A VISUALIZATION OF SENTIMENT ANALYSIS OF CUSTOMER OPINION: A CASE STUDY OF AMAZON PRODUCT REVIEWS

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ABSTRACT

Sentiment analysis on customer reviews is used to analyze the overall sentiment or sentiments expressed by customers about a product, service, or brand. Businesses may get useful insights from this that they may use to better their goods and services, build client loyalty, and improve customer happiness. This paper presents a case study on the sentiment analysis of customer opinions regarding Amazon products sold in 2018. The study uses an Exploratory Data Analysis (EDA) steps and utilizes natural language processing techniques and visualization tools to analyze and visualize customer sentiment on the Amazon products; providing insights into the nature of customer opinions and preferences. Our findings indicate that the majority of customers have a positive experience with the products and services of Amazon as the positive reviews accounted for a significant portion of all reviews analyzed, signifying high levels of satisfaction and happiness among customers. However, negative reviews were also present, indicating that some customers had less-than-satisfactory experiences. In addition, there were reviews that were neither positive nor negative, but rather neutral. A core limitation to the study is that the data was collected from a single online repository and only structured data was used, which may not provide a complete picture of the company's operations. Overall, this study showcases the potential of sentiment analysis and visualization tools in enhancing our understanding of customer behavior and preferences in the context of e-commerce.

KEYWORDS: *Customer Opinion, Data Visualization, Exploratory data analysis, Sentiment Analysis, VADER*

1. INTRODUCTION

E-commerce has grown significantly in recent years, which has caused a rise in the amount of consumer evaluations that are available online. These evaluations offer insightful information about the preferences, opinions, and experiences of consumers with goods and services. In order to comprehend client feedback and enhance their products and services, organizations are increasingly turning to sentiment analysis, a computer approach that extracts and analyzes subjective information from text data. For businesses like Amazon, one of the biggest e-commerce platforms in the world, sentiment analysis has become a crucial tool for gleaning useful information from the copious amounts of customer evaluations they produce every day (O'Reilly & Milstein, 2018).

Sentiment analysis is an increasingly popular approach for examining text data to ascertain the text's emotional tone. It is helpful for a variety of applications, including marketing, customer support, and product development, since it can recognize the attitude represented in news stories, product evaluations, and social media postings. To better their products and services, Amazon and other businesses can utilize sentiment analysis to spot trends and patterns in customer feedback (Pang & Lee, 2008).

The goal of the research project "A Visualization of Sentiment Analysis of Customer Opinion: A Case Study of Amazon Product Reviews" is to conduct a sentiment analysis of customer opinions on Amazon products and visualize the findings to reveal insights into the general sentiment of customers toward the goods and services provided by Amazon. The ultimate objective is to offer relevant information that Amazon and other companies may utilize to make data-driven decisions to raise customer happiness and operational efficiency.

The rest of the paper is structured as follows. Section 2 provides a literature review on sentiment analysis and its relevance in displaying customer opinion. Section 3 outlines the research methodology used in this study. Section 4 presents visualizations the results of the study and discussion of the findings. Finally, Section 5 presents the conclusions and recommendations for future research.

1.1. Objective of Study

The study aims to identify key positive, neutral and negative sentiments of the Amazon reviews and compare sentiment analysis across different product categories and prices.

2. LITERATURE REVIEW

2.1. Customer Opinion

Customer feedback and reviews play a significant role in influencing consumers' purchasing decisions. Since clients cannot physically inspect things before making a purchase in the e-commerce setting, they are especially crucial. Product reviews, according to studies, can significantly affect sales. For instance, a PowerReviews survey indicated that 95% of consumers read customer evaluations before making a purchase and 86% regard them as a crucial resource when doing so (PowerReviews, 2017).

According to a Reevoo research from 2016, conversion rates can rise by 4.6% for products with 50 or more reviews (Reevoo, 2016). A different Bazaarvoice (2017) survey discovered that the conversion rate of items with reviews is 12.5% greater than that of products without reviews. These results show how critical customer reviews are to increasing purchases.

Potential consumers might develop trust by reading customer reviews and ratings. Products with reviews have a 270% higher possibility of being bought than those without evaluations, according to a poll by Spiegel Research Center (Spiegel Research Center, 2017).

