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Prediction of Customer Behaviour on purchase of solar panels

Abhishek Dixit[1], Dr. Arvind Kumar Verma[2]
[1]Research Scholar, MBM University, Production, and Industrial Engineering
[2]Professor, MBM University, Production, and Industrial Engineering
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ABSTRACT

It is widely recognized that every individual possesses a unique perspective and decision-making process. The study of customer behaviour concentrates on various client segments to facilitate informed decisions based on perceptions, preferences, and the utility of characteristics that evolve with technological advancements and market growth. Numerous established methods influence consumer behaviour or affect their choices, as evidenced by peer influence, media utility, recommendations from friends and family, or the evaluation of a product or service based on relevant criteria. Notably, in the current digital age, a plethora of resources is readily accessible at our fingertips through social media, digital marketing, and other commercial platforms. This paper aims to provide insights into how customer behavior can be anticipated when data is available, considering multiple parameters, as understanding customer behaviour is crucial for making purchasing decisions that may also influence others. Established methodologies such as forecasting and statistical analysis, along with the contemporary application of Artificial Intelligence and Machine Learning algorithms, offer valuable perspectives for making informed decisions in similar future scenarios with comparable data. As this field continues to evolve and technological progress accelerates, it is essential to adapt accordingly. Statistical methods provide a framework for predicting behaviour, data analysis, and its application; however, the use of machine learning algorithms like gradient boosting and SVM can yield more precise predictions and accurate outcomes. This paper illustrates the application of one such method to obtain relevant results for behaviour prediction. The research underscores the necessity for ongoing efforts in developing strategies within the realm of consumer behaviour.
Keywords: Consumer behaviour, Statistical analysis, Machine learning, Artificial Intelligence

1. Introduction

The concept of customer behavior encompasses the customer's perception in making purchasing decisions based on prevailing conditions. Numerous strategies are currently employed to forecast customer purchasing behavior based on specific characteristics. Research conducted by various scholars has identified several key concepts and relevant factors for making these predictions, which include:

- **Data Analysis:** This process is essential for validating the work, as CRM data ensures the reliability of the information and facilitates predictive analysis through correlation, trend analysis, and pattern recognition.
- **Predictive modelling:** This is crucial for creating predictive models through quantitative analysis, which can offer insights into future customer interactions.
- **Machine learning algorithms:** These algorithms assist in developing models by learning from historical and CRM data to forecast future customer behavior.

2. Analysis of customer behaviour

A significant component of customer behavior analysis is the methodology employed for predictions, which follows a structured approach summarized as follows:

1. **Data collection:** This initial step involves gathering pertinent information from various sources, including customer databases, CRM systems, interactions, reviews, and surveys.
2. **Market Segmentation:** This process is necessary for categorizing the overall group into several subgroups based on shared characteristics, such as income, service type, age group, or other criteria, enabling organizations to identify target groups effectively.
3. **Analysis of purchase history:** This data is instrumental in understanding customer behavior regarding their selection criteria when purchasing products or services, providing insights into areas that require attention to enhance sales.
4. **Conducting surveys and collecting feedback:** Another important aspect of analysis of behaviour of the customer is is collecting the data through surveys and try to gather the information about the satisfaction of the customers, their preference, and choices. Also, it provides a valuable information about the areas of improvements in a particular field.

5. **Analysis of social media:** This helps to cater the information about what is new in the market? how well the customers are understanding the perspective of the brand?, identify the best brand as per the choice of the customers and marketing perspective and help to take decision about the purchase by understanding the sentiments of the customers.
6. **Predictive analysis:** this is helpful in understanding and converting the customer views and needs into measurable characteristics by utilising the historical data and statistical analysis with the help of representations through charts, diagrams and data analysis.
7. **Competitive analysis:** This analysis is also required to understand the behavioural patterns and how other competitors are making their strategical approach towards identifying and finding the prediction about the purchase behaviour.
8. **Integrating technology:** We all know that fast growing tools like AI and ML are very helpful for the mankind to quickly provide access to the large data available and therefore, integrating the technology will help to provide the valuable results for the future.
9. **Ethics in the analysis:** Apart from the regular predefined procedure, it is required that ethics is taken in consideration whether it is data collection or it is the analysis for interpreting the results.

