# Customer Awareness and Adoption of IOT and Solar Energy Solutions in Madurai District

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A Study of Solar Energy and Smart Technology Solution Companies

Madurai District, Tamil Nadu, India

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## ABSTRACT

The current research aims to explore the extent to which customers are aware of and have a good understanding of the concept of IoT and solar energy solutions in Madurai district of Tamil Nadu state. As the costs of electricity continue to rise coupled with increasing concerns about the environment, renewable energy consumption has become increasingly significant both at household and industrial levels. In this research, a survey instrument was used on a sample size of 50 consumers in Madurai, representing households, commercial organizations and agricultural units. The methods used in data analysis include percentage method, weighted average technique, Garrett ranking and Chi-square test. Major findings include that economic issues including initial cost of installation and reduction of electricity expenses, rather than gender, determine customers' adoption behaviour.

Keywords: Solar Energy, IoT, Customer Awareness, Renewable Energy, Madurai, Smart Technology, Adoption

## 1. INTRODUCTION

The trend towards renewable sources of energy in the world has resulted in increased opportunities in emerging markets in India. Madurai district in the state of Tamil Nadu has seen a rise in awareness levels as well as a rise in tariff rates. The lack of supply from the national grid in the area combined with awareness of environmental issues has increased demand for solar energy as well as the use of IoT to provide smart solutions.

Solar energy, which is backed by government policies like the National Solar Mission in India, provides a practical as well as cost-efficient solution to electricity for consumers in all spheres of life. However, there is low uptake of these technologies in semi-urban and urban districts because of various challenges, including the costs involved and lack of information on how to adopt and manage them.

## 2. OBJECTIVES OF THE STUDY

The primary objectives of this research are as follows:

(i) To study customer awareness and preference towards IoT and solar solutions in Madurai District.

(ii) To evaluate customer satisfaction with solar and smart technology service companies.

(iii) To identify the factors influencing the adoption of renewable and smart technologies.

(iv) To provide recommendations for improving service quality and business performance in the Madurai market.

## 3. REVIEW OF LITERATURE

The author Painuly (2001) discussed major impediments to the use of renewable energy in developing nations, namely the problem of high initial investments, the issue of consumer awareness, and policy-related barriers. Rogers (2003) offered a theoretical framework on diffusion of innovations which included five phases such as awareness, interest, evaluation, trial, and adoption along with the importance of social systems and communication channels.

In addition, Gubbi et al. (2013) presented an architectural model of IoT and its applications in both residential and industrial systems. Furthermore, Porter and Heppelmann (2014) explained how smart products using IoT technology alter competition dynamics in an organisation. Similarly, Sharma and Goel (2017) assessed the consumer's perception regarding solar power in India, finding out that the benefits like cost savings and environmental protection motivated customers, whereas high installation expenses are the main deterrent.

Likewise, Kumar and Singh (2018) explored the influence of IoT technology on organisations' operations, verifying that IoT has contributed positively to organisational performance by bringing efficiencies. According to the International Energy Agency (2020), solar energy is the fastest-growing global energy resource due to falling technology costs and favourable policies.

## 4. RESEARCH METHODOLOGY

The present research is conducted using a descriptive and empirical approach that utilizes a mixed-methods research design including both quantitative and qualitative methods. Quantitative data collection involved using close-ended and Likert-scale questions in structured questionnaires. Information in qualitative form was collected via informal discussions with customers in Madurai District.

**Location for Study**: Madurai District, Tamil Nadu, India

A selective sampling technique was used, choosing 50 respondents among the residents, commercial, agricultural, and service sector segments in Madurai based on their knowledge or usage of solar and IoT technologies. Questionnaire distribution was done both online and offline.

**Statistics Techniques Utilized:**

(i) Percentage Technique (ii) Weighted Average Technique (iii) Garrett's Ranking Technique (iv) Chi-Square Technique

This study adopts a descriptive and empirical research design combining both quantitative and

## 5. DATA ANALYSIS AND INTERPRETATION

### 5.1 Demographic Profile of Respondents

**Table 1: Gender Distribution**

| Gender | No. of Respondents | Percentage (%) |
|---|---|---|
| Male | 35 | 70 |
| Female | 15 | 30 |
| Total | 50 | 100 |

The majority of respondents (70%) are male, indicating that men are the primary decision-makers for adopting IoT and solar solutions in Madurai District.

