

## MARKET SALES PREDICTION USING MACHINE LEARNING

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### ABSTRACT

In the current digital era, online shopping has drastically changed how consumers make decisions about what to buy and how businesses run. With a large number of websites and sellers offering similar products, the level of competition has become extremely high. Businesses must continuously innovate and regulate to shifting consumer prospects in order to remain competitive. Today consumers believe fast delivery, tailored suggestions and a hassle-free, continuous shopping experience. One of the major online retailers in the world is Amazon which offers millions of products in a different of categories and brands. Though this is difficult for separate businesses to stand out in the market due to the various number of sellers. Forecasting of Sales is essential in this situation. It involves forecasting upcoming product demand, which companies aids in pricing, inventory, and it entails forecasting upcoming product demand, which aids companies in efficiently planning their pricing, marketing, and inventory strategies.

This paper investigates various methods for forecasting Amazon product sales. Such as electronics, toys and cosmetics were among the categories from which data was collected. The paper defines which categories produce have highest sales and which products are most in demand and also which brands are favored by consumers using ML and data analysis techniques. Furthermore, it appearances at things like the product quantity reviews and also seasonal patterns such as the months with the greatest sales.

**Keywords:** ML, Estimating of Sale, Time Sequence, Ideal air time series.

**How to cite this article:** Panchal P, Patel DP, Varia D, Panchal MN, Ramanbhai PH, BharatKumar SN. Market Sales Prediction Using Machine Learning. Int J Drug Deliv Technol. 2026;16(55s): 1353-1359. DOI: 10.25258/ijddt.16.55s.140

**Source of support:** Nil.

**Conflict of interest:** None.

### INTRODUCTION

Online transactions, product listings, and customer interactions have all increased dramatically due to the rapid growth of e-commerce platforms in today's digital environment. Businesses must correctly predict demand trends as more customers shop online in order to efficiently manage inventory and prevent shortages or overstocking. Pricing and sales forecasting are important in this situation because they forecast future product performance based on past behavioral and transactional data [21]. Initial solutions for demand prediction have been offered by conventional statistical forecasting techniques like Holt-Winters and ARIMA. These methods, however, are mainly intended for time-series data that are comparatively stable, have linear patterns, and have few influencing factors. Because of this, they might not function well in the fast-paced, intricate world of contemporary e-commerce, where a variety of factors affect consumer behavior and sales patterns.

Modern e-commerce datasets are essentially multidimensional, nonlinear, and influenced by a wide range of elements, including product attributes, pricing patterns, consumer opinions, marketing initiatives, seasonal events, and socioeconomic factors. Researchers are looking into machine learning (ML) techniques that can handle complex structured and semi-

structured data because these complexities reduce the predictive accuracy of conventional forecasting models. Regression analysis, ensemble methods, and deep neural networks are examples of machine learning techniques that have demonstrated enhanced forecasting capabilities by incorporating various contextual elements and capturing nonlinear interactions [1, 17, 20]. The methods, data preprocessing strategies, model selection strategies, performance outcomes, and future research directions in ML-driven sales forecasting for e-commerce platforms are all examined in this review article.

### OVERVIEW OF DATASHEET

Both categorical and numerical characteristics that describe product attributes, seller information, marketplace performance metrics, and past sales trends on e-commerce platforms make up the dataset used for sales forecasting in this study [11-13]. With a variety of performance-related and descriptive fields, each entry represents a unique product.

The following are the main variables included in the dataset:

**URL:** A direct link to the online marketplace's product listing.

**ASIN:** Products in the Amazon catalog are uniquely identified by their ASIN, or Amazon Standard

Identification Number.

**Title:** The product's full name as it appears on the platform.

**Brand:** The manufacturer or commercial brand associated with the product.

**Fulfillment Type:** Indicates the inventory management approach, typically categorized as Fulfillment by [16]:

Amazon (FBA)

Merchant (FBM)

**Category & Subcategory:** Listings in the marketplace are arranged according to a hierarchical classification of products.

Products are ranked according to how well they perform in comparison to other products in the same category using a metric called BSR (Best Seller Rank).

