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Rural households' renewable energy usage intention in Iran: Extending the unified theory of acceptance and use of technology

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ABSTRACT

This research work tests a model about the intention of using renewable energy sources at the rural household level in Iran. The model focuses on the unified theory of acceptance and use of technology (UTAUT), which we expand to investigate the factors influencing the intention of using renewable energy sources. By drawing on the responses of 280 household heads in the rural areas of Zabol county (located in the south of Iran) and employing a multivariate technique of structural equation modeling, we identified four variables—perceived behavioural control, awareness, relative advantage, and moral norms—which had statistically significant positive relationships with the variable of intention and explained about 46% of its variances. However, there was no significant relationship between intention and social norms. In addition, the attitude variable mediated the relationship of intention with three variables—awareness, relative advantage, and moral norms. After the inclusion of the variable of attitude as mediating variable in the model, the predictive power of the model was found to increase up to 19%. The findings not only provide evidence for the five mediated paths in the cognitive processing of intention of using renewable energy but also provide support to investment decisions for developing renewable energy in the rural areas of Iran and other developing countries.

1. Introduction

The increase in demand for energy consumption along with the risk of depletion of fossil fuels has led to an increased need for the rapid development of renewable energy sources (RES) to meet the demands. Despite this, the share of such energy sources in supplying the total energy required in the world is still at a minimum level [1]. Moreover, the deployment of RES infrastructures and capacities still raises many questions and doubts about public support of and tendency towards using these resources in different countries [2]. However, the results of several studies have suggested public acceptance as a critical issue for the development of RES [3,4]. In other words, RES development is not only a question of economic and technical capacities, but also a matter of the acceptance of individuals, who play a major role in the transition from conventional energy sources to RES [5]. In this regard, Alam et al. [6] believed that RES adoption is a social process, in which people's perceptions of and intentions towards using such sources of energy have a vital role.

Iran's energy system is significantly dependent on fossil fuels. This issue has caused some problems, such as depletion of fossil fuels, social, economic, and environmental damages, and territorial imbalance. Thus, it is necessary to design and implement a sustainable energy system in the country based on renewable energy applications [7]. However, in spite of the importance and great potential of RES in Iran, especially in rural areas, their share in the current energy mix remains insignificant compared to those of fossil fuels and nuclear energy [2]. As mentioned above, the social process of RES acceptance can be primarily developed by enhancing public awareness of these types of energy and encouraging their usage via lifestyle changes. To this goal, it is incumbent to elevate the relevant stakeholders' acceptability of such energy policies after investigating their views [8]. In the developing countries like Iran, only the technical and economic studies of renewable energy have been taken into account [9,10], while the user's viewpoint, which has been mainly regarded in the developed countries [11–13], has been neglected. Notably, the results obtained from the studies conducted in the developed countries cannot be directly generalized to the developing countries as stated by Dewan and Kraemer [14] due to their significantly different social, cultural, economic, political, and legal contexts [15]. Therefore, an extensive

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empirical research is required to be performed in the developing countries on the users' perceptions of renewable energy and their viewpoints towards RES application as a determinant factor. Accordingly, the current study was carried out in order to:

(1) Comprehend the socio-psychological factors affecting the intention of using RES, with an emphasis on the rural areas of Iran; (2) Study the efficiency of the unified theory of acceptance and use of technology (UTAUT) in the field of developing the use of RES; and (3) Develop the UTAUT to enhance its predictive power and provide new insight into the intention of using RES.

Regarding the stated objectives, since the UTAUT had not been well used in the field of renewable energy in rural areas in the previous studies, this research aims at substantially contributing to the related literature by considering some effective factors on the intention to use RES and validating a comprehensive model for renewable energy applications. Also, considering the fact that the previous studies had mainly focused on investigating the direct relations between the variables present in the UTAUT and the indirect mechanisms and relationships between these variables had attracted little attention, more empirical evidence on the cognitive processing of the intention to use RES for rural household purposes is provided in this research by extending the UTAUT to fill the research gap in this area. Furthermore, reasonable explanations for the existing intention-behaviour gap in renewable energy usage are presented by providing new implications and insights into this intention (Theoretical contribution). To this purpose, through an extensive review of the existing theoretical and empirical literature, the principal concepts of this study are defined using precise operational measures and indicators, as well as an appropriate research design based on advanced statistical techniques like structural equation modeling (SEM). Then, the validities and reliabilities of the scales and indicators are examined and modified so as to make them usable in the future research (Empirical contribution). As aforementioned, limited empirical studies have been conducted to investigate the existence of this intention-behaviour gap and the socio-psychological factors affecting the intention of using RES in rural areas in Iran. Therefore, by relying on the first-hand data collected from the villagers as the main stakeholders of RES, the results of this research help to understand and analyze the factors driving the intention to use RES and provide essential and realistic information and practical relevant solutions to coherent planning and policy-making for RES applications in rural areas. Hence, this study tries to fill the gap between the related science and policy-making in the rural areas of the developing countries, such as Iran (Practical contribution).

2. Background

2.1. An overview of RES in Iran

Iran is a rich country in terms of RES such as wind power, solar power, geothermal energy, biomass, etc. [16]. The geographic and climatic conditions in Iran are very suitable for the generation and usage of renewable energy—with a vast land area of 1,648,195 square kilometres, the deserts in the east, the Caspian Sea in the north, and the Persian Gulf in the south, it has a great variety of natural environments. The country enjoys an outstanding direct normal irradiation (DNI) of up to 5.5 kWh/sqm/day and an average of 300 sunny days per year. Particularly, the central and southern regions of Iran, such as the provinces of Yazd, Kerman, and Sistan and Baluchestan, have high solar irradiation with a DNI of approximately 5.2–5.4 kWh/sqm/day. Likewise, there is great potential for harnessing wind energy. According to a presentation of the Renewable Energy Organization of Iran, the potential installed capacity of wind power is estimated to be 30,000 MW [17]. Despite notable potentials and capacities in the field of renewable energy, the development of RES is in its early stage in Iran, and the contribution of RES in Iran's energy basket is insignificant [18].

