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Technical Note

Policy Model of Renewable Energy Development in Iran's Agriculture Sector

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A B S T R A C T

The purpose of this study is to present a renewable energy policy model in the agricultural sector of Iran. To achieve this goal, a questionnaire consisting of 57 items was designed. The reliability of the questionnaire was confirmed by Cronbach's alpha (0.916). Also, to analyze the validity and reliability of the research tool, the Average Variance Extracted (AVE) and Composite Reliability (CR) were calculated. The validity of the questionnaire was determined using face validity, Content Validity Ratio (CVR), and Content Validity Index (CVI). The statistical population of the study consists of energy policymaking experts who were estimated at about 80 people. The sampling method was random and 70 samples answered the questionnaire using the Krejcie and Morgan table. Using structural equation modeling and the maximum likelihood method and using LISREL software, the model fit was estimated at a favorable level. Based on the findings, it was found that the priorities of the agricultural sector and the needs of this sector had not been considered in renewable energy policymaking. Policymaking is done top-down and stakeholders are not considered. Renewable equipment market policies are not adequate and the market is not properly managed. Interaction between policymaking institutions is not in good shape. The results of this study can help address the various shortcomings of the renewable energy policy as well as reduce the common inconsistencies in this area. Finally, suggestions were made for the development and promotion of policies in the field of renewable energy in the agricultural sector of Iran.

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1. INTRODUCTION

In today's world, non-renewable energy sources are running low. Moreover, the price of this type of resource in global markets fluctuates quite a lot. The limited resources of fossil fuels and the problems caused by the emission of greenhouse gases have made it necessary to pay much more attention to renewable energy.

Ensuring a secure and sustainable supply of energy at all times has encouraged countries to adopt the best and most appropriate policies. Energy policy is a very important issue that can restore the true identity of energy. In energy policymaking, governments seek to solve problems and the national energy policy underlies the formulation and implementation of a set of measures to oversee energy sector activities. Developing the right policy ensures the confidence of investors and encourages them to participate [1].

The path of renewable development is difficult without government support. Governments are implementing supportive policy packages for the development of renewable energy. The favorable policy package takes into account the current state of the global market and adaptation to changing barriers. As mentioned, these policies need to take into account changes in technology and its market position on a global scale. In other words, a country that uses renewable energy needs to constantly adapt its policymaking tools. Putting the right action package at the right time is the key to the successful use of renewables [2]. Therefore, policymaking must move to support investment in renewable energy on a larger and more integrated scale [3]. In the meantime, special attention should be paid to the agricultural sector, because agriculture plays a key role both in the discussion of food security and of economic development. One of the challenges facing sustainable agriculture is that most farms still rely on fossil fuels. Energy consumption in the domain of agriculture is a global concern [4] because CO_2 emissions from fossil fuels, which are used as the main source of energy, have increased rapidly [4, 5]. Agriculture plays an important role in global warming through greenhouse gases due to activities such as tillage operations, methane emissions from livestock, etc. [6]. On the other hand, the cost of agricultural production depends on the price of fuel [7]. Therefore, reducing the share of fossil fuels and increasing the share of biofuels are two of the most important future goals in this sector. Renewable resources in agriculture are a good alternative to conventional fuels which can ensure energy security and at the same time, they have the least destructive effect on the environment [5,

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8]. For this reason, investment in this type of energy is increasing worldwide [9].

Currently, the share of renewable energy in Iran's energy portfolio is very small [8, 9]. One of the reasons for the failure to use renewable energy is inefficient policies. A review of renewable energy policies in Iran reveals that there have been repeated challenges in adopting and implementing the necessary policies.

A look into global experience shows that the agricultural sector is still supported by governments; however, in most countries, the structure of support has shifted to environmentally friendly support and the support that increases the efficiency and productivity of the agricultural sector. There are many successful experiences and innovations in this field. However, it requires a reform of protectionist policies. In order to adopt the right policy, it is necessary to know all aspects of the main issue. It is also necessary to identify the needs of the agricultural community correctly and with the least deviation in this field.

Due to the unscientific nature of energy policies in Iran, there are problems such as organizational interference and overlap, managerial interference, lack of cooperation between responsible institutions and organizations, inattentiveness to differences in the needs and potentials of different regions, and lack of evaluation of renewable energy policymaking. One of the reasons for the failure in the development of renewable energy is the lack of a coherent and complete policymaking framework and model in the field of renewable energy [10], which also affects the agricultural sector. Unfortunately, in Iran, there is no regular policymaking cycle and the policymaking model is not used to better manage the renewable energy policymaking process. Systematic scientific knowledge of the disadvantages of planning and policy-making structure in the country's renewable energy sector, compliance of existing policies with the needs of renewable energy development in the agricultural sector, correction of the existing incomplete cycle, designing of a policymaking model appropriate to Iran's agricultural conditions are necessary. Providing a model that is compatible with Iran's conditions can facilitate the process of policymaking and achieving energy goals in Iran, especially in the agricultural sector. Studies show that unfortunately, enough research has not been done in this area and the field of renewable energy is suffering severe information weakness in the field of policy conditions. The novelty of this study shows its significance. Analysis of renewable energy policies is a necessity that is felt in this area because to improve or eliminate problems, it is necessary to fully identify the shortcomings and weaknesses. Despite the great significance of renewable energy in the agricultural sector, it has not yet received much attention and energy policies in this sector have not been analyzed as necessary. This study seeks to answer these questions: 1-What are the weaknesses in Iran's renewable energy policies in the agricultural sector? 2-What is the current state of renewable energy policies in Iran's agricultural sector? 3-What policies should be revised and reformed? In this regard, this study is a pioneer and tries to examine the status of renewable energy policies by using the structural equation modeling method and to identify and examine weaknesses. The purpose of this research is to design an appropriate policy model for the development of renewable energy in the agricultural sector. This research helps to identify weaknesses and shortcomings in the development of renewable energy and because of its uniqueness in this field can help managers and policymakers to identify shortcomings and in order to take steps to fix these problems. The results of this study can be used in countries with similar conditions to Iran. In order to achieve the mentioned goals, the following studies and literature are studied and policymaking models are reviewed to design the default model. Then, the research methodology is explained and in the next section, the research model is presented. Finally, suggestions are provided to solve the existing problems.

2. THEORETICAL FRAMEWORK

2.1. Agriculture and renewable energy

For decades, developed and developing countries have been using fossil fuels extensively to promote their goals in all economic sectors such as manufacturing, tourism, transportation, and agriculture. This led to the emission of carbon dioxide in almost all parts of the world.

