Tracking Selection Criteria of Solar Panels on Consumer Market in Bangladesh

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Abstract: Among the extrinsic problems faced by the people of Bangladesh, load shedding carries much weight. This study prescribes a solution by offering a feasible alternative source of energy: solar panel. Solar panels are effective in providing an equivalent amount of energy at a reasonable cost compared to existing power plants. Though there is usage of solar panels in Bangladesh, the concept is not commercially prevailed for consumer markets in remote areas. The main objective of the study is to provide a blend of different attributes that consumers may consider for purchasing solar panels. By conducting depth interviews, 3 key attributes have been derived, i.e., capacity, installment, and price; along with different levels. 48 respondents were offered 20 different profiles of attribute levels to put ratings at a 100-point scale. It has been found from the analysis that people mostly prefer 100 watt panels to purchase in 12 installments each for BDT 1500-2000. Yet, corporations in Bangladesh have scope to work on it and commercialize efficiently.

Keywords: Solar Panels, Conjoint Analysis, Selection Criteria, Commercialization, Attributes and Levels.

Introduction :

Today's world is much dependent on electric power supply. In every step of our lives, electricity has its necessity. As the time passes by, the demand for energy is increasing with the increase in the world's population. From different large corporation to small households, people need energy to perform daily tasks. As the science and technology is developing, people's lives are also becoming more and more complex. To meet energy demands, Dhaka Electric Supply Company (DESCO) is providing the power supply. But it is getting tougher to ensure electricity in all sectors. That's why, people are facing load shedding. People are using substitute sources like, IPS (Instant Power Supply), Generator, Candles etc. to get rid of this problem. But these alternatives can hardly serve the total demand during load shedding.

Bangladesh is a developing country. Here all people are not able to lead life expensively. If they use IPS or generator during load shedding, they will face very high price of it along with the maintenance cost. Electricity is required to recharge the battery of IPS that causes the electricity bill to be very high. Besides, IPS requires changing the battery after every two years that will incur additional costs. In rural areas, IPS is unable to provide the power supply because there is not enough electricity to recharge the battery. Even IPS cannot supply the power more than 4 or 5 hours at a stretch. Generator requires fuel for

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providing the supply. Generator consumes 1 liter diesel or octane for an hour. The price of diesel or octane is already high and it is increasing day by day.

In this situation, renewable energies such as solar panel can be a good substitute to supply energies for household along with other sectors. Today, many solar companies exist. They provide a complete solar package at reasonable price so that every class of people can afford.

This report intends to investigate whether there is any prospect of solar energy in Bangladesh. In Bangladesh, near about 30% people know about solar energy but only 3% people are using it for their daily purposes (BTRC, 2014). Primarily solar energy is used for households to run light and fan. But today solar energy is being used for larger projects like power supply of a shopping mall, irrigation projects, etc. Many countries are using solar power to run vehicles also. This culture is also seen in Bangladesh as well.

For a developing country like Bangladesh, people can easily use solar panel because it has lower cost. People can pay the price of solar energy through installments. Many companies exist in Bangladesh that are providing easily affordable installment packages. It consumes the power from the sunlight through a panel which is set on the roof top of households so that it does not require any other sources like electricity or any other fuel to recharge its battery. The products which are essential to provide the supply like panel or battery are given a long time warranty so that they ensure a low maintenance cost. Lights or fans which are run with the power do not consume much energy. The battery is rechargeable even in low power of sun.

Objectives of the Study:

The main objective of the study is to track the selection criteria of solar panels for consumer decision making. Apart from this, the report has following specific objectives:

- To know the consumer demand of solar panel
- To find what elements are necessary to sell a solar panel
- To identify which package of solar panel attracts consumer mostly
- To provide suggestions to solar panel suppliers about the business potentials

Significance of the Study:

Human being has always been in search of new and better products and services. In the process, societies forever demand and produce all kinds of goods and services. In case of solar energy, people are trying to get the latest technology so that they can easily consume it. This study helps people get valuable information about existing solar energy options they have in the market. The least maintenance cost advantage along with environment friendliness of solar panels makes a win-win situation for both the customers and the society. Moreover, zero usage of fuel and other fossils ensures no cutting of trees as well as financial gains. This study shows up that even though the initial purchase cost is higher, installment options are being provided by solar panel providers. Thus, every class of people can afford it. Further, this study allows other researchers to take into account more variables to design better business modules for solar panels.

