Determining the Influencing Factors of Biogas Technology Adoption Intention in Pakistan: The Moderating Role of Social Media

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Abstract: Environmental degradation and rapid climate change have forced researchers and practitioners to find sustainable practices to save the world. Increasing energy demand is not only consuming scarce natural resources, but also damaging the climate and overall ecosystem. In this regard, biogas technology is beneficial in two ways—by meeting the energy demand and saving natural resources. Pakistan is an agricultural country and has a high potential for producing energy through biogas technology. Therefore, this study aims to find farmers’ intentions of adopting biogas technology in Pakistan by employing the extended norm activation model. Furthermore, the moderating role of social media was explored. Purposive sampling was used to collect data from farmers and results were extracted by using Partial least square structural equation modelling software. The results suggest that awareness of consequences, ascription of responsibility, environmental concern and perceived consumer effectiveness positively and significantly influence personal norms of the farmers. Consequently, personal norms affect farmers’ intentions of adopting biogas technology in Pakistan. The moderating role of social media was also confirmed by the results. This study considers the notable insights of biogas technology adoption in Pakistan. Finally, the limitations of the study and suggestions for future research are discussed.

Keywords: renewable energy; biogas technology; norm activation model; social media; Pakistan

1. Introduction

The concept of environmental sustainability and protection has become a major topic in research and policy agendas in the past few decades because climate change is the most critical factor that causes adverse impacts on the sustainable development of the global economy [1]. Environmental deterioration, the increasing demand for energy, and the scarceness of nonrenewable sources of energy have forced countries to shift from the conventional sources of energy to renewable energy sources worldwide [2]. Renewable energy techniques address environmental issues and provide sustainable solutions for such energy problems [3]. Due to fast-paced industrialization, the demand for energy is increasing, and this increase is not only resulting in higher prices, but also improved economic development and living standards [4]. The world population is growing significantly, and lifestyles are also improving, leading to a higher demand for energy all over the world [5]. A gap between the demand and supply of energy creates hurdles in economic growth, development, prosperity and
sustainable development, which have adverse effects on water resources, the environment, human health, and agricultural productivity in a country [6,7].

Most of the energy is produced with fossil fuels worldwide, but energy demand and consumption are increasing with every passing day. Fossil fuel resources are not enough to meet the desired needs, and their unstable prices have a negative impact on the world’s economy [8]. In the global south, the population is more than 650 million, from which 250 million people are still using traditional sources of energy for heating, cooking, lighting, and other daily needs [9]. Increased dependence or overuse of fossil fuels and fuel wood severely damages the ozone layer and produces an amplified degree of contamination with carbon emission, sulfur dioxide, and other harmful gases. Even though fossil fuels have adverse effects on the environment, the world is still using such nonrenewable power sources on a large scale. There is a dire need to explore and adopt renewable energy resources to cope up with the energy crisis, as well as to overcome environmental issues. Recently, most countries have explored eco-friendly and sustainable sources of energy, such as solar systems, wind energy and biogas technology [10].

Biogas is considered the most probable and potential source to address these energy and environmental issues, especially in developing countries like Pakistan. Biogas is produced through the anaerobic digestion process in which animals’ manure is mixed with water and is converted to methane gas in an airtight underground tank [11]. Biogas can not only put an end to the energy shortfall, but additional energy can be offered in the upcoming years. Biogas provides several benefits in terms of electricity generation, gas generation, bio-fertilizer, socioeconomic uplift and environmental preservation because biogas does not produce air contaminants like carbon dioxide, sulfur oxide, nitrogen oxide and other harmful fumes [12].

Pakistan is the sixth-largest country in the world in terms of population, with an annual population growth of 2%, and has 213 million residents [13]. With this growth and economic development, residents are facing multifaceted energy problems in Pakistan, due to which Pakistan experienced an energy shortage due to its high dependence on fossil fuels for power generation in recent years. During the period of 2011–2013, Pakistan has faced severe energy crises and load shedding problems [14]. Basically, Pakistan relies on conventional thermal resources for power generation, and these energy resources are not only expensive, but also unsustainable and harmful to the environment. Hence, there is a dire need to explore renewable energy alternatives in Pakistan.

Agriculture has an essential role in supporting economic growth and sustainability all around the globe. Pakistan is an agricultural economy; agriculture plays a significant role in employment generation and contributes almost 22 percent of the gross domestic Product (GDP) of Pakistan. A survey conducted in 2012–2013 highlighted that the livestock sector contributed 56 percent of the agriculture in Pakistan, which is approximately 12 percent of GDP in the country [11]. Almost 95 percent of rural families in Pakistan use conventional biofuel sources to meet their energy and cooking needs. They use livestock manure, woody (forest, farm, and urban trees) and non-woody (crop shells, straws, leaves) materials [15]. The use of fuel wood on a large scale creates environmental hazards such as soil erosion, deforestation, flooding, land degradation and land dryness. Moreover, it has adverse effects on human health due to the accumulation of smoke in poorly ventilated houses [16].

Biogas technology has the potential to produce 8.8–17.2 billion cubic meters of gas per year from animal dung and other residues. Moreover, the bagasse, which is a residue of sugarcane and sorghum processes, has the potential to produce 5700 GWh electricity annually, and this is almost equal to 6.6% of existing power generation in Pakistan [17].

Rural farmers can gain multiple advantages from these biogas energy resources because these biogas plants can generate electricity, gas generation and bio-fertilizer, and this is also an eco-friendly technology. Pakistan has the great potential to produce almost 21 million tons of bio-fertilizer every year among gas and electricity generation [18]. The slurry, which is produced during the power generation process of biogas, is used as a bio-fertilizer. The slurry is the fibrous material or inorganic entities that cannot be broken down nor converted into methane gas, but it contains numerous fruitful and
beneficial elements such as phosphorus, nitrogen, iron, cadmium, zinc, chromium, sodium, calcium and potassium [19]. Livestock manure can minimize the cost of organic fertilizers and also improve the productivity of the soil by acting as a renewable energy source. Biogas technology offers multiple economic, social and environmental benefits, but its adoption rate is very slow in developing countries such as Pakistan, especially for small farmers. Pakistan has the capacity to install around 15 million biogas plants in the country due to the abundance of this particular source [13]. In Pakistan, household biogas technology was introduced in 1959. However, there are still a limited number of biogas plants in the country (approximately 5357), even though the country has an enormous potential to install many more plants [20]. In spite of social and environmental benefits, the adoption rate of biogas technology in Pakistan is extremely low [2,3]. Hence, at this juncture, it is valuable to understand potential factors that trigger biogas technology adoption [2,20] particularly in the context of a developing country [3] such as Pakistan.

The previous literature indicates that altruistic values (concern for others) and egoistic values (pro-self) are the two main domains to predict pro-environmental behavior [21]. The literature identified that altruistic values and egoistic values are negatively associated with each other [22]. To think about inner satisfaction or for others are two different things, and both of these visions are practically incompatible and mismatched. On the other hand, both of these distinct values may exist in a person and may influence his or her attitude [23]. Egoistic values like installation cost, performance or outcomes and altruistic values like environmental concerns influence farmers’ acceptance of biogas technology. Meanwhile, the nature of biogas adoption constitutes both egoistic and altruistic values. However, extant studies mainly focused on egoistic values for biogas adoption, e.g., [3,20,24], but the role of altruism (pro-environmental) on biogas adoption was ignored or not thoroughly investigated.