In fact, the use of fossil fuel farm equipment, water pumping for irrigation, animal husbandry, and use of nitrogen-rich fertilizers have all contributed significantly to greenhouse gas emissions from agriculture. Also, a strong relationship between energy consumption and agricultural productivity has been proven; for this reason, politicians support the use of energy in agriculture [11].

As GDP increases, so does diesel and electricity consumption in the long run. In this regard, researchers recommend that governments should improve infrastructure and provide subsidies for rural and agricultural electricity to increase agricultural production [12]. However, Sabri and Obaid believe that if proper management in the field of energy is not done, energy can also act as a limiting factor for agriculture and shock it [12]. However, the Food and Agriculture Organization of the United Nations believes that the agricultural sector has significant potential to reduce greenhouse gas emissions. In fact, many agricultural activities, such as irrigation, can be sourced from renewable energy sources [19]. Therefore, renewable energy can be a good solution [17, 18] and plays an important role in improving agricultural production [13, 14]. They also can help to reduce emissions [15]. Therefore, reducing the share of fossil fuels and increasing the share of biofuels is one of the most important future goals in this sector. The development of renewables, especially biofuels, in addition to reducing global warming, is effective in creating employment and encouraging the agricultural sector [16, 17]. Subsidy policies and tax concessions facilitate the rapid expansion of renewable energy in agriculture. Items such as setting guaranteed rates minimize the investment risk and make the investor more confident [23]. Appropriate policies are the main driver of investment in the renewable sector. In this regard, many policies such as feed in tariffs, insurance tariffs, financial incentives, etc. are implemented in the world and are very diverse, but the most important and most widely adopted policy is feed in tariffs [24-26].

The development of renewables, especially biofuels, in addition to reducing global warming, is effective in creating employment and encouraging the agricultural sector [16, 17]. Biomass energy has great potential to meet the challenges of rural development and environmental damage. Biomass, like agricultural residues, has a high potential for energy production. After oil, natural gas, and coal, biomass is one of the most important energy sources worldwide [18-20].

Agricultural residues are a potential source of energy that can be used in the energy production process [21].

Iran has many agricultural products and wastes that can be used to produce biofuels. Biomass resources from agricultural waste, including fruits, can be used to generate energy and renewable resources [9]. According to the production capacity of agricultural products in 2018, from the residues of oilseeds and products, approximately 4.8 billion liters of bioethanol and about 526 thousand tons of biodiesel could be obtained [22]. Nonetheless, the share of biofuels in Iran is very small [23]. So far in Iran, biofuels remain at the level of research and development. There is no suitable market for this type of fuel. The lack of appropriate supportive policies in this area is one of the reasons [21].

2.2. Renewable energy policy

Global warming is a serious problem for the global environment [24]. Rising temperatures affect agricultural productivity [25], human health [26, 27], infrastructure, and many other aspects of society. In this regard, policy-making and modeling for the energy system play a key role in the development of a sustainable energy system. Different energy models are useful tools for identifying changes in the implementation of different policies. Policymakers always need to be equipped with up-to-date information, meaningful figures, and analysis of the impact of the adopted policy. Renewable energy policies will be crucial to achieving the goals of energy policy and other benefits of renewable energy such as reducing climate change and air pollution, improving energy security, and increasing access to energy. Because a development that relies on the use of non-renewable resources affects the well-being of future generations in terms of resource depletion, environmental impacts, and unsustainable development [28]. A proper understanding of the complex interactions between the factors affecting the development of renewable energy is essential to designing appropriate economic, environmental, and energy policies and achieving goals in this field [29]. Today, renewable energy policies are prescribed as a pillar of energy security and sustainable development in all countries. Countries rich in fossil fuels and oil exporters are usually less inclined to use renewable energy [30]. Designing and evaluating renewable energy policies is difficult because policymakers and decision-makers must consider several aspects [31]. They need to evaluate the impact of their strategies and policies [32].

Many studies have been conducted in the field of renewable energy policies, and most of them have concluded that existing policies need to be reformed and revised. Radmehrder et al. (2021) concluded that policymakers should increase their support for universities and research centers so as to reduce the cost of producing energy from renewable sources. Radmehr's findings also show that policies that increase the cost of using fossil fuels must be adopted [29]. The study by Ghorashi (2021) and Maranlou demonstrated that the power purchase agreement and feed-in-tariff had positive effects on the renewable energy market in Iran [33]. The study of Norouzi et al. (2021) demonstrated that the level of achievement of the goals stated in the renewable energy policies in Iran remains generally low. The multiplicity of documents and institutions involved in RE, lack of operational plans, and lack of optimal use of private sector capacity are the main weaknesses. They further conclude that Iran can take an effective step in the development of renewables if the conditions for private sector participation be more favorable and appropriate operational and practical plans be considered. Finally, they suggest that the adoption of a comprehensive and integrated RE policy, as well as the centralization of RE management in a small number of institutions, represent an important factor in facilitating the success of renewable energy in Iran [34].

The results obtained by Arizen et al. identified weaknesses in renewable energy policies. This study illustrated that the carbon tax was not high enough to act as an incentive to invest in renewable technologies. To make renewable energy competitive in the electricity market, public support is essential through public subsidies through carbon taxes. Technology-driven policies are more appropriate than demand-driven policies [35].

A study conducted in ASEAN countries also pointed to policymaking weakness. This study concluded that policy of ASEAN countries is to increase the share of biofuels in the energy basket to reduce dependence on oil imports and climate change is not their priority. Malaysia and the Philippines, although having national biofuels policies and biofuels law, respectively, have weak policies on biofuels development [36].

Banse and colleagues also conducted research on renewable energy policies in the agricultural sector. The results of this study make it clear that without a combination of laws or subsidies to stimulate the use of biofuels, the goals of the EU Biofuels Directive will not be achieved. By combining the rules, the increased demand for biofuel products has a severe impact on agriculture globally and in Europe. Excess demand from the energy sector may slow or reverse the long-term trend of declining agricultural prices. Providing subsidies is essential to stimulating the production of biofuel products [37].

The Rajagopal study in India concluded that the focus of renewal policies is on Jatropha, and this is wrong because there are better options. Biofuel policies should focus on short-term, versatile, and drought-resistant crops such as sweet sorghum. Reform policies should focus on broader options, which can provide benefits that are more direct to the rural poor [38]. The study of Jeli and Yusuf (2015) also proved the importance of policies in the agricultural sector. They note that subsidizing renewable energy consumption in the agricultural sector helps the sector be more competitive in global markets while leaving less pollution [39]. Experimental results from a study by Hong et al. (2020) in China showed that investing in renewable energy, including bioenergy, solar, and hydropower, actually enhanced China's rural household economy [40]. Esmailzadeh et al. (2020) used interpretive structural modeling techniques in their study and concluded that government policies, oil crisis, economic growth, and recession were the most important factors affecting the photovoltaic technological innovation system in Iran [41].

