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RESEARCH ARTICLE

PRIORITISING THE SUB CRITERIONS TO GAUGE CUSTOMER SATISFACTION LEVELS OF SOLAR WATER HEATER USERS USING AHP APPROACH

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ABSTRACT

It is observed that the customers expect more, have various choices and are less Brand Loyal these days. The organizations will have to continually improve their methodologies, processes, and products in order to stay in the business as well as attract and retain the potential and existing customers. The aim of this study is to present an Analytic Hierarchy Process (AHP) approach methodology that prioritises the various sub criteria's, which increases the customer satisfaction levels of solar water heater users. The study has used the three criteria of Perceived Ease of Use, Benefits and Innovativeness for gauging Customer Satisfaction levels. This study shows how AHP approach can be used effectively used in prioritising the sub criterions that gauges the satisfaction levels of solar water heater users in Southern city of India (Mangalore).

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INTRODUCTION

The major benefit of strong customer satisfaction is vital for the long run survival of the organization. Firms with short term views usually lack customer focus and the commitment to build the long term relationships with the customers (Best, 2009). Strong level of customer satisfaction will lead to increased loyalty levels which in turn increases the profitability. Customer satisfaction is a forward looking indicator for the organizations as it indicates how well the customers will respond to it in the future (Best, 2009). Thus the firms will have to prioritize the various criterions and sub criterions of their products that gauge the satisfaction levels. The objective of this study is prioritising the sub criterions to gauge Customer Satisfaction levels of solar water heater users in Southern City of India (Mangalore). Though there are many approaches, AHP is considered to be the most effective methodology in prioritization of criterions (Ruchi, 2012). AHP is also adept in treating large number of criteria and sub criteria's proficiently (Bevilacqua and Braglia, 2000).

The approach can also be applied to solve complex problems in various areas and it helps to evaluate the problem methodically (Singh *et al.*, 2007; Wasil and Golden, 2003). The methodology not only helps in meeting the desired objectives but also enables the organization's to identify the various areas where its attention is needed and plan for the strategies so as to have a better edge over their competitors and to attract as well as retain the customers (Asamoah *et al.*, 2012).

Literature Review

The aim of the literature review in this study is the identification of criterions to gauge the Customer Satisfaction levels among the solar water heater users in Southern City of India (Mangalore) and how AHP as a tool is utilised in setting the priorities. Literature Review, and solar water heater users suggestions has been utilized to develop an AHP based model for the evaluation of the Customer Satisfaction levels. From Table 1 an AHP model is constructed. In order to reduce the threats involved in the progress of new products and services, customer's wants should be viewed as a multi-criteria decision-making problem. Even though the Utility and the Score Model is available, AHP is possibly the most dominant and the most widely used approach in prioritisation process.

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It letsthe people who are in charge of decision making, measure the evenness and solidity in the decisions (Madu and Georgantzas, 1991; Madu et al., 1991; Saaty, 1980). A model is constructed comprising of the goals, criteria's and the sub criteria's as shown in Figure 1.

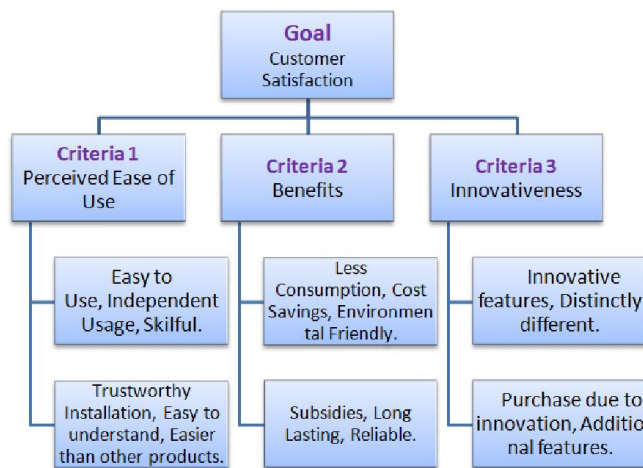


Figure 1. The AHP Model: Goal, Criteria's and Sub Criteria's (Source: Author, 2015)

In the current model, the goal is Customer Satisfaction. Once goals are set, the subsequent step is brainstorming the criteria's and the sub criteria's that might help to satisfy this goal. Perceived Ease of Use (PEU) is defined as the belief that, using a particular system would be free from effort (Kohli, 2000). A solar water heater is easy to use and can be used independently. Operations of solar water heater are clear and easily understandable. So most of the customers believe that the solar water heater can be used with ease, without experiencing any difficulties. The perceived ease-of-use influences purchases and increases the customer satisfaction (Kim, 2007).