To overcome this shortcoming, we study biogas adoption from an altruistic (pro-environmental) perspective, based on the norm activation model. The norm activation model (NAM) is one of the most exquisite descriptive models to measure altruistic behavior. Essentially, NAM postulates that pro-environmental behavior is predicted by personal norms [25]. Researchers in pro-environmental behavior agreed that personal norms are activated by four factors: aspiration of responsibility (AR), awareness of consequences (AC), environmental concerns (EC) and perceived consumer effectiveness (PCE) [26]. Personal norms are significant predictors of pro-environmental behavior [27,28]. However, the evidence for whether personal norms trigger pro-environmental behavior is mixed [29,30]. While some studies do show a positive effect, others do not, which is referred to as the personal norms pro-environmental behavior gap [31]. So, to resolve this inconclusiveness of this relationship in the literature, it becomes necessary to consider another variable as a moderator to strengthen the relationship of personal norms and pro-environmental behavior. In support of this view, we employ social media as a moderating variable to examine the predictive power of the personal norm and pro-environmental behavior relationship. Empirical evidence points to the fact that social media has become part and parcel of pro-environmental behavior [30]. Social media, the internet and mobile technology have become essential and useful communication instruments in connecting people all over the world. Previous studies have studied the role of social media for several social reasons, like green purchasing, environmentally-friendly actions, recycling intention or reduction in fast food consumption [32,33]. However, the current understanding of biogas technology adoption from a social media perspective is still lacking in the literature, especially in the context of Pakistan, where the Population of internet users is approximately 71 million, from which 32 million have a Facebook account. Hence, this study is an attempt to bridge this gap in the literature by studying the moderating role of social media in the relationship between personal norms and biogas technology adoption.

2. Literature Review

This section covers the detailed review of the energy situation and potential of biogas technology in Pakistan. After analyzing the scenario, the theoretical support of NAM was taken, and hypotheses were developed based on the previous literature.
2.1. The Energy Situation in Pakistan

The proper availability and easy accessibility of energy are the essential elements for individual quality of lifespan, employment opportunities and economic growth in any country. The socio-economic growth is heavily based on the energy stream and is considered the backbone of an economy. Developing countries like Pakistan are suffering from severe energy problems, and this crisis further leads to adverse economic, social and environmental issues in the long term [34]. The energy consumption in Pakistan is increasing with every passing day due to the growing population and the demand for energy is rising by approximately 11–13 percent per year. Fossil fuels like coal, oil and gas are the primary energy sources in Pakistan and are an expensive source of energy with an annual expenditure of nearly seven million US dollars [35]. Pakistan generates approximately 61 percent of electricity from expensive sources such as crude oil and gas. However, the country is still facing a deficiency in electricity of about 14–18 h in rural areas and 8–10 h in urban areas since 2006 [36]. To meet its energy needs, Pakistan spends almost 1.4 billion US dollars on the import of fossil fuels, which causes adverse effects on economic growth because this fuel cost was only 530 million US dollars in 1996 [11]. The demand for energy has been estimated to rise threefold by 2050 in Pakistan, but the electricity production rate is shallow and is not even able to meet the current demand for energy in the country [37]. The neglect of sustainable energy sources, higher dependency on fossil fuels and lack of knowledge are the leading causes of energy crises in Pakistan [38]. Meanwhile, all sectors in the country are adversely hit by the energy shortfall, but the textile industry faces the most acute energy crisis; in recent years, about 50 to 60 percent of textile industries shifted their businesses to Bangladesh and China [13].

2.2. Biogas Potential in Pakistan

Biogas is the fourth leading energy source in the world that provides almost 14 percent of primary energy and power [2]. Biogas is one of the best alternates of fossil fuel, fuel wood, agricultural residues and animal dung, which are mostly used as energy and cooking sources in rural areas. In developing countries like Pakistan, biomass energy has a prime significance due to multiple factors such as the production of low-cost electricity, small capital investment and, most importantly, the easy availability and accessibility of its raw material [13]. Biogas technology produces hygienic and safe energy which is environmentally friendly and does not compromise human health. Pakistan is an agricultural and agro-livestock country, which has excellent potential to provide a significant quantity of animal dung [39]. In Pakistan, there are more than 170 million livestock animals, of which 72 million are cows and buffalo and their (approximately) 72 million kg of dung has an abundant potential to produce biogas energy in the country [40]. It is estimated that, probably, a medium size single cow and buffalo can produce 10 kg of dung per day [41] and 20 kg of wet animal dung can provide approximately one cubic meter of biogas. Besides, bagasse, poultry waste, slaughterhouse waste and street waste can also be used to create biogas energy in the country. It is estimated that Pakistan can produce $14.25 \times 10^6$ m$^3$/day of biogas energy which is adequate to meet the needs of the 112 million people living in rural areas [42]. In Pakistan, the livestock sector is growing at a rate of four percent each year. To overcome the energy crises in the country, the Pakistan Council of Renewable Energy Technologies has installed 4016 biogas plants which have the potential to produce biogas of almost 20,454 m$^3$/day [43]. Sindh was the first province in Pakistan to establish a biogas plant in 1959, and an additional 21 plants were established across the country in 1974 [18]. Currently, three significant departments, Pakistan Council for Appropriate Technologies, Pakistan Council of Renewable Energy Technologies and Pakistan Renewable Energy Society have installed 5357 biogas plants [41].

2.3. Norm Activation Model (NAM)

The norm activation model was proposed by Schwartz [25], and is quite popular in social psychology to study altruistic or pro-environmental behavior. According to the norm activation model,
personal norms are considered as the crucial construct which drive the feelings or emotional state of personal moral responsibility to behave in a specific manner [44]. The NAM is considered a useful model to study altruistic behavior and has been mostly used to examine pro-environmental behavior such as energy preservation activities [45–47] and sustainable environmental grievance attitude [48,49].

This model contains three variables: the ascription of responsibility, awareness of consequences and personal norms. Ascription of responsibility (AR) is described as feelings of moral responsibility for negative or harmful effects of not performing pro-environmentally [50]. Personal norms (PR) are defined as performing moral responsibilities with specific actions, and this element of the norm activation model is useful for predicting pro-environmental behavior instantly [44]. Awareness of consequences (AC) reflects whether or not a person is aware of the adverse effects of his actions on the society or conscious about those values which are not pro-environmental [50]. From these three variables of NAM, the ascription of responsibility and awareness of consequences are antecedent variables of personal norms that can affect an individual’s behavioral intentions, plans or actions [51].

Unfortunately, NAM only covers internal factors and ignores the external factors. Many researchers improve the explanatory power of this model by adding different factors [47,52]. Scholars usually extend the norm activation model from two different perspectives, such as by introducing additional antecedents of personal norms and incorporating the external elements. In previous studies, the NAM model was extended by perceived consumer effectiveness [26,53] and environmental concern as an antecedent of the personal norm [26]. Moreover, NAM is also augmented by adding perceived behavioral control as an antecedent of the personal norm to study and understand consumer behavior [54]. Another work in this domain developed an extended norm activation by incorporating external cost variables to better explain the choice behavior of consumers [55]. Although previous studies highlighted the inclusion of external variables, inconsistencies in the relationship between personal norms and pro-environmental behavior were not incorporated by many studies [31]. In this study, we include the moderating role of social media to understand farmers’ choice behavior towards the adoption of biogas technology in Pakistan.

2.4. Research Framework and Hypothesis Development

Environmental concerns, perceived consumer effectiveness, the ascription of responsibility and awareness of consequences are antecedent variables of personal norms. Subsequently, personal norms can affect an individual’s behavioral intentions of adopting biogas technology. Besides, external factors (the role of social media) moderate the influence of personal norms, perceived consumer effectiveness and environmental concerns on farmers’ intentions toward the adoption of biogas technology (see Figure 1). Hence, we propose the following hypotheses:

\[ H1: \text{Personal norms have a significant positive influence on farmers’ intentions toward biogas technology;} \]

\[ H2: \text{Awareness of consequences has a significant positive influence on personal norms;} \]

\[ H3: \text{Ascription of responsibility has a significant positive influence on personal norms.} \]

2.5. Environmental Concerns

Environmental concern indicates the consumer’s overall orientation towards environmental issues [56]. In the last few decades, ecological changes have occurred quite dramatically, and many researchers have turned their focus to environmental issues, specifically eco-friendly behavior or actions [57]. Environmental concern is one of the most crucial elements in shaping the personal norms of consumers toward environmentally friendly activities [58]. Environmental concerns are based on the consumer’s level of understanding of their ecosystem and consumers who have more knowledge about environmental issues exert more efforts to solve the ecological problems compared to those who have less knowledge about environmental issues [59]. Environmental concerns play a vital role in a consumer’s decision to adopt environmentally friendly behavior because those people who show more
significant concerns about ecological problems are more willing to accept and promote renewable energy sources for the sake of environmental protection and also engage themselves in eco-friendly activities [26,60]. Therefore, we hypothesize that:

H4: Environmental concerns positively affect consumers’ personal norms.