Oryani et al. (2021) reached a conclusion that based on the effects of increased energy consumption and environmental degradation, switching from conventional energy to renewable energy sources should be considered in national energy policies. Accordingly, they believe that market-based intervention policies and non-market-based interventions are necessary [42]. A study by Muhammed and Tekbiyik (2020) demonstrated that renewable policies would increase the development of RE installation capacity in three countries, China, the United States, and Brazil [43].

In a research paper, Hafeznia et al. (2017) studied renewable energy policies in Iran. The results indicated that policies to support photovoltaic technologies were equal in all regions and that the government needed to differentiate between different regions with different potentials in designing new policies [44]. The results of the Onifade study revealed that the current policies were outdated and ineffective and that policies such as incentive tariffs and quota commitments needed to be used. It is also necessary to develop a market for renewables [45]. A study in Pakistan discussed RE policies in Pakistan. They argue that existing policies and activities have not been sufficient to increase significant change in the country's renewable sector. Renewable technology equipment must be imported, which increases the cost of RE projects. Government subsidies reduce the energy costs of crude oil. The complete lack of a marketing and advertising strategy is another weakness of RE policies in Pakistan. Mutual communication and partnerships between different government agencies are also weak. Smyth et al. (2010) concluded that at the national level, biofuel policies were poorly implemented and it would be necessary to establish an effective and efficient framework for the development of biofuels [46]. In a study on renewable policies in Canada, the results showed that under the combination of market incentives and the policy guidelines scenario, biomass-based ethanol and electricity generation could increase significantly and potentially lead to fundamental changes in land use practices. In general, agriculture enjoys significant potential for biomass production for energy and significant potential for reducing greenhouse gas emissions. However, the appropriate combination of market policies and incentives will have significant impact on the type of bioenergy produced [47].

2.3. Policymaking models

Iran lacks a proper policymaking framework for renewable energy and this is a major challenge for developing renewable energy technologies in the country. Although it seems that laws are enacted and directives are issued, it lacks executive instructions. An appropriate and precise policy can reduce the conflict between renewable and non-renewable energies. Success in the development of renewable energy depends on good political decision-making [48]. In this regard, many policymaking models have been presented over the years. The most basic policymaking model belongs to Laswell, which consists of seven main stages. These stages are knowledge, promotion, prescription, invocation, implementation, termination, and evaluation [49, 50]. The Purdon model consists of six steps: identifying the problem, setting criteria, identifying options, evaluating and selecting, evaluating the process, and evaluating the consequences [51]. The models of Lin [52], Ghavifekr et al. [53], Dye [54], Denhardt et al. [55], Ahrens [56], Janssen and Helbig [57], and Onifade [45] were also studied. Many policymaking models were presented that led to the diversity of these models. However, most researchers consider similar steps for the policymaking including the process of problem identification, policy formulation or development, decision-making, policy implementation, and policy evaluation [57-60] (Figure 1).

The model presented in Figure 1 was used as the default model in this research.

3. METHODOLOGY

The method of this research is quantitative and is applied in terms of purpose and survey in terms of strategy. Structural Equation Modeling (SEM) was used for the statistical analysis of research data. SEM is a data analytical approach that shows causal relations between measured and/or latent variables. For model analysis, SEM is not considered as a purely statistical technique, but as an analytical process involving model conceptualization, parameter identification and estimation, and data model fit assessment [61]. Researchers have become highly aware of the need to use multiple observed variables to understand their field of research better. Basic statistical methods consider only a limited number of variables simultaneously that are incapable of dealing with more advanced and complex theories. Using a small number of variables to understand complex phenomena is limited by itself. However, structural equation modeling allows researchers to statistically model and test complex phenomena. Structural equation modeling techniques are methods for confirming or rejecting theoretical models in a quantitative way. Another important point is the attention to the high importance of the validity and reliability of observation scores obtained by measuring instruments, e.g., in particular, measurement error, which is a fundamental issue in all disciplines. For analyzing data statistically, structural equation modeling techniques also took into account measurement errors. However, in classical statistical methods, measurement error and statistical analysis of data are done separately. Structural equation modeling programs can be used as easily as possible and be run with a Windows system. Therefore, structural equation modeling software is now easier to use and has features similar to other software packages under Windows [62-66].

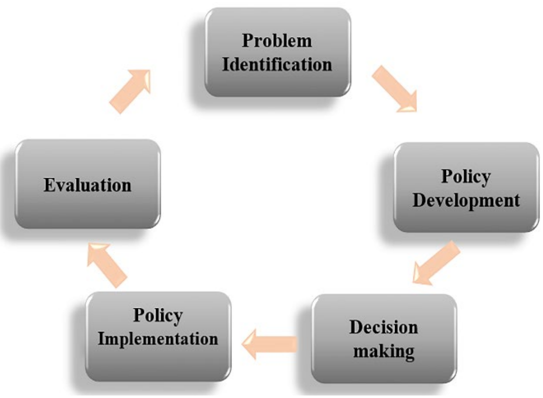

Figure 1. Default policy model.

The statistical population of this study consisted of all experts who had experience, expertise, and activities in the field of renewable energy policymaking. Although there is no exact information in this field for various reasons such as irregular retirements and returning to work after retirement in different areas of operation, according to the collected statistics, about 80 people are active in official and administrative affairs in this field and using the Krejcie and Morgan table, 70 samples must be considered. Therefore, the questionnaire was given to 70 energy policymaking experts who constituted the statistical sample to collect their opinions. Random sampling was used for this study. The main tool for data collection was a questionnaire designed based on the Likert spectrum, which was presented in two parts: demographic characteristics and main variables of the research. The research variables consist of five main variables, each of which is composed of a number of items. These variables are problem identification (10 items), policy formulation (16 items), decision-making (8 items), policy implementation (17 items), and policy evaluation (6 items).

The validity of the research tool was determined using face validity, Content Validity Ratio (CVR), and Content Validity Index (CVI). Face validity determines whether the appearance of the questionnaire is appropriately designed to assess the researcher's intended purpose [67]. In this section, experts were asked about the appropriateness, attractiveness, and logical sequence of items, as well as the brevity and comprehensiveness of the questionnaire.