2.2. Sentiment Analysis

Sentiment analysis, sometimes called opinion mining, is the procedure of locating and extracting subjective information from text, such as views, attitudes, and emotions. The sentiment analysis of Tweets data was used in a study by Bouazizi, & Ohtsuki (2018) to predict consumer reviews. They discovered that sentiment analysis could correctly anticipate customer reviews, and that adding contextual information, such as product characteristics and user demographics, might increase prediction accuracy even further.

The use of sentiment analysis and its ability to forecast customer happiness and thoughts was investigated more by Kumar et al. in their study from 2019. The researchers discovered that sentiment analysis can be useful in forecasting customer happiness with online purchasing, but the precision of the predictions can be increased by integrating sentiment analysis with additional data, such as previous purchases and demographic data. However the precision of the predictions may differ based on the quality of the data, the kind of sentiment analysis algorithm employed, and the particular situation in which it is utilized.

2.3. Data Visualization

Data visualization has been shown to help companies make better decisions and solve problems. Data visualization has the capacity to convey complicated facts in an understandable and succinct manner. Data may be presented in a form that is simple to comprehend and interpret, even for individuals who are not specialists in the topic, by utilizing charts, graphs, and other visual aids (Tam, N. & Song, I., 2016).

Abdelkareem and Augustyn (2023) further stressed that by providing users with concise summaries of correct and timely information, data visualization may help assist decision-making. Users can easily spot trends and patterns that would otherwise go unnoticed when data is presented graphically. This can aid decision-makers in making more intelligent choices that have better consequences.

Sentiment analysis must include visualization since it makes data easier to interpret and convey in a meaningful way. A scatter plot was used in a research by Le and Huh (2021) to show the sentiment distribution of customer reviews of an online shopping platform. The graphic revealed information on the distribution of both good and negative client sentiments as well as the general mood of the market.

2.4. VADER

VADER (Valence Aware Dictionary and sEntiment Reasoner) is a lexicon and rule-based sentiment analysis tool designed to identify the polarity (positive, negative, or neutral) of a piece of text. It was developed by Hutto and Gilbert in 2014 as an improvement over existing

sentiment analysis tools that struggled with the nuances of human language (Hutto & Gilbert, 2014).

By combining the individual word valence values and making adjustments based on a set of criteria that take into consideration the context and grammatical structure of the text, VADER utilizes a method known as sentiment intensity scoring. The valence ratings range from -1 to +1, with -1 denoting very negative feeling, +1 strongly positive sentiment, and 0 a neutral attitude (Hutto & Gilbert, 2014).

The threshold for deciding whether or not a text is neutral is in the range of -0.05 to +0.05. Texts with sentiment scores falling within this range are seen to be neutral, while texts with scores falling outside of this range are thought to be either positive or negative (Hutto & Gilbert, 2014).

Thelwall et al. (2017) revealed that VADER outperformed SentiStrength, a well-known sentiment analysis tool, in identifying sentiment in social media data. Likewise, Elbagir & Yang (2020) evaluation of VADER's effectiveness in evaluating the sentiment of Twitter data related to 2016 US election and discovered that VADER beat other sentiment analysis tools.

2.5. Exploratory Data Analysis (EDA)

Exploratory data analysis (EDA) is a method of data analysis that enables researchers to discover patterns and structures in their data. According to Sahoo et al. (2019), EDA is particularly helpful for spotting unexpected patterns and associations in large datasets, as well as for creating novel ideas that may be tested further.

Researchers now find it simpler to conduct EDA in a more organized and rigorous manner thanks to recent developments in data visualization and computational tools. For instance, Purwoningsih et al. (2020) show how machine learning methods may be used to direct the EDA process, while Alminagorta et al. present a novel approach for displaying high-dimensional information.

2.5.6 Related works on Amazon

A research by Du et al. (2019) examined 142.8 million Amazon customer reviews. By examining the summary headline, product remark, and helpfulness information for each review, the study

concentrated on determining each review's helpfulness and unhelpfulness. All blank and non-English product reviews were filtered by the researchers to increase the reliability of the results. The only people chosen were those that received the most votes (Du et al., 2019). The reviews that received the most votes showed that customers rely on the data to make informed judgments about their purchases. Positive product reviews assist buyers to obtain greater trust for the items they want to buy online, according to the findings, which are similar with Anh, Nagai, and Nguyen's (2019) analysis into how customer reviews affect online buying.