**Price & Price Trends:** The product's INR price and its percentage change over a given 90-day period.

**Monthly Sales:** The anticipated monthly average of units sold.

**Sales Trend:** Indicates how a specific ASIN's purchasing patterns have changed recently.

**Monthly Revenue:** Pricing and sales data are used to forecast monthly revenue.

**Review Count & Review Rating:** The average rating that corresponds to the total number of customer reviews.

**Seller & Active Sellers:** The seller's name and the number of sellers vying for the same item.

**Last Year Sales:** The total sales numbers from the preceding year.

**Size Tier:** Product size classification used for storage and transportation.

**Best Sales Period:** The calendar year's month with the highest demand in the past.

**Age (Months):** The total number of months that have passed since the product's first platform listing.

**Total Images:** The total number of images associated with the product listing.

**Variation Count:** The total number of product variations that can be bought.

**Sales-to-Reviews Ratio:** A computed measure that shows how sales volume and customer review activity are related [14, 15].

**Review Count & Review Rating:** The total number of customer reviews and their average rating.

**Seller & Active Sellers:** The merchant's name and the number of sellers vying for the same product.

**Last Year Sales:** The total sales numbers recorded for the year prior.

**Size Tier:** The product size classification used for storage and transportation.

METHEDLOGY

The dataset is gathered from the Amazon platform, which serves as the study's main source of product information. To eliminate noise, fix inconsistencies, and guarantee overall data quality and dependability, the raw data is put through a number of cleaning processes. Following preprocessing, the dataset is subjected to exploratory data analysis (EDA) to find important trends, patterns, and preliminary insights. A visualization dashboard is created to aid in interpretation

and help stakeholders comprehend the analytical findings.

Following this, relevant features and target variables are selected for the forecasting task. These selected attributes are then used to build a machine learning model. The model is trained and validated to assess its performance and its ability to generalize to unseen data. Finally, the validated model is applied to generate sales forecasts for future time periods, as illustrated in Figure 1.

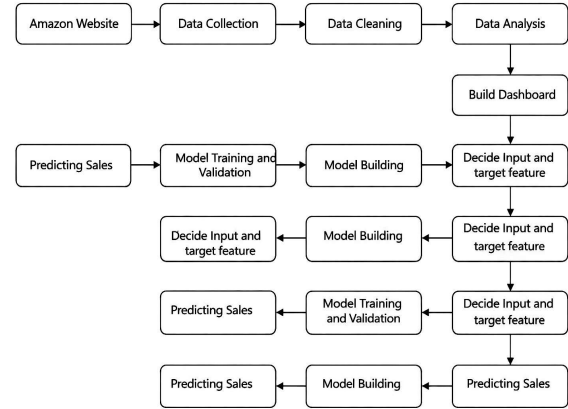


Figure 1 : prediction of Pipeline of market sales  
**Data Collection**

In the starting phase, arranged product data was collected from the platform of Amazon using automatic web scraping techniques [3]. Includes various dataset qualities such as category of product titles, and subcategory information, brand details, pricing data, and other descriptive features. This complete set of variables which available for a strong foundation for conducting exploratory data analysis and developing predictive models [11].

**B. Cleaning Data**

Cleaning data also mentioned to as preprocessing of data is a critical step in the pipeline of ML. In this phase concentrations on errors of identifying and correcting, inconsistencies, and missing values present in the raw dataset to ensure data quality and reliability for additional analysis. The following some preprocessing steps were executed:

**Value of Missing Handling Data:**

Missing records with minor values were detached to maintain data reliability. For necessary data, such as information of brand, missing data were retrieved using product URLs whenever possible.

**Renaming of Column:**

All quality terms were standardized allowing to consistent naming resolutions, improving readability and confirming compatibility with the analysis pipeline.

**Irrelevant Qualities Removal**

Qualities such as height, length, width and capacity of storage were removed, as they were not appropriate to sales prediction and introduce to could unnecessary noise into the model.

**C. Data Analysis of Exploratory**

The starting stage of the Examining Data Analysis (EDA) process which comprises examining the dataset

to uncover key identify patterns, insights and detect any irregularities or unusual data points [1,8]. The main objective of examining data analysis in this study is to understand the relationships between different product qualities and determine which features are most relevant for predicting sales performance.