2.6. Perceived Consumer Effectiveness (PCE)

The concept of perceived consumer effectiveness (PCE) is referred to as the psychological phenomenon in which consumers show a positive attitude towards sustainable and renewable energy sources to preserve the environment [61]. PCE is defined as how consumers justify their behavior and have faith that their behavior and actions are beneficial for the environment [45]. In the current study, perceived consumer effectiveness (PCE) is defined as the general public’s beliefs that they can contribute and assist in overcoming the negative impacts of energy consumption on the environment by adopting renewable energy sources such as biogas technology.

In previous studies, most of the researchers proposed that PCE affects the attitudinal aspects of consumers, like their attitude and subjective norms [59,62]. Consumers who are more concerned about environmental issues are more willing to work for ecological sustainability and develop a favourable attitude towards the environment [63]. Perceived consumer effectiveness can activate the personal norms of consumers. In other words, when consumers believe that their behaviors are environmentally friendly, they are probably more motivated to reduce environmental contamination.

PCE is one of the most significant and leading elements in explaining pro-environmental consumer behavior and also motivates consumers to show a positive attitude towards the adoption of sustainable options of energy production [63]. Individuals can feel pleasure when protecting the environment through their actions and feel guilty when environmental deterioration occurs through their actions. This feeling of guilt leads to the development of positive personal norms. Hence, we hypothesize that:

H5: Perceived consumer effectiveness positively affects consumers’ personal norms.

2.7. Moderating Role of Social Media

Since it was found from the literature that there are contradictions in the relationship between personal norms and pro-environmental behavior, which implies the need for external factors in this relationship [31]. Because it was found that pro-environmental behavior is not just influenced by the consumer’s personal obligation towards environment but also some other factors, the study includes social media as moderating variable to better understand and strengthen the relationship.

Media channels play a crucial role in providing sufficient and accurate information to educate society about their mutual environmental concerns [64]. Social media is becoming an essential instrument of communication, expressing interest and gaining information about what is going on. It connects people all over the globe, enabling them to understand what is going and where. This proliferation of social media not only influences the individual’s interest but also the consumer’s behavior [65]. The social causes, or justification, of green consumption behavior suggested by social groups is influencing others to behave similarly. The general public can easily see the results of green behavior through social media, motivating other people to engage themselves in pro-environmental activities.

Moreover, it is found that social media can improve comparison psychology and self-efficacy and, ultimately, these attributes contribute to promoting pro-environmental behaviors [66–68]. It was found that media channels have a direct influence on consumers’ attitudes and behaviors toward different kinds of environmental issues such as greenhouse gasses, energy crises and environmental deterioration [69]. Even though digital media is becoming a very popular and impressive tool for direct actions or movements, its success in enacting environmental changes or environmental protection actions or policies is still under investigation [70–72]. Recently, a study found the moderating role
of electronic word of mouth (eWOM) in pro-environmental behavior [31]. So, based on the above discussion it can be hypothesized that:

**H6:** Social media positively moderates the relationship between personal norms and farmers’ intentions toward biogas technology.

![Conceptual framework](image)

**Figure 1.** Conceptual framework.

## 3. Methodology

Pakistan is an agricultural country, with most of its agricultural land concentrated in Punjab. Sahiwal is the 14th biggest city in Punjab and the 21st biggest city in Pakistan. The Sahiwal division is one of the famous divisions in the province of Punjab due to several reasons such as its fertile agricultural land, peaceful natural environment and animal husbandry. We select the Sahiwal division for this study because it has the largest number of livestock and a favorable temperature, which are prerequisites for the production of domestic biogas digesters. The Sahiwal Division was divided into three districts: Sahiwal District, Okara District and Pakpattan District. To collect data, non-probability (purposive) sampling was employed in this research as it provides a representative sample when it is problematic to access the complete sampling frame. Moreover, purposive sampling is appropriate for theoretical generalization when it is challenging to access the whole population [73]. Animal ownership (number of animals) and landholdings (cultivated land area) are two crucial factors in the adoption of biogas technology. Hence, respondents were selected through purposive sampling in this study, and small farms with a minimum of five animals (cows and buffalo) and a minimum of 12.5 acres of cultivated land were chosen, because cultivated land is an essential factor in the adoption of biogas technology. In Pakistan, individuals are considered small farmers if they have a minimum of 12.5 acres of land in Punjab. Generally, to run a small biogas plant, a minimum of four animals (cows and buffalo) are required, producing 40 kg of animal dung per day. Therefore, the number of livestock animals is considered as an essential factor for the adoption of biogas technology [74].

### 3.1. Sample and Procedure

Hair et al. [75] proposed a rule of thumb for sample size as a one to five ratio; hence, the questionnaire used in this study comprises 31 measurement objects which required a minimum collection of 155 (31 × 5) functional questionnaires. In this regard, a total number of 310 questionnaires were distributed, of which 207 were returned and 191 were usable for the analysis, and the response rate was 61.6 percent. The household head was the respondent in this study from whom the
data was collected regarding financial attributes and how convenient it is to use biogas technology. The demographic profile of the respondents is given in Table 1.

**Table 1. Demographic profile.**

| Variables       | Characteristics | Frequency | Percentage |
|-----------------|-----------------|-----------|------------|
| Gender          | Male            | 117       | 61.26      |
|                 | Female          | 74        | 38.74      |
| Age             | Less than 20    | 26        | 13.61      |
|                 | 21–30           | 58        | 30.37      |
|                 | 31–45           | 42        | 21.99      |
|                 | 46–55           | 35        | 18.32      |
|                 | 56–65           | 19        | 9.95       |
|                 | 65 and above    | 11        | 5.76       |
| Income          | Less than 50,000| 35        | 18.32      |
|                 | 50,001–75,000   | 62        | 32.46      |
|                 | 75,001–100,000  | 46        | 24.08      |
|                 | 100,001–125,000 | 33        | 17.28      |
|                 | 125,001 and over| 15        | 7.86       |
| Head of Cattle  | 5–10            | 38        | 19.90      |
|                 | 11–15           | 48        | 25.13      |
|                 | 16–20           | 65        | 34.03      |
|                 | 21–25           | 16        | 9.42       |
|                 | 26–and above    | 22        | 11.52      |
| Cultivate Land area | 12.5–20 | 43        | 22.52      |
|                 | 21–30           | 82        | 42.93      |
|                 | 31–40           | 40        | 20.94      |
|                 | 41–and above    | 26        | 13.61      |

3.2. Measurement Items

Items of this research have been adopted from different studies. All of the items used in this study have been measured using the five-point Likert scale, in which one symbolizes strongly disagree, and five expresses strongly agree. Items based on awareness of consequences and ascription of responsibility were constructed based on Zang et al. [76]. Items regarding personal norms were adopted from Smith and McSweeney [25,77]. Items related to environmental concern were adopted from Wang et al. [78]. Items of perceived consumer effectiveness were constructed based on Kim and Choi [56]. Items of social media were adopted by Sujata et al. [79,80]. All items adopted from the previous studies were first translated into the local language, i.e., Urdu, by two professional translators. After that, these statements were again translated into English by another translator, as per the suggestion of Brislin [81]. No significant differences were found, but some grammatical issues arose, which were resolved. After that, questionnaires were distributed for data collection in the local language. The items of the questionnaires are attached in Appendix A.