Scopes and Limitations of the Study:

This study has taken into consideration the attributes and levels derived from in-depth interview with industry experts. Later, the primary data are generated by interviewing targeted people of different classes who are the heads of their families. Eventually, the corporate houses, industries, and factories are excluded from this study. It covered the families that are using or not using substitute sources at the time of load shedding. The study covers overall possibilities of solar energy and marketing. The survey has been conducted over people from remote rural areas along with divisional cities. People from rural areas are not that much aware of solar panels and thus they responded based on intuition after getting brief idea from interviewers. Thus, it created some chance of articulated data that have further been reduced by applying orthogonal design.

Literature Review

The culture of using solar panels to run households is getting popular in Bangladesh with local demands along with government initiatives. Moreover, NGOs are also working to fight the need for energy for the root level people. With its growing popularity and emergence in the lives of Bangladeshi people, the concern of conducting a research for commercializing solar panels gets focus. This section provides insights on criteria people consider before buying solar panels in different developing countries of the world. In one study conducted by Ledwatcher (2016), it has been suggested to think about house condition first including duration of stay, energy needed to power the house, roof type to check whether solar panel fits in it, budget for the panels, location to set the panels to ensure adequate sunlight, legal permission to avoid legislature issues, and solar panel supplier.

One study related to the subject matter shows up two views for the selection of solar panels. Firstly, in view of suppliers, consumers should check the aluminum quality used to prepare the solar panel along with the thickness and UV resistance nature. Further, capsulation of cells and coverage of water seal add to the longevity of the solar panels. For better maintenance, it has been suggested to check the cable quality and micro cracking protection. Secondly, in view of consumers, consumers desire the power level to execute all their activities of home. Moreover, ongoing performance with minimal maintenance hassle should be there backed by technical confidence through high power tolerance (LG, 2016). Another report emphasized on the suitability of roof assuming differences in materials used to prepare the roof. Consumers tend to avoid the maintenance troubles and excessive running costs for a daily necessity amenity service. Even consumers may hardly have detailed knowledge about how the panel works in actual and expect the end product to be easy to use. There is a belief that solar panels are mostly imported and thus included tariffs in the end price. Such addition of tariffs hikes the price and lowers consumer demands (Greenmatch, 2014).

Solar panels run with sunlight and thus it is a must to ensure that sun touches the roof throughout the year. Even once the panels are installed, it is difficult to move and shift. Thus, a reliable vendor has to be selected at a reasonable installation cost. In case the cost is beyond people's reach, customers may expect financial assistance or installment facility

from the vendor or any other financial institutions. It is advised to run on solar panels if the total duration of use is longer to adjust with the cost and installment contract. The size and nature of solar panels varies based on the capacity to be derived from the panels (Complete Solar, 2013). Consumers intend to make a balance on price paid to acquire solar panels and benefits received from using it. There is a rumor about solar panels that they get over heated during operation and can hardly provide required voltage. Experts suggest looking into conversion of solar panels before buying along with resistance in terms of potential induced degradation and light induced degradation. Solar panels with embodied energy storage are preferable to consumers as it gives smooth electricity supply even when the sun is not present. Additional features like warranty of services, variations in size, difference in watts, etc. add value to solar panels in consumer minds (Energy Matters, 2016).

Methodology

This study is a descriptive research including both qualitative and quantitative analyses. For qualitative research, secondary data have been analyzed to identify the attributes and levels of solar panels. For quantitative research, survey has been conducted over 248 people who are the heads of the family households. Apart from demographic information, they were asked about preference of solar panels based on following attributes and levels:

Table 1: Attributes and Levels for AVA solar

Attributes	Level 1	Level 2	Level 3	Level 4
Capacity	50 w	100 w	150 w	200 w
Installment	12 months	24 months	36 months	
Price	BDT 500-1000	BDT 1000-1500	BDT 1500-2000	