CVR is used to determine if the most important and correct content has been selected [68]. To determine the CVR, experts are asked to examine each item in the following three terms: "necessary", "useful but not necessary", and "not necessary". Finally, the CVR is calculated according to the following formula:

$$\mathrm{CVR} = \frac{n_E - \frac{N}{2}}{\frac{N}{2}}$$

In this case, n_E is the number of specialists who answered the "necessary" option and N is the total number of specialists. Table 1 specifies the minimum amount of validity to be accepted. In determining this amount, the number of respondents is also considered. If the value obtained is greater than the value of the table (Table 1), the validity of the content of that item is accepted [69].

Table 1. Deciding on a CVR

Number of specialists	Minimum amount of validity
5	0.99
6	0.99
7	0.99
8	0.85
9	0.78
10	0.62
15	0.49
20	0.42
25	0.37
30	0.33
40	0.29
Reference: [69].	

The reliability of the questionnaire was calculated using Cronbach's alpha, the values of which are shown in Table 3. SPSS 25 and LISREL 80.8 software products were used to analyze the research data.

The CVI also determines whether the questionnaire items are best designed to measure content [68, 70]. The CVI is calculated by dividing the approximate scores for each item that scored "relevant but in need of review" and "fully relevant" by the total number of professionals. If the value is less than 0.7, the item is rejected. If it is between 0.7 and 0.79, a review should be performed and if it is greater than 0.79, it is acceptable [71]. In the pilot test, 30 experts were consulted to achieve CVI and CVR values and an initial questionnaire was provided to them, the results of which are given in Table 2.

Table 2. Calculated CVI and CVR questionnaire

Abbreviation	Items		
	Item	CVI	CVR
	Problem identification (pi)		
P1	In the renewable energy policy-making process, the priorities of the agricultural sector are considered.	0.80	0.66
P2	Renewable policies are adopted according to the needs of the country and the agricultural sector.	0.83	0.53
P3	There is a lack of management in setting priorities.	0.90	0.86
P4	Targeting in the adoption of renewable energy policies is well done.	0.86	0.60
P5	Strategic study to identify priority technologies has not been done according to the needs of each region.	0.83	0.46
P6	Accurate identification of stakeholders in the agricultural sector is not done.	0.80	0.93
P7	Support for renewable energy research in the agricultural sector is not well done.	0.93	0.93
P8	Policy-making is based on personal desires, aspirations, and interests.	0.86	0.60
P9	The development of policies for the use of agricultural waste for biogas production will play an important role in the development of renewable energy.	0.83	0.66
P10	Policy-making is done without considering the existing facts and objective problems and regional and local issues.	0.83	0.86
	Average	0.85	0.71
	Policy formulation (pf)		
Pf1	Policies to motivate the private sector to encourage the production of renewable energy are at a desirable level.	0.86	80.0
Pf2	It seems necessary to highlight the role of the Ministry of Agriculture in renewable energy policymaking.	0.90	73.0
Pf3	In the process of renewable energy policymaking, there is a lack of policy coherence.	0.80	1
Pf4	Lack of focus on renewable energy matters does not contribute much to development in this area.	0.80	0.80
Pf5	The focus of policy-making in a single organization helps develop renewable energy policies.	0.93	0.86
Pf6	Renewable equipment market development policies are in good condition.	0.86	0.53
Pf7	Simplification of laws and regulations related to renewables seems to be necessary, especially in the agricultural sector.	0.93	0.80

Pf8	Subsidies for the "consumption" of renewable energy should be increased, especially in the agricultural sector.	0.90	0.73
Pf9	Subsidies for the "production" of renewable energy, especially in the agricultural sector, should be increased.	0.96	0.86
Pf10	Renewable energy education and promotion policies have good conditions, especially in the agricultural sector.	0.80	0.60
Pf11	Organizational interference in policy-making is clearly observed as a problem in the policy-making path.	0.83	0.86
Pf12	At present, the parallelism of organizations and institutions in the implementation of adopted policies and programs acts as an obstacle.	0.80	0.93
Pf13	Real policymakers are not employed in the renewable energy policymaking cycle.	0.83	0.60
Pf14	There is a top-down approach to renewable energy policymaking in the agricultural sector.	0.83	0.46
Pf15	Policies should be adopted to reduce the role of fossil fuels in the agricultural sector.	0.90	1
Pf16	Relevant authorities have a high level of awareness in the field of renewable policymaking.	0.80	0.53
Average		0.81	0.76
Decision making (dm)			
Dm1	Participation of all stakeholders in renewable energy policymaking is low.	0.90	0.53
Dm2	There is a bottom-up approach to renewable energy policymaking in the agricultural sector.	0.83	0.66
Dm3	The setting of criteria and indicators and standards related to renewable energy production is well managed.	0.80	0.33
Dm4	The participation of agricultural stakeholders in renewable energy policymaking is adequate.	0.80	0.86
Dm5	It is necessary to eliminate subsidies for fossil fuels to encourage the production of renewable energy.	0.80	0.46
Dm6	Consumption pattern modification is one of the programs that can help the development of renewables.	0.83	0.53
Dm7	Policies to use incentives for farmers to produce and use renewables need to be considered.	0.93	0.60
Dm8	The adopted solutions are presented and selected according to the problem diagnosis stage.	0.83	0.60
Average		0.84	0.57
Policy implementation (pim)			
Pim1	The management of culture making and public awareness about renewable energy is in a convincing position.	0.83	0.66
Pim2	It does not seem necessary to highlight the role of the Ministry of Agriculture in the use of renewable energy.	0.80	0.73
Pim3	Planning to implement priorities suffers from severe managerial weakness.	0.90	0.86
Pim4	Government direct investment in the renewable energy sector is sufficient and appropriate.	0.80	0.66
Pim5	Groups involved in policy-making also monitor implementation.	0.83	0.60
Pim6	The necessary human resources are considered in the implementation of renewable energy policies.	0.86	0.73
Pim7	Coordination between the various departments enforcing renewables laws needs to be strengthened.	0.90	0.93
Pim8	Necessary executive resources are considered in the implementation of renewable energy policies.	0.93	0.80
Pim9	Adoption of policies without executive guarantees is widespread.	0.93	0.93
Pim10	Policy implementation is well managed.	0.86	0.86
Pim11	Sufficient work force is employed in the renewal policy cycle.	0.86	0.73
Pim12	Expert manpower has a high level of awareness.	0.80	0.66
Pim13	There are no enforcement guarantees for the policies adopted.	0.90	0.80
Pim14	All adopted policies are properly transformed to program.	0.86	0.40
Pim15	Cooperation between institutions and organizations in the implementation of renewable energy policies is adequate.	0.83	0.53
Pim16	The necessary financial resources are considered in the implementation of renewable energy policies.	0.86	0.25
Pim17	The relationship between academia and industry and policy-making institutions should be reviewed and strengthened.	0.80	0.46
Average		0.85	0.69
Policy evaluation (pe)			
Pe1	Evaluation of executive policies is done appropriately.	0.96	0.86
Pe2	Evaluations are used to address issues.	0.80	0.86
Pe3	The multiplicity of regulatory organizations is a major barrier to policy evaluation.	0.93	0.66
Pe4	There is no evaluation of implemented policies.	0.86	0.86
Pe5	Renewable development projects in the agricultural sector without subsidies are not economically justified.	0.80	0.33
Pe6	Evaluation takes place during the implementation of renewable development policies.	0.90	0.80
Average		0.87	0.72