Perceived Ease of Use influences attitude toward using the product, and has a direct impact on Customer Satisfaction. Benefit (BNF) is another variable that drives the use of technology. Usage of solar water heater saves cost. It is environmental friendly and long lasting. When the product is ambiguous it has a direct impact on customer satisfaction, on the other hand when the product is unambiguous such as a solar water heater the performance of the product has a direct impact on customer satisfaction (Youjiae, 1993).

Positive Benefits increases the Customer Satisfaction whereas negative benefits decrease the Customer Satisfaction (Oliver, 1980). Innovation (INN) refers to creation of something new say a product, a service or technology by an organization so as to satisfy the customers and increase its revenues. A solar water heater is an innovative product that makes use of rays produced by the Sun to get hot water. New variants of solar water heater are being made available in the market, which is more efficient, unique or something which has not been done before. Innovation is used as a tool by the organization's to increase Customer Satisfaction and enhance the Brand Loyalty. The innovation also is described as a process of converting an idea into a product so that the customer embraces it and provides financial benefits to its providers (Naveed et al., 2012).

MATERIALS AND METHODS

The study has used the three criteria's of Perceived Ease of Use, Benefits and Innovativeness for gauging Customer Satisfaction levels as shown in the Figure 1. Interviews were conducted to gather data from the users of solar water heaterusers to determine the importance of Customer Satisfaction and pair wise comparison was made for the three criteria chosen to gauge the satisfaction levels using element comparison values as shown in Table 2.

Table 1. Key definition of constructs

Constructs	Definition	Author
Perceived Ease of Use (PEU)	Is one which acts as a predecessor to Perceived Usefulness; Belief that using a particular product would be free from effort; Belief that a product can be used without experiencing any difficulty.	Davis (1989); Kohli (2000); Kim (2007).
Benefits (BNF)	Enhancing Job Performance; Unambiguous Performance of Product.	Davis (1993); Youjiae (1993).
Innovativeness (INN)	Tool to increase the Customer Satisfaction; Converting an Idea into Product.	Pan (2006); Naveed et al., (2012).
Customer Satisfaction (CSN)	A predecessor of Customer Loyalty; Extent to which perceived performance of product matches the expectations of the buyer; Client Happiness.	Sivadas (2000); Kotler (2002); Agbor (2011).

Table 2. Element comparison values, Taylor (2010)

Particulars	Rating
Extremely preferred	9
Very strongly preferred	7
Strongly preferred	5
Moderately preferred	3
Equally Preferred	1
Intermediate values between two	2,4,6,8

Table 3. RI Values fordifferent Values of n (Enyinda et al (2010); Developed by Saaty)

n	1	2	3	4	5	6	7	8	9	10
RI value	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

Two criteria's were compared with each other and the results were tabulated which is shown in the Table 4.

Table 4. Pair-wise comparison of Criteria's (Source: Field Survey, 2015)

	PEU	BNF	INN
PEU	1	9	5
BNF	0.1111	1	0.25
INN	0.2	4	1
Total	1.311111111	14	6.25

Table 5. Normalized Score Table for the Criteria's (Source: Field Survey, 2015)

	PEU	BNF	INN	Local weights	Weights in %
PEU	0.7627	0.6429	0.8000	0.7352	74%
BNF	0.0847	0.0714	0.0400	0.0654	7%
INN	0.1525	0.2857	0.1600	0.1994	20%
Total	1	1	1	1	100%

CR for the criteria's = 0.0625 < 0.1. Therefore it is accepted.

Consistency Check

To ensure the consistency of the final results, pair wise assessments are made. Evaluations in AHP is based on the theory that the decision maker is logical, that is if X is preferred to Y and Y is preferred to Z, then X is preferred to Z. A Consistency Ratio (CR) of 0 means that the decisions are perfectly reliable. According to Saaty, if the CR is more than 0.1 the decisions are unreliable as they are too close for comfort to arbitrariness and the process must thus be repeated.