As mentioned above, several regions and provinces in Iran have suitable conditions for accessing and using RES. Among these, the Sistan and Baluchestan province—especially the county of Zabol—has specific geographic and climatic conditions and is a suitable area of the country to take advantage of RES. Zabol county, with over 335 days of the sunshine per year and average of 9.8 h of the sunshine per day, has a great potential for using solar energy. Furthermore, the 120-day winds of Sistan are the most prominent local winds in Iran. In this regard, based on studies conducted in synoptic stations, Zabol station has the best conditions for the construction of wind farms [19]. In recent years, some attempts have been made to develop the use of RES—particularly solar energy—in the region. However, this process has been very slow; the use of RES and related technologies has not been accompanied by acceptance on the part of the people in different areas, especially in rural areas. Therefore, villagers have a very low intention of using RES. Issues such as the dispersion of villages, lack of access to suitable roads, high energy consumption, low income of villagers, etc. [7] can expose rural areas in Zabol and other provinces of Iran to a serious energy supply crisis in the near future.

2.2. Theoretical background and hypotheses development

In recent years, many theories and models have been proposed by different researchers and experts to investigate the behavioural intention of people and identify the socio-psychological factors affecting it. One of the most important of such theories is the UTAUT, which is increasingly being applied in diverse research fields [20–22]. This model, proposed by Venkatesh et al. [23], has been developed in recent years. The UTAUT, which is considered to be one of the most powerful predictive models of behaviour [24], has been developed by the integration of elements of eight prominent models, including theory of rational action (TRA), the technology acceptance model (TAM/TAM2), the motivational model (MM), the theory of planned behaviour (TPB), a model agreement between the TAM and the TPB (Combined TAM-TPB), the model of personal computer utilization (MPCU), the innovation diffusion theory (IDT), and the social cognitive theory (SCT) [25]. Strong theoretical foundation, comprehensiveness, high explanatory power (ability to explain 70% of the variances of adoption behaviour), attention to the social and humanistic factors parallel to each other and the ability to integrate them, attention to the role of demographic factors, and the effect of reference groups on the behavioural intention of individuals are among the unique characteristics that distinguish the UTAUT from other common models [23].

The main components of the developed UTAUT include the behavioural intention as the most important determinant of actual behaviour of individuals, social norms, perceived behavioural control, awareness, relative advantage, moral norms, and attitudes. In this regard, social norm is defined as perceived social pressure on an individual to perform or not to perform a specific behaviour [26]. Normally, people act on the perceptions of what others think [27]. Their intention to accept behaviour is potentially influenced by the individuals with whom they have a close relationship [28]. This issue has also been confirmed by the results of numerous studies, i.e., the social norms have a positive and significant effect on the

intention to use RES [24,29]. Perceived behavioural control—one of the other components of the UTAUT—refers to the level of control over decisions relating to performing or not performing a particular behaviour [30]. In fact, it signifies the individuals' perception of ease or difficulty in performing the behaviour of interest [31]. Different studies have shown that perceived behavioural control is considered to be the determining variable of behavioural intention of individuals, which can considerably affect their self-efficacy in performing a particular behaviour, including the use of RES [2,32]. According to the results of different studies, awareness is another principal component of the UTAUT which has a direct effect on the behavioural intention to use RES [33,34]. This concept is the extent to which users are cognizant of the existing technology—its new benefits and drawbacks and how to use it. Evidently, the more information people have, the better will be their understanding, and the higher intention they may show for using a new technology. Alam et al. [6] emphasize that lack of awareness is the principal negative factor which affects the intention of technology usage; the information gap makes the acceptance of new technology much less likely. Likewise, relative advantage—one of the principal components of the UTAUT—is simply defined as the extent to which an innovation is perceived as better than the idea it supersedes or its nearest alternative [35]. Characteristically, people look for innovations that have relatively lower cost, easier to use, and provide more benefits for them in the future [36]. Therefore, as diverse studies demonstrate, relative advantage is one of the best predictor variables of behavioural intention to use RES and has a direct effect on it [6,37]. In addition to the mentioned components, moral norm, which is another main component of the UTAUT, is shaped on the basis of internal values [38]. It is related to the individual's belief regarding what is the right thing to do for a positive self-evaluation [39]. The results of several studies suggest that people will have a higher intention to perform a particular behaviour such as using RES to the same extent that they have stronger moral norms [33,40,41]. Finally, the last component that plays a very key role in the UTAUT is attitude. Attitude towards a particular behaviour indicates a positive or negative subjective evaluation by an individual of the results of a behaviour [28], which determines how an individual will react in the face of that behaviour [24]. Generally, attitude is seen as a key predictor of pro-environmental behaviour such as adoption of renewable energy [34,42,43]. However, it is worth mentioning that TAM identifies attitude towards using (ATU) as a mediator between behavioural intention, and perceived ease of use and perceived usefulness. Similarly, the TRA labels attitude towards behaviour as one of the first-stage mediators between beliefs and evaluations and behavioural intention [36]. In light of the above and the results of studies such as those by Alam and Rashid [44], and O'Driscoll et al. [45] in this study, in order to achieve a closer insight, we attempted to investigate the mediator role of attitude in the relationship of the principal components of the UTAUT—social norms, perceived behavioural control, awareness, relative advantage, and moral norms—with the behavioural intention to use RES in the form of a more perfect model.

