on this willingness. Data were collected from 287 households in Nowshera using the contingent valuation method. It investigated the numerous elements affecting households' willingness to pay (WTP) for enhanced electricity services and the adaptation of renewable energy sources. The data showed the substantial impact of socioeconomic parameters such as income, education level, household size, and electrical reliability on WTP. Higher education, income levels and larger household sizes are directly linked to a greater tendency to pay for improved electrical services. Furthermore, homes with inconsistent electricity supply and frequent power outages demonstrated a higher WTP for upgrades.

Environmental awareness and attitudes towards renewable energy also influenced customer preferences. The study discovered that economic variables especially price significantly influence raising awareness and marketing of the benefits of green energy. This could ultimately improve WTP for renewable energy sources. Therefore, obstacles like high costs, lack of knowledge, and institutional impediments must be overcome to encourage widespread usage.

Furthermore, the study found that factors such as advance notification of power outages, the impact of power interruptions on everyday activities, and government measures significantly affect WTP. According to the study, households are more likely to pay for reliable electricity when they see tangible benefits, such as uninterrupted power for critical activities. However, gender and specific cultural or religious activities have little effect on WTP. It also stressed the significance of government involvement in promoting renewable energy and strengthening power infrastructure. Strategic investments, effective pricing strategies, and public awareness initiatives are critical for promoting a sustainable and reliable energy sector. According to the study, targeted policies particularly those that improve renewable energy education and address economic inequities have the potential to raise WTP and help the transition to greener energy options.

In conclusion, this study emphasizes the complexities of the factors influencing families' willingness to pay for enhanced electrical services and renewable energy adoption. By addressing economic and environmental issues and raising public knowledge, policymakers can establish methods that link consumer preferences with sustainable energy goals, resulting in a more reliable and ecologically friendly electricity supply.

5.2 Policy Recommendations

Based on the findings, the following recommendations are made for policy consideration. The government should actively promote renewable energy policies to cater to both the supply and demand sides, using information campaigns to encourage the use of renewable resources. Investment in power sector infrastructure is crucial, particularly in replacing outdated power plants to enhance efficiency and reduce generation costs, thereby improving service reliability and consumer satisfaction, which could increase their willingness to pay higher tariffs. Policies should prioritize replacing imported crude oil with domestically abundant coal for thermal power plants and encourage the extraction of natural resources. Enhancing education and income levels is essential, as educated individuals are more likely to appreciate and pay for better electricity services. Additionally, creating a favorable environment for small and large-scale investors by reducing loan interest rates can boost commercial activities and household incomes. This will increase their willingness to pay for reliable electricity. Conducting pilot studies in diverse regions through public-private partnerships can provide valuable insights for optimal electricity supply development.

6. LIMITATIONS AND FUTURE STUDIES

The study also has a few limitations. Firstly, the sample size may need to reflect the larger population. Therefore, the findings' generalizability has become inconclusive speculating the inclusion of other variables or factors to discern results that can be accurately applied to the rest of the population holistically. Secondly, the study depends on self-reported data, which may be liable to biases. Thirdly, the study focuses on a specific geographical region, which may limit the results' application to other areas with diverse socioeconomic or cultural backgrounds. Finally, external factors such as government regulations or market dynamics may affect households' willingness to pay. Considering these limitations, the researchers propose future studies that can incorporate these factors which could be thoroughly examined.

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Appendix 1: Questioner

Willingness to pay for the Reliable and Uninterrupted Electricity Supply in district Nowshera

The questioner is based on people willingness to pay for the uninterrupted electricity supply to their home. Objective of the study is to determine the factors that influence their willingness to pay additional amount for improved electricity supply service and also the impact on social and cultural activities due to electricity outages on respondent's willingness to pay an additional amount for better electricity services.

Demographic Factors:

Age of respondent ____________________ Gender ________________

Education ____________________ Profession ________________

Type of home ownership ____________________

Q1: How many individuals are there in this household? ____________________________

Q2: How many of them are working? ______________________________________

Q3: Do you have any other job besides your main occupation? If yes, what is it?

Q4: What is your total monthly income? i.e. The sum of monthly incomes of all persons who are working in this house. Rs.____________

Q5: How many hours does it take on average when power goes off (on days that it does)?

____

Q6: How many units of electricity do you consume during every month? ____________________

Q7: On average, how much do you pay for electricity service on monthly base?

Rs. ___________________

Q8: What is your alternative source of power when electricity goes off?

1. Generator **2.** Solar energy **3.** Torch light **4.** Gas lights **5.** No alternative (specify)

____

Q9: On average, how much do you spend on this alternative source of power during power outages in a month?

Q10: How necessary do you consider the current supply of electricity an issue worth discussing?

1. Extremely necessary **2.** Very necessary **3.** Necessary **4.** Moderately Necessary **5.** Not Necessary

Q11: How would you rank the reliability of current supply of electricity to your home/ neighborhood?

1. Reliable **2.** Not reliable

Q12: How would you rank the quality (complete level of voltage) of current supply of electricity to your home/ neighborhood?

1. Excellent **2.** Very good **3.** Good **4.** Poor **5.** Very poor

Q13: Have you experienced any damages due to low quality and unreliable electricity supply?

1. Yes **2.** No

If yes then mentioned, how much the cost was? Rs ___________________

Q14: Have you ever experienced the prior notification given before an outage of current supply of electricity to your home?

1. Yes **2.** No

Q15: Are you sensitive about the electricity?

1. Yes **2.** No

Q16: Do you think the appropriate authorities have done enough to solve or at least deal with the problems of providing reliable and quality electricity supply?

1. Yes **2.** No

Q17: Will you be willing to pay higher for the improvement (uninterrupted supply) of this electricity service?

1. Yes **2**. No

Q18: How much you will be willing to pay higher for the uninterrupted supply of this service per month?

Q19: Have you ever been affected from interrupted electricity supply? ____________________

1. Yes **2.** No

If yes, then specify the following:

	Agree	**Disagree**
Sports		
Religious		
Cultural		

Q20: Who is responsible for the current power outages?

1. Government **2.** Myself **3.** Electricity thief

Q21: What would you like to suggest to the government about the issue?