Table 6. PEU Sub Criteria's (Source: Field Survey, 2015)

PEU	Easy to Use	Independent Usage	Easy to Understand	Trustworthy Installations	Easier than other products	Skilful
Easy to Use	1	1	1	1	2	5
Independent Usage	1	1	2	1	3	6
Easy to Understand	1	0.5	1	2	1	8
Trustworthy Installations	1	1	0.5	1	1	8
Easier than other products	0.5	0.333333333	1	1	1	8
Skilful	0.2	0.1667	0.125	0.125	0.125	1
Total	4.7	4	5.625	6.125	8.125	36

Table 7. Normalized Score Table for PEU (Kindly include the table below)

PEU	Easy to Use	Independent Usage	Easy to Understand	Trustworthy Installations	Easier than other products	Skilful	Local weights	Weights in %
Easy to Use	0.2128	0.2500	0.1778	0.1633	0.2462	0.1389	0.1981	19%
Independent Usage	0.2128	0.2500	0.3556	0.1633	0.3692	0.1667	0.2529	19%
Easy to Understand	0.2128	0.1250	0.1778	0.3265	0.1231	0.2222	0.1979	20%
Trustworthy Installations	0.2128	0.2500	0.0889	0.1633	0.1231	0.2222	0.1767	20%
Easier than other products	0.1064	0.0833	0.1778	0.1633	0.1231	0.2222	0.1460	20%
Skilful	0.0426	0.0417	0.0222	0.0204	0.0154	0.0278	0.0283	3%
Total	1	1	1	1	1	1	1	100%

CR for PEU = 0.0509 < 0.1. Therefore it is accepted.

Sometimes the Consistency Ratio more than 0.1 can also be accepted. For example, a variation of 10% or less must sometimes be accepted (Coyle, 2004).

Calculation of Consistency Ratio

To evaluate the consistency ratio, we first compute the average (AVG) which is obtained by dividing the product of obtained matrix with that of the local weights, which enables us to compute the consistency index and also the consistency ratio.

AVG = average [Matrix Product / Local Weights]
 Consistency index, CI is given by the formula
 $CI = [AVG - n] / [n - 1]$

The Consistency Ratio is then calculated. The Consistency Ratio (CR) = CI / RI, where CI is the consistency index and RI is the value for different values of n. RI Value is taken from the Table 3.

RESULTS AND DISCUSSION

This section consists of the analyses and the discussion of the study. Table 4 shows the pairwise comparison between the two criteria's. PEU is compared with BNF. Since PEU is extremely preferred over BNF the value is taken as 9 (value decided based on the surveys and interviews conducted), which is taken from the element comparison values displayed in Table 2. The diagonal values are taken as 1. Now when BNF is compared with PEU the resulting value obtained is the reciprocal, that is 1/9 = 0.1111. The same procedure is repeated till all the values are filled in the table. To calculate the Normalized scores the comparison value is divided by the summation of that column

that is the comparison value of PEU over BNF is 9 and the summation of that column is 14. The normalized score of PEU over BNF is given by 9/14 = 0.6429 which is shown in the

Table 8. Benefits Sub Criteria (Source: Field Survey, 2015)

Benefits	Less Consumption	Cost Savings	Environmental Friendly	Subsidy Attraction	Long Lasting	Reliable
Less Consumption	1.00	9.00	1.00	6.00	1.00	1.00
Cost Savings	0.11	1.00	0.20	0.20	0.13	0.20
Environmental Friendly	1.00	5.00	1.00	7.00	1.00	1.00
Subsidy Attraction	0.17	5.00	0.14	1.00	0.14	0.20
Long Lasting	1.00	8.00	1.00	7.00	1.00	5.00
Reliable	1.00	5.00	1.00	5.00	0.20	1.00
Total	4.28	33.00	4.34	26.20	3.47	8.40

Table 9. Normalized Score Table for Benefits (Source: Field Survey, 2015)

Benefits	Less Consumption	Cost Savings	Environmental Friendly	Subsidy Attraction	Long Lasting	Reliable	Local weights	Weights in %
Less Consumption	0.2338	0.2727	0.2303	0.2290	0.2884	0.1190	0.2289	23%
Cost Savings	0.0260	0.0303	0.0461	0.0076	0.0360	0.0238	0.0283	3%
Environmental Friendly	0.2338	0.1515	0.2303	0.2672	0.2884	0.1190	0.2150	22%
Subsidy Attraction	0.0390	0.1515	0.0329	0.0382	0.0412	0.0238	0.0544	5%
Long Lasting	0.2338	0.2424	0.2303	0.2672	0.2884	0.5952	0.3095	31%
Reliable	0.2338	0.1515	0.2303	0.1908	0.0577	0.1190	0.1639	16%
Total	1	1	1	1	1	1	1	100%

CR for Benefits = 0.0942 < 0.1. Therefore it is accepted.

