Developing a Marketing Model for Solar Energy Production Equipment Based on a Combined Grounded Theory and Partial Least Squares Approach

Mohammad Hossein Rezvanian[1] , Farideh Haghshenas Kashani[2*] , Mehdi Karimizand [3]

1. PhD student, Department of Business Administration, Central Tehran Branch, Islamic Azad University, Tehran, Iran.
2. Assistant Professor, Business Management Department, Central Tehran Branch, Islamic Azad University, Tehran, Iran(Corresponding author).
3. Assistant Professor, Business Management Department, Central Tehran Branch, Islamic Azad University, Tehran, Iran.

*** Corresponding author email address**:fahaghshenaskashani_93@yahoo.com

Received: 2024-01-11 **Reviewed:** 2024-01-16 **Revised:** 2024-03-16 **Accepted:** 2024-03-22 **Published:** 2024-03-31

Abstract

The objective of this study is to present a marketing model for solar energy production equipment based on a combined grounded theory and partial least squares approach. In the qualitative part of this research, utilizing a purposive judgment sampling method, the opinions of 15 professors and experts from the Iran Renewable Energy Association, the Iran Renewable and Electric Energy Efficiency Organization, and the Solar Energy Committee of the Scientific and Technological Deputy were utilized. Additionally, in the quantitative section of the study and based on Cochran's formula, opinions from 384 experts related to the research topic were utilized. The data analysis process was conducted in two stages, which included identifying factors affecting the marketing of solar energy production equipment through interviews and the grounded theory approach, and examining relationships, model fitting, and validation through questionnaire instruments and structural equation modeling using the partial least squares approach. The research results indicated that the paradigm model consists of causal factors, including climate change and the necessity of environmental preservation, cost reduction, assistance in sales growth, and the need for communication channels to inform customers; contextual conditions, including market research and the use of digital capabilities; intervening conditions, including distrust in solar technologies and equipment, the indigenous lifestyle of each region, and government policies; effective strategies for marketing advanced solar energy production equipment, including defining and identifying the target audience and market and optimizing marketing through social media; and consequences resulting from the application of advanced solar energy production equipment marketing, including business survival in a competitive market and trust building through social proof.

Keywords: *Marketing, Solar Equipment, Solar Energy.*

How to cite this article:

Rezvanian M,Haghshenas F,Karimizand M. (2024). Developing a Marketing Model for Solar Energy Production Equipment Based on a Combined Grounded Theory and Partial Least Squares Approach. Management Strategies and Engineering Sciences, 6(1), 1-8.

1. Introduction

Human beings have various needs that grow over time; therefore, meeting such increasing needs requires more optimal energy sources that must be provided directly or indirectly through the multiple resources available. Current studies indicate that underground fossil fuels fulfill the majority of energy demands. Fossil fuels are energy sources that play a significant role in human development and welfare [1]. However, the importance of utilizing renewable energy sources to meet global energy needs has significantly increased over time. This has been driven by the global rise in electricity consumption, which can be attributed to the dominance of technology in almost every aspect of human life, including healthcare, education, industry, and technology [2].

The importance of using renewable energy sources in electricity production has been highlighted globally for several reasons, including the fact that, for instance, solar technologies rely on the sun, a natural resource that is abundantly available and accessible daily. Moreover, utilizing such resources will help reduce dependence on conventional fossil fuel energy sources, which are being depleted from the earth and significantly contribute to carbon dioxide (CO2) emissions. This, in turn, will limit the negative impact on the environment [3]. Accordingly, and given the benefits of using solar energy, the installed capacity of solar power generation systems worldwide reached 700 gigawatts in 2020. However, the total solar power generated in Iran by 2021 was only 455.5 megawatts, which constitutes a small portion of the total electricity generated in Iran. For solar energy to have a significant share in energy production, and consequently contribute to the green economy and the reduction of greenhouse gases, there is a need for further expansion in the use of solar technology. However, expanding the use of solar power generation systems is not an easy task. The reality is that companies providing these technologies must address key market growth barriers, including marketing challenges [4].