Based on the above discussion, the theoretical research framework and the hypothesized relationships are given in Fig. 1. As the Figure suggests, according to the UTAUT, the villagers' intention to use RES is influenced by social norms of using RES, perceived behavioural control of using RES, awareness on RES, relative advantage of RES, and moral norms of using RES (Hypotheses 1 to 5). In addition, the variable of attitude towards the use of RES is considered as a mediator variable in the relationships of the five mentioned variables with the variable of intention. Therefore, mediation hypotheses of the research are developed (Hypotheses 6 to 10).

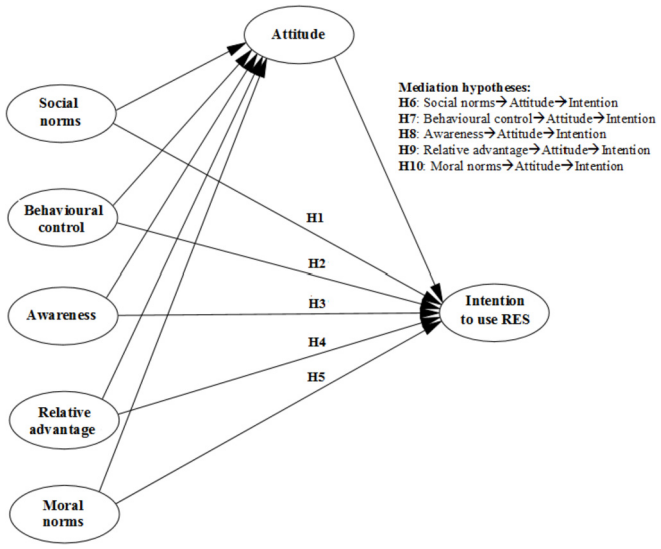

Fig. 1. Research theoretical framework.

3. Materials and methods

The target population of the research comprised all heads of households in the rural areas of Zabol county. According to the statistics of Zabol Agri-Jihad Organization [46], the total number of rural heads of households included in the survey area was 63,736. According to the table by Bartlett et al. [47], a sample of 300 respondents was selected through multistage sampling. The county of Zabol is made up of four districts, which are subdivided into 13 rural districts. In the first step, two districts—Markazi and Mian Kangi—were randomly selected. In the next step, 24 villages from the two districts were selected by using the random cluster sampling method. Relevant information was collected from the randomly sampled heads of households of the selected villages on the basis of proportional allocation, with the help of a structured questionnaire. After excluding questionnaires with missing information, a total of 280 questionnaires met all the required criteria of the survey. Data were collected through a structured questionnaire which is composed of eight parts relating to the respondents' profiles, and questions related to measuring the intention of using RES, attitude towards using RES, social norms of using RES, perceived behavioural control of using RES, awareness on RES, relative advantage of using RES, and moral norms of using RES. A list of measured items and the sources of each part is separately presented in Table 3. Respondents were asked to specify their opinion on each item, using a five-point Likert-type scale from 1 to 5 as follows: 1 = strongly disagree; 2 = disagree; 3 = neither agree nor disagree; 4 = agree; and 5 = strongly agree. However, it should be noted that in addition to the mentioned parts, in order to examine the use of RES in the surveyed area, we measured the extent of use of RES by villagers in another part of the questionnaire, so that regarding the natural conditions of Zabol county and the region's significant potential in terms of having energies – viz., solar, wind and biomass energies, we examined their usage of these three energy sources in order to measure the villagers' use of RES. Accordingly, 11, 6, and 4 statements were employed to measure the use of solar energy, wind energy, and biomass energy respectively. The scale for measuring these parts was a six-point continuum from zero to five as "not at all = 0, very low = 1, low = 2, medium = 3, high = 4 and very high = 5". Face validity and construct validity (including convergent validity and discriminant validity) were used to examine the validity of the questionnaire.

The face validity of the questionnaire was examined and confirmed by the comments from faculty members and experts. Regarding construct validity; convergent validity was examined via three different criteria—standardized factor loadings equal to or greater than 0.5, average variance extracted (AVE) equal to or larger than 0.5, and composite reliability (CR) equal to or greater than 0.7. In addition, in order to test the discriminant validity based on the approach suggested by Hair et al. [48], the AVE for each latent variable should be larger than the average shared squared variance (ASV) and the maximum shared squared variance (MSV) among all latent variables in a measurement model. In addition to the validity of the instrument, CR was used to assess the reliability of the research instrument, whose value for each latent variable must be greater than 0.7 [48].

Regarding the fit of the model, various indices were employed in this research. In this case, the chi-square test statistic was the most fundamental measure of the overall fit, which was assumed to be of multivariate normality [49]. Since the chi-square test is sensitive to sample size, the model would be assumed to demonstrate a reasonable fit if the statistic adjusted by its degrees of freedom (i.e., the relative/normed chi-square) did not exceed 3.0 [50]. The comparative fit index (CFI) and incremental fit index (IFI) as incremental fit indices were capable of comparing the fit of the hypothesized model to the null or independence model, in which all the variables were uncorrelated with each other. However, the calculations of these fit indices and their underlying assumptions might be somewhat different. Values of greater than 0.90 indicated an acceptable fit [51]. The goodness-of-fit index (GFI) was a measure of fit between the hypothesized model and the observed covariance matrix. The adjusted GFI (AGFI) corrected the GFI, which was affected by the number of the indicators of each latent variable. The GFI and AGFI range between 0.0 and 1.0 with a value of over 0.9, which generally indicates the acceptable fit of a model [52]. The root mean square residual (RMR) was an index of the average of residuals between the observed and the hypothesized covariance matrices. The RMR ranges from 0.0 to 1.0 with a value of 0.08 or less, which indicates a model's acceptable fit. Finally, the root mean square error of approximation (RMSEA) was an index of the difference between the observed covariance matrix per degree of freedom and the hypothesized covariance matrix, which denoted the model. Values up to 0.08 demonstrated a reasonable fit to the data [53].