Now consider the dataset of product information from a inclusive range of online shopping categories, allowing for a complete analysis across different market sectors. The main categories considered in this study include: Car & Motorbike Accessories, Clothing & its Accessories, Beauty product, Electronics product, Home product, Health care product, Scientific and Industrial product, Office Product, Spots and fitness product, Toys and Games are considers.

Examining data across these all categories to helps in identifying trends and understanding customer preferences, and discovering patterns that contribute to accurate sales forecasting.

**Overall Insights:**

**Top-Selling Categories:**

A bar plot showing the top ten categories based on sales see in figure 2 volume revealed that Beauty products had the highest demand, followed by Clothing & Accessories.

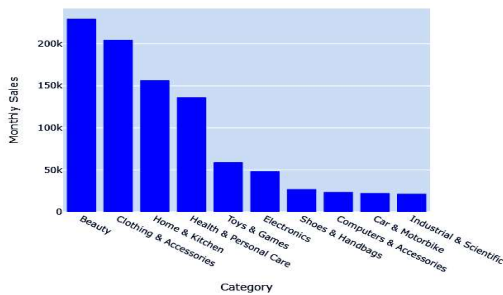


Figure 2 top ten categories by sales

**Top categories for Distribution :**

Illustrate the figure 3 Pie chart depicting the overall distribution.

Figure 3 Pie chart of top categories by sale

**Products of top Selling:**

Illustrate Table I a table describing the highest selling products in each category.

Table I Top Selling Products

Category	Title	Last Year Sale
Beauty	Maybelline New York Matte Lipstick, colour of Intense, Oiled Lips, etc..	307,867
Car & Motorbike	Autofy 100% waterproof RE size bike cover Dustproof UV Protection Bike	31,748
Clothing & Accessories	Miniskirt Cotton, Pants with all over paints for boys and girls (Multi colours)	60,826
Computer	Arche C50, TP link,	35,097

& Accessories	AC1200 Wireless Dual Band cable Router, Wi-Fi Speedup to 867	
Electronics	BoAt Airdopes 121 Pro, TWS Earbuds	83,250
Health & Personal Care	MANGLAM Brimseni Camphor Chunk 50G Jar-Pack of 1	25,901
Home & Kitchen	Wake fit 100% water resistance Premium Cotton Mattress Protection   Hypoallergenic and Breathable	176,618
Industrial & Scientific	3M 110 Ear Plugs Corded, Extra Soft, Reusable Earbuds Noise cancellation	32,501
Musical Instruments	JNKC Mic Lapel Collar Mic Voice Recoding Filter Microphone for Singing	3,759
Office Products	Reynolds AEROSLIM BP 5CT POUCH-BLACK   Ball Point Pen Set with Comfortable	25,849
Shoes & Handbags	DOCTOR EXTRA SOFT Care Diabetics Orthopedic Pregnancy Flat	6,646
Sports, Fitness & Outdoor	Boldfit Heavy Resistance Band for Exercise & Stretching	5,062
Toys & Games	Pikipo Froggy Face Ratrle Soft Toy with Squeeze Handle for Squeaky Sound	55,355
Watches	Fire-Boltt Phonix Pro 139 "Bluetooth Calling Smart watch, AI Voice Assistant	34,578

**Number of Products with Desirable BSR:**

BSR refers to the Best Seller Rank on Amazon and a good rank falls between the range 1-10,000 (see in figure 4).