3. Literature Review

The literature review was conducted to thoroughly examine the current research and to reinforce existing theoretical frameworks (Abu et. al, 2019, Bashiri, 2018). The study examines consumers interest for residential, commercial or agricultural solar panels within “Theory of Reasoned Action”, “Theory of Planned Behavior” & “Stimulus Organism Response” (Patil, 2022, Zheng et. al, 2022).

3.1 Theory of Planed Behaviour:

The framework was established by Ice Ajen and subsequently expanded to serve as the basis for the research on the 'Theory of Reasoned Action' (Ramayah et al., 2012). This theory posits that three fundamental assumptions must be met for it to be applicable in research. Firstly, it assumes that the intention to purchase is entirely within the consumer's control, viewing consumers as rational entities who effectively utilize the information at their disposal. Furthermore, it specifies that prior to undertaking any action, consumers must consider the consequences of their decisions (Fishbein, 1977). According to the 'Theory of Reasoned Action', beliefs are the precursors to attitudes and subjective norms. Consequently, both consumer perceptions and subjective standards influence individual behavioral intentions, which in turn affect actual behavior. In the context of renewable energy, the 'Theory of Reasoned Action' has been validated as a powerful instrument for assessing individual intentions and behaviors, as well as cognitive processes. The 'Theory of Planned Behavior' further enhances the ability to predict behavioral intentions and their translation into actual behaviors within the renewable energy sector (Ajzen, 1991). Current research is concentrated on forecasting consumers' actual purchasing behaviors regarding residential, agricultural, and commercial solar panels in Bikaner, Rajasthan.

3.2 Consumers perception to solar panels

The perception of consumers regarding environmental information related to solar panels is associated with their attitudes and educational levels, which in turn fosters increased pro-environmental behaviors (Palm, 2017; Kesari et al., 2021). Raising awareness about green products, such as solar panels, is both a technical and fundamental endeavor (Hemmati, 2017). This awareness aids consumers in making informed purchasing decisions regarding solar panels and alleviates uncertainties surrounding their adoption (Sing, 2016). The research has also indicated that technological advancements have facilitated early adopters in transitioning towards an eco-friendly society (Schelly, 2014). Consequently, choosing solar systems and enhancing the dissemination of information about new technologies motivates customers to prioritize environmental conservation (Palm, 2017). Generally, consumers may possess limited knowledge about photovoltaic (PV) systems (Muyingo, 2015). They require a foundational understanding of how solar systems function and are utilized by average consumers. Thus, comprehension and awareness of solar PV systems have been linked to customer attitudes and behaviors regarding ecological issues (Salazar et al., 2013). Solar energy presents two primary benefits: firstly, solar PV systems do not adversely affect the environment, and secondly, they promote the adoption of environmentally sustainable production practices by companies (Maloney, 1973). The literature review further indicates that knowledge of eco-friendly technologies and their implications is crucial for understanding solar photovoltaic systems as an alternative energy source for residential use (Batley et al., 2011). Therefore, it is essential to enhance consumer awareness of environmental issues and encourage the acceptance of household solar PV systems (Akter, 2012).