The American Marketing Association defines marketing as the process of planning and executing the concept, pricing, promotion, and distribution of ideas, goods, and services to create exchanges that satisfy individual and organizational goals [5]. Effective marketing guides how, when, and where product information is delivered to consumers, with the ultimate goal of persuading consumers to purchase a particular brand or product [6]. In this context, a broad stream of previous literature has analyzed how consumers are persuaded to use renewable energy. Additionally, related drivers and barriers to investing in renewable energy generation systems have been examined [7, 8]. However, only a few existing studies have specifically addressed the marketing of solar power generation systems. Although these studies report different aspects of marketing, they tend to have a limited definition of marketing. The approaches reviewed in these studies primarily focus on communication-driven initiatives, such as website strategies, relationship-building activities, and stakeholder education [9, 10], or marketing in specific applications of solar technology, such as solar water heaters, photovoltaic cells, etc. [11, 12], or specific market segments or customers [13, 14], which corroborate the sustainable growth in demand for solar energy production equipment driven by increased awareness of environmental issues and a growing focus on renewable energy. These aspects are of particular importance and have enriched the existing research; however, marketing in a broader sense should play a crucial role in overcoming existing barriers and expanding the market for solar energy production systems, which has largely been overlooked in domestic research. Therefore, a deeper understanding of consumer behavior and market competitors is essential, and with the continuous development of solar energy generation technologies, there is an increasing need for new marketing models to improve the supply and promotion of products.

Given the existing research gap, this study will expand the knowledge related to the marketing of solar power generation systems with a particular focus on the question: What is the marketing model for solar energy production equipment in Iran?

2. Methodology

This study is applied in nature regarding its objectives, descriptive in terms of inference method, and exploratory mixed-method in terms of data nature. The research population in the qualitative part of this study consisted of managers and experts from the Iran Renewable Energy Association, the Iran Renewable and Electric Energy Efficiency Organization (SATBA), the Solar Energy Committee of the Scientific and Technological Deputy, as well as university professors. These individuals were experts in the field related to the research topic. The method of selecting participants in this study was judgmental sampling (review by research team members). In other words, the researcher selects those who can enrich the data collection

process to enable theory development from a pool of potential participants. In this method, instead of selecting a fixed sample, the sample size is increased until theoretical saturation is reached (Islam & Aldaihani, 2022). Accordingly, and given the nature of the sampling method, the final sample size in this study was determined to be 15 individuals, based on available experts willing to collaborate.

The research population in the quantitative section included all experts from the aforementioned organizations who were familiar with the research topic to some extent. To determine the random sample size for the quantitative part of the study, the available sampling method and Cochran's formula were used. Accordingly, the necessary sample size for structural equation modeling, with a 95% confidence level, was determined to be at least 384 individuals. Given that the exploratory mixed-method research approach first uses qualitative research methods followed by quantitative research methods, the present study was conducted as follows:

Qualitative Section: In this section, to collect data and information for analyzing the qualitative section and identifying the components of the marketing model for solar energy production equipment, interviews and the grounded theory method were utilized.

Quantitative Section: Given the objective and nature of the research topic, the most appropriate method for the quantitative phase of this study was the descriptive-survey method. Therefore, this method was used to obtain expert opinions on validating the research results (determining the measurement model and structural model of the research). In this section of the study, a researcher-designed questionnaire was used to collect quantitative data. The questionnaire was designed based on the dimensions and components extracted from the grounded theory process. For quantitative data analysis, the Partial Least Squares (PLS) method in structural equation modeling was used, utilizing software specifically designed for this purpose.