Sharma, Chakraborti, and Jha (2019) looked at how online reviews affect book sales at Amazon. Customers believe internet reviews to be a trustworthy source of information, according to the report. Reviews are more thorough and approachable in the eyes of the consumer. The study discovered that consumer experiences and product costs are highly influenced by internet reviews. The results are in accordance with research on online reviews and attitudes done by Chong et al. (2016).

3. METHODOLGY

3.1. Data Collection

For this study, secondary data of an open-source Amazon reviews made available by Jianmo Ni and accessed through the Kaggle repository on reviews of Amazon's product sold in 2018. The dataset consists of 551,159 rows and 14 columns which included attributes such as 'userName', 'verified', 'itemName', 'description', 'image', 'brand', 'feature', 'category', 'price', 'rating', 'reviewTime', 'summary', 'reviewText', and 'vote'.

3.2. Data Analysis

This data was analyzed using exploratory data analysis (EDA) techniques, including problem definition, data collection, data cleansing, data transformation, data characterization, data visualization and data interpretation. Microsoft Excel, the python programming language with the use of Numpy, Pandas and VADER for analysis of sentiment. And WordClouds, Matplotlib and Microsoft BI were used for data visualization.

To address the research questions, this study employs an exploratory data analysis (EDA) approach. EDA is a type of data analysis that is used to examine and summarize data in a way that allows for the identification of patterns, trends, and relationships. In this study, the following steps were followed in the EDA process:

3.2.1. Problem definition

The research question was clearly defined in the objective of the study.

3.2.2. Data collection

Data was collected from the Kaggle repository as described above.

3.2.3. Data cleansing

The next step in the EDA process was to remove any errors or inconsistencies in the data. The data was cleaned using Microsoft Excel and Python's Pandas and Numpy hereby removing duplicates, null values, incorrect data types or formatting issues and reviews that were not in English language. Unwanted columns like 'userName', 'description', 'image', 'brand', 'feature', 'reviewTime', and 'summary' were also filtered and removed.

3.2.4. Data transformation

Once the data was cleansed, the customer 'reviews_text' column was then analysed using VADER (Valence Aware Dictionary and sEntiment Reasoner) algorithm, which is a lexicon and rule-based approach to sentiment analysis as to identify the score of sentiment expressed in each review. This further aggregated the data by relevant dimensions, such as listing if customers' text sentiment polarity was Positive, Neutral or Negative; hereby creating derived variables to capture additional insights.

A new table 'price_range' which categorizes the prices of all products sold was created for better insight and visualization of the data.

3.2.5. Data characterization

After the data was cleaned and read into the development environment, it was characterized by exploring its structure and content. This included generating summary statistics and visualizing the data to gain a better understanding of its distribution and relationships.

3.3. Data Visualization

The data collected was then visualized using WordClouds, Matplotlib and Microsoft Power BI, which allows for a clear and concise representation of the data, which facilitated the analysis process.

3.4. Data interpretation

The visualized data was then interpreted and analyzed to satisfy the research objectives and draw conclusions. By using advanced analytics techniques and an interactive operations dashboard, we were able to extract valuable insights from the data and provide practical recommendations for optimizing supply chain performance.
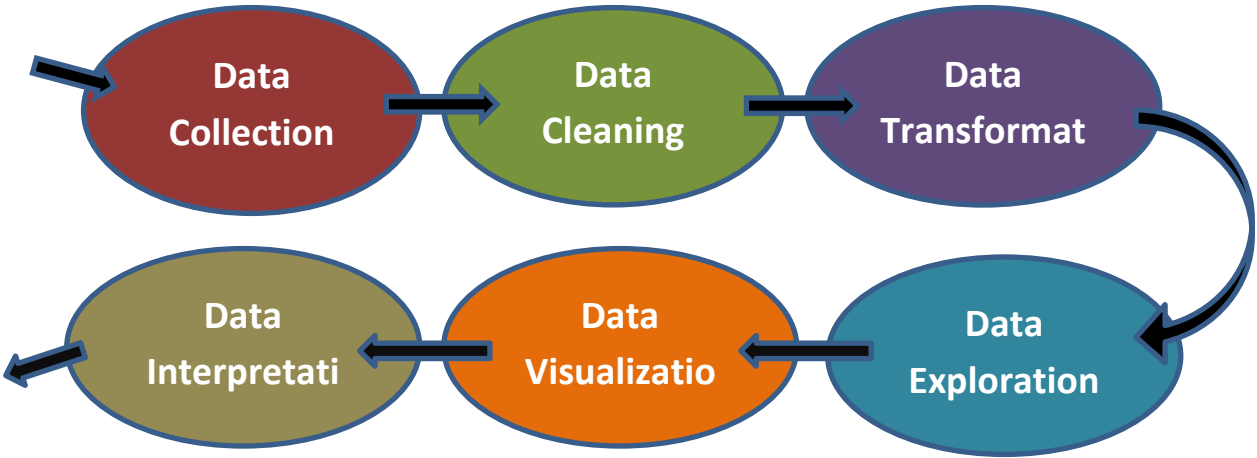