**Table 2: Age Distribution**

| Age Group | No. of Respondents | Percentage (%) |
|---|---|---|
| Below 25 | 10 | 20 |
| 25 – 30 | 12 | 24 |
| 30 – 40 | 13 | 26 |
| Above 40 | 15 | 30 |
| Total | 50 | 100 |

The largest group (30%) comprises respondents above 40 years, followed by the 30–40 age group (26%). This indicates that middle-aged and older adults in Madurai are the primary investors in solar and smart technology solutions.

**Table 3: Monthly Income Distribution**

| Monthly Income (₹) | No. of Respondents | Percentage (%) |
|---|---|---|
| Below ₹20,000 | 12 | 24 |
| ₹20,000 – ₹40,000 | 13 | 26 |
| ₹40,000 – ₹60,000 | 15 | 30 |
| Above ₹60,000 | 10 | 20 |
| Total | 50 | 100 |

The income distribution shows that 56% of respondents earn between ₹20,000 and ₹60,000 per month, confirming that the middle-income group constitutes the primary customer base in Madurai District. Affordability is therefore a critical factor in adoption decisions.

### 5.2 Awareness and Electricity Usage

**Table 4: Electricity Dependency and Awareness**

| Parameter | Category | Respondents | % |
|---|---|---|---|
| Electricity Usage | More than 12 hrs/day | 34 | 68 |
| Rooftop Solar Awareness | Aware (Yes) | 32 | 64 |
| Rooftop Solar Awareness | Not Aware (No) | 18 | 36 |
| Primary Awareness Source | Local Dealers | 18 | 36 |
| Primary Awareness Source | Word of Mouth | 13 | 26 |

68% of respondents in Madurai use electricity for more than 12 hours per day, highlighting heavy dependency and a strong potential market for solar solutions. While 64% are aware of rooftop solar systems, 36% remain uninformed. Local dealers (36%) and word of mouth (26%) are the most influential awareness channels, underscoring the importance of strengthening dealer networks in Madurai.

### 5.3 Satisfaction and Decision Factors

**Table 5: Satisfaction with Current Electricity Cost (Weighted Average)**

| Satisfaction Level | Respondents (X) | Weight (W) | WX |
|---|---|---|---|
| Highly Satisfied | 0 | 5 | 0 |
| Satisfied | 3 | 4 | 12 |
| Neutral | 24 | 3 | 72 |
| Dissatisfied | 13 | 2 | 26 |
| Highly Dissatisfied | 10 | 1 | 10 |
| Total | 50 | — | 120 |

**Weighted Average = ΣWX / ΣX = 120 / 50 = 2.4**

A weighted average score of 2.4 (on a scale of 1–5) indicates that satisfaction with electricity costs among Madurai respondents is critically low. 74% of respondents are either neutral or actively dissatisfied, confirming the strong motivation to switch to solar energy as a cost-saving alternative.

**Table 6: Factors Influencing Adoption Decision**

| Influencing Factor | No. of Respondents | Percentage (%) |
|---|---|---|
| Reduced Electricity Bills | 17 | 34 |
| Economic Benefits (Long-term Savings) | 14 | 28 |
| Government Incentives / Subsidies | 13 | 26 |

| | | |
|---|---|---|
| Environmental Concerns | 6 | 12 |
| Total | 50 | 100 |

Reduced electricity bills (34%) and economic benefits (28%) are the most influential factors driving solar adoption in Madurai District, confirming that financial motivation outweighs environmental concern (12%). This has direct implications for how solar companies should position and market their services.

### 5.4 Garrett Ranking: Barriers to Solar Adoption

Respondents ranked five barriers affecting their decision to adopt solar systems. The Garrett ranking method was applied to convert rankings into percentage scores.

**Table 7: Garrett Ranking Results**

| Barrier Factor | Total Score (XF) | Mean Score (%) | Rank |
|---|---|---|---|
| Initial Investment Cost | 2980 | 59.6 | I |
| Government Subsidy Availability | 2655 | 53.1 | II |
| EMI / Loan Options | 2458 | 49.2 | III |
| Savings on Electricity Bills | 2382 | 47.6 | IV |
| Return on Investment | 2075 | 41.5 | V |

Initial investment cost ranks as the most significant barrier to solar adoption (mean score 59.6%), followed by access to government subsidies (53.1%) and financing options such as EMI and loans (49.2%). Return on investment ranks last, suggesting that consumers in Madurai are more concerned with immediate financial constraints than long-term returns.