In this study, target population is defined as those who face load shedding in daily lives and who are looking for alternative solution. From those, sampling frame included middle and upper class people of 8 divisional cities of Bangladesh including Dhaka, Chittagong, Rangpur, Rajshahi, Sylhet, Barisal, Khulna, and Mymensingh. For any analysis to be normally distributed, at least 30 samples are needed (Levin and Rubin, 1998). For better accuracy and generalization, samples are taken from each division considering the population size and proportion of using solar panels. The number of sample taken initially is 240 and it is and rounded to the nearest decimal counting 99% incidence and completion rate. The final sample size is calculated by following formula:

$$Total\ Sample$$

$$Initial\ Sample\ Incidence\ Rate \times Completion\ Rate$$

$$240$$
$$0.99 \times 0.99$$

$$247.82 \approx 248\ (rounded\ to the nearest\ decimal)$$

This study is based on a blend of primary and secondary data. At first, secondary research has been conducted to identify variables, attributes, and levels for the final product. Based on those attribute-levels, primary data is collected through survey from people using

structured questionnaire. The survey questionnaire used to collect primary data was a combination of MCQ, and dichotomous questions. Other than this, full profiles of attribute-levels were included. The respondents were asked to rate each profile in a 100- point scale. After data collection, the profiles were ranked based on the rating given by the respondents. Only a few demographic questions were set. The major focus was on the consumption of solar panels. The resultant data is analyzed by using Conjoint Analysis procedure. The software package used in this study is SPSS 16 and MS Excel 2007.

Data Analysis and Discussions:

Discussion on Consumer Behavior toward Solar Panel

Among 248 respondents, 141 were male and 107 were female. Monthly income of interviewed people were mostly within BDT 20000 to 40000. Only a few households had earned more than BDT 60000. The majority of response (68%) for the duration of load shedding was more than 2 hours. 115 households had no electricity at all at remote areas. Among 248 households, 159 (over 60%) families used candle or other sources at the time of load shedding, 66 families had IPS, and only 23 families used solar panels. Majority of households (nearly 80%) spend less than BDT 100 at the time of load shedding using substitute sources daily. It is alarming that in divisional cities, apart from Dhaka, the capital of Bangladesh, people hardly knew about solar

panels (13%). Even people who know about panels, only a meager proportion (6.9%) actually use solar panels in their households during load shedding. Some important reasons behind not using solar panel are prohibition from the house owners, initial high expense to install solar panel, and unawareness of how to use it.

Identifying Attribute-Levels Solar Panels

To analyze the data, a conjoint analysis is done in this study. The conjoint analysis follows formal process starting from problem formulation that ends at reliability assessment. In this study, the attributes and its levels are selected from the secondary research. They are shown in the table below:

Attributes	Level No.	Description
Capacity	1	50 w
	2	100 w
	3	150 w
	4	200 w
Installment	1	12 months
	2	24 months
	3	36 months
Price	1	BDT 500-1000
	2	BDT 1000-1500
	3	BDT 1500-2000

Table 2: Attribute Name, Number, and Levels

From the table above, full profiles were constructed by combining all the attributes and levels. The probable number of profiles is 36 (4 X 3 X 3). The number of profiles has

been decreased by using *fractional factorial design*. Thus, the number of profiles becomes 16. In each of the profiles, the respondents have put their ratings in a 100-point scale. This rating gives the data in an interval scale resulting in metric data.

The basic conjoint model is used to measure the utility of each combination of attributes and levels. The model may be represented by following formula:

$$U(X) = \sum_{i=1}^{m}\sum_{j=1}^{k_i} \alpha_{ij} X_{ij}$$

Where, U(X)= Utility of the variable

α = Significance level X =

Dummy variable

i = Attribute of the variable

j = Level of the variable

There are many procedures available for estimating this model. The simplest way is dummy variable regression. In doing this, the variables are needed to be converted into dummy variables. The following table shows dummy variables for the attributes.