Figure 1. Exploratory Data analysis Process

4. RESULTS AND ANALYSIS

This section summarizes the findings of the conducted analysis. This report is based on trends uncovered by the research:

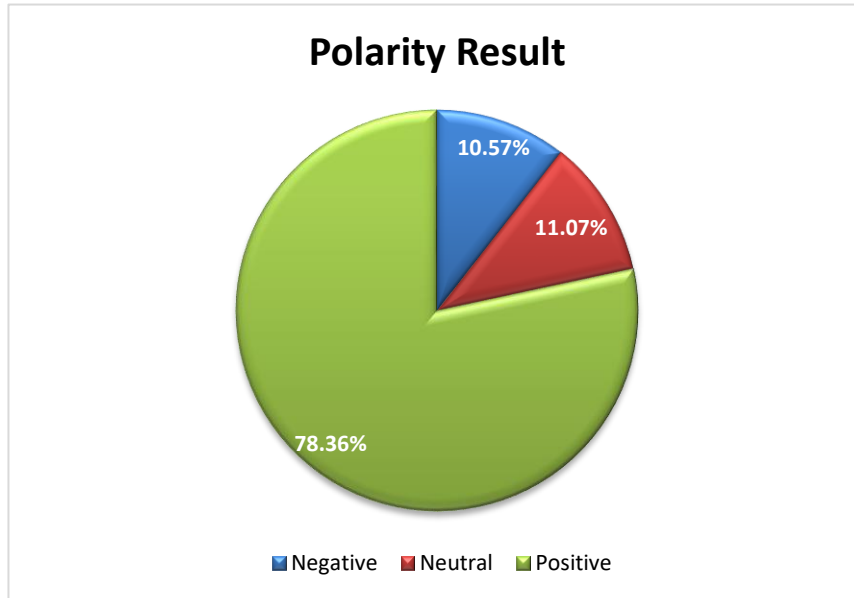### 4.1. What is the Polarity Results of Reviews made by Customers?

Figure 2. What is the polarity result of reviews made by customers

The pie chart above illustrates the percentage of the sum of polarity reviews of reviews made by customers across all products. 78.36% of all reviews made by customers were positive, 10.57% were neutral comments as they did not say anything good or bad about the products or services and negative reviews were 11.07%. These findings suggest that majority of the reviews made by customers of the goods sold by Amazon were positive. These insights show that in overall customers are happy with the goods and services offered by Amazon.

4.2. What are the Common Positive Words used in the Review?

Figure 3. What are the common Positive Words used in the review

The figure above shows the top 10 positive words that were commonly used by costumers in the reviews sections. The words with higher frequency are greater in font sizes and as the font size of the words decreases it shows they are lesser in frequency. It can be seen that the word "Great" has the highest frequency and followed by the "Good". Words like "Good Products", "Excellent" and "Nice" appeared lower in frequency among the top 10 positive words used in review section.

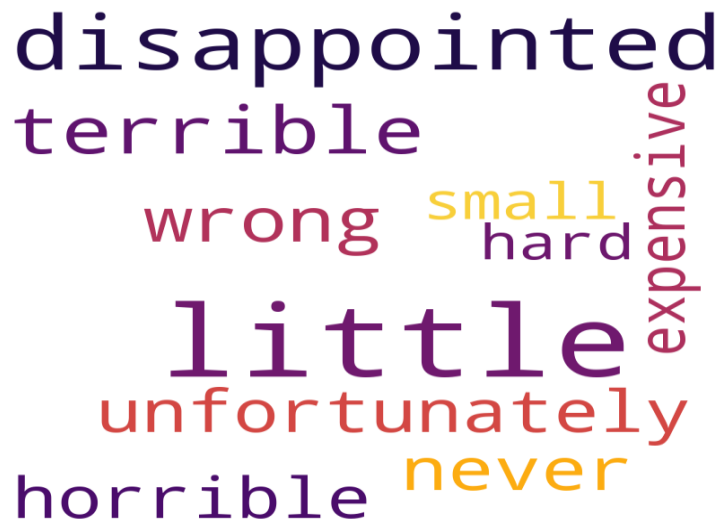**4.3. What are the Common Negative Words used in the Review?**