### 5.5 Chi-Square Test: Gender and Solar Awareness

*$H_0$: There is no significant association between gender and awareness of rooftop solar systems.*

*$H_1$: There is a significant association between gender and awareness.*

**Table 8: Chi-Square Contingency Table and Calculations**

| Category | Observed (O) | Expected (E) | $(O-E)^2$ | $(O-E)^2/E$ |
|---|---|---|---|---|
| Male – Aware | 25 | 22.4 | 6.76 | 0.30 |
| Male – Not Aware | 10 | 12.6 | 6.76 | 0.54 |
| Female – Aware | 7 | 9.6 | 6.76 | 0.70 |
| Female – Not Aware | 8 | 5.4 | 6.76 | 1.25 |
| Total $\chi^2$ | — | — | — | 2.79 |

**Calculated $\chi^2 = 2.79$ | Table value at df=1, $\alpha$=0.05 = 3.84**

Since the calculated value (2.79) is less than the critical value (3.84), the null hypothesis is accepted. There is no significant association between gender and solar awareness in Madurai District. This implies that awareness campaigns should target all demographic groups equally, without gender-based segmentation.

## 6. FINDINGS

This study provides the following main findings concerning Madurai district:

(i) The male gender group (70%) constitutes the predominant consumer base, but the impact of gender on awareness cannot be ignored (Chi-Square Test).

(ii) The target audience in Madurai consists primarily of middle-aged people (above 30 years) and middle-class people (₹20,000 to ₹60,000 per month).

(iii) More than 68% of the survey participants consume electricity for more than 12 hours, implying high dependence on electricity and hence high interest in exploring other means of consumption.

(iv) Awareness among customers about roof-top solar panels is only moderate (64%), but still 36% of consumers from Madurai are unaware of such technology.

(v) The major source of information regarding solar panels is the local dealers and word-of-mouth communication.

(vi) Consumer dissatisfaction level regarding electricity price is very poor (average weighted rating of 2.4/5), thereby pulling the customers towards solar panel usage.

(vii) Initial cost is the highest barrier to usage (Garrett Rank I), followed by availability of subsidy from the government and finances.

(viii) About 66% consumers think that solar energy will be the way of the future.

## 7. SUGGESTIONS

Considering the above findings from Madurai District, the below mentioned suggestions are recommended to solar energy as well as IoT solution firms operating within the district:

(i) Access to Finance: Provide flexible EMI options, free installation schemes, as well as collaboration opportunities with banks and non-banking financial institutions in Madurai.

(ii) Government Subsidies: The firms need to set up dedicated help desks at their office premises in Madurai which can help them in guiding consumers in applying for subsidies from TEDA.

(iii) Dealer Network and Customer References: Strengthening the existing dealer network in Madurai, as well as encouraging customer referrals via loyalty and referral schemes.

(iv) Consumer Education Programmes: Hosting awareness and educational programs in schools and colleges, as well as creating digital campaigns in Tamil language targeting the segment of Madurai consumers unaware of the concept of rooftop solar panels.

(v) Agricultural Sector Outreach: Firms should extend their services to farmers in rural areas of Madurai by making use of solar power to irrigate farmlands through solar water pumps.

(vi) Enhanced After-Sales Services: Setting up a service center in Madurai for offering timely technical and other after-sales services.

## 8. CONCLUSION

The present research has offered an exhaustive examination of the awareness, perception and adoption behavior towards solar energy and IoT technology in Madurai District, Tamil Nadu. As per the results, it is clear that there is increasing and positive attitude among customers towards adopting renewable energy sources in Madurai District, which is mainly due to their economic considerations such as reduction in hefty electricity bills, rather than environmental motives.

Nonetheless, the two most important issues hampering their adoption are high investment costs and low customer awareness in a few sections. The Chi-square test proves that customer awareness is not affected by the gender of customers, which allows firms to adopt inclusive marketing strategies. Provided appropriate finance, subsidies from the government and efficient dealership networks, the solar and IoT solution market in Madurai District can be expected to have good growth opportunities.

The current paper will serve as useful knowledge about renewable energy adoption at the district level for solar energy companies, policy makers and academicians in South Tamil Nadu.

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