Table 3. Cronbach's alpha values of different parts of the questionnaire

Latent variable name	Cronbach's alpha
Problem identification	0.919
Policy formulation	0.925
Decision making	0.951
Policy implementation	0.933
Policy evaluation	0.853
Total	0.916

A summary of the research methodology framework is shown in Figure 2.

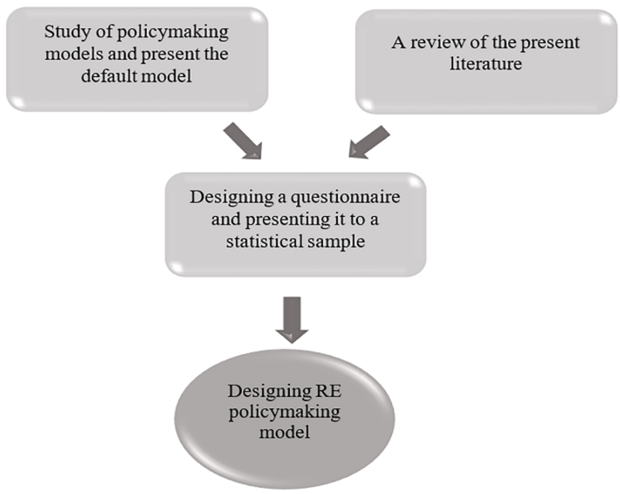

Figure 2. A summary of the research methodology framework

4. FINDINGS

In this section, descriptive statistics related to individual characteristics including age, education, field of study, and work experience in the field of renewables were examined.

Respondents in this study included 70 people. In terms of gender distribution, all respondents were male and their mean age was 54.12 years. People ranged in age from 40 to 69 years. In terms of records and experience, the subjects who aged 15.38 years on average have had experience in this field (Table 4).

Table 4. Age, gender, and work experience of the respondents

Variable	Gender	Age	Work experience
Mean	-	54.12	15.38
Max	-	69	35
Min	-	40	7
-	Male	-	-
Number	70	70	70

Out of 70 respondents, 64 (91.4 %) had a doctoral degree and six respondents (8.6 %) had a Master's degree (Table 5).

Table 5. Level of education of the respondents

Educational degree	Frequency	Percentage
Ph.D.	64	91.4
Masters	6	8.6
Total	70	100

The variety of fields of study was so great that about 23 fields of study were registered. Among them, 12 people (17.1 %) stated that their field of study was chemistry. The lowest number was related to the fields such as management and water resources (1.4 %).

4.1. Structural equation modeling

The results of the validity and reliability analysis and the structural model obtained from the analysis of the five Latent Variables of "problem identification", "policy formulation", "decision making", "policy implementation", and "policy evaluation" are as follows (Table 6):

Table 6. Validity and reliability results of research factors

latent factors	Cronbach's alpha	AVE	CR
Problem identification	0.919	0.700	0.930
Policy formulation	0.925	0.746	0.947
Decision making	0.951	0.701	0.949
Policy implementation	0.933	0.736	0.951
Policy evaluation	0.853	0.817	0.914
Total	0.916	0.704	0.938

4.2. Validity and reliability analysis of research variables

For each factor, two indices of Average Variance Extracted (AVE) and Composite Reliability (CR) were calculated. These two indicators are used to measure the validity and reliability of factors. The AVE index shows what percentage of the variance of the studied factors has been affected by the variables of those factors. Researchers have set a value of 0.5 or higher for the appropriateness of this index [72, 73]. Regarding the value of CR, it is stated that if it is greater than 0.7 for each of the factor, they exhibit acceptable reliability and the closer this value is to one for each factor, the reliability of that factor is higher. Based on the results, the values of the AVE and the CR calculated for all five factors named in the present study are listed in Table 6. In general, according to the obtained results, it can be said that the research tool had good validity and reliability.

To continue the analysis, a structural equation modeling technique was used and Confirmatory Factor Analysis (CFA) was selected. In this step, upon adding five factors "problem identification", "policy formulation", "decision making", "policy implementation", and "policy evaluation" and their items into LISREL software, the structural model of the research was presented. The question is whether the existing relationships between latent variables based on the previous studies, extracted and plotted, are confirmed. The presented final model states that the markers considered in the research could have properly confirmed their relationship. As shown in Figure 3, all relationships are significant ($t \geq 1.96$). Figure 4 shows the structural model of the research. For example, the factor load of the first observed variable "problem identification" variable is 0.63. The larger the factor load and the closer it is to the number one, the better the observed variable can explain the independent variable. If the factor load is less than 0.3, a weak relationship is considered and it is ignored. The factor load between 0.3 to 0.6 is acceptable; and if it is greater than 0.6, it is desirable [74].

In the problem identification factor, the factor load p1, which is related to considering the priorities of the agricultural sector, is 0.63. This factor load indicates the amount of variance that the item has explained. The factor load of item p2, which indicated how much attention was paid to the needs of the agricultural sector, was 0.66. In addition, the factor load of considering technology and its priority in each region is estimated to be 0.64. Lack of support for renewable energy research in agriculture (p7) also exhibited a factor load of 0.66. All of these items indicated a factor load greater than 0.6, implying that these observations could explain the problem identification variable well. In addition, the lowest factor loading is related to managing priorities (p3) and identifying stakeholders (p6) in the agricultural sector. In the policy formulation, item pf6, which measures the status of policies of renewable equipment market development, had a factor load of 0.73. Item pf11, with a factor load of 0.76, examines organizational interference in policymaking. The parallel work of organizations and institutions in the implementation of adopted policies and programs (pf12) demonstrated a factor load of 0.78, which indicated that observations could explain the variable well (Table 7) in this factor. Accordingly, the items that examined the role of the Ministry of Agriculture in the renewables policymaking (pf2) and the condition of renewable energy education (pf10) were lower than the other items.