Figure 4. What are the common Negative Words used in the review

The figure above shows the top 10 most common negative words that appeared in the reviews written by customers. The words with higher frequency are greater in font sizes and as the font size of the words decreases it shows they are lesser in frequency. It can be seen that the words "Little" and "Disappointed" has the highest frequency in descending order. Words like "Hard" and "small" appeared lower in frequency among the top 10 negative words used in the reviews.

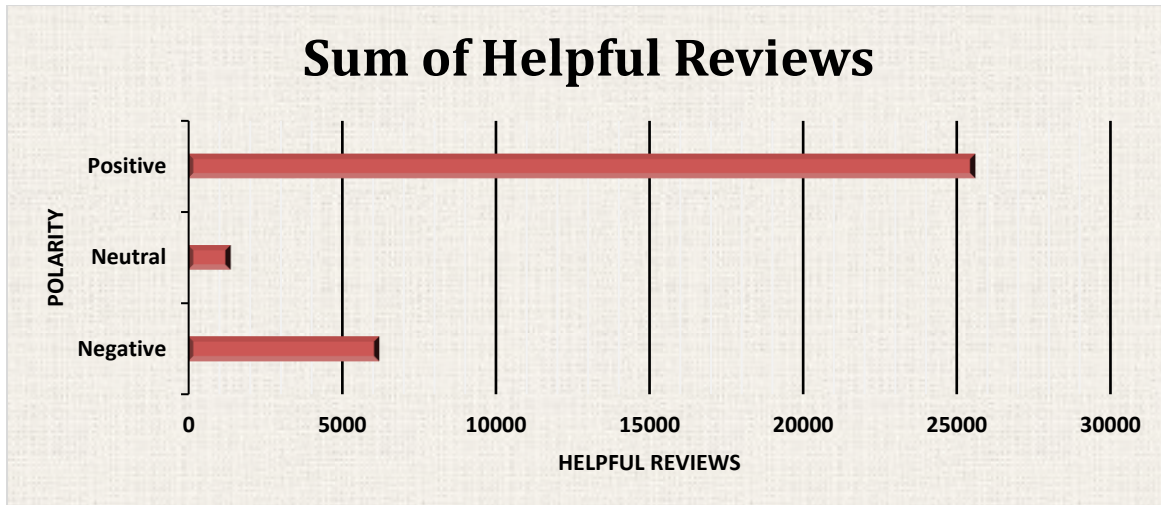**4.4. What is the Sum of Helpful Reviews per Polarity?**

Figure 5. What is the sum of Helpful Reviews per polarity

The data in this chart reflects the number of customers that found the reviews helpful in order to make their decisions across all products per polarity. A little over 25,000 customers found the positive reviews helpful and about 6,000 customers found the negative comments helpful for decision to buy products or not. While about 1,000 customers found the neutral comment helpful. This shows how important customer reviews and how it can influence them their purchasing decisions of products.