A two-step procedure in the SEM was used to test the research hypotheses. In the first step, the research measurement models (first-order confirmatory factor analysis) with the maximum likelihood method estimation was conducted to evaluate the fit of the research model and examine the validity and reliability of the constructs. In the second step, the hypothesized structural relationship among latent variables was estimated on the basis of the structural model [54]. To this end, two structural models were estimated—direct model for testing the first to fifth hypotheses and mediation model for testing the sixth to tenth hypotheses. In this regard, the bootstrapping method was employed for the mediation/indirect hypotheses [55]. Bootstrapping is a supplementary method advocated for testing mediation that provides an estimate of the magnitude of the indirect effect, testing its statistical significance, and determining confidence intervals for the point estimate [56]. As such, bootstrapping serves as a resampling procedure by which the original sample is considered to represent the population. Multiple subsamples of the same size as the parent sample are then drawn randomly, with replacement from this population and providing the data for empirical investigation of the variability of parameter estimates and indices of fit [57]. Additionally, the causal steps approach which tests for significance of different paths, was employed to detect the presence of mediation relationships. Baron and Kenny [58] argue that a critical starting point for mediation analysis is a significant relationship between independent and dependent variables. From this perspective, a significant coefficient of the variables can be seen as an initial and necessary condition for testing mediation. Therefore, in the first step, the total effect model or the direct effect model of the independent variable on the dependent variable is estimated. If this effect is significant, in the second step, the mediation effect model which includes the mediator variable, is estimated to test the significance of the indirect effect. If the indirect effect is significant, then the mediation hypothesis is supported [59]. This practice is common in the reporting of mediation analyses [60]. The software of $AMOS_{20}$ Graphics [61] was used to analyze the data and perform the SEM and bootstrapping method.

4. Results

4.1. Descriptive results

4.1.1. Socio-demographic profile

The results of the socio-demographic profile of the villagers surveyed are presented in Table 1. Mean age of the villagers was 46.62 years, with a tendency towards the 35–45 years category. Accordingly, most of the villagers were middle-aged people. Regarding education, most villagers (30.4%) were in the category of secondary education and almost one-third of the respondents (27.5%) reported no education at all (i.e., they have never been in a school environment). Therefore, education level of the villagers was low. The main occupation of most of the villagers was agriculture, with an average farming experience of 28.42 years which shows that the villagers had high farming experience and background. The average family size was 5.09 people. The average net income from the main occupation was 7.539 million Rials annually (1 US Dollar was equal to 36,300 Rials in 2016). This suggests that the villagers had low level of income. The average farm size of the villagers was 5.26 ha. In this manner, most villagers were smallholder farmers. With regard to ownership, 4.3% of the farming systems were rented, and 95.4% were owned. As shown in Table 1, most villagers

Table 1
Socio-demographic profile of the villagers surveyed (n = 280).

Variable	Frequency (%)/Mean
- Age (years)	46.62
≤25	3.2
25–35	15.4
35–45	33.2
45–55	28.6
≥55	19.6
- Education level (%)	–
No formal education (illiterate)	27.5
1–5 years of schooling (elementary education)	26.4
6–12 years of schooling (secondary education)	30.4
Above 12 years of schooling (some college)	15.6
- Main occupation (%)	–
Agriculture	89.3
Non-agriculture	10.7
- Average farming experience (years)	28.42
- Average family size (no. of individuals)	5.09
- Average annual farm income (*10^6 Rials[a])	7.539
- Average farm size (ha)	5.26
- Ownership of farming system	–
Owned	95.4
Non-owned/rented	4.3
- Previous training on renewable energy	–
Yes	8.5
No	91.5

[a] 1 US Dollar was equal to 36,300 Rials in 2016.

(91.5%) had not received any training as regards renewable energy and this issue has made the necessary information about the types of RES and related technologies not to be provided for the villagers and as a result, they had a low level of awareness in this field.

4.1.2. Villagers' use of RES

Percentage distribution of the villagers is shown in Table 2 in terms of their extent of use of RES, in addition to the mean of each of the use cases. The results revealed that the highest rate of using solar energy was related to drying local spices (Mean = 2.729), wind energy for cooling home (Mean = 2.209) and biomass wastes which were related to using crop residues as animal fodder (Mean = 1.860). In total, the villagers' use of RES varies for different usages, and it was less than the medium for most usages.

4.2. Measurement models estimation

In order to test the construct validity, CR, and fit of the model, the full measurement model was estimated through the implementation of first-order confirmatory factor analysis. Based on the results, the standardized loadings of all observed variables (with the exception of one observed variable—$ReAd_1$) were significant and greater than 0.5 (Table 3). In addition, the values of AVE and CR calculated for all latent variables were larger than 0.5 and 0.7 respectively (Table 3). Therefore, convergent validity and CR of the research instrument were obvious. The AVE values of all latent variables were larger than the MSV and ASV amounts in the measurement model, signifying satisfactory discriminant validity (Table 3). As indicated in Table 3, various fit indices ranged from very good to excellent, whereas the full measurement model displayed a good overall fit of the data.

4.3. Structural model estimation

In this section, we estimate the two structural models of the research—total/direct model to test the first to fifth hypotheses and mediation model to test the sixth to tenth hypotheses.

4.3.1. Total/direct structural model

The total/direct structural model demonstrates the direct relationship between the dependent variable of research, i.e., intention to use RES, and the independent variables of social norms, perceived behavioural control, awareness, relative advantage, and moral norms. As Fig. 2 suggests, although the estimated model based on the chi-square significant indicator lacks a goodness of fit, the model has an acceptable goodness of fit based on other criteria. According to the results, the five independent variables explain approximately 46% of the variances of intention (Fig. 2).