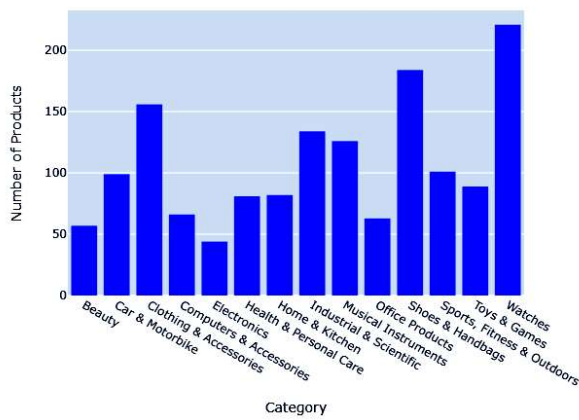
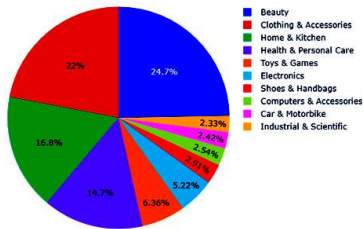


Figure 4 Desirable BSR for Number of product by Category

**Top Brand Selling:**

Illustrate figure 5 Bar chart that shows the Top Selling brands across all the categories. Maybelline is the top



selling brand.

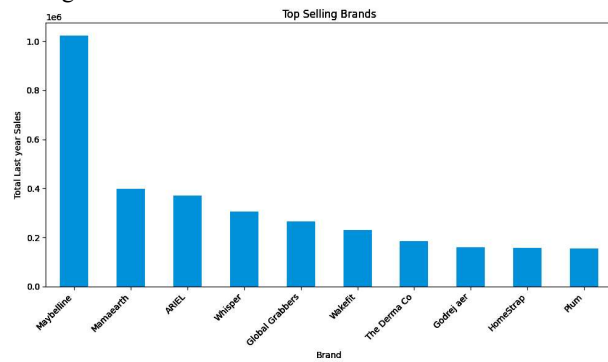


Figure 5 Top brand Selling

**Top Brands Reviewed:**

It shows in figure 6 the brands that have the highest reviews across all categories. boAt has the highest reviews indicating a good engagement with the customers.

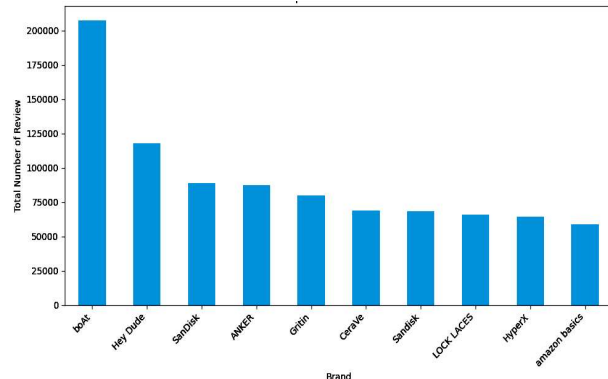


Figure 6 Top Reviewed Brand

**Average last year sales:**

Table II showing the average last year sales for each category

No.	Category	Last Year Sale
1	Beauty	8.43
2	Car & Motorbike	717
3	Clothing & Accessories	4812
4	Computer & Accessories	866
5	Electronics	1541
6	Health care & Personal Care	3786
7	Home   Kitchen	4997
8	Industrial & Technical	489
9	Instruments of Musical	124
10	Workplace Products	610
11	Shoes & Handbags	548
12	Sports, Fitness & Outdoor	253
13	Toys & Games	1685
14	Watches	291

**Best month of Sales:**

Chart describing the month in which the particular category is sold the most (See in Figure 7).

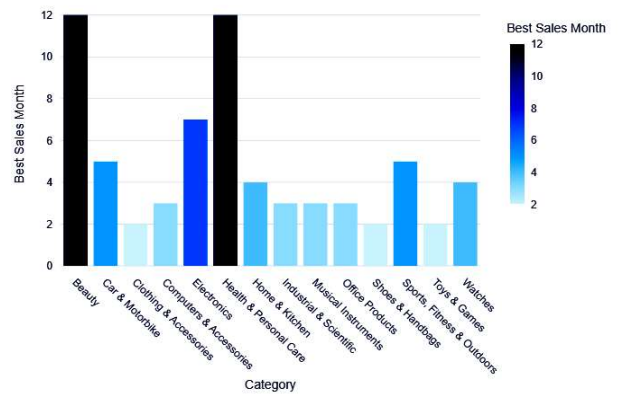


Figure 7 Top month of sales

**Assessments Count:**

Bar chart that shows (figure 8) which categories have the highest number of reviews. Shoes and handbags are the most reviewed products followed by electronics, indicating a better engagement with audience.