4.5. What is the Percentage of Polarity per Product Category?
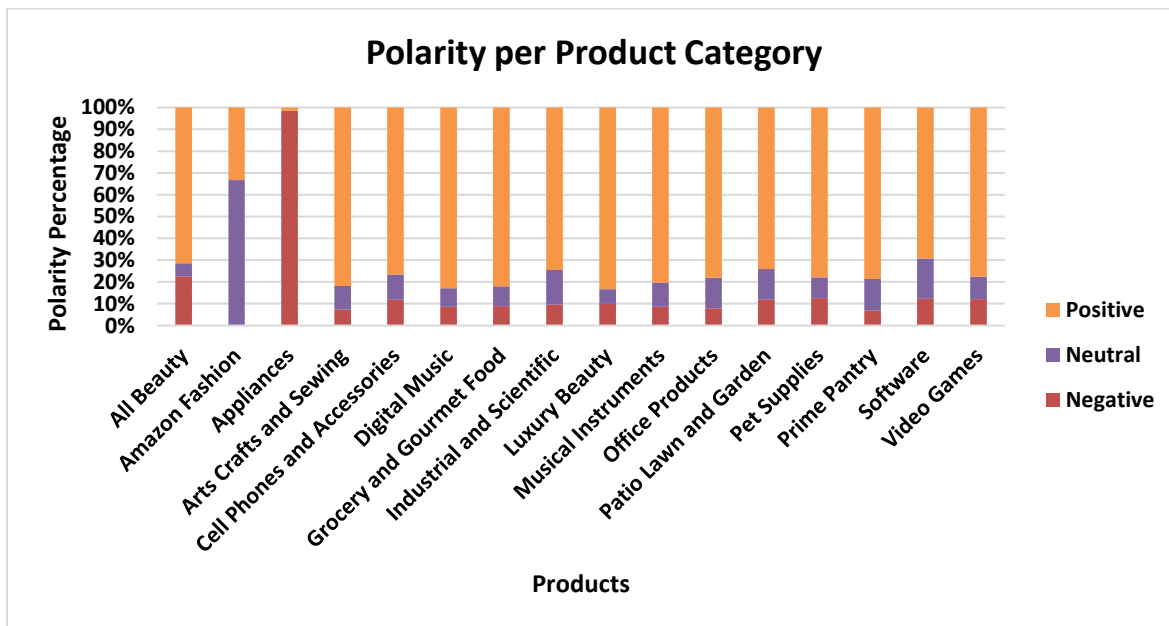
Figure 6. What is the Percentage of Polarity per Product Category?

The chart above shows the percentage of negative, neutral and positive comments that were made by customers in each of the product category. According to the chart, about 22% of the comments made on 'All Beauty' products were negative; less than 8% were neutral and over 70% were positive. In the closer row which is 'Amazon Fashion' about 68% of the reviews were neutral while the rest positive indicating that there were no negative comments in any of these products. The 'Appliance' product section shows that almost all the reviews of these products were negative. The remaining product categories show that positive reviews were highest in them all but the negative and neutral vary per product category. Further analysis may be necessary to understand the specific factors which caused consumers to give positive, negative or neutral reviews in each category.

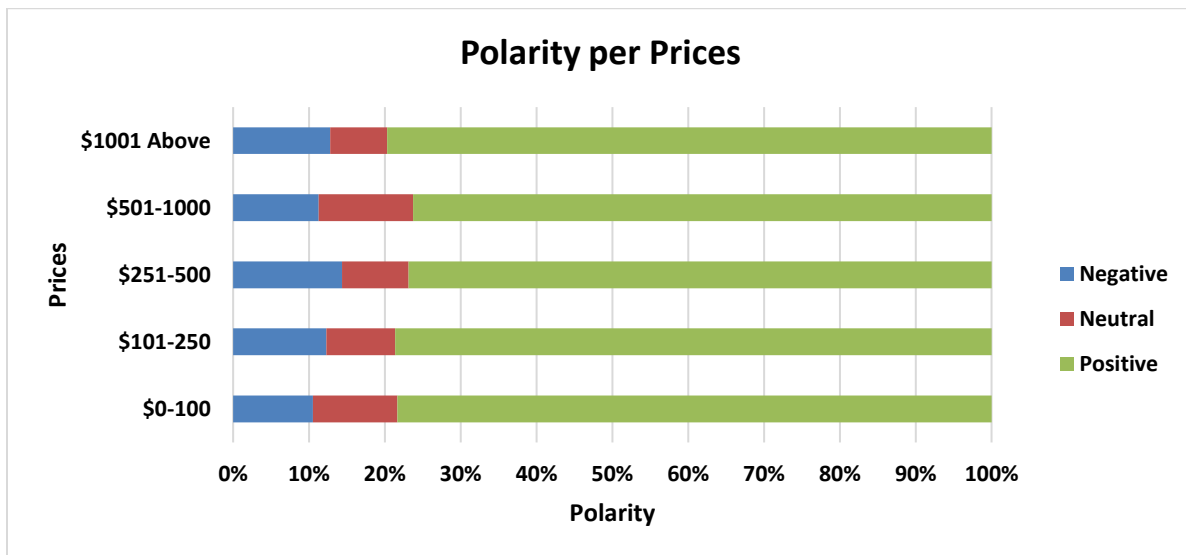## 4.6. What is the Polarity of Reviews of Products per Prices?

Figure 7. What is the Polarity of Reviews of Products per Prices

The data in this chart above reflects the polarities of reviews of products per the prices there were sold for in 2018. Products that cost over $1,000 had the highest positive reviews on average with 80% of its comment being positive in its price range. For products within $251-$500 price range, about 13% of the reviews were negative, 9% were neutral and 78% had positive reviews.