4. Data Analysis using Structural Equation Modeling (PLS-SEM)

Structural equation modelling (SEM) is more beneficial for statistical analysis in terms of accuracy, efficiency and convenience compared to other traditional statistical analysis methods [82,83]. SEM is a second-generation technique that covers the issues of first-generation analysis tools. It is a multivariate analysis method that can help to analyse numerous variables at the same time. Its ability to deal with complex and multiple relationships simultaneously is making it popular in business research day by day [83]. SEM has two well-known techniques: covariance-based SEM (CB-SBM) and variance-based SEM (VB-SBM) or partial least square (PLS)-SEM [84]. To select an appropriate statistical method is most important for social science researchers because the inappropriate selection of analytical methods
can cause inaccurate conclusions [85]. Because data tend to have the problem of normality in social science studies, partial least square (PLS) is typically used and preferred over CB-SEM, as it addresses the issues of normality [86].

PLS-SEM is a two-stage analysis approach that includes measurement results in two steps; the first step is a measurement model, and the second step is a structural model [87]. The assessment of the measurement model includes the assessment of the inner model or reliability and validity tests. In contrast, the assessment of the structural model consists of the assessment of the outer model or hypotheses/relationships testing. This study used PLS 3.0 software for analysis.

4.1. Measurement Model

In this study, reliability and validity tests were conducted for all the given constructs for the measurement model evaluation. The valuation of the measurement model was based on reliability tests (internal consistency reliability and item reliability) and validity tests (discriminant validity and convergent validity) [88]. Item reliability was measured through outer loading, internal consistency reliability was measured through composite reliability (CR), and convergent validity was measured through the average variance extracted (AVE). The loadings of all items are well above the threshold value of 0.5 [89], and values are presented in Table 2. The value of composite reliability for each paradigm exceeds the cut-off point of 0.7, and AVE surpasses the suggested value of 0.5, which shows that the measurements are reliable [90]. The results of the study indicate that all the values of AVE are between 0.518 (intention to adopt Biogas technology) and 0.648 (social media), all the values of CR are between 0.809 (intention to adopt Biogas technology) and 0.851 (perceived consumer effectiveness), and all additional loadings are between values of 0.5 and 0.9. In this measurement model, all the values verify the validity and reliability. All the values are given below in Table 2 and Figures 2 and 3.

| Constructs                        | Item     | Loading | CR   | AVE   |
|-----------------------------------|----------|---------|------|-------|
| Personal norm                     | PN1      | 0.732   |      |       |
|                                   | PN2      | 0.680   |      |       |
|                                   | PN3      | 0.809   | 0.836| 0.562 |
|                                   | PN4      | 0.732   |      |       |
| Awareness of consequences         | AC1      | 0.806   |      |       |
|                                   | AC2      | 0.803   |      |       |
|                                   | AC3      | 0.761   |      |       |
| Ascription of responsibility      | AR1      | 0.745   |      |       |
|                                   | AR2      | 0.768   |      |       |
|                                   | AR3      | 0.713   | 0.840| 0.569 |
|                                   | AR4      | 0.788   |      |       |
| Environmental concern             | EC1      | 0.809   |      |       |
|                                   | EC2      | 0.785   |      |       |
|                                   | EC3      | 0.809   | 0.843| 0.642 |
| Perceived consumer effectiveness  | PCE1     | 0.644   |      |       |
|                                   | PCE2     | 0.819   |      |       |
|                                   | PCE3     | 0.832   | 0.851| 0.590 |
|                                   | PCE4     | 0.764   |      |       |
| Social media                      | SM1      | 0.828   |      |       |
|                                   | SM2      | 0.821   |      |       |
|                                   | SM3      | 0.765   | 0.847| 0.648 |
| Intention to adopt Biogas Technology | IN1  | 0.826   |      |       |
|                                   | IN2      | 0.734   |      |       |
|                                   | IN3      | 0.560   | 0.809| 0.518 |
|                                   | IN4      | 0.734   |      |       |
Discriminant validity is confirmed if the value is less than 0.85 [91] or 0.90 [92]. Table 3 shows that all values are less than 0.90.

Figure 2. Loadings.

Figure 3. Structural model evaluation (bootstrap).

For discriminant validity, the Heterotrait–Monotrait ratio of correlations (HTMT) criterion is considered more appropriate due to criticism of the Fornell–Larcker criteria by different researchers [83]. Discriminant validity is confirmed if the value is less than 0.85 [91] or 0.90 [92]. Table 3 shows that all values are less than 0.90.
Table 3. Discriminant validity Heterotrait–Monotrait (HTMT) table.

| Constructs | AR  | AC  | EC  | IN  | PCE | PN  | SM  |
|------------|-----|-----|-----|-----|-----|-----|-----|
| AR         |     | 0.481 |     |     |     |     |     |
| AC         | 0.455 |     | 0.586 |     |     |     |     |
| EC         | 0.440 | 0.663 |     | 0.543 |     |     |     |
| IN         | 0.373 | 0.565 | 0.445 |     | 0.521 |     |     |
| PCE        | 0.614 | 0.557 | 0.478 | 0.812 |     | 0.488 |     |
| PN         | 0.585 | 0.548 | 0.431 | 0.869 | 0.575 |     | 0.889 |

4.2. Structural Model

After the evaluation of the measurement model, the structural model was evaluated, which checked the relationship between endogenous and exogenous variables. The assessment of the structural model is based on t values, path coefficient (β values), effect size (f²), predictive relevance (Q²) and coefficient of determination (R²). A 5000 resample bootstrapping procedure with 5% significance level (one-tailed) was used to test significance of the hypotheses. Results show that all six hypotheses are accepted. Personal norm (β = 0.329, t = 7.119 > 1.64, p < 0.05), awareness of consequences (β = 0.186, t = 4.102 > 1.64, p < 0.05), ascription of responsibility (β = 0.311, t = 6.940 > 1.64, p < 0.05), environmental concerns (β = 0.126, t = 2.795 > 1.64, p < 0.05) and perceived consumer effectiveness (β = 0.162, t = 4.015 > 1.64, p < 0.05) have a positive significant impact on the adoption intentions of biogas technology. Moreover, social media (β = 0.084, t = 3.173 > 1.64, p < 0.05) moderates the relationship between personal norms and intentions toward the adoption of biogas. The R² value for biogas adoption is 0.468, which shows that model has substantial explanatory power for the adoption of biogas technology in Pakistan.

However, it is not an appropriate and effective approach to support a model only based on the value of R² [75]. Thus, the best way is to measure the predictive relevance Q² of the model. If the value of Q² is higher than zero, then latent exogenous paradigms have great predictive relevance [93]. The results show that the value of Q² is 0.237 for farmers’ adoption intentions, which suggests that the model has significant predictive relevance. The values of f² are, 0.02, 0.15 and 0.35, which indicate small, medium and large effects, respectively [94]. Therefore, the value of f² postulates that effect size varies from medium to large (see Table 4).