3.3 Consumers concern to environment and their purchase intentions

Numerous studies have been conducted to assess consumers' environmental concerns and their intentions to purchase solar panels, exploring the relationship between environmental awareness and eco-friendly behaviors. Research demonstrates a notable link between environmental concerns and purchasing behavior among environmentally conscious individuals (Abdul Wahid et al., 2011). Additionally, a study highlighted similar findings regarding green shopping habits among younger consumers (Lee, 2008). Furthermore, it has been suggested that there is a strong relationship between environmental considerations and the intention to purchase sustainable products (Chan et al., 2000). However, research by Ramayah on Malaysian consumers' propensity to buy sustainable clothing indicated that environmental factors could serve as a potential predictor of purchase intentions for sustainable goods (Ramayah et al., 2010; Do Paco et al., 2009). Supporting this notion, a study conducted in Portugal also emphasized the importance of environmental concerns in influencing purchasing behavior. Over the years, environmental issues have garnered significant attention from scholars and marketing professionals. The findings suggest that pro-environmental behavior is more prevalent among individuals who prioritize environmental issues (Czap et al., 2010). Empirical evidence indicates that those with pro-environmental attitudes are more inclined to act as conscientious consumers regarding green products (Bacon, 1997; Czap, 2010). The research also revealed that pro-environmental consumers are willing to invest more and demonstrate greater concern for purchasing sustainable products (Bang et al., 2000).

3.4 Intentions of purchase as a mediator

In view of “Theory of Purchase Behaviour”, the consumer's behavior as an individual can be determined from behaviour intention (Liobikienė et.al, 2016, Zheng et.al, 2022). Further, according to the empirical studies, consumers’ intentions of purchase can be predicted as the positive role to determine purchase behaviour for sustainable products such as solar panels (Kamalanon, 2022, Al-Mamun, 2018, Wei, 2017).

4. Data analysis

The research has been carried out in Bikaner, Rajasthan, utilizing a regression analysis methodology. Additionally, the unique geographic location and climate of Rajasthan are considered significant advantages for the adoption of solar energy in the country (Raheem et al, 2016). Moreover, the effective implementation of solar panels has emerged as a sustainable solution to address energy shortages in Rajasthan (Ali et al, 2020). The study employed quantitative methods alongside deductive reasoning as recommended by Creswell & Creswell, 2017. Data was collected from various companies, yielding 483 responses that were analyzed. Empirical research indicates that a quantitative approach is optimal for validating the research framework and testing theories (Denscombe 2017). The study is designed as cross-sectional, incorporating two time lags for data collection through a market survey targeting consumers, specifically family heads, who are responsible for decisions regarding the purchase of solar panels as a clean energy option. Initially, questionnaires were completed by consumers expressing an intention to purchase solar panels for residential, agricultural, or commercial use, followed by responses from those who actually made a purchase.

5. Findings

The gathered data was utilized and organized according to the analytical requirements, categorized by demographic profiles and various other characteristics. Some responses included comparisons of brands (yes/no), power capacity (3-5 kW, 6-8 kW, and 10 kW or more), reasons for purchase (cost reduction, environmental sustainability, and dependable power backup), availability of subsidies, key attractions, and more. The specifics can be observed in the following graphs:

Fig. 5.1: Comparing brands

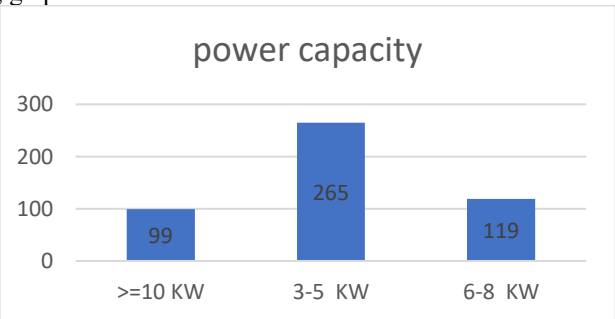
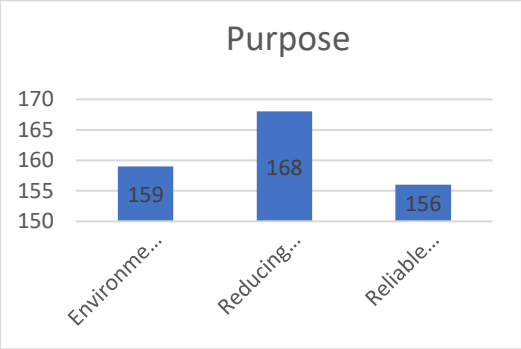