Majority of the reviews per prices were positive in polarity while it varied per price range when it came to negative and neutral.

4.7. Findings and Discussions

The findings of our research show that sentiment analysis is an effective method for examining and evaluating customer feedback, which may aid businesses in enhancing the services they provide.

The majority of positive reviews indicate that Amazon's consumers are happy with the level of quality of its offerings. Our findings correlates with Srujan et al, (2018) whose studies used sentiment analysis to evaluate both the products and services offered by Amazon and the results showed that the majority of the reviews were good. Positive evaluations could be a sign of prompt deliveries, high-quality goods, and reasonable costs. Negative evaluations, on the other side, may point out areas that require development. Furthermore, the neutral reviews may indicate that customers did not have strong feelings about the product or service. It is possible that some of these neutral reviews could have been positive if customers were more engaged or felt more strongly about the product or service. To address such issues, we recommend an improvement in engagement of customers more effectively by providing better personalized experiences, such as customized product recommendations or targeted marketing campaigns. By better understanding customer preferences and needs, companies like Amazon can provide better products and services that meet the specific needs of each customer.

The result also reflects that customers found other reviews helpful in order to make their decisions across all products per polarity. Majority of the customer found the positive reviews helpful and this correlate with a study done by Du et al. (2019) whose results stated that positive product reviews assist buyers to obtain greater trust for the items they want to buy online. This shows how important customer reviews and how it can influence them their purchasing decisions of products.

Additionally, the research uncovered a concerning pattern: virtually all of the evaluations for goods in the "Appliance" category are negative. As a large variety of items that are necessary for

daily usage are included in the Appliance category, this is cause for worry. It is possible that the unfavorable perception of appliances is due to particular subcategories like refrigerators, air conditioners, or washing machines. The appliance category includes a wide range of products, from small kitchen appliances to large home appliances. Amazon must take proactive action to conduct a more thorough analysis of the Appliance category's subcategories in order to identify the specific products that are fueling negative sentiment. By doing so, it will be easier to identify the underlying causes of customer dissatisfaction and implement remedies. Additionally, by providing comprehensive product information, giving technical help, and streamlining the returns and exchange procedure, Amazon may enhance customer care and support for goods in this area.

5.0 CONCLUSION

Our examination of the attitude in customer reviews on Amazon led us to the conclusion that most users are satisfied with the goods and services they receive. The majority of the evaluations that were positive were found, which suggests that customers are quite satisfied and happy. But there were also some unfavorable ones, showing that not all consumers had positive experiences. There were evaluations as well that were neutral in nature rather than either good or negative. Overall, this sentiment study shows how satisfied Amazon consumers are with the platform's capacity to supply them with high-quality goods and services and offers insightful information about customer contentment on the site.

The sentiment analysis done on Amazon reviews further emphasizes how crucial sentiment analysis is for organizations. Businesses may learn more about customer satisfaction through the analysis of consumer feedback, spot areas for development, and make data-driven decisions to enhance their goods and services. Additionally, sentiment analysis may assist companies in keeping tabs on the perception of their brands, spotting new trends, and evaluating the success of their marketing initiatives. Sentiment analysis is a key instrument for fostering corporate expansion and consumer happiness in today's cutthroat business environment.

5.1. Limitations of the study

There are a few limitations to this study. First, the data used was limited to the operations of Amazon and may not be representative of all businesses. Additionally, the data was collected from a single online repository and structured data was used, which may not provide a complete picture of the company's operations. Thirdly, the study was limited to the use of exploratory data analysis and did not utilize more advanced analytics techniques such as predictive modeling or optimization algorithms. Fourthly, the data is only subject to 2018 and the results might not be applicable to other years.

Lastly, From the product 'category' table the products sold that was gather for this research were 'All Beauty', 'Amazon Fashion', 'Appliances', 'Arts Crafts and Sewing', 'Cell Phones and Accessories', 'Digital Music', 'Grocery and Gourmet Food', 'Industrial and Scientific', 'Industrial and Scientific', 'Luxury Beauty', 'Musical Instruments', 'Office Products', 'Patio Lawn and Garden', 'Pet Supplies', 'Prime Pantry', 'Video Games', and 'Software'. So the results might not be applicable to products like shoes and sport cloths as they were not part of the data collected.

These limitations should be taken into consideration when interpreting the results of the study, and for further research.

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