3. Findings

A) Identifying the Components of the Solar Energy Equipment Marketing Model

As mentioned in the methodology section, the present study used interviews for data collection in the qualitative section and grounded theory for analysis. Accordingly, to collect qualitative data, a framework for interview questions was developed after reviewing the literature related to the research topic. Subsequently, 15 experts, including academics and members from the Iran Renewable Energy Association, the Iran Renewable and Electric Energy Efficiency Organization (SATBA), and the Solar Energy Committee of the Scientific and Technological Deputy, were selected through purposive sampling. In the second phase, the interviews were coded using grounded theory. Based on this, during the data familiarization stage, 70 verbal evidences identified from the interview texts were categorized into 19 initial or open categories. Below is an excerpt from an interview to illustrate the coding process:

Interviewee 3: "... Given that marketers are increasingly responsible for interpreting and predicting consumer behavior, keeping a pulse on changing trends and customer expectations has always been a priority. However, predicting these factors in the world of advanced solar energy production equipment is more challenging than ever. We live in a very turbulent time—from the pandemic and ongoing climate crisis to rising inflation and, more recently, the Ukraine crisis. It is clear [...] that consumers now expect brands to not only provide value but to actively engage with social and environmental issues. If our sales are to be truly successful, marketers must invest time in understanding their market and customers, defining and identifying the target audience, and carefully considering what matters to them.

Interest in renewable energy is rising, which is good news for anyone in the solar solutions business. This technology is better than ever, environmental awareness is at its peak, and a flawless trend of increasing demand seems to grow year by year. Many solar energy providers have stepped in to claim their market share, and since the solar industry enjoys positive public reaction, launching a successful and sustainable solar business is one of the main concerns for solar business owners. Business owners need to elevate their marketing to experience steady growth. Social media, in the meantime, is a good platform to enhance your marketing strategies..."

Subsequently, axial coding was performed according to the grounded theory method, and the identified categories (open codes) were allocated to axial categories. Table 1 presents the components of the research model within the framework of these categories.

Table 1. Results of Axial Coding of Interviews

Axial Coding	Open Coding
Causal Conditions	¬ Climate change and the need for environmental preservation
	¬ Cost reduction
	¬ Contribution to sales growth
	¬ Need for communication channels to inform customers
Contextual Conditions	¬ Market research
	¬ Utilization of digital capabilities
	¬ Creativity in marketing
Intervening Conditions	¬ Distrust in solar technology and equipment
	¬ Indigenous lifestyle of each region
	¬ Government policies
Strategies and Approaches	¬ Defining and identifying the target audience and market
	¬ Creating added or unique value for the product
	¬ Optimizing marketing through social media
	¬ Remarketing
Outcomes and Consequences	¬ Improving customer experience and creating a memorable product impression
	¬ Business survival in a competitive market
	¬ Building trust through social proof
	¬ Increasing brand/product awareness
	¬ Public benefits from the social and environmental advantages of sol

In this part of the study, the results of the qualitative section were tested using the Partial Least Squares (PLS) method. Descriptive statistics were first reported, followed by inferential statistics derived from the analysis.

Table 2. Characteristics of Respondents (n = 384)

Demographic Variables	Variable Levels	Frequency	Percentage
Gender	Male	320	83
	Female	64	17
Age	20-30 years	48	12
	30-40 years	214	56
	40-50 years	98	26
	Over 50 years	24	6
Work Experience	5-10 years	103	27
	10-20 years	162	42
	20-30 years	108	28
	Over 30 years	11	3
Education	Bachelor's degree	146	38
	Master's degree	153	40
	Doctorate	85	22

Additionally, the research model was tested using the Partial Least Squares (PLS) technique with Smart PLS software. In this model, all relationships were analyzed simultaneously. Figure 1 presents the research model with standardized coefficients.