As Table 4 depicts, the values of the critical ratio are larger than 1.96 for four variables of perceived behavioural control, awareness, relative advantage, and moral norms, therefore, these four variables had statistically significant positive relationships with the variable of intention. Moreover, considering the amounts of standardized estimates, which are the same standardized regression coefficients, the variable of awareness ($\beta = 0.365$) had the highest effect on intention compared to others. However, there was no significant relationship between intention and social norms (Table 4).

4.3.2. Mediation structural model

Given the significance of the relationships between intention and the four variables—perceived behavioural control, awareness, relative advantage, and moral norms—in the total/direct structural model, in this section we address the mediating effect test of attitude for the relationships between intention with the four mentioned variables, using the bootstrapping method. However, as mentioned in Table 4, since the relationship between intention and social norms was insignificant, the initial conditions of mediation did not occur; as a result, the sixth hypothesis of the research was not supported (Table 5). To perform bootstrapping method, as recommended by Preacher and Hayes [55], we created and substituted a sample of 5000 with a 95% Percentile-confidence intervals through resampling with replacement drawn from the original data. The results of the analysis revealed that, although the estimated model based on the chi-square significant indicator lacks a goodness of fit, the model's goodness of fit is at an acceptable level based on the other indices (Fig. 3). Given the suitability of the fitness of the model, in the following section we test the hypotheses

Table 2
The extent of use of RES by villagers.

Rank	Type of energy	Use	Mean score[a]	Extent of use (percentage of villagers)					
				Not at all	Very low	Low	Medium	High	Very high
1	Solar energy	Drying local spices	2.729	18.4	8.4	5.2	16.4	49.6	2
2		Heating water	1.932	20.8	13.2	9.6	17.6	38.8	0
3		Drying whey	1.929	39.6	8	5.6	10.8	33.2	2.8
4		Drying edible seeds (Pumpkin, Sunflower, etc.)	1.806	25	21.8	14.5	18.5	20.2	0
5		Drying fodder (Alfalfa and Clover)	1.571	33.6	16.4	17.2	14.4	17.6	0.8
6		Drying seeds or corn	1.282	54.3	4.9	5.7	14.6	20.6	0
7		Drying medicinal plants	0.789	64	5.6	14.8	11.6	4	0
8		Drying legumes (Beans, etc.)	0.730	76.2	1.6	1.6	6.5	13.3	0.8
9		Drying cow dung (For use as fuel in winter)	0.630	73.8	2.4	12.5	4	6.9	0.4
10		Drying vegetables (Dill, etc.)	0.557	73.6	4.8	13.2	3.6	3.6	1.2
11		Bathroom with hot sand (Sand therapy)	0.548	74.7	7.2	14.9	2.4	0.8	0
1	Wind energy	Cooling home	2.209	13.3	19.4	21.8	17.7	27.8	0
2		Separating fodder seeds from chaff	1.442	46.8	8.1	10.1	10.9	23.8	0.4
3		Drying crops, especially Alfalfa and Clover	1.441	37.3	19.3	12	14.5	16.5	0.4
4		Drying animal manure	1.258	47	9.6	18.9	11.2	12.9	0.4
5		Separating beans seeds from chaff	0.754	76	1.2	1.2	6	15.6	0
6		Separating wheat and barley seeds from chaff	0.018	98.8	0.4	0.8	0	0	0
1	Biomass energy	Using crop residues as animal fodder	1.860	26.9	13.7	16.9	18.5	24.1	0
2		Using charcoal to tandoor oven for bakery	1.503	48.8	4.8	8.8	11.6	26	0
3		Using animal manure to improve soil fertility	1.492	37.2	8	20.4	24.4	10	0
4		Using biomass wastes to heat or cook	0.962	57.8	5.2	21.7	6.4	8.8	0

[a] Scoring pattern: not at all = 0, very low = 1, low = 2, medium = 3, high = 4 and very high = 5.

Table 3
Constructs, measurement items, and reliability and validity tests.