Table 10. Innovativeness Sub Criteria (Source: Field Survey, 2015)

Innovativeness	Innovative Features	Distinctly Different	Purchase due to innovation	Additional Features
Innovative Features	1	0.33	1	1
Distinctly Different	3	1	1	5
Purchase due to innovation	1	1.00	1	1
Additional Features	1	0.20	1	1
Total	6	2.53	4	8

Table 11. Normalized Score Table for Innovativeness (Source: Field Survey, 2015)

Innovativeness	Innovative Features	Distinctly Different	Purchase due to innovation	Additional Features	Local weights	Weights in %
Innovative Features	0.1667	0.1316	0.2500	0.1250	0.1683	17%
Distinctly Different	0.5000	0.3947	0.2500	0.6250	0.4424	44%
Purchase due to innovation	0.1667	0.3947	0.2500	0.1250	0.2341	23%
Additional Features	0.1667	0.0789	0.2500	0.1250	0.1552	16%
Total	1	1	1	1	1	100%

CR for Innovativeness = 0.0971 < 0.1. Therefore it is accepted.
 Calculation of AVE, CI and CR

Table 5. The local weight is the average of the row mean. The same technique is applied to the entire sub criteria's from Table 6 to 11. Once the Consistency Index and Reliability is calculated, the criteria and the sub criteria along with their local weights are arranged as shown in Table 13. To calculate the global weights, the local weights of the sub criteria are multiplied by the local weight of the respective criteria. For example the local weight of Sub Criteria, Ease of Use is 0.1981.

It comes under the PEU criteria whose local weight is 0.7352. The global weight is then calculated by multiplying the local weight of Ease of Use with the local weight of PEU that is $0.1981 \times 0.7352 = 0.1457$. The same procedure is continued till all the global weights for the sub criteria are determined. The sub criteria are then ranked on the basis of the highest global weights as shown in the Table 14. Table above displays the ranking of the sub criteria that gauges the satisfaction levels of solar water heater users in Mangalore City.

Table 12. Matrix for PEU (Source: Field Survey, 2015)

	Matrix						Local Wt		Matrix Prod		Matrix Prod/Local Wt
Easy to Use	1	1	1	1	2	5	0.1981		1.2594		6.3558
Independent Usage	1	1	2	1	3	6	0.2529		1.6316		6.4512
Easy to Understand	1	0.5	1	2	1	8*	0.1979	equals	1.2486		6.3094
Trustworthy Installations	1	1	0.5	1	1	8	0.1767		1.0994		6.2217
Easier than other products	0.5	0.333333333	1	1	1	8	0.1460		0.9307		6.3740
Skilful	0.2	0.1667	0.125	0.125	0.125	1	0.0283		0.1752		6.1828

The AVG is the average of Matrix Prod/ Local Weight that is
 $AVG = (6.3558 + 6.4512 + 6.3094 + 6.2217 + 6.3740 + 6.1828) / 6 = 6.3158$.
 The Consistency Index is given by $CI = (AVG - n) / (n - 1) = (6.3158 - 6) / (6 - 1) = 0.0632$.
 The Consistency Reliability is given by $CR = CI / RI = 0.0632 / 1.24 = 0.0509$.

Table 13. The Criteria’s and the Sub Criteria’s (Source: Author, 2015)

Criteria	Local weight	Sub criteria	Local weights	Global weights
PEU	0.7352	Easy to Use	0.1981	0.1457
		Independent Usage	0.2529	0.1859
		Easy to Understand	0.1979	0.1455
		Trustworthy Installations	0.1767	0.1299
		Easier than other products	0.1460	0.1073
		Skilful	0.0283	0.0208
BNF	0.0654	Less Consumption	0.2289	0.0150
		Cost Savings	0.0283	0.0019
		Environmental Friendly	0.2150	0.0141
		Subsidy Attraction	0.0544	0.0036
		Long Lasting	0.3095	0.0202
		Reliable	0.1639	0.0107
INN	0.1994	Innovative Features	0.1507	0.0300
		Distinctly Different	0.4505	0.0898
		Purchase due to innovation	0.2421	0.0483
		Additional Features	0.1568	0.0313

Table 14. Ranking of the Sub Criteria’s (Source: Author, 2015)