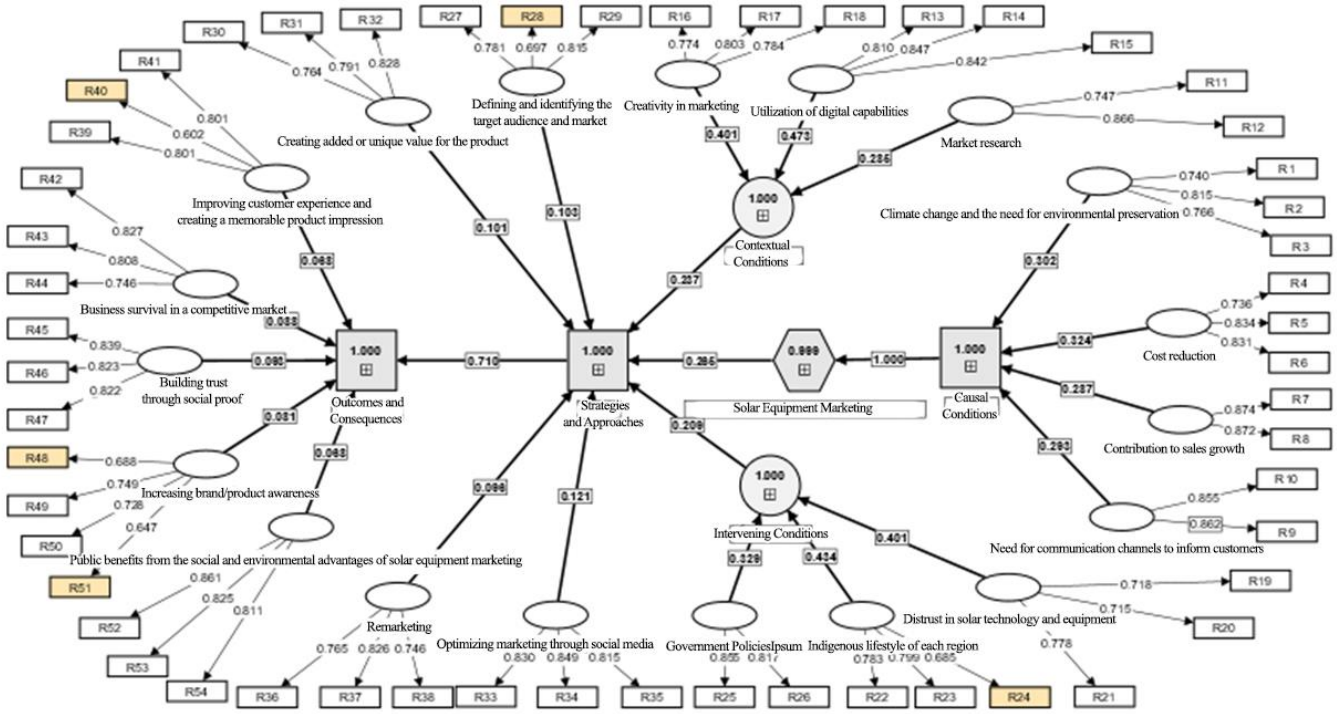

Figure 1. Research Model Test with Standardized Coefficients

Next, after removing factor loadings less than 0.7, the fit of the measurement model was evaluated using two criteria: composite reliability and discriminant validity. The composite reliability coefficients for all constructs were greater than 0.7, indicating sufficient reliability of the model. Furthermore, convergent validity, which examines the correlation of each construct with its indicators, was assessed using the average variance extracted (AVE) calculated by the PLS software. The appropriate value for AVE is 0.5 or higher. As shown in Table 3, the composite reliability (AVE) values all fall within the appropriate range, confirming the adequacy of the reliability, validity, and convergence of the external relationships in the research model.