Latent and observed variables	Standardized loading	t- value
- Intention (Yazdanpanah et al. [2]; Kardooni et al. [34]), (AVE = 0.608, CR = 0.820, MSV = 0.286, ASV = 0.167)		
I will try to use RES at my home or farm in the future ($Intention_1$).	0.90	fixed
I will strongly recommend that others use RES and its related technologies ($Intention_2$).	0.79	14.543
I intend to use RES at my home or farm in order to supply a part of my required energy ($Intention_3$).	0.63	11.324
- Attitude (Park and Ohm [43]; Zyadin et al. [62]), (AVE = 0.519, CR = 0.842, MSV = 0.299, ASV = 0.160)		
In my opinion, the use of RES at home or farm is beneficial and valuable ($Attitude_1$).	0.82	fixed
Given the high cost and polluting nature of fossil fuels (e.g., petroleum, natural gas, and coal), I believe that using RES is extremely wise ($Attitude_2$).	0.75	13.511
I agree to pay additional money in order to receive clean energy through RES ($Attitude_3$).	0.69	12.286
I discover that the quality of RES-related products is not as good as that of ordinary products ($Attitude_4$).	0.75	13.538
I strongly agree with the use of RES at my home or farm ($Attitude_5$).	0.58	10.072
- Social norms (Yazdanpanah et al. [2]), (AVE = 0.902, CR = 0.965, MSV = 0.106, ASV = 0.049)		
Most people who are important to me think that I should use RES at my home/farm (SN_1).	0.96	fixed
People in my life, whose opinions I value, would approve if I use RES at home/farm (SN_2).	0.91	27.072
Most people who are important to me think that the use of RES at home/farm is desirable (SN_3).	0.95	31.361
- Perceived behavioural control (Alam and Rashid [44]; Ahmad et al. [36]), (AVE = 0.696, CR = 0.872, MSV = 0.106, ASV = 0.056)		
I have the knowledge and ability to use RES at my home/farm (PBC_1).	0.74	fixed
I have adequate financial resources to buy and use technologies related to RES at my home/farm (PBC_2).	0.92	14.671
Using technologies is totally within my control (PBC_3).	0.84	14.261
- Awareness (Alam and Rashid [44]; Park and Ohm [43]), (AVE = 0.621, CR = 0.865, MSV = 0.286, ASV = 0.122)		
I am sufficiently knowledgeable about RES ($Aware_1$).	0.86	fixed
I am familiar with technologies related to RES (i.e., solar water heater, solar dryer, biogas plant, etc.) ($Aware_2$).	0.93	20.097
I know the necessity of using RES at my home/farm ($Aware_3$).	0.71	14.099
I can easily identify the different RES and related technologies ($Aware_4$).	0.61	11.557
Relative advantage (Ahmad et al. [36]), (AVE = 0.847, CR = 0.943, MSV = 0.299, ASV = 0.079)		
Using RES reduces fossil fuels usage ($ReAd_1$).	Dropped	–
Using RES decreases environmental pollution ($ReAd_2$).	0.91	fixed
Using RES reduces the costs of energy supply ($ReAd_3$).	0.89	24.328
Generating energy from RES is easier than from fossil fuels ($ReAd_4$).	0.96	28.612
- Moral norms (Yazdanpanah et al. [2]; Fornara et al. [33]), (AVE = 0.536, CR = 0.771, MSV = 0.249, ASV = 0.086)		
I feel good about using RES at my home/farm (MN_1).	0.85	fixed
I feel good about myself if I invest in improving RES at my home/farm (MN_2).	0.54	8.573
I feel morally obligated to use RES at my home/farm (MN_3).	0.77	10.967

Goodness-of-fit statistics: Relative chi-square = 2.081; AGFI = 0.851; GFI = 0.885; CFI = 0.948; IFI = 0.948; RMSEA = 0.060; RMR = 0.070.

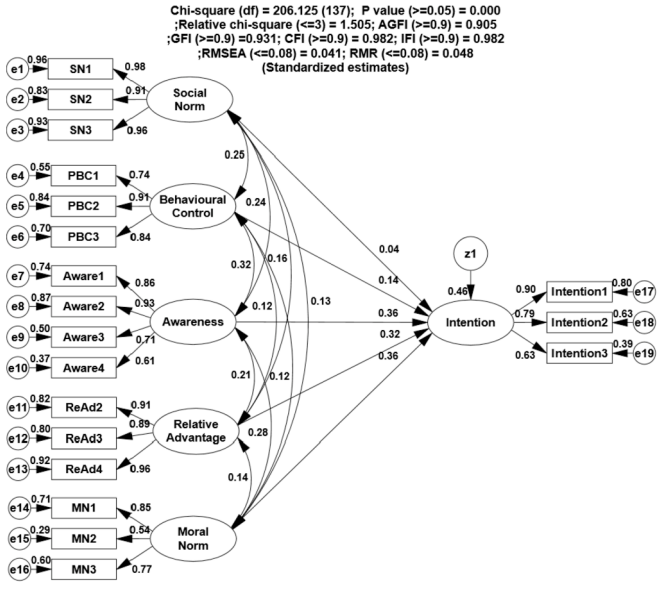

Fig. 2. Direct structural model with standardized estimates.

of the research. In the seventh to tenth hypotheses, the results of the bootstrapping method show that the sum of indirect effects of the three variables—awareness, relative advantage, and moral norms—on intention through the variable of attitude were significant; therefore, Hypotheses 7, 9, and 10 were supported, which indicates the mediating effects of attitude in the relationships of intention with awareness, relative advantage, and moral norms (see Table 5). However, the sum of indirect effect of perceived behavioural control on intention was not significant. Therefore, the eighth hypothesis of the research was not supported (Table 5). As such, regarding the amounts of standardized estimates, the variable of relative advantage (β = 0.095) had the highest indirect effect on intention.

As Fig. 3 demonstrates, after the inclusion of the variable of attitude (as mediator variable) in the model, the predictive power of the model increased; the independent variables can explain about 65% of the variances of intention, which shows a 19% increase compared to the direct structural model. Such increase in the amount of explained variances in mediation model which is considered a significant amount [59] suggests that generally, the attitude variable has an adequate mediator role in the model and among the five paths of tested mediation in this study, could well mediate the relationships between the three variables of awareness, relative advantage and moral norm with the intention. In other words, based on the significant variation in the variances of direct and mediated structural models, it can be concluded that considering indirect relationships between variables by inclusion of the attitude in the UTAUT has improved the efficiency of this model and significantly increased its exploratory power in the field of predicting the intention to use RES.

Based on the results of direct and mediation structural models, we have calculated the total effect (sum of direct and indirect effects) of each independent variable on the dependent variable, i.e., intention. As Table 6 shows, two variables—awareness (β = 0.312) and relative advantage (β = 0.095)—had the highest direct and indirect effects on intention respectively. Also, as regards the total

Table 4
The results of estimating the direct structural model.

Hypothesized relationship	Unstandardized estimates	S.E.	Standardized estimates	Critical ratio	Sig.	Hypothesis test
social norms → intention (H_1)	0.028	0.043	0.036	0.664	0.507	Not supported
awareness → intention (H_2)	0.459	0.078	0.365	5.845	0.001	Supported
perceived behavioural control → intention (H_3)	0.181	0.077	0.136	2.355	0.019	Supported
relative advantage → intention (H_4)	0.224	0.051	0.319	4.392	0.001	Supported
moral norms → intention (H_5)	0.274	0.047	0.362	5.808	0.001	Supported

Table 5
The results of estimating mediation structural model.