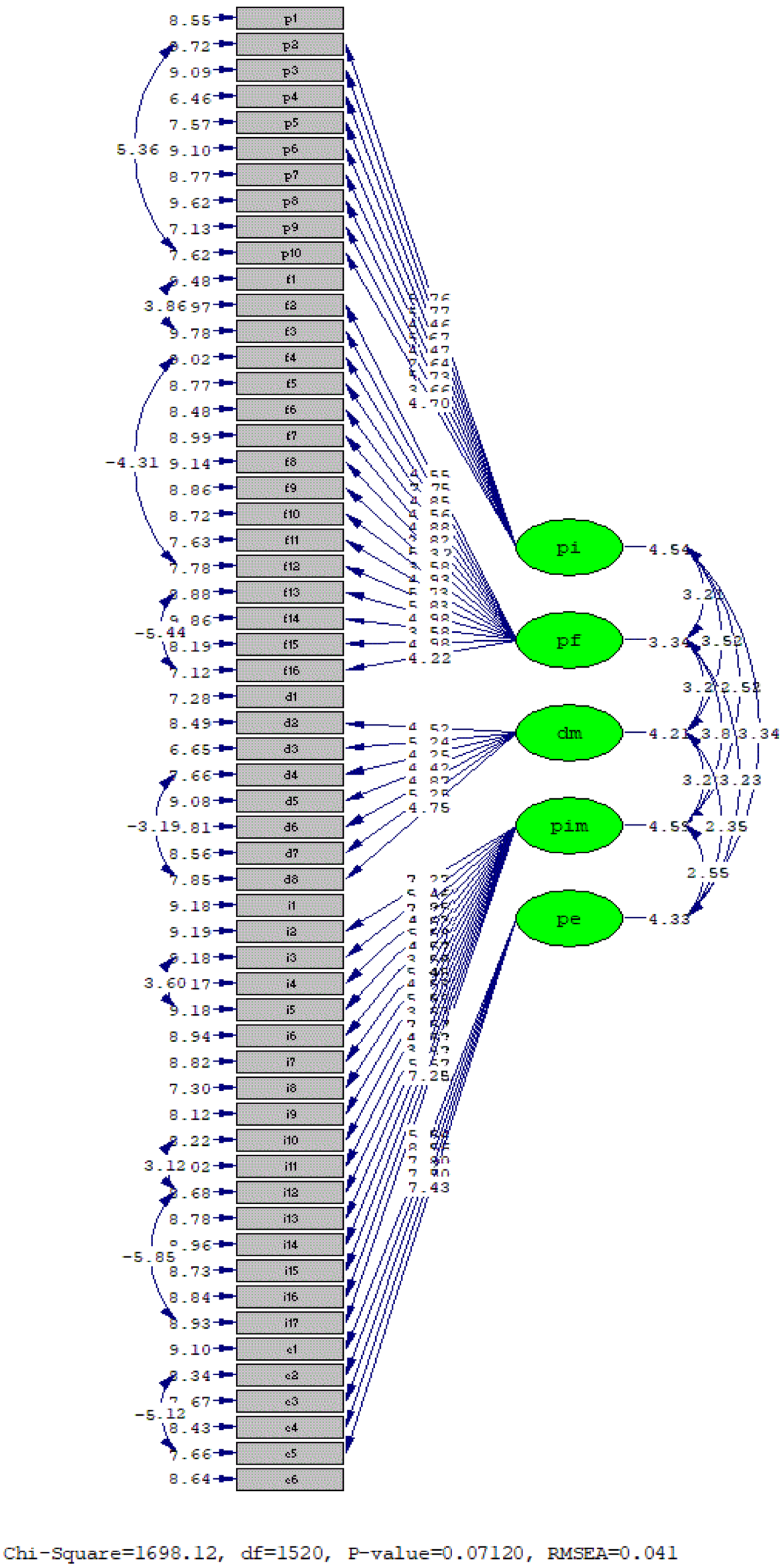

Figure 3. T-values in the structural model of renewable energy policymaking in the agricultural sector