Table 3. Measurement Model Fit

Factor	Composite Reliability (Alpha > 0.7)	Convergent Validity (AVE > 0.5)
Utilization of digital capabilities	0.872	0.694
Increasing brand/product awareness	0.839	0.723
Creating added or unique value for the product	0.837	0.632
Building trust through social proof	0.867	0.685
Marketing advanced solar energy production equipment	0.855	0.596
Remarketing	0.823	0.608
Business survival in a competitive market	0.834	0.627
Improving customer experience and creating a memorable impression	0.828	0.707
Public benefits from the social and environmental advantages	0.871	0.693
Optimizing marketing through social media	0.870	0.691
Defining and identifying the target audience and market	0.839	0.723
Climate change and the need for environmental preservation	0.817	0.599
Creativity in marketing	0.830	0.620
Strategies	0.915	0.546
Indigenous lifestyle of each region	0.843	0.728
Government policies	0.815	0.690
Contextual conditions	0.875	0.636
Intervening conditions	0.840	0.567
Outcomes and consequences	0.901	0.602
Need for communication channels to inform customers	0.845	0.732
Cost reduction	0.874	0.776

Contribution to sales growth	0.864	0.761

Furthermore, based on the fitted model in Figure 1, the t-statistic for all hypotheses should be greater than 1.96, and the p-value should be less than 0.05. Accordingly, Table 4 presents the path coefficients, standard deviation, t-statistic, and p-value based on the fitted model.

Table 4. Results of Structural Model Implementation

Factor	Path Coefficients	Standard Deviation	T-Statistic	P-Values	Result
Utilization of digital capabilities -> Contextual conditions	0.803	0.010	81.106	0.000	Confirmed
Increasing brand/product awareness -> Outcomes and consequences	0.001	0.018	0.083	0.934	Rejected
Creating added or unique value for the product -> Strategies	0.008	0.012	0.706	0.480	Rejected
Building trust through social proof -> Outcomes and consequences	0.399	0.025	16.026	0.000	Confirmed
Market research -> Contextual conditions	0.287	0.008	37.850	0.000	Confirmed
Marketing advanced solar energy production equipment -> Strategies	0.112	0.015	7.454	0.000	Confirmed
Remarketing -> Strategies	0.000	0.011	0.019	0.984	Rejected
Business survival in a competitive market -> Outcomes and consequences	0.162	0.016	10.163	0.000	Confirmed
Improving customer experience and creating a memorable impression -> Outcomes and consequences	0.019	0.020	0.980	0.328	Rejected
Public benefits from social and environmental advantages -> Outcomes and consequences	0.012	0.018	0.688	0.492	Rejected
Optimizing marketing through social media -> Strategies	0.359	0.018	19.991	0.000	Confirmed
Distrust in solar technology and equipment -> Intervening conditions	0.361	0.015	23.380	0.000	Confirmed
Defining and identifying the target audience and market -> Strategies	0.345	0.015	23.103	0.000	Confirmed
Climate change and the need for environmental preservation -> Causal conditions	-0.035	0.011	3.141	0.002	Confirmed
Creativity in marketing -> Contextual conditions	0.002	0.001	1.413	0.158	Rejected
Strategies -> Outcomes and consequences	0.463	0.025	18.667	0.000	Confirmed
Indigenous lifestyle of each region -> Intervening conditions	0.532	0.017	32.249	0.000	Confirmed
Government policies -> Intervening conditions	0.313	0.010	31.740	0.000	Confirmed
Contextual conditions -> Strategies	0.200	0.014	13.811	0.000	Confirmed
Causal conditions -> Marketing advanced solar energy equipment	0.969	0.002	500.816	0.000	Confirmed
Intervening conditions -> Strategies	0.090	0.014	6.371	0.000	Confirmed
Need for communication channels to inform customers -> Causal conditions	0.317	0.024	13.390	0.000	Confirmed
Cost reduction -> Causal conditions	0.758	0.016	48.162	0.000	Confirmed
Contribution to sales growth -> Causal conditions	0.052	0.010	5.246	0.000	Confirmed

Based on the results presented in Table 4, the T-statistic indicates the significance of the relationships between the model variables, as the p-value is less than 0.05. In other words, the significance test of the path coefficients shows that all paths, except for Creativity in marketing -> Contextual conditions; Creating added or unique value for the product -> Strategies; Remarketing -> Strategies; Increasing brand/product awareness -> Outcomes and consequences; Improving customer experience and creating a memorable impression -> Outcomes and consequences; and Public benefits from social and environmental advantages -> Outcomes and consequences, are statistically significant and their effects are confirmed. This implies that the components developed in the research model, after removing the above paths, possess appropriate reliability.