Sub criteria	Global weights	%
Independent Usage	0.1859	18.59%
Easy to Use	0.1457	14.57%
Easy to Understand	0.1455	14.55%
Trustworthy Installations	0.1299	12.99%
Distinctly Different	0.1111	11.11%
Easier than other products	0.1073	10.73%
Purchase due to innovation	0.0333	3.33%
Additional Features	0.0280	2.80%
Innovative Features	0.0270	2.70%
Skilful	0.0208	2.08%
Long Lasting	0.0202	2.02%
Less Consumption	0.0150	1.50%
Environmental Friendly	0.0141	1.41%
Reliable	0.0107	1.07%
Subsidy Attraction	0.0036	0.36%
Cost Savings	0.0019	0.19%
Net	1	100%

The sub criterions along with the percentage of the global weights are displayed in the table above. With reference to Figure 2 we can infer most of the customers are satisfied as the Solar Water Heater can be used independently, easily used and

easy to understand the operations of the product. Cost Savings was found to have least significance in the study conducted. The respondents were of the opinion that the savings was less as they had to make use of auxiliary heating device during rainy season.

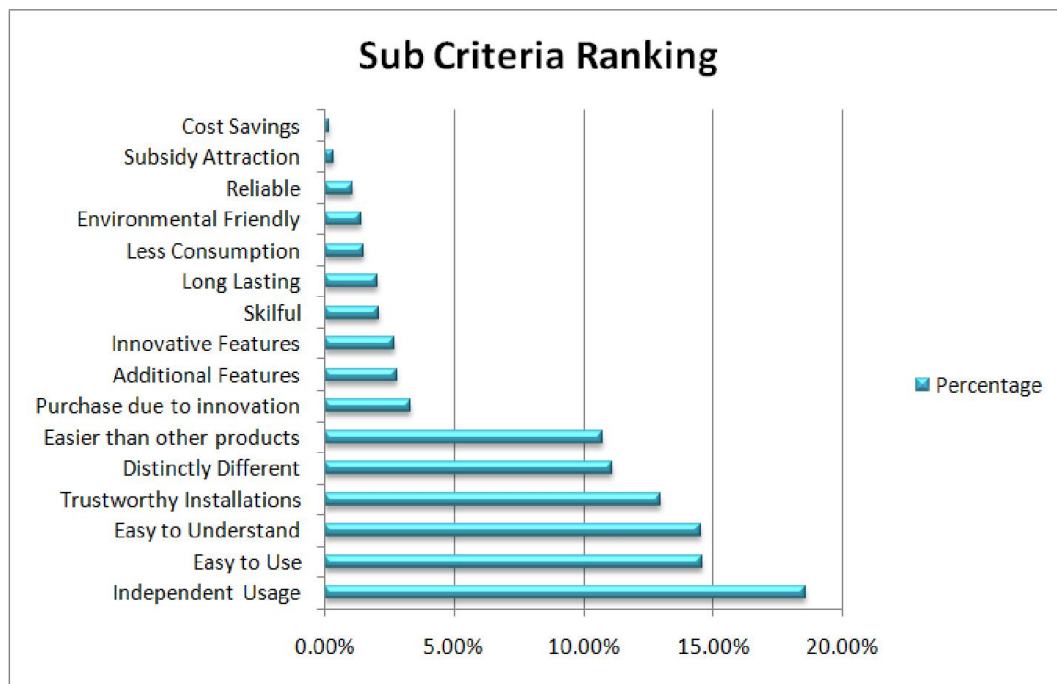


Figure 2. Sub Criterion priorities (Source: Author, 2015)

Conclusion

The conclusions of this research was based on interviews and survey responses taken from solar water heater users in Mangalore City, so there is a possibility of response bias and it is suggested that future research can overcome this problem by employing various methodologies in addition to surveys like conducting other qualitative approaches, brainstorming sessions, expert consultations etc. Secondly, in this research only a few variables have been taken into account in the main model. Future research on gauging Customer Satisfaction can consider other significant factors such as Customer Service, Trust, Perceived Usefulness and Perceived Control etc. This approach enables the firms to analyse their strengths and weaknesses. Competitive Advantage can also be achieved if the customer’s needs are met and the AHP approach is an important input in this regard. Customer Satisfaction is an important linkage to market strategy and the profits. The ultimate objective of any strategy is to attract, satisfy and retain target customers. If the firms are able to meet these objectives it will produce god profits and will have an edge over its competitors. For Organizations it is essential to understand the customer’s needs, select the best possible alternative and implement them successfully. For an accurate prediction various statistical techniques can be used to improve the reliability and validity of the results.

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