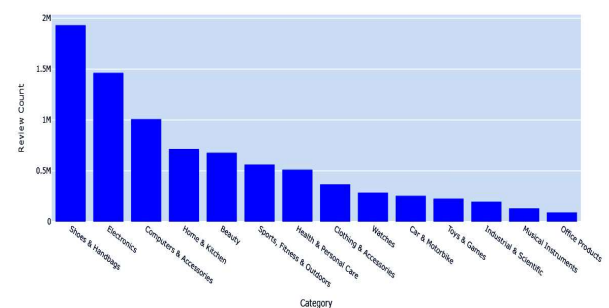


Figure 8 Assessment Count

**Fulfillment type distribution:**

Pie chart see in figure 9 indicating the ratio of Fulfillment type by amazon vs fulfillment by merchant.

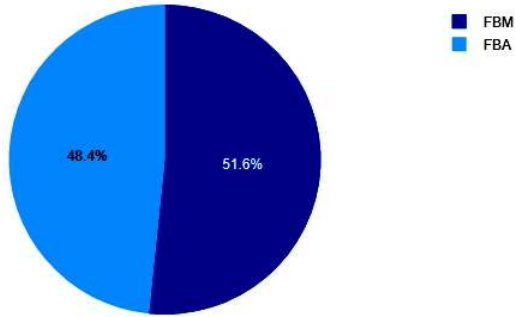


Figure 9 Fulfillment type distributions

**Category wise Analysis:**

Top subcategories by sales: The top 10 subcategories within each category that have the highest sales (see in figure 10)

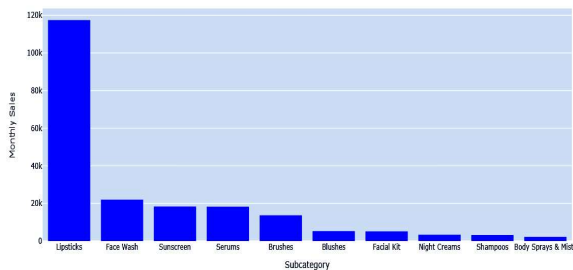


Figure 10 Top subcategories by sales

**Top brands selling:**

Bar chart (see in figure 11) indicating the top selling brands in the particular category.

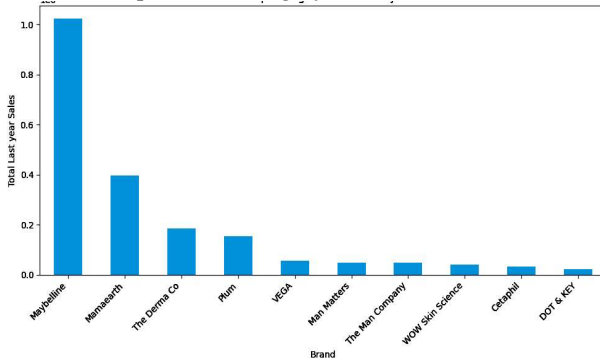


Figure 11 Top Brands Selling

**D. Dashboard Development**

Following this exploratory data analysis, an interactive dashboard has been developed using the Streamlit framework for effectively presenting various types of visualizations in a grouped manner and providing detailed insights [2]. This dashboard is a unified interface in which various charts, vital data, and performance indicators are presented in a systematic and understandable manner.

**E Building Model**

For the purpose of predicting market sales, the relevant variable has been identified as monthly sales, which is a continuous numerical data type. Hence, the problem has been defined in terms of a regression problem. Several models have been used for expect different patterns in

the data, with Linear Regression [24], Random Forest Regressor [5], and XGBoost Regressor [4].

**Linear Regression:**

Linear regression is one of the simplest and most widely used data analysis techniques for determining the relationship between a dependent variable and one or more independent variables. It assumes a linear relationship, where changes in the independent variable(s) lead to proportional changes in the dependent variable. This method is particularly useful for understanding trends and making basic predictions when the data follows a linear pattern.