Hypothesized relationship	Indirect standardized estimates	Indirect effect S.E.	Confidence intervals		Two-tailed sig. (PC)	Hypothesis test
			Lower bounds (PC)	Upper bounds (PC)		
social norms → attitude → intention (H_6)	0.028	0.015	0.001	0.061	0.038	Not supported
awareness → attitude → intention (H_7)	0.045	0.022	0.004	0.090	0.029	Supported
perceived behavioural control → attitude → intention (H_8)	0.002	0.015	−0.033	0.031	0.959	Not supported
relative advantage → attitude → intention (H_9)	0.095	0.047	0.013	0.198	0.024	Supported
moral norms → attitude → intention (H_{10})	0.049	0.025	0.006	0.105	0.025	Supported

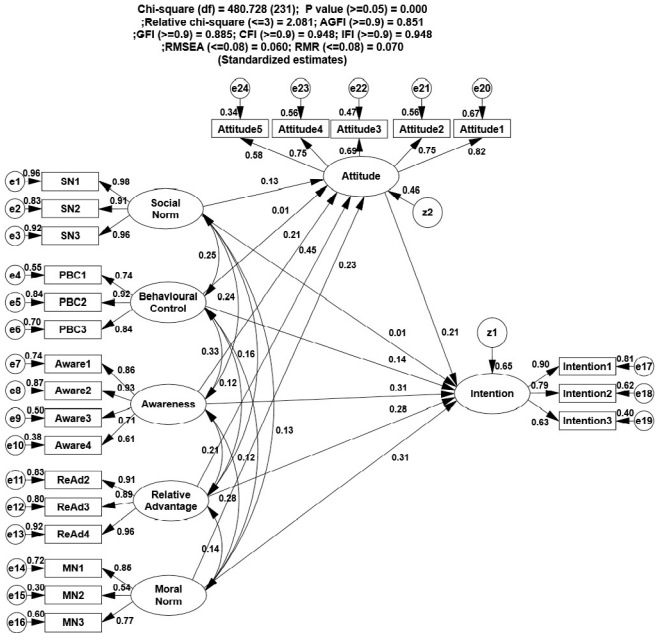

Fig. 3. Mediation structural model with standardized estimates.

Table 6
Direct, indirect, and total effects of independent variables on intention.

Relationship	Standardized effects		
	Direct	Indirect	Total
attitude → intention	0.213	–	0.213
social norms → intention	Insignificant	$0.133 \times 0.213 = 0.028$	0.028
perceived behavioural control → intention	0.137	Insignificant	0.137
awareness → intention	0.312	$0.213 \times 0.213 = 0.045$	0.357
relative advantage → intention	0.279	$0.449 \times 0.213 = 0.095$	0.374
moral norms → intention	0.311	$0.234 \times 0.213 = 0.049$	0.360

effect, the relative advantage variable ($\beta = 0.374$) had the highest effect on intention.

5. Discussion

Given the importance of RES as a sustainable source of clean energy and a safe alternative to fossil fuels on the one hand, and the importance of intention of using RES as the most essential determinant of behaviour on the other hand, this research aims at studying the factors affecting the intention to use RES in rural areas of Iran. The results of the research reveal that Hypothesis 1 is not supported—there is no significant relationship between social norms and the intention to use RES. This result is not consistent with the results of Saleh et al. [24], and Feng [29], but it is in agreement with the result of Fornara et al. [33]. Most of the villagers in Zabol county have no experience in the use of RES as an innovation; therefore, using these energy sources is not considered as a common social norm among rural people. As a result, individuals do not feel social pressure from family, friends, and other villagers to use RES.

As the results indicate, Hypothesis 2 is supported—perceived behavioural control variable has a positive and significant effect on the intention to use RES. This finding is consistent with the results of Yazdanpanah et al. [2], and Hassan et al. [32]. As stated, perceived behavioural control refers to individual's perception of the degree of his control over the behaviour and it is a reflection of the facilitators and barriers of performing a particular behaviour. In this case, if the individual has sufficient financial resources to purchase and use technologies related to RES and has the necessary awareness and skill to use them, then using such energy sources and related technologies such as solar water heaters, solar dryers, biogas plant, etc. demonstrate higher self-confidence and self-efficacy. This in turn indicates more intention to use RES. However, considering that most of the villagers in Zabol county are smallholder farmers with relatively low levels of income and financial strength, it is necessary for the government to provide the necessary support— especially through financial credits—to help villagers purchase RES technologies. Furthermore, by holding educational extension courses, the villagers should be provided with more in-depth knowledge about how to use RES and related technologies.

The results show that Hypothesis 3 is supported—the awareness variable has a significant and positive effect on the intention to use RES. This finding is consistent with the results of Fornara et al. [33], and Kardooni et al. [34]. Indubitably, in any attempt to change behaviour, awareness is considered to be the first necessary and key element to its success. As long as the villagers are ignorant about the disadvantages of excessive use of fossil fuels and the need to use RES and are not familiar with related technologies, owing to lack of sufficient motivation and tendency, they cannot be expected to move towards the use of RES. In fact, as Mirza et al. [63] emphasize, a higher level of awareness enables the users to make an informed decision and also increases the level of technology acceptance. The awareness variable has the most direct effect on the intention to use RES; therefore, it is necessary for villagers to be purposefully provided with readily available and right information. Through large-scale training and community awareness programmes, particularly with the help of mass media such as radio and television, the importance of using RES should be emphasized among rural people. The importance of this issue is multiplied, considering the fact that rural people in developing countries do not have a professional and clear knowledge or awareness regarding RES [7].