Table 4. Structural model results (hypotheses testing).

| Hypothesis | Relationship | Path Coefficient | Std. Error | t Value | p-Value | Supported | R² | Q² | f² |
|------------|--------------|------------------|------------|---------|---------|-----------|----|----|----|
| H1         | PN → IN      | 0.309            | 0.043      | 7.119   | 0.000   | Yes       | 0.468 | 0.237 | 0.099 |
| H2         | AC → PN      | 0.186            | 0.046      | 4.102   | 0.000   | Yes       | 0.179 | 0.037 |       |
| H3         | AR → PN      | 0.311            | 0.045      | 6.940   | 0.000   | Yes       | 0.118 |       |       |
| H4         | EC → PN      | 0.126            | 0.043      | 2.795   | 0.000   | Yes       | 0.018 |       |       |
| H5         | PCE → PN     | 0.162            | 0.040      | 4.015   | 0.000   | Yes       | 0.031 |       |       |
| H6         | Moderating effect SM → IN | 0.084 | 0.024 | 3.173 | 0.001 | Yes | 0.478 | 0.019 |       |

4.3. Moderating Role of Social Media

The moderating effect of social media is studied by the interaction effect on the adoption intentions. The findings of this study demonstrate that social media significantly (β = 0.084, t = 3.173 > 1.64, p < 0.05) moderates the relationship between personal norm and the intentions of adopting biogas technology (see Figure 4). This moderation has changed and the value of R² has increased from 0.468 to 0.478. This means that after the addition of social media, the explanation power of the model is increased. Although the change is not very large, it plays an important role in examining the relations between personal norms and intentions of adopting biogas technology.
worse environmental issues and acute energy crises in Pakistan. Most of the energy is produced from fossil fuels, like crude oil and gas, which emits harmful gases. Rural areas heavily rely on fossil fuels or fuel wood and produce hazardous gas, causing respiratory diseases, particularly for women and children because fossil fuels emit an extensive amount of smoke [41]. To protect the environment, it is imperative to explore and adopt the best alternatives and renewable energy sources. Biogas is environmentally friendly because it is a smoke-free gas, has zero contribution to global warming, and is suitable for women’s health while cooking. Biogas technology is very cost-effective and does not require a large expense. Other neighbouring countries of Pakistan, like China and India, are utilizing biogas technology at a very economical cost [95]. Biogas plants are based on animal dung; thus, to run biogas plants, enough animals are required. Pakistan is an agricultural country with more than 170 million livestock animals. Normally, to run a small-scale biogas plant, 40 kg/day of animal dung is sufficient [96].

In this study, we explored the significance of altruistic value in determining farmers’ intentions toward biogas technology in Pakistan. The findings of this study show that altruistic beliefs (environmental issues) have a significant influence on farmers’ intentions toward biogas technology. Based on the norm activation model, this study explores the influencing elements for Pakistani people toward biogas technology adoption with the moderating role of social media. The extended version of NAM has been applied in this research, which can better explain the intentions toward biogas and provide the theoretical foundation for this study. Environmental concerns, awareness of consequences, the ascription of responsibility, personal norms, perceived consumer effectiveness and the role of social media are six variables that are used to explain farmers’ intentions toward biogas technology. From the specific analysis of these six factors, we found that environmental concerns, awareness of consequences, the ascription of responsibility and personal norms has a significant positive impact on farmers’ intentions toward biogas adoption. Personal norms have the most substantial influence and are the most crucial factor, and a considerable predictor of eco-friendly behavior, and these findings are in line with the results of Schwartz [25]. The results of this study support the hypothesis H1 that

5. Discussion

The current situation of industry, modernization and high growth in population is leading to worse environmental issues and acute energy crises in Pakistan. Most of the energy is produced from fossil fuels, like crude oil and gas, which emits harmful gases. Rural areas heavily rely on fossil fuels or fuel wood and produce hazardous gas, causing respiratory diseases, particularly for women and children because fossil fuels emit an extensive amount of smoke [41]. To protect the environment, it is imperative to explore and adopt the best alternatives and renewable energy sources. Biogas is environmentally friendly because it is a smoke-free gas, has zero contribution to global warming, and is suitable for women’s health while cooking. Biogas technology is very cost-effective and does not require a large expense. Other neighbouring countries of Pakistan, like China and India, are utilizing biogas technology at a very economical cost [95]. Biogas plants are based on animal dung; thus, to run biogas plants, enough animals are required. Pakistan is an agricultural country with more than 170 million livestock animals. Normally, to run a small-scale biogas plant, 40 kg/day of animal dung is sufficient [96].

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Figure 4. Moderating effect of social media.
personal norms have a significant positive influence on farmers’ intentions toward biogas technology. Many previous studies have validated the role of personal norms in predicting the intentions toward adoption behavior [48,97,98]. Hence, these findings are helpful to determine a farmer’s possible intentions of adopting and using biogas technology.

We also found that both awareness of consequences and ascription of responsibility have a significant positive influence on personal norms and this is consistent with the statement that Personal Norm (PN) in the norm activation model can be triggered by awareness of consequences and ascription of responsibility as moderating factors [51]. The findings of this research show that the two main components of NAM, awareness of consequences and ascription of responsibilities, have a positive effect on the personal norms associated with the use of biogas technology. Hence, these findings support our hypotheses H2 and H3. These findings are consistent with the previous results that personal norms can be triggered by identifying the responsibility and consequences of the particular behavior [98]. Simply, we may say that awareness of consequences and ascription of responsibility plays a vital role in developing and strengthening personal norms. Consequently, it is more likely that farmers will be motivated to use biogas technology because of the awareness that the overuse of non-renewable energy sources can be harmful to their health and the environment. Awareness of consequences is considered an early phase in the direction of responsible behavior [25].

When individuals are more concerned about environmental issues, it is easy to promote renewable energy sources, and this statement also correlates with the previous findings that environmental concerns profoundly affect personal norms [99]. Awareness of the consequences of ecological issues plays an essential role in making and performing pro-environmental behavior [27]. When individuals have more knowledge and awareness about the environmental consequences, they are be more thoughtful and sensitive towards others and about how they consider and evaluate ecological concerns [97]. The findings of this study also support the hypothesis H4 that environmental concerns positively influence personal norms. It can be concluded that when farmers are more informed about the outcomes of biogas plants, they will have more favorable intentions toward biogas technology.

Moreover, the findings of this study support the hypothesis H5 that perceived consumer effectiveness is a cogent antecedent which positively affects consumers’ personal norms. These findings are aligned with the previous results that perceived consumer effectiveness has a significant positive influence on adoption intentions [63], as perceived consumer effectiveness is one of the most prominent elements in the explanation of pro-environmental behaviors that can positively affect behavioral intentions [56,59,100].

Social media is found to be a strong predictor that has a significantly positive influence on behavioral intentions and supports the hypothesis H6 that social media positively moderates the relationship between personal norms and farmers’ intentions toward biogas technology. Different social media platforms play a vital role in educating people about environmental issues by sharing images and messages. Extant research also found that social media influences individual behavioral intentions [101–103]. Posting videos, text, pictures and links associated with social, environmental and health issues increases the possibility that one will engage in more or less pro-environmental activities. Analysis of the study shows that using social media is a significant mechanism for expressing opinions, ideas and joining national causes. Hence, the findings of this study concurred with previous findings that social media sites are beneficial in developing favourable attitudes in terms of environmental protection activities [79]. Besides, the results of this study support the arguments that technology facilitates the provision of alternate solutions for environmental sustainability [104]. Therefore, we recommend that social media is a valuable tool to educate people with proper and meaningful information about environmental degradation and encourage them to promote renewable energy sources. The popularity and use of social media have given opportunities to government agencies and NGOs to promote renewable energy sources. Similarly, relevant specialists and opinion leaders have the responsibility of designing their content properly and more attentively to interact with ordinary people on social media platforms in order to promote renewable energy sources such as
biogas technology. This is because, in Pakistan, approximately 72 million people use the internet and social media websites.

5.1. Practical Implications

The demand for electricity is increasing with every passing day and Pakistan is pressurized to import both conventional or unconventional sources of energy to meet the electricity demand in the country. On average, the energy shortfall in the country is 5000 MW, and this shortfall touches up to 7000 MW in June and July when the demand for energy is at its peak. However, animal waste in the country has the potential to produce almost 4761–5554 MW electricity [11]. The outcomes of this study have significant practical implications for economic growth as well as for the wellbeing of rural farmers in term of energy generation and biofertilizers. Biofertilizers can improve the productivity or efficiency of the soil. This research provides ideas and alternate solutions to cope with energy crises via renewable energy sources such as biogas technology, with the consideration of personal norms, awareness of consequences and ascription of responsibility, environmental concerns and perceived consumer effectiveness to enhance the intentions in the long run. Personal norms highly influence individuals’ enthusiasm toward the adoption of renewable energy sources. Government agencies are beginning to pay more attention to personal norms to promote renewable energy sources such as biogas technology. The government of Pakistan has set the target to increase the share of renewable energy sources from less than one to five percent by 2030. In this regard, biogas technology has substantial potential to achieve this growth rate. To achieve such targets, education and publicizing the environmental benefits of biogas, while also highlighting the moral obligations is essential because moral obligations motivate individuals to adopt biogas technology.