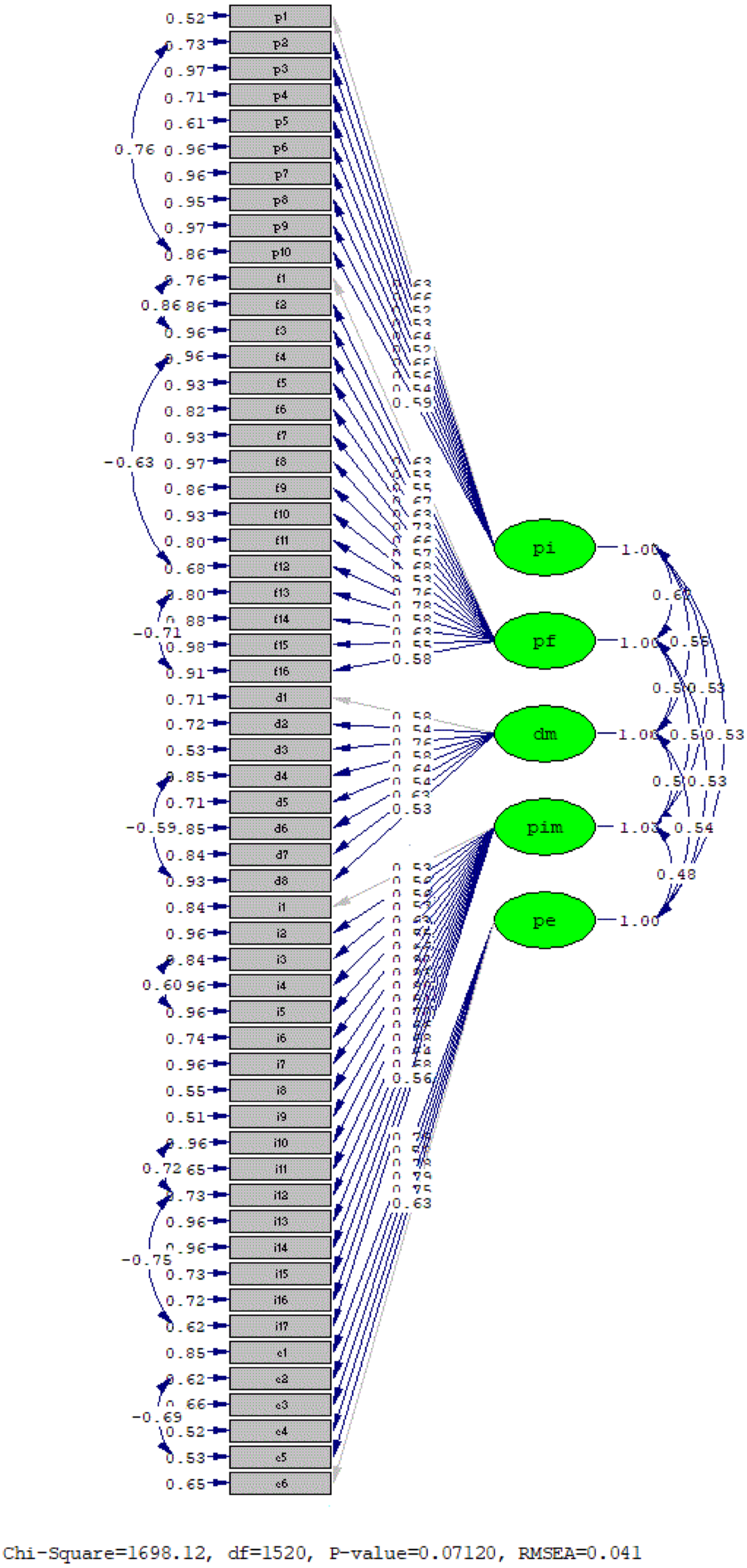

Figure 4. Structural model of renewable energy policymaking in agriculture

Table 7. Factor loads in the final model

Item		Factor loading
Problem identification (pi)		
P7	Support for renewable energy research in the agricultural sector is not well done.	0.66
P2	Renewable policies are adopted according to the needs of the country and the agricultural sector.	0.66
P5	Strategic study to identify priority technologies has not been done according to the needs of each region.	0.64

P1	In the renewable energy policy-making process, the priorities of the agricultural sector are considered.	0.63
P10	Policy-making is done without considering the existing facts and objective problems and regional and local issues.	0.59
P8	Policy-making is based on personal desires, aspirations, and interests.	0.56
P9	The development of policies for the use of agricultural waste for biogas production plays an important role in the development of renewable energy.	0.54
P4	Targeting in the adoption of renewable energy policies is well done.	0.53
P3	There is a lack of management in setting priorities.	0.52
P6	Accurate identification of stakeholders in the agricultural sector is not done.	0.52
	Policy formulation (pf)	
Pf12	At present, the parallelism of organizations and institutions in the implementation of adopted policies and programs acts as an obstacle.	0.78
Pf11	Organizational interference in policy-making is clearly observed as a problem in the policy-making path.	0.75
Pf6	Renewable equipment market development policies are in good condition.	0.73
Pf9	Subsidies for the "production" of renewable energy, especially in the agricultural sector, should be increased.	0.68
Pf4	Lack of focus on renewable energy matters does not contribute much to development in this area.	0.67
Pf7	Simplification of laws and regulations related to renewables seems to be necessary, especially in the agricultural sector.	0.66
Pf1	Policies to motivate the private sector to encourage the production of renewable energy are at a desirable level.	0.63
Pf14	There is a top-down approach to renewable energy policymaking in the agricultural sector.	0.63
Pf5	The focus of policy-making in a single organization helps to develop renewable energy policies.	0.63
Pf16	Relevant authorities have a high level of awareness in the field of renewable policymaking.	0.58
Pf13	Real policymakers are not employed in the renewable energy policymaking cycle.	0.58
Pf8	Subsidies for the "consumption" of renewable energy should be increased, especially in the agricultural sector.	0.57
Pf3	In the process of renewable energy policymaking, there is a lack of policy coherence.	0.55
Pf15	Policies should be adopted to reduce the role of fossil fuels in the agricultural sector.	0.55
Pf2	It seems necessary to highlight the role of the Ministry of Agriculture in renewable energy policymaking.	0.53
Pf10	Renewable energy education and promotion policies have good conditions, especially in the agricultural sector.	0.53
	Decision making (dm)	
Dm3	The setting of criteria and indicators and standards related to renewable energy production is well managed.	0.76
Dm5	It is necessary to eliminate subsidies for fossil fuels to encourage the production of renewable energy.	0.64
Dm7	Policies to use incentives for farmers to produce and use renewables need to be considered.	0.63
Dm4	The participation of agricultural stakeholders in renewable energy policymaking is adequate.	0.58
Dm1	Participation of all stakeholders in renewable energy policymaking is low.	0.58
Dm2	There is a bottom-up approach to renewable energy policymaking in the agricultural sector.	0.54
Dm6	Consumption pattern modification is one of the programs that can help the development of renewables.	0.54
Dm8	The adopted solutions are presented and selected according to the problem diagnosis stage.	0.53
	Policy implementation (pim)	
Pim12	Expert manpower has a high level of awareness.	0.70
Pim14	All adopted policies are properly transformed to program.	0.68
Pim16	The necessary financial resources are considered in the implementation of renewable energy policies.	0.68
Pim8	Necessary executive resources are considered in the implementation of renewable energy policies	0.67
Pim7	Coordination between the various departments enforcing renewables laws needs to be strengthened.	0.66
Pim13	There are no enforcement guarantees for the policies adopted.	0.66
Pim15	Cooperation between institutions and organizations in the implementation of renewable energy policies is adequate.	0.64
Pim5	Groups involved in policy-making also monitor implementation.	0.63
Pim9	Adoption of policies without executive guarantees is widespread.	0.56
Pim10	Policy implementation is well managed.	0.56
Pim17	The relationship between academia and industry and policy-making institutions should be reviewed and strengthened.	0.56
Pim6	The necessary human resources are considered in the implementation of renewable energy policies.	0.55
Pim4	Government direct investment in the renewable energy sector is sufficient and appropriate.	0.53
Pim1	The management of culture making and public awareness about renewable energy is in a convincing position.	0.53
Pim11	Sufficient workforce is employed in the renewal policy cycle.	0.53
Pim2	It does not seem necessary to highlight the role of the Ministry of Agriculture in the use of renewable energy.	0.50

Pim3	Planning to implement priorities suffers from severe managerial weakness.	0.50
	Policy evaluation (pe)	
Pe1	Evaluation of executive policies is done appropriately.	0.79
Pe4	No evaluation of implemented policies is done.	0.79
Pe3	The multiplicity of regulatory organizations is a major barrier to policy evaluation.	0.78
Pe5	Renewable development projects in the agricultural sector without subsidies are not economically justified.	0.75
Pe6	Evaluation takes place during the implementation of renewable development policies.	0.63
Pe2	Evaluations are used to address issues.	0.58

In the decision-making variable, item dm3, which is related to the management of regulatory criteria, indicators, and standards in the production of renewable energy, could explain the main variable more strongly than other cases. Factor loads of other items such as the elimination of fossil fuel subsidies (dm5) and consideration of incentive policies for farmers (dm7) were also recorded above 0.6. In the policy implementation variable, the factor load of nine items above 0.6 and three items exhibited a factor load above 0.7, indicating a good explanation of the variable by these items. In the last variable, policy evaluation, four items could elaborate the main variable with a factor load greater than 0.7. These items examined and measured the extent of policy evaluation (pe1), the multiplicity of regulatory organizations in policy evaluation (pe3), and the existence of policy implementation evaluation (pe4). It should be noted that the factor loads in this factor exhibited higher values than other factors.