Figure 5.2: Need of power capacity



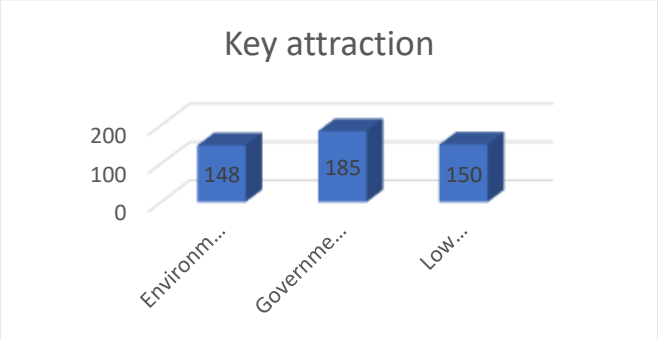


Figure 5.3: Purpose of purchase

Figure 5.4: Key attractions of purchase

6. Conclusion and Results

The analysis of the results concerning the prediction of purchasing behavior was conducted using a logistic regression method, alongside the development of a machine learning model for training purposes. The model was trained on 80% of the dataset, while the remaining 20% was utilized to predict customer purchasing behavior regarding solar panel purchases. The model achieved an accuracy rate of 67%, which is deemed satisfactory for deriving relevant behavioral predictions. A review of 97 responses in the confusion matrix indicated that the model yields acceptable results, suggesting that if similar data is provided, the model can effectively ascertain customer purchase intentions based on the specified parameters, as recommended by numerous researchers.

	precision	recall	f1-score	support
0	0.69	0.61	0.65	44
1	0.71	0.77	0.74	53
accuracy			0.70	97
macro avg	0.70	0.69	0.69	97
weighted avg	0.70	0.70	0.70	97

Fig 6.1: Model accuracy for purchase decision (Logistic Regression)

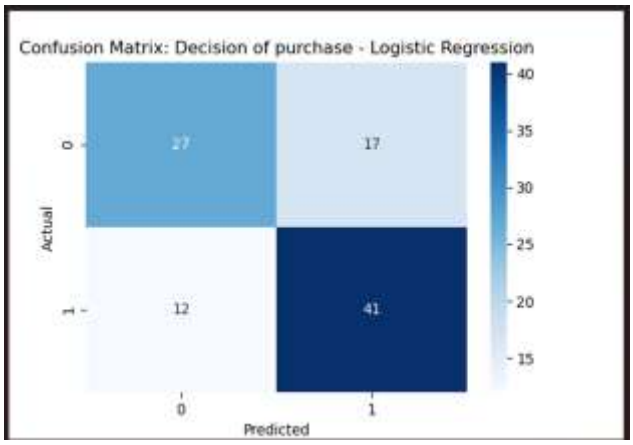


Fig 6.2: Confusion Matrix for decision of purchase

The analysis conducted using the trained algorithm indicates a satisfactory outcome after evaluating 20% of the randomly selected data from the sample. Among the 97 customers surveyed, 27 indicated that their purchasing decision would align with the provided parameters, and the model accurately predicted this outcome. Similarly, for the 41 customers who expressed a refusal to purchase, the model also correctly predicted their decision, achieving an overall accuracy of 70%, which is commendable in the realm of Artificial Intelligence and machine

learning applications. It is widely recognized that increasing the sample size can enhance the model's accuracy. Therefore, it can be concluded that logistic regression has proven to be a significant statistical method for deriving valuable insights through the development of models utilizing machine learning algorithms. Additionally, methodologies such as gradient boosting and support vector machines (SVM) may also be employed to forecast customer purchasing behavior, representing potential avenues for future research.

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