It is noted that rural farmers are not considering biogas technology seriously due to their lack of knowledge and awareness. Promotion of biogas adoption through media channels can be helpful, along with educating the female members of the household. The outcomes of the moderating role of social media are also useful for policymakers and practitioners in promoting biogas technology, as there is a vast segment of the population using the internet and social media websites. Therefore, government agencies can use social media and other media platforms to convey the harmful consequences of using non-renewable energy sources such as global warming, environmental degradation and risks associated with the overuse of fossil fuels, coal or liquefied petroleum gas (LPG). As a result, people will show more favourable behavior toward renewable energy sources to resolve the energy crises and environmental issues.

Furthermore, rural farmers have some reservations in the adoption of biogas technology, such as initial investment. To overcome such impediments, the government shall provide subsidies, interest-free loans and arrange proper training programs to assist in the installation and function of biogas plants. Likewise, the private sector and NGOs can also take initiatives such as offering sponsorships and provision of small and easy loans for the installation of biogas plants, because if the installation cost or risks associated with biogas are high, the adoption intentions of this technology will slow down [105]. Consequently, in Pakistan, biogas is produced through animal dung at a limited or local level, though it can be taken up to a large or commercial scale if the government pays proper attention and formulates policies and strategies to promote this technology.

The empirical outcomes of this research are appropriate and applicable not only in the context of Pakistan but can also be helpful for other countries because the norm activation model (NAM) has universal acceptability for pro-environmental behaviors and energy issues that exist around the globe.

5.2. Limitations and Future Research Directions

Biogas technology will be the most crucial substitute for energy in Pakistan in the upcoming years. Some domains still need work or the attention of researchers in the development of biogas technology in Pakistan. The study is only limited to the intention/adoptions of biogas technology. Still, there is always a gap in actual behavior and the intention of consumers, so future studies can investigate the
actual buying behavior of the farmers. Secondly, this integrative model could only describe 47.8 percent
of the variance of farmers’ intentions to use biogas technology. Therefore, it is suggested that some
additional variables from other relevant models, such as the trans-theoretical model (TTM), innovation
diffusion theory (IDT) and technology acceptance model (TAM), can also influence farmers’ intentions.
Hence, these models can also be employed along with the NAM to improve the explanatory power
of the proposed model. Furthermore, in this study, we only use the role of social media, but other
media channels like broadcast, print and electronic media are also used to familiarize rural society
with biogas technology adoption; thus, we also suggest extending the norm activation model with
such factors. Future studies may also be conducted on the safe and nontoxic storage of biogas energy
that is produced locally.

6. Conclusions

This study employs an extended version of the norm activation model because the model is
suitable for describing the individual’s adoption intentions in pro-environmental issues. To extend
the model, we integrate internal variables with external variables. With the help of NAM, we studied
the relationship between personal norms and intentions toward the adoption of biogas technology
in Pakistan. We also investigated the moderation effect of social media between personal norms
and adoption intentions and also inspected the antecedents of personal norms, such as ascription of
responsibilities, awareness of consequences, perceived consumer effectiveness and environmental
concerns. The empirical results of this study enhance our understanding of the practical and theoretical
implications of farmers’ intentions to use biogas technology in Pakistan.

Furthermore, we investigated the economic, environmental and health benefits of adopting biogas
technology as a renewable source of energy in Pakistan. Out of all renewable sources of electricity,
biogas is considered one of the most suitable alternatives that is not only economical, but also an
environmentally friendly source of energy. Pakistan is an agricultural country and has abundant
resources of raw materials to run biogas plants. In Pakistan, the agriculture and livestock sectors have
enormous potential and prospects, as they produce animal waste in massive quantities. Currently,
there is no significant use of animal dung, and this waste causes environmental hazards because animal
waste is thrown in open land areas, which can cause serious health issues. Hence, this technology is not
only beneficial for farmers and households, but also beneficial for economic growth and environmental
preservation. Thus, the present study highlights that biogas technology is one of the most essential
and suitable alternatives for energy production in Pakistan.

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Appendix A

“Social media

1. Posts of statements referring to the environment appear in the newsfeed of my social media account.
2. Posts to videos on environmentally damaging events due to non-renewable energy resources
appear in the newsfeed of my social media account.
3. Posts to links to renewable energy technologies websites appear in the newsfeed of my social
media account.

Awareness of Consequences
1. Adoption of biogas technology can lower the exhaustion of natural resources.
2. Adoption of biogas technology can reduce harm to the environment.
3. Adoption of biogas technology can mitigate global warming.

Environmental concern

1. I pay close attention to environmental protection and energy conservation.
2. I have a sense of mission to save energy and protect the environment.
3. I think the use of non-renewable energy resources can affect the environment pollution.

Ascription of Responsibility

1. I feel jointly responsible for the exhaustion of fossil fuels.
2. I feel joint responsibility for the contribution of non-renewable energy resources usage to global warming.
3. I feel joint responsibility for the contribution of non-renewable energy resources usage to local ecological damage.
4. I feel joint responsibility for the negative consequences of non-renewable energy resources usage.

Perceived Consumer Effectiveness

1. Each person’s behavior can have a positive effect on society by adopting biogas technology.
2. I feel I can help solve natural resource problem by adopting biogas technology.
3. I can protect the environment by adopting biogas technology.
4. There is not much that I can do about the environment (Reverse).

Personal Norm

1. I feel a moral obligation to conserve non-renewable energy resources and protect the environment no matter what other people do.
2. I feel that it is important to use non-renewable energy resources as little as possible.
3. I feel a moral obligation to use renewable energy resources instead of non-renewable energy resources.
4. People like me should do everything they can do to decrease the use of non-renewable energy resources.”

References

1. Zhou, K.; Yang, S.; Shen, C.; Ding, S.; Sun, C. Energy conservation and emission reduction of China’s electric power industry. *Renew. Sustain. Energy Rev.* 2015, 45, 10–19. [CrossRef]
2. Amir, S.M.; Liu, Y.; Shah, A.A.; Khayyam, U.; Mahmood, Z. Empirical study on influencing factors of biogas technology adoption in Khyber Pakhtunkhwa, Pakistan. *Energy Environ.* 2019, 31, 1–22. [CrossRef]
3. Yasmin, N.; Grundmann, P. Pre- and Post-Adoption Beliefs about the Diffusion and Continuation of Biogas-Based Cooking Fuel Technology in Pakistan. *Energies* 2019, 12, 3184. [CrossRef]
4. Hall, C.A.S. Introduction to special issue on new studies in EROI (Energy Return on Investment). *Sustainability* 2011, 3, 1773–1777. [CrossRef]
5. Bianco, V.; Manca, O.; Nardini, S. Electricity consumption forecasting in Italy using linear regression models. *Energy* 2009, 34, 1413–1421. [CrossRef]
6. Amigun, B.; Sigamoney, R.; von Blottnitz, H. Commercialisation of biofuel industry in Africa: A review. *Renew. Sustain. Energy Rev.* 2008, 12, 690–711. [CrossRef]
7. Arshad, M.; Bano, I.; Khan, N.; Imran, M.; Younus, M. Electricity generation from biogas of poultry waste: An assessment of potential and feasibility in Pakistan. *Renew. Sustain. Energy Rev.* 2018, 81, 1–6. [CrossRef]
8. Coyle, E.D.; Simmons, R.A. *Understanding the Global Energy Crisis*; Purdue University Press: West Lafayette, IN, USA, 2014.
9. Garfi, M.; Castro, L.; Montero, N.; Escalante, H.; Ferrer, I. Evaluating environmental benefits of low-cost biogas digesters in small-scale farms in Colombia: A life cycle assessment. *Bioresour. Technol.* 2019, 274, 541–548. [CrossRef]

10. Iwaro, J.; Mwasha, A. Towards energy sustainability in the world: The implications of energy subsidy for developing countries. *Int. J. Energy Environ.* 2010, 1, 705–714.