4. Discussion and Conclusion

The present study aimed to develop a marketing model for solar energy production equipment. The components of this model were identified based on the analysis of interview results using grounded theory and subsequently validated through a questionnaire and structural equation modeling using the Partial Least Squares (PLS) method. The results of the study indicated that the paradigm model consists of causal factors, including climate change and the need for environmental preservation, cost reduction, contribution to sales growth, and the need for communication channels to inform customers; contextual conditions, including market research and the utilization of digital capabilities; intervening conditions, including distrust in solar technology and equipment, the indigenous lifestyle of each region, and government policies; effective strategies for marketing advanced solar energy production equipment, including defining and identifying the target audience and market,

optimizing marketing through social media, and remarketing; and outcomes resulting from the application of these strategies, such as improved customer experience and creating a memorable product impression, business survival in a competitive market, building trust through social proof, increasing brand/product awareness, and providing social and environmental benefits to the general public through solar equipment marketing.

Overall, the findings from existing research in this field suggest that neither domestic nor international studies have addressed the marketing of advanced solar energy production equipment in the manner presented in this study. Therefore, this research is unique in its objectives and the novelty of its propositions. However, the overall aim of this research overlaps with the general objectives of previous studies [13, 15-17], in their focus on solar marketing. In fact, the researcher derived the general objective of this study from these scholars. Additionally, it can be stated that most studies aimed at providing a model for marketing advanced solar energy production equipment have not utilized a combined approach.

Based on the research results, the marketing theory for solar energy production equipment can be explained as follows: considering the importance of addressing climate change and the need for environmental preservation, cost reduction, contribution to sales growth, and the need for communication channels to inform customers as a set of causes and conditions that impact the central theme of curriculum development in the workplace with a foresight approach in Iran's higher education system; provided that contextual conditions such as market research, utilization of digital capabilities, and creativity in marketing are met on the one hand; and alongside resolving distrust in solar technology and equipment, improving the indigenous lifestyle in each region, and government policies in this domain on the other hand; the marketing strategies for advanced solar energy production equipment will be realized. These strategies include defining and identifying the target audience and market, creating added or unique value for the product, optimizing marketing through social media, and remarketing. These strategies are expected to lead to outcomes such as improved customer experience and creating a memorable product impression, business survival in a competitive market, building trust through social proof, increasing brand/product awareness, and providing social and environmental benefits to the general public through solar equipment marketing.

Therefore, this study presents a paradigm model for marketing solar energy production equipment. Furthermore, the findings of this study can be used to better prepare organizational conditions in the field of solar energy production equipment marketing by implementing and allocating a step-by-step process to downstream executive organizations or upstream decision-makers. Hence, it is recommended that governmental and private centers establish a suitable framework to provide the necessary training in this field, aiming to prepare the groundwork for understanding various aspects of solar energy production equipment marketing and its implementation strategies as identified in the research.

Authors' Contributions

Authors equally contributed to this article.

Acknowledgments

Authors thank all participants who participate in this study.

Declaration of Interest

The authors report no conflict of interest.

Funding

According to the authors, this article has no financial support.

Ethical Considerations

All procedures performed in this study were under the ethical standards.

References

[1] A. Mostafaeipour *et al.*, "A conceptual new model for use of solar water heaters in hot and dry regions," (in en), *Sustainable Energy Technologies and Assessments*, vol. 49, p. 101710, 2022, doi: 10.1016/j.seta.2021.101710.