Based on the results, Hypothesis 4 is supported—the variable of relative advantage has a significant and positive effect on the intention to use RES. This finding is in agreement with the results of Ahmad et al. [36], and Alam et al. [37]. Simply put, faced with a specific innovation/technology, users consciously or unconsciously evaluate the benefits and costs of using the technology in comparison to other technologies, and considering diverse aspects, make their decision to use or not to use that technology. In this regard, Alam et al. [37] state that the greater the perceived relative advantage of small-scale renewable energy, the more rapid is its rate of adoption. Therefore, as a result of the numerous relative advantages and the justified use of RES in rural areas of Iran, such as reduction of costs of energy supply, reduction of environmental pollution, reduction of pressure on energy production through fossil fuels (e.g., petroleum, natural gas, and coal), and more convenient production and supply of energy [7], it appears that if the requirements are provided, the villagers' intention to use RES will increase. Nevertheless, in rural areas of the country, including Zabol county, fossil fuels—considered to be the most important sources of energy—have relatively low prices owing to government support and subsidies. For instance, the price of natural gas in Iran is lower than international standards and Iran is one of the tenth cheapest countries in the world in terms of natural gas price [64]. In spite of the fact that investment in different types of RES in Iran is justifiable [65,66], due to the abundance of fossil fuels and their low price, presently the use of RES at the local level has no economic justifiability for rural people [7] and, consequently, their motivation and intention is extremely low to use RES. Therefore, as Moshiri and Lechtenböhmer [64] stress, energy policy reform is necessary and inevitable in Iran, especially in terms of pricing fossil fuels such as natural gas.

The results indicate that the variable of moral norms has a positive and significant effect on the intention to use RES (supporting Hypothesis 5). This finding is consistent with the results of Fornara et al. [33], and Kaiser and Scheuthle [41]. In this context, Schwartz [67] believes that moral norms play an important role within the framework of the theory of norms activation or the value-beliefs-norms theory. As the results of various studies demonstrate, environmental concerns, individuals awareness of the results of excessive use of fossil fuels, its driven risks (particularly air pollution, climate change, loss of biological diversity, etc.), interest in the environment, feeling of personal responsibility for environmental protection, and generally having a feeling of moral obligation are the most important factors resulting in an increase in the villagers' intention to use RES as clean energy sources [40]. In this way, the extent to which the villagers are committed to using RES in order to protect the environment and natural resources in terms of personal beliefs and religious and moral values affect the level of intention to use these energy sources. However, the villagers have always had a close and friendly relationship with the environment and strong religious beliefs concerning the value of the environment; this can be well used to improve people's behavioural intention and to highlight the use of RES as a strong moral norm among the villagers.

As the results of various studies show, the attitude variable is one of the most important variables influencing the behavioural intention of using RES [34,42,43]. In this regard, even Ajzen and Gilbert Cote [68] believe that attitude is the best predictor of people's intention to use technology. Likewise, Yazdanpanah et al. [2] emphasize that in order to enhance the intention of various stakeholders, it is essential to carefully study and comprehend their attitude towards RES. Otherwise, all programmes and activities connected with the development of RES would be incomplete and ineffective. In fact, if the villagers have a favourable attitude towards RES, they will be mentally better prepared in the face of such energy sources and could respond to them more properly. Given the importance of the attitude variable, the results of this study show that although the hypothesis of mediating effect of attitude in the relationship of the social norms and perceived behavioural control variables with intention is not supported (Hypotheses 6 and 8), Hypotheses 7, 9, and 10 are supported—attitude has a mediating effect on the relationship of intention with three variables, viz. awareness, relative advantage, and moral norms. In general, after the inclusion of the variable of attitude as a mediating variable in the model, the predictive power of the model significantly increases. Based on the results, in addition to directly affecting the intention to use RES, the awareness variable has an indirect effect on the dependent variable through the attitude. In other words, an increase in awareness among rural people increases their knowledge of the advantages and benefits of using RES and related technology, leading to the creation of favourable attitudes in villagers and ultimately an increase in their intention in using such energy sources. In the same way, the more relative benefits there are of using RES, the better will be the villagers' mentality towards them. This will indicate a higher intention to use RES. Hence, the improvement of moral norms of villagers as regards RES, in addition to its direct effect, can also influence their intention to use RES by improving their attitudes. However, it should be mentioned that in a few studies, the mediating effect of attitude in the relationship of the intention with variables of relative advantage [44] and awareness [24,36] has been evaluated and supported, although no similar study has been reported on the mediating effect of attitude in the relationship between the intention and moral norms.

6. Conclusion

In this paper, based on an extensive review of diverse studies, psychological models, and theories, a comprehensive framework is proposed for understanding and identifying the villagers' intention to use RES in Iran. The results of this study reveal that five variables—perceived behavioural control, awareness, relative advantage, moral norms, and attitude—are the most important variables affecting the villagers' intention to use RES so that these variables explain 46% of the variances of intention. Among the variables, two variables—awareness ($\beta = 0.312$) and relative advantage ($\beta = 0.095$)—had the highest direct and indirect effects on intention respectively; generally, the relative advantage variable ($\beta = 0.374$) had the highest total effect on intention. Moreover,

attitude as the mediator variable has a more central role in predicting intention to use RES, and this variable largely (about 19%) increases the predictive power of the UTAUT. Although previous studies predominantly focused on the direct relationships between the variables in the UTAUT, this study provides evidence for five mediator paths in the cognitive processing of intention to use RES—this can contribute in filling the research gap in this area. By providing new insights into the intention to use RES, reasonable explanations for the behaviour-intention gap for RES can be proposed. Finally, since very few studies have been conducted to study the use of RES in rural areas of Iran, this study not only contributes to strengthening the existing literature in this field but also provides planners and policy-makers with relevant information for developing the use of RES in the rural areas of Iran.

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