11. Uddin, W.; Khan, B.; Shaukat, N.; Majid, M.; Mujtaba, G.; Mehmoood, A.; Ali, S.M.; Younas, U.; Anwar, M.; Almeshal, A.M.; et al. Biogas potential for electric power generation in Pakistan: A survey. *Renew. Sustain. Energy Rev.* 2016, 54, 25–33. [CrossRef]

12. Han, J.; Mol, A.P.J.; Lu, Y.; Zhang, L. Small-scale bioenergy projects in rural China: Lessons to be learnt. *Energy Policy* 2008, 36, 2154–2162. [CrossRef]

13. Irfan, M.; Zhao, Z.Y.; Panjwani, M.K.; Mangi, F.H.; Li, H.; Jan, A.; Ahmad, M.; Rehman, A. Assessing the energy dynamics of Pakistan: Prospects of biomass energy. *Energy Rep.* 2020, 6, 80–93. [CrossRef]

14. Ikessides, N. Chaos in power: Pakistan’s electricity crisis. *Energy Policy* 2013, 55, 271–285. [CrossRef]

15. Yasar, A.; Nazir, S.; Tabinda, A.B.; Nazar, M.; Rasheed, R.; Afzaal, M. Socio-economic, health and agriculture benefits of rural household biogas plants in energy scarce developing countries: A case study from Pakistan. *Renew. Energy* 2017, 108, 19–25. [CrossRef]

16. Yasmin, N.; Grundmann, P. Adoption and diffusion of renewable energy—The case of biogas as alternative fuel for cooking in Pakistan. *Renew. Sustain. Energy Rev.* 2019, 101, 255–264. [CrossRef]

17. Martinez-Hernandez, E.; Amezcua-Allieri, M.A.; Sadhukhan, J.; Anell, J.A. Sugarcane Bagasse Valorization Strategies for Bioethanol and Energy Production. *Sugarcane* 2018. [CrossRef]

18. Amjid, S.S.; Bilal, M.Q.; Nazir, M.S.; Hussain, A. Biogas, renewable energy resource for Pakistan. *Renew. Sustain. Energy Rev.* 2011, 15, 1–5. [CrossRef]

19. Gupta, M.K. *Handbook of Organic Farming and Bio-Fertilizers*; ABD Publishers: Jaipur, India, 2007.

20. Abbas, T.; Ali, G.; Adil, S.A.; Bashir, M.K.; Kamran, M.A. Economic analysis of biogas adoption technology by rural farmers: The case of Faisalabad district in Pakistan. *Renew. Energy* 2017, 107, 431–439. [CrossRef]

21. Yadav, R. Altruistic or egoistic: Which value promotes organic food consumption among young consumers? A study in the context of a developing nation. *J. Retail. Consum. Serv.* 2016, 33, 1–6. [CrossRef]

22. Schwartz, S.H. Universals in the content and structure of values: Theoretical advances and empirical tests in 20 countries. *Adv. Exp. Soc. Psychol.* 1992, 25, 1–65.

23. Kareklas, I.; Carlson, J.R.; Muehlng, D.D. ‘I eat organic for my benefit and yours’: Egoistic and altruistic considerations for purchasing organic food and their implications for advertising strategists. *J. Advert.* 2014, 43, 18–32. [CrossRef]

24. Ansari, S.H.; Khan, M.S.; Haider, M.S.; Ahmad, A.; Ahmad, M.A. A study on economic feasibility of biogas plant for a small town | request pdf. *Sci. Int.* 2011, 23, 325–326.

25. Schwartz, S.H. Normative influences on altruism. In *Advances in Experimental Social Psychology*; Elsevier: Amsterdam, The Netherlands, 1977, Volume 10.

26. Han, H. Travelers’ pro-environmental behavior in a green lodging context: Converging value-belief-norm theory and the theory of planned behavior. *Tour. Manag.* 2015, 47, 164–177. [CrossRef]

27. Schwartz, S.H. Consumers’ purchasing decisions regarding environmentally friendly products: An empirical analysis of German consumers. *J. Retail. Consum. Serv.* 2016, 31, 389–397. [CrossRef]

28. Khare, A. Antecedents to green buying behaviour: A study on consumers in an emerging economy. *Mark. Intell. Plan.* 2015, 33, 309–329. [CrossRef]

29. Hynes, N.; Wilson, J. I do it, but don’t tell anyone! Personal values, personal and social norms: Can social media play a role in changing pro-environmental behaviours? *Technol. Forecast. Soc. Chang.* 2016, 111, 349–359. [CrossRef]

30. Jaini, A.; Quoquab, F.; Mohammad, J.; Hussin, N. ‘I buy green products, do you . . .?’: The moderating effect of eWOM on green purchase behavior in Malaysian cosmetics industry. *Int. J. Pharm. Healthc. Mark.* 2019. [CrossRef]