It was mentioned above that the research model was in good condition in terms of AVE and CR. Table 8 shows that the model has good fitness. Root Mean Square Residual (RMR), Standardized Root Mean Square Residual (SRMR), Goodness of fit index (GFI), Normed Fit Index (NFI), Normalized Fit Index (NNFI), Incremental Fit Index (IFI), Comparative Fit Index (CFI), and Root Mean Square Error of Approximation (RMSEA) were employed to evaluate the fitness of the model. The information in Table 4-27 shows the value of each of these indicators in the research model. As can be seen, the overall research model has a goodness of fit.

Table 8. Results of the values of compliance of the research model with fitness indicators

	($\frac{x^2}{df}$) Relative chi-square	**RMSEA**	**RMR**	**SRMR**	**CFI**	**GFI**	**NFI**	**NNFI**
Reception area*	3>	0.08>	Close to zero	0.08>	0.90≤	0.90≤	0.90≤	0.90≤
Research finding	1.11	0.041	0.21	0.053	0.99	0.99	0.99	0.99

5. DISCUSSION

The designed model shows that in the problem identification stage of the policymaking cycle, the priorities of the agricultural sector and the needs of the country in this sector are not considered. Selection of technologies is not based on the priority of this section and no strategic study is done in this area. Another important issue is the lack of accurate and correct identification of stakeholders in the agricultural sector. This will lead to wrong policy in the next step because it will suggest adopting policies that are unrelated to the target group. Ferris's findings also confirm that stakeholder participation increases the chances of achieving goals [59].

Analysis of the opinions of responsive experts indicated that at the policy-making stage, policies related to the market for renewable equipment are not in good condition. Problems related to organizational interference as well as parallelism in policymaking were acknowledged. These cases were identified as one of the most important problems of this step because they had the highest factor load (above 0.7) and could explain the highest variance. After these cases, another important issue is the simplification of laws and regulations related to this area. Cumbersome laws and troublesome bureaucracy prevent the facilitation of administrative and executive affairs. Another issue is the production subsidy for renewable energy. These subsidies and protections need to moderate the difference between the cost of conventional and renewable fuels. Mezher et al. (2012) came to the same conclusion. They argued that fossil fuel subsidies and a lack of economic support for renewable resources hindered active private sector participation [75]. Radmehr also believed that policies that increase the cost of using fossil fuels must be adopted [29]. It is necessary to correct the top-down approach in decision-making to bridge the gap between what is needed and what is offered. Lieu's findings also suggest that the interaction between all institutions at the policymaking stages, policymakers, and stakeholders can be beneficial, because ignoring stakeholder responses can lead to a set of policies that may seem very strong in theory and policy design but are inconsistent in practice [76]. At the decision-making stage, it is necessary to better define the criteria, indicators, and standards related to renewable energy production. There should also be incentives for farmers to encourage them to use and produce renewables.

Expert opinions on policy implementation showed that expert manpower needed more training because they did not have the necessary level of knowledge in this area. Mechanisms must also be put in place to ensure that policies are implemented and that all of these policies are well planned and effective. Policy evaluation also indicates that the need for effort and review in this step is necessary because the weakness in policy evaluation is clearly observed and policy evaluation is not done. This problem is similar to what Chapman et al. (2016) stated in their findings [77]. The multiplicity of monitoring organizations acts as a barrier. Nowruzi also confirmed the claim that the centralization of RE management in a small number of institutions would facilitate the success of renewable energy in Iran [34]. As demonstrated by the results, it is necessary to provide subsidies for renewable development projects in the agricultural sector in order to justify their economic value. In general, it should be noted that the factor loadings in the policy evaluation factor showed higher values than other factors. It can be implied that the proposed model indicates the greatest weaknesses and shortcomings in policy evaluation. It is clear that evaluating the implementation of policies and programs as well as examining the effects and extent of achieving predetermined goals are essential. This helps better identify existing errors or shortcomings and fix these problems more easily. However, now, lack of proper evaluation is one of the major problems in renewable energy policy.

6. CONCLUSIONS

In conclusion, it can be said that with the depletion of fossil fuel resources in the world, all countries are looking to replace these fuels with renewable energy sources, especially in agriculture, to avoid any disruption in the economy, because energy is very important for comprehensive development. In this regard, appropriate policies are necessary for the utilization of renewable resources and success in this field, which will not be possible unless we have an effective and efficient policymaking cycle. The role and ability of organizations and institutions should be carefully considered and each of them, according to their capacity and importance, plays a role in different stages of the renewable policymaking cycle. Greater attention should be paid to the evaluation stage and the role of individuals and groups involved in this stage of policymaking should be taken seriously. While economic growth is dependent on energy, governments should consider renewables as a substitute for non-renewables and adopt appropriate policies. Energy policy is an important issue, especially for a country like Iran, because Iran's economy is based on oil and fossil fuels. Iran performed poorly in the development and use of renewable energy in the past. Considering the institutions and organizations involved in policymaking in Iran, it is necessary to use an appropriate model for policymaking and the development of renewables. Iran performed poorly in the development and use of renewable energy in the past. It is necessary to make up for the loss by revising policies and measures in this area.

For future studies, issues such as how policies are implemented, the extent to which defined goals have been achieved, and the needs assessment for each agricultural region for the development of renewable energy can be considered by researchers. Also by conducting research and model design in other communities, comparative validation is also possible.

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NOMENCLATURE

RE	Renewable energy
CFA	Confirmatory factor analysis
AVE	Average variance extracted
CR	Composite reliability
CVR	Content validity ratio
CVI	Content validity index
Pi	Policy identification
Pf	Policy formulation
Dm	Decision making
Pim	Policy implementation
Pe	Policy evaluation

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