Capacity			Installment		Price	
X_1	X_2	X_3	X_4	X_5	X_6	X_7
1	0	0	0	1	0	1
0	0	1	0	1	0	0
1	0	0	0	1	1	0
1	0	0	0	0	0	0
0	0	1	0	0	0	1
0	0	1	1	0	1	0
0	0	0	1	0	0	1
0	1	0	0	0	0	0
0	0	0	0	0	1	0
0	0	0	0	0	0	0
0	0	0	0	1	0	0
0	1	0	0	0	0	1
0	1	0	1	0	0	0
0	0	1	0	0	0	0
1	0	0	0	0	1	0
1	0	0	1	0	0	0

Table 3: Dummy Variables

The model can be represented as:

U

2009)

$$b_0 + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 + b_5 X_5 + b_6 X_6 + b_7 X_7$$

(Douglas et al.,

Where, X_1, X_2, X_3 = Dummy variable representing Capacity X_4,

X_5= Dummy variable representing Installment X_6, X_7 =

Dummy variable representing Price

b = Parameters

By doing regression analysis, the parameters are estimated as follows:

b_0 = 62.898		b_3	= -14.250		b_6 = -0.802
b_1 = 11.156		b_4	= -0.974		b_7=-3.661
b_2 = 8.464		b_5	= -2.490		

These parameters are helpful in estimating the utility of each attribute-level. The detailed calculation is given below:

- **For Capacity,**

$ά_{11} − ά_{14} = 11.156$ .... (i)

$ά_{12} - ά_{14} = 8.464$ …..................... (ii)

$ά_{13} - ά_{14} = -14.250$ …................... (iii)

$ά_{11} + ά_{12} + ά_{13} + ά_{14} = 0$ …........... (iv)

Solution:

From (i)

$ά_{11} − ά_{14} = 11.156$

$\therefore ά_{11} = 11.156 + ά_{14}$

From (ii)

$ά_{12} - ά_{14} = 8.464$

$\therefore ά_{12} = 8.464 + ά_{14}$

From (iii)

$ά_{13} - ά_{14} = -14.250$

$\therefore ά_{13} = ά_{14} - 14.250$

Put into (iv)

$11.156 + ά_{14} + 8.464 + ά_{14} + ά_{14} - 14.250 + ά_{14} = 0$

$\Rightarrow 5.34 + 4 ά_{14} = 0$

$\Rightarrow 4 ά_{14} = -5.34$

$\therefore ά_{14} = -1.34$

Put into (i)

$ά_{11} + 1.34 = 11.156$

$\therefore ά_{11} = 9.81$

Put into (ii)

$ά_{12} + 1.34 = 8.464$

$\therefore ά_{12} = 7.12$

Put into (iii)

$ά_{13} + 1.34 = -14.250$

$\therefore ά_{13} = -15.59$

- **For Installment,**

$ά_{21} − ά_{23} = -0.974$ … .... (i)

$ά_{22} − ά_{23} = -2.490$ … .... (ii)

$ά_{21} + ά_{22} + ά_{23} = 0$ …................. (iii)

Solution:

From (i)

$$\acute{\alpha}_{21} - \acute{\alpha}_{23} = -.974 \qquad \therefore \acute{\alpha}_{21} = \acute{\alpha}_{23} -.974$$

From (ii)

$$\acute{\alpha}_{22} - \acute{\alpha}_{23} = -2.490$$

$$\therefore \acute{\alpha}_{22} = \acute{\alpha}_{23} -2.490$$

Put into (iii)

$$\acute{\alpha}_{23} -.974 + \acute{\alpha}_{23} -2.49 + \acute{\alpha}_{23} = 0$$

$$\Rightarrow 3\acute{\alpha}_{23} - 3.464 = 0$$

$$\therefore \acute{\alpha}_{23} = 1.154$$

Put into (i)

$$\acute{\alpha}_{21} - 1.154 = -.974$$

$$\therefore \acute{\alpha}_{21} = 0.18$$

Put into (ii)

$$\acute{\alpha}_{22} - 1.154 = -2.490$$

$$\acute{\alpha}_{22} = -1.336$$

- **For Price,**

$$\acute{\alpha}_{31} - \acute{\alpha}_{33} = -.802 \ldots \ldots \ldots \ldots (i)$$

$$\acute{\alpha}_{32} - \acute{\alpha}_{33} = -3.661 \ldots \ldots \ldots (ii)$$

$$\acute{\alpha}_{31} + \acute{\alpha}_{32} + \acute{\alpha}_{33} = 0 \ldots \ldots \ldots (iii)$$

Solution:

From (i)

$$\acute{\alpha}_{31} - \acute{\alpha}_{33} = -.802$$

$$\therefore \acute{\alpha}_{31} = \acute{\alpha}_{33} -.802$$

From (ii)

$$\acute{\alpha}_{32} - \acute{\alpha}_{33} = -3.661$$

$$\therefore \acute{\alpha}_{32} = \acute{\alpha}_{33} -3.661$$

Put into (iii)

$$\acute{\alpha}_{33} -.802 + \acute{\alpha}_{33} -3.661 + \acute{\alpha}_{33} = 0$$

$$\Rightarrow 3\acute{\alpha}_{33} -4.463 = 0$$

$$\therefore \acute{\alpha}_{33} = 1.49$$

Put into (i)

$$\acute{\alpha}_{31} -1.49 = -.802$$

$$\therefore \acute{\alpha}_{31} = 0.69$$

Put into (ii)

$$\acute{\alpha}_{32} - 1.49 = -.661$$

$$\therefore \quad \acute{\alpha}_{32} = -2.17$$

Ranges of Part-Worth Utility:

The range of part-worth utility for each of the attributes is calculated by maximum utility minus minimum utility for each of the levels. It can be shown as the following equation:

$$I \quad \{ max(\alpha) - min(\alpha) \}_{ij}$$

For Capacity $= \acute{\alpha}_{max} - \acute{\alpha}_{min}$

$$= 9.81 - (-15.59)$$

$$= 25.4$$

For Installment $= \acute{\alpha}_{max} - \acute{\alpha}_{min}$

$$= 1.154 - (-1.336)$$

$$= 2.49$$

For Price $= \acute{\alpha}_{max} - \acute{\alpha}_{min}$

$$= 1.49 - (-2.17)$$

$$= 3.66$$

Relative Importance:

The relative importance of each attribute-level is the ratio of the range of the part-worth utility to the total importance of the attributes. Thus, the relative importance weight is calculated below:

For Capacity = Range of Part-Worth Utility / Total Importance

$$= 25.4 / 31.55$$

$$= 0.805$$

For Installment = 2.49 / 31.55

$$= 0.0789$$

For Price = 3.66 / 31.55

$$= 0.116$$

The final outcome can be shown in the following table:

Table 4: Outcome of Conjoint Analysis

Attribute	Level	Utility	Range of Part-Worth Utility	Relative Importance
Capacity	100 w [$\acute{\alpha}_{11}$]	9.81	25.4	0.085
	150 w [$\acute{\alpha}_{12}$]	7.12		
	200 w [$\acute{\alpha}_{13}$]	-15.59		
	50 w [$\acute{\alpha}_{14}$]	-1.34		
	24 months[$\acute{\alpha}_{21}$]	0.18		

	36 months [ά $_{22}$]	-1.336	2.49	0.0789
	12 months [ά $_{23}$]	1.154		
Price	BDT 500-1000 [ά $_{31}$]	0.69		
	BDT 1000-1500 [ά $_{32}$]	-2.17	3.66	0.116
	BDT 1500-2000 [ά $_{33}$]	1.49		
		Total	31.55	

From the table above, it can be said that – People's

demand for 100 w is higher. People refer 12

installments to pay the price.

People are ready to spend BDT 1500-2000 per installment.

Recommendations and Conclusion :

As the results of conjoint analysis shows about the consumers' choice about solar panels, it can be said that companies should develop 100w solar panels in greater quantity. In order to generate awareness about solar panels in remote areas as well as sub-urban cities, companies should give advertisements in broadcast and print media for more reach. It is important to educate the target consumers on how to use solar panels and give them clear information that even if the initial set up cost is higher, the long term benefit derived from using solar panels is way too efficient. Moreover, in order to ease the purchase process, companies can offer installment facilities as the research findings indicate. As the concept in still new in Bangladeshi market, branding it properly may give generic brand name advantage in coming days to stay ahead of competition. To build trust in consumers' minds, companies should develop a customer care help line number so that the customer or other people can get help 24 hours. In case companies target rural people with lower income range, companies should provide loan and other financial facilities to increase the sale.

Today renewable solar energy is recognized in the world as the main engine that runs the economy. The demand of energy is very high, particularly in Dhaka and other major cities. So, the prospect of solar business is very high. Now if the solar companies run their business according to the demand of middle class, lower middle class, and higher middle class people, the business must be profitable. The number of population all over the world is increasing day by day whereas the supply of energy is not increasing in the competition with the increasing people. Solar energy has become a good source of power supply all over the world.

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