31. Wamuyu, P.K. Leveraging Web 2.0 technologies to foster collective civic environmental initiatives among low-income urban communities. *Comput. Human Behav.* 2018, 85, 1–14. [CrossRef]
58. Chen, M.F.; Tung, P.J. Developing an extended Theory of Planned Behavior model to predict consumers’ intention to visit green hotels. *Int. J. Hosp. Manag.* **2014**, *36*, 221–230. [CrossRef]
59. Wesley, S.C.; Lee, M.Y.; Kim, E.Y. The Role of Perceived Consumer Effectiveness and Motivational Attitude on Socially Responsible Purchasing Behavior in South Korea. *J. Glob. Mark.* **2012**, *25*, 29–44. [CrossRef]
60. Tobler, C.; Visschers, V.H.M.; Siegrist, M. Eating green. Consumers’ willingness to adopt ecological food consumption behaviors. *Appetite* **2011**, *57*, 674–682. [CrossRef]
61. Kinnear, T.C.; Taylor, J.R.; Ahmed, S.A.; Lynch, P.; Chandler, R.; En, N. Ecologically Concerned Consumers: Who Are They? *J. Mark.* **1974**, *38*, 1–5. [CrossRef]
62. Straughan, R.D.; Roberts, J.A. Environmental segmentation alternatives: A look at green consumer behavior in the new millennium. *J. Consum. Mark.* **1999**, *16*, 558–575. [CrossRef]
63. Kang, J.; Liu, C.; Kim, S.H. Environmentally sustainable textile and apparel consumption: The role of consumer knowledge, perceived consumer effectiveness and perceived personal relevance. *Int. J. Consum. Stud.* **2013**, *37*, 442–452. [CrossRef]
64. Yu, T.Y.; Yu, T.K.; Chao, C.M. Understanding Taiwanese undergraduate students’ pro-environmental behavioral intention towards green products in the fight against climate change. *J. Clean. Prod.* **2017**, *161*, 390–402. [CrossRef]
65. Wang, T. Social identity dimensions and consumer behavior in social media. *Asia Pacific Manag. Rev.* **2017**, *22*, 45–51. [CrossRef]
66. Grevet, C.; Mankoff, J. Motivating Sustainable Behavior through Social Comparison on Online Social Visualization. Available online: https://pdfs.semanticscholar.org/693d/4134daad1f174a30d5205d335d395da00622.pdf (accessed on 18 March 2020).
67. van Leeuwen, E.; Täuber, S. Demonstrating knowledge: The effects of group status on outgroup helping. *J. Exp. Soc. Psychol.* **2011**, *47*, 147–156. [CrossRef]
68. Xu, J.; Han, R. The influence of place attachment on pro-environmental behaviors: The moderating effect of social media. *Int. J. Environ. Res. Public Health* **2019**, *16*, 24. [CrossRef] [PubMed]
69. Muralidharan, S.; Rej-Guardia, F.; Xue, F. Understanding the green buying behavior of younger Millennials from India and the United States: A structural equation modeling approach. *J. Int. Consum. Mark.* **2016**, *28*, 54–72. [CrossRef]
70. Senbel, M.; Ngo, V.D.; Blair, E. Social mobilization of climate change: University students conserving energy through multiple pathways for peer engagement. *J. Environ. Psychol.* **2014**, *38*, 84–93. [CrossRef]
71. Grainger, M.J.; Stewart, G.B. The jury is still out on social media as a tool for reducing food waste a response to Grainger and Stewart (2017). *Resour. Conserv. Recycl.* **2017**, *122*, 407–410. [CrossRef]
72. Young, C.W.; Russell, S.V.; Barkemeyer, R. Social media is not the ‘silver bullet’ to reducing household food waste, a response to Grainger and Stewart (2017). *Resour. Conserv. Recycl.* **2017**, *122*, 405–406. [CrossRef]
73. Calder, B.J.; Phillips, L.W.; Tybout, A.M. Designing Research for Application. *J. Consum. Res.* **1981**, *8*, 197–207. [CrossRef]
74. Gautam, R.; Baral, S.; Herat, S. Biogas as a sustainable energy source in Nepal: Present status and future challenges. *Renew. Sustain. Energy Rev.* **2009**, *13*, 248–252. [CrossRef]
75. Hair, J.F.; Hult, G.T.M.; Ringle, C.M.; Sarstedt, M. *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*; Sage: Thousand Oaks, CA, USA, 2016; p. 45.
76. Zhang, Y.; Wang, Z.; Zhou, G. Antecedents of employee electricity saving behavior in organizations: An empirical study based on norm activation model. *Energy Policy* **2013**, *62*, 1120–1127. [CrossRef]
77. Smith, J.R.; McSweeney, A. Charitable Giving: The Effectiveness of a Revised Theory of Planned Behaviour Model in Predicting Donating Intentions and Behaviour. *J. Community Appl. Soc. Psychol.* **2007**, *17*, 363–386. [CrossRef]
78. Wang, Z.; Wang, X.; Guo, D. Policy implications of the purchasing intentions towards energy-efficient appliances among China’s urban residents: Do subsidies work? *Energy Policy* **2017**, *102*, 430–439. [CrossRef]
79. Oakley, R.L.; Salam, A.F. Examining the impact of computer-mediated social networks on individual consumerism environmental behaviors. *Comput. Human Behav.* **2014**, *35*, 516–526. [CrossRef]
80. Sujata, M.; Khor, K.S.; Ramayah, T.; Teoh, A.P. The role of social media on recycling behaviour. *Sustain. Prod. Consum.* **2019**, *20*, 1–10. [CrossRef]
81. Brislin, R.W. Back-Translation for Cross-Cultural Research. *J. Cross. Cult. Psychol.* **1970**, *1*, 185–216. [CrossRef]
82. Richter, N.; Cepeda-Carrion, G.; Roldán, J.; Ringle, C. European management research using Partial Least Squares Structural Equation Modeling (PLS-SEM). *Eur. Manag. J.* **2016**, *34*, 589–597. [CrossRef]
83. Henseler, J.; Ringle, C.M.; Sarstedt, M. A new criterion for assessing discriminant validity in variance-based structural equation modeling. *J. Acad. Mark. Sci.* 2014, 43, 115–135. [CrossRef]

84. Chin, W.W.; Newsted, P.R. Structural equation modeling analysis with small samples using partial least squares. *Stat. Strateg. Small Sample Res.* 1999, 1, 307–341.

85. Ramayah, T.; Ahmad, N.H.; Halim, H.A.; Zainal, S.R.M.; Lo, M.C. Discriminant analysis: An illustrated example. *African J. Bus. Manag.* 2010, 4, 1654–1667.

86. Osborne, J.W. Improving your data transformations: Applying the Box-Cox transformation. *Pract. Assess. Res. Eval.* 2010, 15, 1–9.

87. Henseler, J.; Ringle, C.M.; Sinkovics, R.R. The use of partial least squares path modeling in international management. *Adv. Int. Mark.* 2009, 20, 277–319.

88. Hair, J.F.; Ringle, C.M.; Sarstedt, M. PLS-SEM: Indeed a silver bullet. *J. Mark. Theory Pract.* 2011, 19, 139–151. [CrossRef]

89. Hair, J.F.; Sarstedt, M.; Hopkins, L.; Kuppelwieser, V.G. Partial least squares structural equation modeling (PLS-SEM) An emerging tool in business research. *Pract. Assess. Res. Eval.* 2014, 2, 1–45.

90. Anderson, J.C.; Gerbing, D.W. Structural Equation Modeling in Practice: A Review and Recommended Two-Step Approach. *Psychol. Bull.* 1988, 103, 411–423. [CrossRef]

91. Kline, R.B. *Principles and Practice of Structural Equation Modeling*; Guilford Publications: New York, NY, USA, 2015.

92. Gold, A.H.; Malhotra, A.; Albert, H. Knowledge Management: An Organizational Capabilities Perspective. *J. Manag. Inf. Syst.* 2001, 18, 215–244. [CrossRef]

93. Akbar, A.; Ali, S.; Ahmad, M.A.; Akbar, M.; Danish, M. Understanding the Antecedents of Organic Food Consumption in Pakistan: Moderating Role of Food Neophobia. *Int. J. Environ. Res. Public Health* 2019, 16, 4043. [CrossRef]

94. Cohen, J. *Statistical Power Analysis for the Behavioral Sciences*, 2nd ed.; New York University: New York, NY, USA, 1988.

95. Ghimire, P.C. SNV supported domestic biogas programmes in Asia and Africa. *Renew. Energy* 2013, 49, 90–94. [CrossRef]

96. Boers, W.; Esthete, G. Biogas in Ethiopia: From Skepticism to Enthusiasm. Available online: https://bibalex.org/baifa/en/resources/document/283954 (accessed on 18 March 2020).

97. Park, J.; Ha, S. Understanding Consumer Recycling Behavior: Combining the Theory of Planned Behavior and the Norm Activation Model. *Fam. Consum. Sci. Res. J.* 2014, 42, 278–291. [CrossRef]

98. Shin, Y.H.; Im, J.; Jung, S.E.; Severt, K. The theory of planned behavior and the norm activation model approach to consumer behavior regarding organic menus. *Int. J. Hosp. Manag.* 2018, 69, 21–29. [CrossRef]

99. Shi, H.; Fan, J.; Zhao, D. Predicting household PM2.5-reduction behavior in Chinese urban areas: An integrative model of Theory of Planned Behavior and Norm Activation Theory. *J. Clean. Prod.* 2017, 145, 64–73. [CrossRef]

100. Vermeir, L.; Verbeke, W. Sustainable food consumption among young adults in Belgium: Theory of planned behaviour and the role of confidence and values. *Ecol. Econ.* 2008, 64, 542–553. [CrossRef]

101. Gallivan, M.J.; Spitler, V.K.; Koufaris, M. Does information technology training really matter? A social information processing analysis of coworkers’ influence on IT usage in the workplace. *J. Manag. Inf. Syst.* 2005, 22, 153–192. [CrossRef]

102. Young, S.D.; Jordan, A.H. The influence of social networking photos on social norms and sexual health behaviors. *Cyberspsychol. Behav. Soc. Netw.* 2013, 16, 243–247. [CrossRef] [PubMed]

103. Warren, A.M.; Sulaiman, A.; Jaffar, N.I. Understanding civic engagement behaviour on facebook from a social capital theory perspective. *Behav. Inf. Technol.* 2014, 34, 1–14. [CrossRef]

104. Elliot, S. Transdisciplinary perspectives on environmental sustainability: A resource base and framework for it-enabled business transformation appendix A methodological details. *MIS Q.* 2011, 35, 1–13. [CrossRef]

105. Diouf, B.; Miezian, E. The biogas initiative in developing countries, from technical potential to failure: The case study of Senegal. *Renew. Sustain. Energy Rev.* 2019, 101, 248–254. [CrossRef]