**Random Forest Regression:**

Random Forest Regression is an ensemble learning technique that builds multiple decision trees using random subsets of the data and selected features. Each tree makes its own prediction, and the final output is obtained by averaging the predictions of all trees. This method helps to improve correctness and decreases the risk of over fitting and making it more healthy compared to individual decision tree models.

**XGBoost Regression:**

Here XGBoost short for Exciting Gradient Boosting, is an progressive ensemble learning algorithm that constructs models in a successive manner. In this method, all new model is trained to precise the errors made by the earlier ones, leading to incessant improvement in prediction performance. It improves an objective purpose using gradient succession techniques, which helps in reaching high accuracy and efficiency.

**F. Model Validation and Training**

During the training phase, the dataset was divided into training and testing sets using an 80:20 split, as required [20]. Categorical variables were transformed using label encoding, and additional preprocessing steps, such as feature scaling, were applied to ensure the data was suitable for model training. After training the model, its performance was evaluated on the testing dataset to measure the accuracy and effectiveness of the predictions.

**G. Model Prediction**

In the prediction phase, user data like product name and category were used to predict future sales, as done in the literature [8, 21]. Cosine similarity was used to compare the attributes of the product, after which predictions of monthly sales were made by the model for the selected product.

**RESULT AND DISCUSSION**

By collecting sales data for a certain period, it will show figure 12 trends such as seasonality or certain months where sales normally peak for certain kinds of products. For example, some products might have more demand during festive periods, while others might become more popular during certain climatic conditions or during certain festivities [17].

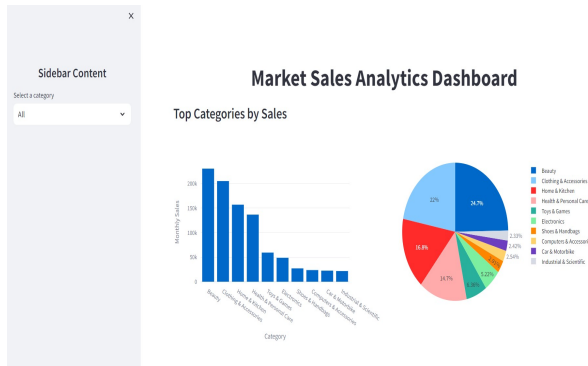


Figure 12 Sales Dashboard for all categories



Figure 13 Sales Dashboard for all Beauty

By knowing the peak sales month for each category, businesses can improve their inventory and marketing strategies [25] as seen in figure 13. They can use this information to better utilize their resources and design marketing campaigns, and even change their pricing strategies to take advantage of peak demand.

Beauty products and Health & Personal Care experience their highest sales in December, as the need for healthcare and beauty products increases during the winters shown in table III. In contrast, Car and Motorbike sales are higher in the summer, especially in May, as it is the time of the year when people usually go for their vacations.

Table III R<sup>2</sup> and MAE values presented below indicate that the table offers a satisfactory fit to the data.

Model	R <sup>2</sup>	Mean Absolute Error
XGBoost Regression	0.8655692	25.0474
Random Forest Regression	0.899869	27.0711
Linear Regression	0.768033	104.96847

CONCLUSION

In conclusion, based on the sales pattern over time, it can be seen that there are different peak sales months for different categories of products. For example, beauty and health products have peak sales in December, while car and motorbike sales peak in May, which corresponds to the summer vacation period.

By sales trends analysis, businesses can optimize their strategies to increase overall performance and also

increase revenue. Among the models applied, XGBoost performed the best performance in forecasting market sales and also making it the most effective approach for accurate predictions.

FUTURE SCOPE

In upcoming work, I applied to enhance the model by combining additional data sources like competitor pricing and social media trends which can help a more comprehensive understanding of dynamics market. By behavior of leveraging customer data, the method can also be extended to generate personalized product recommendations, improved leading customer satisfaction and increased sales. Also, automatic generation report can be combined to study to the brand performance and also more efficiently and support data-driven decision making. The acceptance of progressive techniques such as neural networks, DL (deep learning) and reinforcement learning is also expected to improve estimate accuracy and enable more robust and scalable sales forecasting models.

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