[2] H. Abuzaid, L. A. Moeilak, and A. Alzaatreh, "Customers' perception of residential photovoltaic solar projects in the UAE: A structural equation modeling approach," (in en), *Energy Strategy Reviews*, vol. 39, p. 100778, 2022, doi: 10.1016/j.esr.2021.100778.

[3] I. D. Ibrahim *et al.*, "A review on Africa energy supply through renewable energy production: Nigeria, Cameroon, Ghana and South Africa as a case study," (in en), *Energy Strategy Reviews*, vol. 38, p. 100740, 2021.

[4] C. L. Crago, "Economics of Solar Power," in *Oxford Research Encyclopedia of Environmental Science*, 2021.

[5] D. J. Ringold and B. Weitz, "The American Marketing Association definition of marketing: Moving from lagging to

leading indicator," (in en), *Journal of Public Policy & Marketing*, vol. 26, no. 2, pp. 251-260, 2007.
[6] S. Vinerean, "Content marketing strategy. Definition, objectives and tactics," (in en), *Expert Journal of Marketing*, vol. 5, no. 2, 2017.
[7] M. Alipour, H. Salim, R. A. Stewart, and O. Sahin, "Predictors, taxonomy of predictors, and correlations of predictors with the decision behaviour of residential solar photovoltaics adoption: A review," (in en), *Renewable and Sustainable Energy Reviews*, vol. 123, p. 109749, 2020, doi: 10.1016/j.rser.2020.109749.
[8] E. Karakaya and P. Sriwannawit, "Barriers to the adoption of photovoltaic systems: The state of the art," (in en), *Renewable and Sustainable Energy Reviews*, vol. 49, pp. 60-66, 2015, doi: 10.1016/j.rser.2015.04.058.
[9] M. Kratschmann and E. Dutschke, "Selling the sun: A critical review of the sustainability of solar energy marketing and advertising in Germany," (in en), *Energy Research & Social Science*, vol. 73, p. 101919, 2021, doi: 10.1016/j.erss.2021.101919.
[10] A. Stauch, R. Wüstenhagen, and T. Tomczak, "Community solar marketing," doctoral, St.Gallen, 2021. [Online]. Available: https://www.alexandria.unisg.ch/262401/
[11] L. Salgado-Conrado and A. Lopez-Montelongo, "Barriers and solutions of solar water heaters in Mexican household," (in en), *Solar Energy*, vol. 188, pp. 831-838, 2019.
[12] H. Wirtz and M. Janssen, "Development and marketing of solar innovations: A case study," (in en), *Journal of technology management & innovation*, vol. 5, no. 2, pp. 91-103, 2010.
[13] E. Shaughnessy, G. Barbose, R. Wiser, and S. Forrester, "Income-targeted marketing as a supply-side barrier to low-income solar adoption," (in en), *Iscience*, vol. 24, no. 10, p. 103137, 2021.
[14] K. S. Wolske, P. C. Stern, and T. Dietz, "Explaining interest in adopting residential solar photovoltaic systems in the United States: Toward an integration of behavioral theories," (in en), *Energy research & social science*, vol. 25, pp. 134-151, 2017.
[15] J. Kuada, E. Mensah, A. I. Bujac, and J. S. Bentzen, "Marketing solar energy in ghana: A relational perspective," in *Exploring the Dynamics of Consumerism in Developing Nations*, 2019, pp. 301-320.
[16] F. Sadamoro, O. Ajayi, A. Oo, and A. To, "Influence Of Relationship Marketing On Customers' Loyalty Among Solar Power Consumers In Ekiti State, Nigeria," (in en), *British Journal of Management and Marketing Studies*, vol. 6, pp. 81-92, 2023.
[17] M. Tahiri, "Ranking and identifying the factors affecting the marketing and sales of new products for the production of electrical energy (solar panel) - a case study of Fars Province Electricity Distribution Company," Master's Thesis, 2019. [Online]. Available: https://ganj.irandoc.ac.ir/#/articles/c41b181a19c1bc8e64fefbac74af6e39